Tax Revenue Sensitivity and Bond Valuation

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Abstract

How are municipal bond yield spreads exposed to property market value changes through the property tax channel? I examine the sensitivity of property tax revenue growth with respect to property market value growth for each local government. The sensitivity is estimated to be 0.43% on average, with variations observed across cities, counties, and school districts. The variation in sensitivity is driven by a local government's choice in property assessment values, tax rates, and tax exemptions. I further show that a large sensitivity increases municipal bond yield spreads by 23 basis points, referred to as the sensitivity premium. The sensitivity premium is pronounced at the bad state of the world, where property market values decline. Furthermore, municipal bond yield spreads are higher when cities, counties, and school districts face binding frictions such as a statewide cap on the growth of assessment values and infrequent reassessments.

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1 Introduction

In July 2025, heavy flooding along the Guadalupe River led to an estimated \$240 million loss in property assessment values in Kerr County.[1] To support the recovery, the county's Tax Assessor-Collector authorized an 8% emergency cap on increasing property taxes, far exceeding the county's normal 3.5% cap.[2] This authorization means that Kerr County considers increasing property taxes for unaffected properties in the next fiscal year to pay for flood recovery.[3] Similarly, in response to the widespread destruction from Hurricanes Helene and Milton in September 2024, cities along Florida's Gulf Coast raised property tax bills in the following fiscal year to fund recovery. Tampa, in particular, saw the steepest rise in property tax bills, with an average increase of 23% after the hurricanes, which is more than twice the national average over the same period.[4]

These examples highlight a fiscal vulnerability: local governments can fall into deficit just as spending needs explode, forcing them to rely on higher taxes, increased borrowing, and federal transfers. Since property taxes are the largest own-source revenue for local governments, they directly affect the \$4 trillion U.S. municipal bond market.[5] Municipal bonds are not risk-free despite their reputation for safety, as shown in the municipal-Treasury spread in Figure 1.[6] Indeed, a growing body of literature examines risk premia in municipal bonds (e.g., Babina et al., 2021; Cornaggia et al., 2022; Gao et al., 2019a), with an emphasis on default risk (Schwert, 2017) and the volatility of

[1] The \$240 million loss is estiamted by the Kerr Central Appraisal District and announced by the Kerr Coutny Judge. https://www.tpr.org/environment/2025-07-17/kerr-county-considers-property-tax-hike-to-pay-for-flood-repa

[2] In a declared disaster like Kerr County's flood, Texas Tax Code §26.042 allows local governments to temporarily increase the cap to 8% above the no-new-revenue rate.

[3] The county considers increasing own-source revenue despite the Federal transfers. The county judge warned that reimbursements of federal transfers could take three years to arrive.

[4] Over a five-year period, median property tax bills in Tampa and Jacksonville rose by nearly 60%, reflecting storm-driven costs and mounting revenue needs.

[5] Property taxes account for average 30% of tax revenue of local governments each year (U.S. Census Bureau, 2023).

[6] In this figure, the municipal-Treasury spread is calculated as the tax-adjusted nominal yield from Schwert (2017) minus the maturity-matched Treasury yield curve from Liu and Wu (2021). As discussed further in Section 2, the sample includes general obligation municipal bonds issued by 1,457 counties and 6,108 cities from 2000 to 2022. Thanks to the authors of Liu and Wu (2021) for publicly sharing their Treasury yield data.

future cash flows (Goldsmith-Pinkham et al., 2023).

But a fundamental question remains unanswered in the literature: How are municipal bond yield spreads exposed to property market value changes through the property tax channel? Property taxes are levied by applying the mill rate (i.e., the tax rate per $1,000 of assessment value) to the assessment value of a property, net of applicable exemptions. To study this question, I examine the sensitivity of property tax revenue growth with respect to property market value growth for each local government, herein after referred to as the "*sensitivity*". Using GMM, I simultaneously examine how the local government's sensitivity affects municipal bond yield spreads.

Two competing channels are at work here. On one hand, a large sensitivity indicates greater volatility in underlying asset values, which increases the municipal bond yield spreads. On the other hand, local governments with large sensitivity may have greater capacity to increase property tax revenue, in contrast to those that do not respond at all (i.e., show zero sensitivity) to property market value changes. Under this argument, a large sensitivity shows lower yield spreads. This study supports the first argument, finding large sensitivity and high yield spreads, by examining the drivers of sensitivities and effects of sensitivities on yield spreads.

On average, I find that the sensitivity is estimated as 0.43%, which implies that a 1% change in property market value growth is associated with 0.43% change in property tax revenue growth. Cities, counties, and school districts show heterogeneous capacities in raising property taxes in economic upturns and protecting property tax revenue from falling in economic downturns. Figure 2 presents a U.S. map of estimated local government sensitivities—ranging from 0.01% to 2.06%—highlighting dispersion both within and across states. I find that the 85% of local government-variations of the sensitivity are explained by the local government's choice in property assessment values, mill rates, and tax exemptions.

Importantly, local governments with large (small) sensitivity show high (low) municipal bond yield spreads, herein after referred to as the "*sensitivity premium*". When a local government runs deficits and issues municipal bonds, the increased supply leads a representative investor to require higher yields (or equivalently, lower prices). The GMM estimation shows that on average, a large sensitivity is associated with an increase in 23 bps of municipal bond yield spreads.[7] This effect is economically substantial, comparable to a downgrade in credit rating of a local government from AAA to BBB. It is equivalent to \$16.4 billion reduction in a bondholder's wealth in the secondary market.[8] The magnitude of this risk premium is bigger than that of major economic risks identified in prior research, highlighting the importance of sensitivity.[9]

I uncover asymmetric effects of increases and decreases in property market values on municipal bond yield spreads. The sensitivity premium is pronounced in economic downturns. The sensitivity premium arises from cities and counties that cannot protect property tax revenue from falling in a bad state of the world. In a bad state, a 1% decline in property market value growth results in a 0.32% reduction in property tax revenue growth. Here, municipal bond yield spreads increase by 37 bps. Conversely, in a good state of the world, the sensitivity is estimated as 0.40% and commands a minimal risk premium. A 1% increase in property market value growth results in a 0.4% increase in property tax revenue growth, which has little effect on municipal bond yield spreads.

This paper documents two frictions that constrain the translation of property market value growth into property tax revenue. First, thirteen U.S. states impose legislative limits on the percentage of increasing assessment values. For example, California's well-known proposition 13 limits the increase of assessment value no greater than 2%

[7]As it will further be elaborated in Section 3, the estimation controls for year fixed effect, economic conditions of issuers (i.e. personal income, employment, and local GDP), and characteristics and risks of municipal bonds (i.e. maturity, trading volume, and credit rating)

[8]As in Chava et al. (2024), I calculate this as follows: The outstanding municipal debt was \$600 billions on average. The average duration of bonds was 12 years. The average yield spread was 143. Therefore, the yield spread increase of 23 bps on a semi-annual basis after three years is \$16.4 billion ($=\$600 \times 12 \times \frac{0.0023}{1+\frac{0.0143}{2}}$).

[9]Prior studies attribute increases in municipal bond yields to various localized risks—for example, a 20 basis point increase due to the remote delivery of healthcare (Cornaggia et al., 2024b), a 16 basis point increase from climate risk (Painter, 2020), and a 13 basis point increase following the discovery of contamination from per- and polyfluoroalkyl substances (Huang and Kumar, 2021).

each year unless a change in ownership or new construction occurs. Each state has a different cap, as listed in the Appendix Table A.6. When these limits are binding, cities and counties cannot increase property tax revenue in economic downturns. These cities and counties show high municipal bond yield spreads.

Second, lagged property reassessments lead to a declining accuracy over time. Despite initial precision, assessment values gradually become outdated, creating a widening gap between assessment and market values, until the municipality brings in fresh new information. 39 states mandate the comprehensive reassessment every one to ten years, as listed in the Appendix Table A.7. I find significantly higher sensitivity premium when cities and counties do not conduct comprehensive reassessments. Here, I focus on cities and counties where property market values increased relative to the prior year. Then, reassessment lags prevent property tax revenue from incorporating rising property market values. As a result, investors demand higher yield spreads. The effect intensifies with each additional year between reassessments.

Take, for example, Philadelphia and Dallas. Philadelphia demonstrates an inefficient translation of property market value growth into property tax revenue. The city failed to incorporate rising property market values in tax revenue because it had not conducted a single comprehensive reassessment for forty years (Hou et al., 2023).[10] The city also offered higher property tax exemptions than the national average from 2014. Conversely, Dallas updated assessment values annually and increased the assessment value when property market values increased. Consequently, the municipal bond yield spreads in Philadelphia are higher than the national average, while Dallas's are lower. Local governments face binding frictions, such as a lag in reassessment of properties, when translating property market values into property tax revenue.

Default risk in municipal bonds is shaped not only by tax revenue but also by two other key factors: local government spending and federal transfers. When natural disasters strike, spending rises as governments fund emergency services and infrastructure

[10] According to Hou et al. (2023), Philadelphia did not conduct a single comprehensive reassessment from the 1980s to 2012, and only relied on reassessments upon transactions.

repairs. Even in less severe conditions, spending increases for needs such as public health, housing assistance, and infrastructure maintenance. When local governments run deficits (i.e. spending is higher than revenue), it prompts investors to demand higher yields as compensation for default risk. Federal transfers help mute the sensitivity premium. For example, the U.S. Department of Transportation's Emergency Relief program reimburses local governments for post-disaster repairs. Federal transfers following Hurricanes Helene and Milton in 2024 included over $1.1 billion in public funding for debris removal and emergency response. In my study, I find that the sensitivity premium is larger for local governments that receive low Federal transfers.

The concern is that property market values are endogenous to other factors, such as residents' personal income, that directly affect municipal bond yield spreads. To rule out this concern, I employ housing supply elasticity proposed by Saiz (2010), Guren et al. (2021), and Baum-Snow and Han (2024) as an instrument variable (IV) for property value growth, following prior studies (e.g., Chetty et al. (2017), Corradin and Popov (2015), Couture et al. (2024)). Namely, I use an instrument based on the interaction between the national U.S. house price growth and local housing supply elasticity, by using the empirical fact that municipalities with higher supply elasticity are less exposed to national house price fluctuations. I simultaneously estimate the IV within a GMM framework and find that municipalities with higher sensitivity cause an increase in municipal bond yield spreads. The sensitivity effects are robust across different measures of housing supply elasticity.[11]

Accordingly, I am careful to verify that the sensitivity premium is not simply a manifestation of risks that have already been documented by the literature. I show that the sensitivity premium is stable across extensive controls, including local GDP growth, personal income growth, employment growth, credit ratings (Adelino et al.,

[11] While Saiz (2010)'s supply elasticity has been longstanding in the literature, several studies show that this measure remains remains correlated with city characteristics. Guren et al. (2021) suggest an alternative approach to measure supply elasticity using residual variations of house prices. Baum-Snow and Han (2024) extend Saiz (2010)'s housing supply elasticity by estimating supply elasticities at a much more granular, neighborhood level rather than at the MSA level as Saiz (2010) did. These IVs are further elaborated in Section 3.

2017), liquidity risk (Kidwell and Trzcinka, 1982), climate risk (Painter, 2020), local firm's exposure to political risk (Hassan et al., 2019), migration risk (Gustafson et al., 2023), sales and income tax revenue of local governments, intergovernmental transfers, and volatility and dispersion of property prices. I further show that the sensitivity premium is not explained by regressive taxation of properties (Berry, 2021), co-parties between state governor and the president, and income tax-induced market segmentation (Babina et al., 2021).

This paper contributes to the literature by studying how the sensitivities in generating local governments' revenue command risk premia in the municipal bond market. This paper identifies distinct mechanisms through which sensitivities shape bond valuation. First, the degree to which local governments choose the sensitivity depends on local policies on assessments, tax rates, and tax exemptions subject to the statewide regulations. Second, the high sensitivity in economic downturns raises concerns about the sustainability of municipal debt. The increase in yield spreads is large, which emphasizes the role of sensitivity for local governments. Collectively, these findings highlight the complexity of the property tax transmission mechanism and the importance of isolating the role of each channel in shaping bond valuations.

A closely related study, Goldsmith-Pinkham et al. (2023), shows that local exposure to the sea-level rise is priced in municipal bonds after controlling for house prices. They implicitly assume that property market value growth is linear with the property tax revenue growth. The difference with my study is that I focus on the gap between house price growth and property tax revenue growth, and further show that the gap is dispersed across local governments. The sensitivity of property tax revenue growth with respect to property market value growth is heterogeneous across cities, counties, and districts even for those with similar house prices. The sensitivity is explained by a local government's choice in assessment value, mill rate, property tax exemption subject to statewide regulations. There are heterogeneous statewide regulations on assessment growth caps and reassessment frequencies. In the presence of these regulations, I examine how municipal bonds are exposed to property market value changes through the property taxes.

The remainder of the paper is as follows. Following the literature review, Section 2 describes the data sources and sample construction. Section 3 outlines GMM estimation. Section 4 shows empirical results and rules out alternative explanation. Section 5 shows the sources of sensitivity. Section 6 concludes.

1.1 Literature Review.

First, my work connects to a literature on pricing municipal bonds with economic risks. Prior studies show that municipal bond yields are explained by credit ratings (Cornaggia et al., 2018), default risk (Poterba and Rueben, 2001; Schwert, 2017), bankruptcy risk (Gao et al., 2019a), climate and environmental risks (Acharya et al., 2022; Auh et al., 2022; Cornaggia and Iliev, 2023; Goldsmith-Pinkham et al., 2023; Huang and Kumar, 2021; Painter, 2020), migration risk (Cornaggia et al., 2024a; Gustafson et al., 2023), political risk (Chava et al., 2024; Gao et al., 2019b), data breaches (Curti et al., 2023), income tax exemption (Babina et al., 2021; Fleckenstein and Longstaff, 2023; Longstaff, 2011; Poterba and Verdugo, 2011), and liquidity risk (Ang et al., 2014; Kidwell and Trzcinka, 1982). Here, my paper highlights the previously unexplored risk in the municipal bond literature, namely how the yield spreads are exposed to property market value changes through the property tax channel.

An important reference in my study, Schwert (2017) shows that default risk is the major source of risk in municipal bonds. Unexpected fiscal deficits of local governments increase municipal bond yields (Poterba and Rueben, 2001), where the states with tighter anti-deficit rules show lower yields (Poterba et al., 2010). While I exploit a default risk channel to explain the main results, I further study the fundamental drivers of the default risk, particularly focusing on property taxes and how those property taxes are generated based on economic conditions of municipalities and constrained by political and institutional factors.

Several studies focus on property taxation of specific regions such as Massachusetts' Proposition $2\frac{1}{2}$ (Bradbury et al., 2001), Texas (Benson and Marks, 2010; Plummer and Pavur, 2009), and Illinois (Dye and McGuire, 1997; Dye et al., 2005). These studies do not examine municipal bonds, risk premium, and asset prices. Notably, a municipal bond is a fragmented market, with heterogeneous regulations across states. To avoid potential biases from focusing on a single U.S. state, I provide a more generalizable analysis by studying all fifty states.

Lastly, my study relates to a rapidly growing literature that examines a gap between assessment and market values of properties. Studies in the literature emphasize inequality in assessment, such as regressive taxation, which means that properties in wealthier (poorer) neighborhoods are under (over)-assessed (Berry, 2021; McMillen and Singh, 2023). Studies document how assessment gaps are formed based on household wealth gaps (Amornsiripanitch, 2020), racial disparities (Avenancio-León and Howard, 2022b), political partisanship (Kalda et al., 2024), appeal behaviors (Weber and McMillen, 2010), and assessor's home bias (Cohen and Chen, 2024). Some studies find that municipal equity improves after a mandatory comprehensive reassessment of properties (Berry, January 7, 2021; Hou et al., 2023).

These studies focus on the mechanism behind the discrepancy between assessment values and market values of properties. In contrast, my study examines these gaps as key determinants that explain the cross-sectional variation in local governments' sensitivity. There is yet a gap in the literature on how the sensitivity is priced in local assets, specifically on the municipal bond market. I emphasize the role of heterogeneous sensitivities and how the sensitivities command risk premia on municipal bond yield spreads.

2 Data and Measurement

2.1 Sample Construction

The hypothesis is that local governments with large (small) sensitivity of property tax revenue growth with respect to property market value growth generate high (low) municipal bond yield spreads. I use data on prices in residential homes from the Zillow Home Value Index (ZHVI) for each city and county. Commercial and industrial properties show different assessment practices from the residential properties, therefore the commercial and industrial properties are excluded from the sample. For local government's tax revenue, I use data from the Census Bureau's Annual Survey of State and Local Government Finances, which provides dollar amount on debt, spending, and revenue, including property taxes and intergovernmental transfers. This dataset is presented for each state and local government, such as states, cities, counties, and school districts.[12]

On the municipal bond side, Municipal Securities Rulemaking Board (MSRB) requires dealers to report all municipal bond transactions since 1998. I obtain prices and yields of transaction-level data from MSRB and merge this dataset with Bloomberg using CUSIP and transaction date. Bloomberg provides information on whether the bond is a general obligation (GO) bond or revenue bond, whether it is callable or not, and insured or not. The data provides information on the amount of issuance and transaction, its status on income tax exemption, and whether it has fixed or variable coupon. MSRB provides data on date and time of trade, maturity, and coupon rate of the transaction-level municipal bonds. Bloomberg contains the issuer's name, type (i.e. city, county, state), and state code, which are used to merge the bond-level data with the issuer-level property prices from Zillow ZHVI and property tax revenue from the Census. I identify school district bonds by following Goldsmith-Pinkham et al. (2023), first matching issuer names with school district names, then using keywords such as

[12] Thanks to the authors in Pierson et al. (2015) for releasing the data at their website: https://my.willamette.edu/site/mba/public-datasets.

"vocational," "technical," and "elementary," including their abbreviations, and finally hand-matching any remaining issuers.

To focus on property tax revenue and its direct effects, I use GO municipal bonds and school district bonds to test my hypothesis. School district bonds are backed by property taxes; their cash flows are directly tied to property tax revenues and are subject to school district mill rates, which differ from those applied to residential real estate. In contrast, revenue bonds are less exposed to property taxes of local governments. Revenue bonds are constrained by the objective of the project (e.g., utilities and sewage systems, payment toll from highways). Taking all these together, I show that the sensitivity effects are strong in bonds that are directly tied to property taxes, such as GO bonds and school district bonds, and weaker in revenue bonds, further corroborating the sensitivity effects of property taxes on municipal bonds.

I use Corelogic TaxDeeds data to obtain property-level assessment value of residential properties. The data contains information on property type, assessment year and values, and property address including zip code, county, city, and states, which I join with the data on issuer-level property tax revenue and market values. The TaxDeeds data also provide information on property tax exemption, including the total exemption amount for each property, and dummy indicator for homestead exemption. I obtain the headline mill rate for each county and city, provided by the local government from Lincoln Land Institute of Policy.[13] The Lincoln Land Institute of Policy provides data on local government policies on property taxes, further including assessment caps, mandatory reassessment cycles, and mill rate caps. The details in the data cleaning are provided in Appendix A. In brief, I follow influential approaches in prior studies to address data outliers—specifically, Curti et al. (2023), Fleckenstein and Longstaff (2023), and Schwert (2017) for municipal bonds, and Avenancio-León and Howard (2022b), Bernstein et al. (2019) for tax assessments, and Gustafson et al. (2023) for property tax revenue.

[13] https://www.lincolninst.edu/data/significant-features-property-tax/access-databasebase

2.2 Municipal Bond Yield Spreads.

Municipal bond investors benefit from income tax exemptions on the earnings of bonds issued within their state of residence.[14] The investors tend to be local residents, who benefit from these income tax exemptions. The income tax exemption induces market fragmentation on municipal bonds, which results in limited risk sharing across U.S. states (Babina et al., 2021), low borrowing costs (Garrett et al., 2023), and low yields for states with high income tax exemption (Fleckenstein and Longstaff, 2023). To account for the market fragmentation, I follow Schwert (2017) and adjust municipal bond yields with top income tax rates. I then subtract the maturity-matched risk-free rate, using Liu and Wu (2021)'s constant maturity zero-coupon yield curve for US Treasuries.

$$R^e_{it} = \sum_b w_{ibt} \left(\frac{\text{yield}_{bt}}{(1-\tau^{\text{fed}}_t)(1-\tau^{\text{state}}_{s,t})} - r^f_t \right), \tag{1}$$

A local government i's yield spread, R^e_{it}, is the value-weighted average of yield spreads of municipal bonds b, where w_{ibt} denotes the volume weight of transactions in dollar terms. r^f_t is maturity-matched risk-free rate, using Liu and Wu (2021)'s constant maturity zero-coupon yield curve for US Treasuries.[15] The main dependent variable in my study, the municipal bond yield spread, is measured with equation (1), following many prior studies (e.g., Cornaggia et al., 2024b; Curti et al., 2023; Gustafson et al., 2023; Schwert, 2017), to isolate yields from the effect of income tax exemption. I divide the nominal yield by $(1-\tau^{\text{fed}}_t)(1-\tau^{\text{state}}_{s,t})$, where τ^{fed}_t is the top federal income tax rate and $\tau^{\text{state}}_{s,t}$ is the top income tax rate in state s in year t.[16] In robustness checks, I confirm the results using alternative measures of yield spreads, including yield spreads

[14] There are four states that do not provide income tax exemption i.e. IL, OK, WI, and IA. In these states, the tax-adjusted yield spreads are larger since the investors do not benefit from income tax exemption.

[15] The strength of Liu and Wu (2021)'s Treasury yield curve is that it is weighted by duration of bonds, which would avoid valuation windfalls especially for long-term bonds, as van Binsbergen et al. (2023) suggest. Thanks to the authors for releasing the data at their website https://sites.google.com/view/jingcynthiawu/yield-data.

[16] Federal and state income tax rates are collected from Tax Foundation.

with different maturities.

Descriptive statistics. The final sample includes municipal bonds issued by 1457 counties, 6108 cities, and 2226 school districts in the U.S. from 2000 to 2022. The observations include 3,133,784 trades in 41,234 GO bonds and 612,009 trades in 68,001 school district bonds. As in Schwert (2017), I exclude nine states that prohibit or limit GO bond issuance by law: Colorado, Idaho, Indiana, Iowa, North Dakota, Nebraska, South Dakota, West Virginia, and Wyoming.[17] I further exclude Alaska because the majority of municipalities in Alaska do not have property tax revenue.[18]

Table 1 presents descriptive statistics on municipal bonds and income tax rates. The main dependent variable R^e_{it}, tax-adjusted yield spread as estimated in equation (1), shows an average of 1.43%. These values correspond well with prior studies.[19] The yield spreads are time-varying from 2000 to 2022, as shown in Figure 1, but stay positive across all time. Although the yield spread peaks to 3.97% during the Global Financial Crisis, which likely reflects a flight to quality, I confirm that the main results are strong even when excluding the crises, indicating that the crisis and flight to quality are not the sole drivers of the observed risk premium.

Municipal bond yields vary across maturities, as illustrated by the term structure in Figure A.4 estimated using Diebold and Li (2006)'s reformulation of Nelson and Siegel (1987)'s term structure. The Appendix Table A.1 shows the average yields for bonds issued by counties and cities in each U.S. state with maturities ranging from 1 to 30 years. Using this variation, I find that the sensitivity premium is significant at all maturities, but especially pronounced for long-term bonds. Following prior studies (e.g.,

[17]As Schwert (2017) mentions, state constitutions in Colorado, Indiana, Nebraska, and North Dakota prohibit GO debt issuance. While Idaho, Iowa, and Wyoming permit GO bonds with voter approval, none currently have any outstanding. Arizona imposes a constitutional cap of $350,000 on GO issuance. Kansas and Kentucky allow limited GO debt but Kansas has not issued any in decades, and Kentucky has not done so since 1966. South Dakota also imposes constitutional limits on indebtedness and has no GO debt outstanding.

[18]https://www.commerce.alaska.gov/web/dcra/officeofthestateassessor/alaskataxfacts.aspx

[19]In my study, the average tax-adjusted yield is 4.79% from 2000 to 2022, which is similar with the same variable that shows an average of 4.32% from 1998 to 2015 reported in Schwert (2017). The average tax-adjusted yield spread is 1.43% from 2000 to 2022 in my study. This descriptive statistic is similar with that in Fleckenstein and Longstaff (2023), where the state-issued municipal bond yield spreads show an average of approximately 1.4% in 14 states.

Gustafson et al. (2023); Goldsmith-Pinkham et al. (2023)), I interpret the long-term effects as evidence that the sensitivity premium is not driven by short-term rollover risks, but by fundamental risks in local governments' ability to generate property tax revenue.[20]

Furthermore, as presented in Panel B of Table 1, the top income tax rate was in California with 13.30%, whereas nine states (e.g., Washington, Texas) do not have state income tax rates. The top federal income tax rate was 39.60% from 2013 to 2017, while the minimum was 35% from 2003 to 2012. As shown in Panel C of Table 1, the main explanatory variable, the estimated sensitivity of property tax revenue growth with respect to property market value growth ranges from 0.01% to 2.06%, with an average of 0.551% and a standard deviation of 0.591. Figure 3 plots the distribution of local government's sensitivity. Most sensitivities are between 0 and 1, and they are positively skewed.

Lastly, property tax revenue had increased around twice over the past 20 years, as shown in the Appendix Figure A.3, whereas the growth is heterogeneous across local governments. The average share of property tax revenue in total tax revenue is 31% and the distribution is positively skewed, ranging from 2% to 85%, as shown in the Appendix Figure A.2. Local governments with low reliance on property tax tend to depend heavily on intergovernmental transfers from both state and federal governments. Taken together, I find that the sensitivity effects are larger for local governments that rely more on property taxes.

3 GMM Estimation

This study examines the local government's sensitivity of property tax revenue growth with respect to property market value growth, and how the sensitivity affects municipal bond yield spreads. Here, a concern is that the property market value growth is

[20] Gustafson et al. (2023) study migration risk and Goldsmith-Pinkham et al. (2023) study sea-level rise exposure, whereas in both studies, they establish that the risk premia on municipal bonds are larger for long-term maturity municipal bonds.

endogenous to other factors that directly affect municipal bond yield spreads. While I use income tax-adjusted yield spreads as stated in equation (1), I further use an exogenous variation from the interaction between a local supply elasticity and national price fluctuation. The estimation is following:

$$\Delta X_{it} = \phi \left(\Delta P_t^{\text{national}} \times \text{supply elasticity}_i \right) + \nu_{it} \tag{2}$$

for a local government i in year t. Following prior studies (e.g., Chetty et al. (2017), Corradin and Popov (2015), Couture et al. (2024)), I use an instrument based on the interaction between national U.S. house price growth ($\Delta P_t^{\text{national}}$) and local housing supply elasticity. The approach is that, local house prices in municipalities with high supply elasticity will show lower exposure to national average housing price fluctuations.

The housing supply elasticity is measured with three sets of empirical data from Saiz (2010), Guren et al. (2021), and Baum-Snow and Han (2024). While Saiz (2010)'s supply elasticity has been longstanding in the literature, several studies show that this measure remains correlated with city characteristics. Saiz (2010)'s measure is based on topological features of geographies, such as water, steep-train, and mountains. These features might be correlated with city characteristics, such as the city's industrial composition, exposure to economic cycles, and local housing demand relative to the coastal areas. To address this concern, Guren et al. (2021) suggest an alternative approach to measure supply elasticity using residual variations of house prices. They first estimate the historical elasticity of local house prices to regional housing cycles and then interact these historical elasticity estimates with today's shock to regional house prices.

Furthermore, Baum-Snow and Han (2024) extend Saiz (2010)'s housing supply elasticity by estimating supply elasticities at a much more granular, neighborhood level rather than at the MSA level as Saiz (2010) did. They provide supply elasticity across about 50,000 census tracts in 300 U.S. metropolitan areas, decomposing the supply response into its constituent parts such as land development and housing units. They reveal substantial variation within MSAs. Taking all these together, I use Saiz (2010)'s and Guren et al. (2021)'s measures and Baum-Snow and Han (2024)'s supply elasticity on housing units and new development as the IV in equation (2) and find robust results with the sensitivity and its price of risk.

Importantly, the sensitivity of property tax revenue growth with respect to property market value growth can be written as the following equation:

$$\Delta T_{it}^P = \gamma_i \Delta X_{it} + \phi_i C_{it} + \epsilon_{it} \tag{3}$$

Equation (3) specifies the sensitivity γ_i of property tax revenue growth (ΔT_{it}^P) with respect to property market value growth (ΔX_{it}) for a local government i in year t. ΔT_{it}^P is the log annual growth of property tax revenue (T_{it}^P). ΔX_{it} is the log annual growth of property market values (X_{it}), using county- and city-level home values from Zillow ZHVI. C_{it} is a set of controls on economic conditions of local governments, such as personal income growth, employment growth, and local GDP growth, political risk, climate risk, migration risk, volatility and cross-sectional dispersion of property prices, and year fixed effect. These risks are controlled, following the prior literature, to rule out alternative explanations suggesting that risk premium is induced by these other risks.

Lastly, the sensitivity γ_i affects the municipal bond yield spreads of a local government, as following:

$$R_{it}^e = \lambda \gamma_i + \eta_i Z_{it} + u_{it} \tag{4}$$

R_{it}^e is value-weighted average of municipal bond yield spreads of a local government each year, measured as in equation (1). Following the literature (e.g., Goldsmith-Pinkham et al. (2023)), I control for year fixed effect, and municipal bond characteristics in Z_{it}, such as the remaining time to maturity, the years passed since issuance, the trading volume relative to outstanding amount, credit rating, and the bond-month standard deviation of transaction prices. I also control for risks related to municipal bonds, such as credit ratings, liquidity risk, and Moody's Recalibration.

I simultaneously estimate equations (2) , (3), and (4) using Hansen (1982)'s GMM in the spirit of Fama and MacBeth (1973), where $\theta = [\gamma_i, \lambda, \phi]$ is a set of parameters. There are three hypothesis on the parameters. First, ϕ should be negative, since municipalities with high supply elasticity are expected to be less sensitive to national average price fluctuations. Second, the sensitivity γ_i is smaller than 1 on average, but shows cross-sectional variation across local governments. Statistically, this cross-sectional variation allows me to investigate its distinct effects on local yield spreads across local governments. Economically—and more importantly—these estimates show that local governments that do not minimize sensitivity during an economic downturn show higher municipal bond yield spreads. Thus, the third hypothesis is that the price of risk λ is positive and large, which implies that a large sensitivity is associated with an increase in municipal bond yield spreads.

The GMM estimator is based on a set of moment conditions. These conditions require that changes in municipal bond yield spreads are uncorrelated with exogenous variation in municipalities' exposure to national house price shocks, as interacted with local housing supply elasticity. Formally, the set of moment conditions is:

$$g_t = \mathbb{E}_T \begin{bmatrix} \epsilon_{it} \\ I_{it} \times \epsilon_{it} \\ u_{it} \end{bmatrix} = 0 \tag{5}$$

where $\mathbb{E}_T$ is the sample average operator, $I_{it} := \Delta P_t^{\text{national}} \times \text{supply elasticity}_i$ is the instrument for the property market value growth. ϵ_{it} is the residual from equation (3), and u_{it} is the error term from equation (4). The moment condition in equation (5) imposes that the mean change in the residual is orthogonal to the municipality's exposure to the national shock depending on the regional supply elasticity. Since the supply elasticities are constructed with residuals on historical elasticity of local housing prices (Guren et al., 2021) and Bartik (1991)-style labor demand shocks (Baum-Snow and Han, 2024), the resulting changes in the property market value growth are plausibly exogenous in the yield spreads.[21]

I use the above moment conditions and the GMM to estimate the model's full set of parameters, $\theta = [\gamma_i, \lambda, \phi]$. The GMM estimator minimizes the objective function:

$$\hat{\theta} = \text{argmin}(g_t' W g_t) \tag{6}$$

where W is the efficient weighting matrix. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.[22] Since γ_i's are estimated in a regression and show sampling variations, one might be worried about the well-known generated regressor problem (Pagan, 1984). Bootstrapping the standard errors addresses this issue by resampling the entire GMM estimation process and thereby incorporating additional sampling variability (See Kennedy (2008)). The bootstrap re-estimates all stages in each replication and, therefore, does not underestimate standard errors, leading to more accurate inference, as shown in Engelberg et al. (2018) and Wang (2011).

3.1 State-dependent Sensitivity and Asymmetric Effects.

I hypothesize and find asymmetric effects of sensitivities on municipal bonds depending on whether property market values have decreased or increased compared to the previous year. A bad (good) state of the world is defined as property market values decreasing (increasing) compared to the previous year in a municipality. When property market values decrease, a sensitivity indicates that property tax revenue has also decreased, which leads to higher yield spreads. Counties and cities show high yield spreads if they cannot protect property tax revenue from declines when property mar-

[21]Although a completely different research question, these moment conditions are analogous to Ahlfeldt et al. (2015), where they use IV within a GMM estimation to show that changes in concentration of economic activity surrounding the Berlin Wall are exogenous to changes in production and residential fundamentals.

[22]The results are qualitatively unchanged when I use heteroskedasticity and autocorrelation consistent (HAC) standard errors following Newey and West (1986)'s optimal lag.

ket values fall. Conversely, when property market values increase, a large sensitivity indicates that property tax revenue increased, and thereby yield spreads show minimal increase.

$$\Delta T_{it}^{P} = \underbrace{\left[\mathbf{1}\{\Delta X_{it} \geq 0\}\gamma_i^{+}\right]}_{\text{good state of the world}} \Delta X_{it} + \underbrace{\left[\mathbf{1}\{\Delta X_{it} < 0\}\gamma_i^{-}\right]}_{\text{bad state of the world}} \Delta X_{it} + \phi_i C_{it} + \epsilon_{it} \tag{7}$$

Equation (7) specifies a state-dependent sensitivity of property tax revenue growth (ΔT_{it}^{P}) with respect to property market value growth (ΔX_{it}) in good and bad states of the world. γ_i^{+} denotes the sensitivity in a good state of the world, when cities and counties show an increase in property market value compared to the previous year ($\Delta X_{it} \geq 0$). γ_i^{-} shows the sensitivity in a bad state of the world when property market values in cities and counties decrease compared to the previous year ($\Delta X_{it} < 0$).

Simultaneously, I estimate the state-dependent price of risk $\boldsymbol{\lambda} = [\lambda^{+} \quad \lambda^{-}]^{'}$ using:

$$R_{it}^{e} = \boldsymbol{\lambda}^{'} \begin{bmatrix} \gamma_i^{+} \\ \gamma_i^{-} \end{bmatrix} + \eta_i Z_{it} + u_{it} \tag{8}$$

estimated within the GMM. λ^{+} (λ^{-}) presents price of risk in a good (bad) state of the world when property values increase (decrease). As expected, I find that λ^{-} is larger than λ^{+}, which shows that the sensitivity premium is salient when local governments can not protect property tax revenue from decreasing.

4 Empirical Results: Bond Yield Spreads.

Table 2 shows GMM results estimated using equations (2), (3), and (4) and controlling for all the variables as outlined in Section 3. To begin with, ϕ is estimated negative and statistically significant, as hypothesized, since municipalities with higher supply elasticity are less affected by national average price shocks. Second, the sensitivity γ is estimated as 0.3%, which means that a 1% increase (decrease) in property market value growth results in a 0.3% increase (decrease) in property tax revenue growth on average.[23] Third, a large sensitivity causes an increase in municipal bond yield spreads by 19 bps. The estimation on the price of risk λ remains stable in magnitude from 18 bps to 22 bps across different measures of supply elasticity. This approach is important to confirm causality, which shows that the risk premium induced by the sensitivity is not arising from other correlated factors.

There are yet remaining concerns that the results may be driven by alternative explanations. To mitigate these concerns, I expand a set of controls as presented in Table 3, while I estimate equations (2), (3), and (4) using GMM. Here, I use Baum-Snow and Han (2024)'s housing supply elasticity as the IV. In Table 3, building on the previously mentioned controls, I additionally control for municipalities' personal income growth, employment growth, local GDP growth, Moody's recalibration, liquidity risk, political risk, climate risk, migration risk, and property price volatility and dispersion. The choice and measurement of these risks are further presented in Section 4.1. The sensitivity is estimated as 0.43% with all the controls under 99% confidence level. Simultaneously, the sensitivity causes a 23 bps increase in the municipal bond yield spreads. The magnitude of the sensitivity premium remains stable across various control specifications, consistently ranging from 18 to 23 bps.

It is important to evaluate the economic magnitude of the increase in municipal bond yield spreads. The 23 bps increase in the yield spreads is equivalent to a downgrade of the same maturity municipal bond from AAA to BBB.[24] In prior studies, the estimated yield increases are 20 bps due to the remote delivery of healthcare (Cornaggia et al., 2024b), 17 bps due to the opioid crisis (Cornaggia et al., 2022), 16 bps due to climate risk (Painter, 2020), and 13 bps due to the discovery of contamination from per-andpolyfluoroalkyl substances contamination discovery (Huang and Kumar, 2021).[25] My findings highlight that the sensitivity hugely affects local government budget deficits and commands a substantial risk premium on municipal bonds.

[23] The magnitude of the coefficient estimate is very similar with Lutz (2008) who estimates the sensitivity using OLS.

[24] FMS provides average yield spreads for each rating grade for illustration.

[25] Cornaggia et al. (2024b) and Cornaggia et al. (2022) use raw yields to estimate these results.

If credit ratings perfectly capture the sensitivity, then the sensitivity should not add any explanation beyond credit ratings. Qualitative evidence suggests that credit ratings already account for a local government's flexibility to raise own-source revenue (S&P Global Ratings and Moody's).[26] However, I demonstrate that sensitivity explains municipal bond yield spreads beyond credit ratings. For comparison, I regress municipal bond yield spreads on credit ratings and all other controls, excluding the sensitivity. The results, presented in column (3) of Table 6, show an adjusted R^2 of only 0.464, which is lower than the 0.747 reported in the main analysis in Table 3. The addition of sensitivity increases explanatory power in municipal bond yield spreads even after controlling for credit ratings. Taken together, these findings suggest that credit ratings do not fully capture the sensitivity of local governments, and that this sensitivity helps explain yield spreads beyond what is accounted for by credit ratings.

Furthermore, Iliev and Vitanova (2024) suggest that credit ratings is a "bad control" since it already accounts for the relationship between the yield spread and economic conditions, and will lead to a smaller estimate. For a robustness check, I exclude credit ratings from the control variables and find that the sensitivity effects indeed become larger, going up to an increase in 51 bps in the yield spreads, as presented in columns (1) and (2) of Table 6.

Turning to the asymmetric effects presented in Section 3.1, I find that the sensitivity premium arises in a bad state of the world—when cities and counties experience a decline in property market values relative to the previous year, particularly when they are unable to shield property tax revenue from falling. Table 4 shows results on γ^+, γ^-, λ^+, and λ^- estimated from GMM using equations (2), (7), and (8). I do a subsample analysis of cities and counties that show increase and decrease of property market values compared to the previous year. In a bad state of the world, the sensitivity effects are estimated to increase municipal bond yield spreads by 37 bps, under 99%

[26] The highest-rated local governments have flexible revenue-raising capabilities. The next group faces constraints such as property tax caps. The lowest-rated governments cannot raise additional revenue even with voter approval. See S&P Global Ratings Methodology for Rating U.S. Governments and Moody's Regional and Local Government in the U.S.

confidence level. The average sensitivity indicates that a 1% decline in property market value growth results in a 0.323% decline in property tax revenue growth. Here, greater sensitivity leads to a larger decline in property tax revenue and a smaller overall tax base, which in turn results in higher yield spreads. Conversely, in a good state of the world, in cities and counties where property market values increased, the sensitivity carries a statistically insignificant price of risk. The results in the good state of the world highlight that risk premium arises when cities and counties cannot protect property tax revenue from declining.

Intuitively, I find that the sensitivity premium is larger for local governments that rely heavily on property tax revenue. Table 8 presents sensitivities and prices of risk for local governments with high and low reliance on property tax revenue. Here, I sort the local governments based on the government-year ratio of property tax revenue relative to total tax revenue. The risk premium is larger when property market values decline in local governments with higher reliance on property tax revenue (26 bps) compared to those with lower reliance (14 bps).

4.1 Alternative Explanations.

This subsection demonstrates that the sensitivity premium cannot be fully explained by previously documented municipal bond risks. To rule out alternative explanations, I incorporate these risk factors as controls in the IV-GMM estimation. Additionally, I conduct subsample analyses and find that the sensitivity premium persists in both high-risk and low-risk subsamples, reinforcing that the premium is not merely a reflection of known risk channels.

4.1.1 Alternative Explanation 1: Municipal Bond Risks.

Liquidity Risk. Since municipal bonds are infrequently issued and traded, liquidity risk is a well-known factor in the secondary market of municipal bonds (e.g., Ang et al., 2014; Trzcinka, 1982). I address liquidity risk in two ways. First, I estimate fundamental prices of municipal bonds by averaging the highest price on customer sales and the lowest price on customer purchases each day following prior studies (Curti et al., 2023; Fleckenstein and Longstaff, 2023; Green, 1993; Schwert, 2017). Details are cleaning the data are further presented in the Appendix Section A.

Second, I control for liquidity risk in the GMM estimation using Amihud (2002)'s price of impact, Feldhütter (2012)'s price dispersion, and Roll (1984)'s effective bid-ask spread. Higher values of these variables indicate higher liquidity risk in municipal bonds. Details on how these variables are measured are provided in the Appendix Section D. After controlling for these liquidity risks, sensitivity is estimated as $\gamma = 0.46$ and the price of risk $\lambda = 0.18$, showing that the sensitivity increases municipal bond yield spreads by 18 bps, as presented in Panel B of Table 3. That is, the premium denoted in my study is seemingly unexplained by the liquidity risk of municipal bonds. Furthermore, in Table 5, I do a subsample analysis of municipal bonds that show high and low liquidity risk using all the three measures. I show that the sensitivity premium differs little between municipal bonds with high and low liquidity risks. This result indicates that liquidity risk is not the main driver of the risk premium associated with the sensitivity.

Firm's exposure to tax policies. Since municipal bond yield is a proxy for local economic condition, one might be worried that local risk is priced in firm risk, which in turn affects the sensitivity premium. Hassan et al. (2019) proposes a firm-level exposure to political risk, such as tax policy, economic policy, and budget deficits.[27] The strength of this dataset lies in its ability to measure firm-level exposure, allowing for cross-sectionally heterogeneous responses from municipalities where firms are headquartered.[28] I control for this firm's exposure to tax policies for each municipality in the GMM estimation. Results, presented in Panel C of Table 3, show that the sensitivity is estimated 0.43% on average, and the price of risk λ is 22 bps. This result is very

[27] Thanks to the authors for releasing the data at their website https://www.firmlevelrisk.com/home.

[28] I use data from Gao et al. (2021) and identify each firm's historical headquarter location from historical SEC filings. Thanks to the authors for releasing the data at https://mingze-gao.com/posts/firm-historical-headquarter-state-from-10k/index.html.

similar with the main result, showing that firm-level exposure to political risk does not absorb the sensitivity premium.

Climate risk. Prior research documents significant effects of climate-related risks on municipal bond yields. For instance, yields rise in response to threats such as sea-level rise (Goldsmith-Pinkham et al., 2023; Painter, 2020), contamination of drinking water systems (Huang and Kumar, 2021), and heat stress (Acharya et al., 2022). In my study, I collectively control for hazards and disasters that occurred in each municipality in the U.S, including climate changes such as drought, flood, and heat and environmental contamination, such as oil spill, gas leak, and air pollution, as shown in the Appendix Table A.4. I control for the hazards and disasters by assigning a value of 1 if a municipality experienced a hazard or disaster in a given month. Results, presented in Panel B of Table 3, are again robust, showing that γ is 0.392 and λ is 23 bps at the 99% significance level.

Moody's Recalibration. Prior to the Moody's 2010 recalibration, municipal bonds were rated based on their distance to distress. Post-recalibration, it adopted global ratings so they have a continuous measure on expected losses and default probability. Moody's clarified that the recalibration did not reflect improved creditworthiness, but rather a methodological shift intended to enhance comparability across asset classes. The recalibration-led upgrades did not signify any change in the underlying fundamentals of issuers (See Adelino et al. (2017) and Cornaggia et al. (2018)). In my study, to ensure that the sensitivity premium is not driven by Moody's recalibration, I exclude municipal bonds that changed their credit ratings since the recalibration.[29] In Panel C of Table 3, aligning with prior studies, I show that the Moody's recalibration did not change the fundamentals that relate to the sensitivity effects on yield spreads.

[29] Thanks to the authors for releasing cusips that changed ratings after the recalibration (Cornaggia et al., 2018). See https://sites.google.com/site/ryandisraelsen/data?authuser=0.

4.1.2 Alternative Explanation 2: Other Sources of Revenue.

While this paper focuses on property taxes, which is the largest own-source revenue, local governments have revenue from other sources, such as sales, income taxes and intergovernmental transfers.[30] In this subsection, I examine that the effect of property tax sensitivity is distinct from, and not absorbed by, these alternative revenue sources.

Sales and income tax revenue. If sales and income tax revenue are high and stable, the state may not have to pay additional efforts to stabilize property tax revenue. Unlike property taxes, state sales and income tax rates are uniform within states and income brackets, making them easier to impose since they do not require value assessments. Sales and income taxes provide a useful comparison for revenue generation without sensitivities of the tax revenue changes with respect to fundamental value changes. After controlling for sales and income tax revenue, I observe robust results, showing that sensitivity increases yield spreads by 18 bps and 22 bps after controlling for sales tax revenue and income tax revenue respectively, as presented in Panels A and B in Table 7. These findings offer valuable insight into the effects of sensitivities on yield spreads, after accounting for the other sources of government revenue.

Federal transfers. Federal transfers are a big source of revenue for local governments, accounting for 20–30% of their annual tax revenue on average. Federal transfers provide assistance during natural disasters. For example, the city of Tampa received federal aid following Hurricanes Helene and Milton in 2024.[31] Federal transfers also support local governments during less extreme events. For example, the cities of Bloomington and Martinsville in Indiana received federal funding for the construction of Interstate highway, I-69.[32] Federal transfers are not limited to emergency or one-time events; they

[30]Income tax comprises both corporate and individual income taxes. Eight state governments do not impose income tax: Alaska, Florida, Nevada, New Hampshire, South Dakota, Tennessee, Texas, Washington, and Wyoming. Five state governments do not levy a state-level sales tax: Alaska, Delaware, Montana, New Hampshire, and Oregon.

[31]https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2024/10/28/fact-sheet-one-month-following-hurricane-helene-biden-harris-administration-spearheads-ongoing-recovery-efforts-and-support-for-survivors/

[32]https://www.fhwa.dot.gov/ipd/project$_{p}rofiles/in_{i}69_{s}ection5.aspx$

occur regularly as part of the federal government's ongoing fiscal relationship with local governments. These transfers are distributed annually.

Given the importance of federal transfers to local government revenue, it is intuitive that local governments face fewer fiscal constraints when they receive greater federal support. The local governments that receive greater Federal transfers indeed show low sensitivity effects on the yield spreads. As shown in Panel C of Table 7, the sensitivity $\gamma = 0.361$ and the sensitivity increases the yield spreads by 20 bps. This risk premium is smaller than the 29 bps increase for local governments that received lower Federal transfers.

4.1.3 Alternative Explanation 3: Political Factors.

Regressive taxation. Since property tax is ad valorem, one possible explanation for my findings is that property taxation is regressive, which means that properties in wealthier neighborhoods are under-assessed while poorer neighborhoods are over-assessed (See e.g. Berry (2021)). I rule out the alternative explanation by controlling for personal income growth, employment growth, and local GDP growth of the municipality. To further evaluate the channel, I examine the baseline results with local governments that have high and low personal income. If regressive taxation was driving the results, one would observe high risk premium with issuers that have low personal income. Across both sub-samples, I do not find significant difference on prices of risk in issuers with high and low personal income, as shown in Table 9.

State governor-US president party alignment. Poterba (1994) shows that unified governments have much faster deficit adjustment than a divided government. One plausible channel is that intergovernmental transfers are larger for states whose governors belong to the same party as the U.S. president. If this is the case, local governments in co-party states have larger tax revenues, which affects municipal bond yields. However, I do not observe this pattern in the data. As evidenced in Table A.5, federal transfers to state and local governments do not differ significantly between aligned and non-aligned governor–president party affiliations (t-statistic = -0.56). Furthermore, Table 9 shows that the price of risk is large and statistically significant, generating a 21 bp increase in municipal bond yield spreads for states and years where the governor's party aligns with the president's. The price of risk is also high in local governments within co-party states, which is opposite of what the alternative explanation suggests.

Migration risk. The migration risk may affect municipal bonds, since high net-migration may increase the tax revenue of local governments. Indeed, Zimmerschied (2024) documents that migration-driven population growth lowers the municipal bond yields, by examining that the increase in tax revenue exceeds the increase in fiscal spending. In a similar vein, Gustafson et al. (2023) show that the work-from-home effect of COVID-19 induced out-migration, which in turn reduced municipal revenues and increased the yields. In contrast, Cornaggia et al. (2024a) show that the heterogeneity of immigrants are important and study how unauthorized immigration affects municipal bonds. They show that the municipal bond yields rise after inflows of unauthorized immigrants, especially in municipalities with tight labor markets and those that limit cooperation with federal immigration enforcement.

In my study, I control for migration risk in the GMM using two measures. First, I use domestic net migration data provided by the Census, which shows net migration to and from a city and a county in the U.S. Second, to account for unauthorized immigration risk, I use estimates of the unauthorized migration population residing in the U.S. provided by the Office of Homeland Security Statistics.[33] The unauthorized migration data is provided for the entire country, instead of each local government. I use the yearly growth of unauthorized immigration population of the U.S. After controlling for these migration risks, results are very similar with the main findings, γ is estimated as 0.41%, and λ is estimated as 21 bps increase in municipal bond yield spreads, as presented in Panel C of Table 3.

[33] https://ohss.dhs.gov/topics/immigration/unauthorized/population-estimates

4.2 Robustness Checks.

Issuer types and sizes. While both cities and counties are included in the baseline analysis, I estimate the sensitivity and price of risk for municipal bonds issued by cities, counties, and states separately, as shown in Panel A of Table 10. The advantage of focusing on GO bonds is to provide clear identification of whether the issuer is county, city, or state and investigate direct effects of property tax revenue sensitivity. Property tax revenue is the primary source of income for local governments, such as cities and counties, unlike state governments. Consequently, I hypothesize and find that the prices of risk will be higher for cities and counties compared to states, given that the cash flows for municipal bonds are more reliant on property tax revenue in cities and counties.

I find $\lambda = 23$ bps for cities and $\lambda = 19$ bps for counties in 99% confidence level, which are bigger than $\lambda = 12$ bps for states. Furthermore, I present results using urban, micropolitan, and metropolitan governments in Panel B of Table 10.[34] The price of risk generates 22, 30, and 33 bps increase in municipal bond yield spreads focusing on urban, micropolitan, and metropolitan governments, respectively. This is intuitive since the these governments have stronger property tax revenue generation, showing greater effects of the property tax revenue sensitivity.

Bond types. While the sample in the baseline results consists of non-insured and non-callable GO bonds, I present results with different types of bonds in Panel C of Table 10. The results in this table indicate that the effects are more pronounced for municipal bonds directly backed by local governments' property tax revenue. In contrast, revenue bonds—whose cash flows are tied to specific projects rather than general tax revenue—are less sensitive to property tax risk. Accordingly, when revenue bonds are included in the sample, the estimated price of risk, λ, declines to 15 basis points, which is lower than the baseline estimate.

Public schools are primarily funded through local property taxes, making munici-

[34] Following the Census categorization, metropolitan governments consist of at least one urban area with a population of 50,000 or more. Micropolitan governments consist of at least one urban area with a population between 10,000 and 50,000. Urban area has a population of at least 10,000.

pal bonds issued by school districts closely tied to property tax revenue (Goldsmith-Pinkham et al., 2023). In Panel C of Table 10, I show that sensitivity increases municipal bond yield spreads by 30 basis points. Given the reliance of school district bonds on property tax revenue, this sensitivity carries a larger risk premium. The results remain robust when including insured and callable general obligation (GO) bonds, as shown in Table 10. Taken together, the evidence suggests that the sensitivity premium is present across all bond types, with particularly pronounced effects for school district and GO bonds.

Bond maturities and the term premium. Comparison of long-term vs short-term maturity bonds will help us understand the fundamentals of risk that underlie the risk premium. Short-term maturity bonds are exposed to both rollover risk (He and Xiong, 2012) and the fundamental risk, whereas long-term maturity bonds are less exposed to the short-run increase in rollover risk. This analysis will thus be useful in investigating the market's expectation on a local government's future fiscal deficits absent the short-run increase in rollover risk due to a large sensitivity.

Using transaction-level data, I construct the term structure for U.S. states, using bonds with maturities from one to 30 years issued from January 2000 to December 2022, as outlined in the Appendix Section C. The benefit of this estimation is to summarize the entire term structure of yields across maturities, providing a representative yield curve rather than relying on sparse transaction-level bonds of specific maturities.

The short-term maturity includes bonds with maturities under 5 years, the mid-term maturity includes over five and under ten years, while the long-term group consists of those with maturities over 10 years. I then estimate my main regression models—equations (3) and (4)—separately for each maturity group.

The corresponding results are shown in Panel B of Table 12. I find that the sensitivity has the strongest effect on long-term spreads, increasing them by 30 basis points. In comparison, the estimated effects for medium- and short-term bonds are smaller, at 17 and 14 basis points, respectively. Following Gustafson et al. (2023) and Gao and Murphy (2022), I use this evidence to show that the risk premium is not driven by short-term rollover risk, but instead reflects fundamental exposure to the sensitivity. Investors command a risk premium to hold long-term maturity bonds, suggesting that the sensitivity surrounding fiscal deficits is the factor that drives the response in long-term maturity yields.

Alternative measures of yield spreads. For the main analysis, I use Schwert (2017)'s tax-adjusted yield minus the maturity-matched risk-free rate from Liu and Wu (2021), which is derived from the U.S. Treasury yield curve. For robustness checks, I consider alternative yield measures. Specifically, I use raw yields, tax-adjusted yields, tax-adjusted yields minus maturity-matched Gürkaynak et al. (2007)'s risk-free rate, and Garrett et al. (2023)'s tax-adjusted yields. That is, I adjust fundamental yields as in:

$$R_{it}^{\text{Garrett et al.}} = \frac{\text{yield}_{it}}{\tau_t^{\text{fed}}(1 - \tau_{s,t}^{\text{state}}) + \tau_{s,t}^{\text{state}}} \tag{9}$$

Results, presented in Table 12, show that sensitivity and the price risk statistically significant and strong in magnitude. Overall, I find robust results using different measures of returns on municipal bonds.

Exclude recessions. Municipal bonds are often viewed as safe assets and attract investors during periods of heightened uncertainty. To assess whether the observed sensitivity premium is simply a reflection of flight-to-quality behavior during major recessions, I exclude the COVID-19 pandemic and the Global Financial Crisis from the analysis. As shown in Table 11, the premium remains above 11 basis points even when either event is excluded. Tellingly, it still holds at 21 basis points when both episodes are removed from the sample.

5 Sources of Sensitivity

In the property tax system, local governments initially determine the total property tax revenue for the upcoming fiscal year. Assessors then assess the values of properties for taxation. It is the assessment value, not the market value, used for property taxation. For example, a property can be assessed as $240,000 and be taxed as if it was worth the assessment value, even though the market value was $300,000. Market value means the price at which a property would transfer for cash or its equivalent under prevailing market conditions. It is empirically market value data for all homes from Zillow ZHVI.

Prior studies identify the reasons for the gap between assessment value and market values of properties. For example, Cohen and Chen (2024) find that the assessment gap is mostly determined by the local government's budget deficits. If they go deficit, they actively reassess properties to collect the property tax revenue that is closer to the property market value, especially in a state of the world where property market values increased. The inequality in assessment gap is also attributed to household wealth gaps (Amornsiripanitch, 2020), racial disparities (Avenancio-León and Howard, 2022b), political partisanship of municipalities (Kalda et al., 2024), and appeal behaviors of households (Weber and McMillen, 2010).

Mill rate is primarily decided by the tax jurisdiction. Exemptions reduce the amount of property value subject to taxation before assessing the property, for example, homestead exemption and exemptions for seniors or veterans. Credits reduce the tax bill at the final process, after the assessment value and mill rates are calculated. In sum, property tax revenue is calculated with four elements (1) mill rate, (2) assessment value, (3) market value, and (4) exemptions and credits as following[35]:

$$\text{Property tax revenue}_{it} := \sum_{p \in i} \Big[\big(\text{Market value}_{pt} - \text{Exemptions}_{pt}\big) \times \frac{\text{Assessed value}_{pt}}{\text{Market value}_{pt}} \times \text{Mill rate}_{it} - \text{Credits}_{pt} \Big] \quad (10)$$

for each property p that is located in municipality i.

In Section 4, I have shown that the sensitivity is not entirely explained by size effect,

[35] This calculation is from Lincoln Land Institute of Land Policy, "50-State Property Tax Comparison Study", https://www.lincolninst.edu/publications/other/50-state-property-tax-comparison-study-2023/.

income effect, credit rating, liquidity risk, climate risk, and political risk. Then what is it explained by? Changes in average assessment values, mill rates, and exemptions are the main drivers of the local government's sensitivity. To test this, I estimate a 3-year rolling GMM as following:

$$\gamma_{it} = b_1 m_{it} + b_2 a_{it} + b_3 d_{it} + \xi_{it} \tag{11}$$

where m_{it} is the headline mill rate, a_{it} is the average log assessment value, and d_{it} is the average log exemption. Assessment values and exemptions are computed by aggregating property-level values within local government i at time t. I use the headline mill rate provided by the local government for GO purposes.[36] I simultaneously estimate equations (3), (4), and (11) using a 3-year rolling GMM including year fixed effect and all the controls same with the Table 3.

As assessment values and mill rates are higher and exemptions are lower, a local government translates more of property market values into property tax revenue. As presented in Table 13, the mill rate, assessment value, and exemptions jointly explain 85% of the variations in sensitivities across local governments.[37] When tested with univariate regressions across columns (1) to (3), the assessment value shows the largest explanatory power, followed by the exemption and the mill rate. The strong explanatory power supports that mill rates, assessment values, and tax exemptions are key drivers of sensitivity, consistent with the property tax collection framework shown in equation (10).

[36] The headline mill rate is provided by the local government, and presented in Lincoln Land Institute of Policy: https://www.lincolninst.edu/data/significant-features-property-tax/access-databasebase

[37] The remaining 15% of the explanatory power may stem from the dispersion of mill rates and assessment ratio across types of residential properties within a local government. For example, New York City imposes different mill rates on class 1 residential property (i.e. one- to three-family residential homes against class 2 residential properties (i.e. co-ops, condos, and 4+ units). Therefore, the mill rate is not linear. However, the research interest in this paper is not the difference in mill rates across property types. Rather, it is how the local government's total property tax revenue is priced in local asset market. For the purpose of the study, I use the headline mill rate presented for each local government.

5.1 Examples of assessments, mill rates, and exemption.

This subsection provides examples of cities with changes in assessment values, mill rates, and exemptions, with additional cases provided in Appendix Section B. While these examples are not about causality—note that causality is empirically addressed in Section 3—they offer insight into how these sources constrain the generation of property tax revenue.

California. The statewide Proposition 13 limits the increase of assessment value no greater than 2% each year unless a change in ownership or new construction occurs for all municipalities in California. This friction is especially binding in an economic downturn, since the cities in California cannot increase property assessment values by more than 2%, even though they are in fiscal deficits. Despite rising property market values, binding caps on assessment value growth prevent cities from incorporating these increases in their property tax revenue.

Houston. Mill rates do vary across times. For example, Houston, TX decreased 8.5% in the local mill rate for GO purposes, combined with an increase in homestead exemption from $40,000 to $100,000 of value from fiscal year 2021 and 2022. All three sources, assessment value, mill rate, and tax exemption, interact with one another. Since homestead exemptions and tax credits are typically set as fixed dollar amounts, their share of tax exemption shrinks as a home's assessment value grows.

Boston. Boston, MA is well-known to provide significant primary homestead exemption. Here, less of property market values are translated into property tax revenue. In Boston, the residential exemption was 35% of the citywide average assessment values of residential properties in fiscal year of 2017, which is 5% increase from 30% in the previous year. This exemption translates into property tax bill with 8.5% lower than the previous year for a city-wide average assessment value.[38]

[38] See https://www.bmrb.org/boston-adopts-35-residential-exemption-for-fy17/. In fiscal year 2017, the average assessment value of a single-family home in Boston was $534,836. After applying the homestead exemption and the property tax rate of $10.59 per $1,000 of assessment value, the resulting tax bill was $3,231. This amount is $302—or 8.5%—lower than the prior year's bill of $3,533.

5.2 Frictions in Property Taxation

Approximately 25% of city-year and county-year observations in the sample show declines in property tax revenue compared to the previous year. As shown in the Appendix Table A.9, these cities and counties show low growth in local employment, GDP, and population, suggesting that they have weak fundamentals and lower capacity to raise property tax revenue. More relevantly, these cities and counties show lower assessment value in both dollar terms and annual growth, and mill rates.

I study two sources of frictions that constrain the translation of property market values into property tax revenue. First, thirteen U.S. states have regulations that impose caps on increasing assessment values in percentage from the previous year, as listed in the Appendix Table A.6, sourced from Avenancio-León and Howard (2022a) and updated with a recent record from the Lincoln Institute of Land Policy.

Following Avenancio-León and Howard (2022b), I do three sub-sample analysis based on the presence and effect of state-wide assessment cap policies. I examine: (1) cities and counties without any state-wide caps, (2) cities and counties with the state-wide caps in place, and (3) cities and counties where the state-wide cap is binding, which is defined based on whether the house prices in cities and counties have risen beyond the cap. Table 14 shows the effects of sensitivity on yield spreads in these three sub-samples. For binding-cap municipalities, the sensitivity effects on yield spreads are the largest, increasing them by 48 bps. The effects are smaller, 28 bps, in municipalities subject to caps that include both binding and nonbinding, and the smallest, 7 bps increase, in cities and counties with no caps. These results suggest that local investors raise concerns on the local government borrowing cost, when the governments impose a binding cap in increasing property taxes through assessment values.

Second, infrequent property reassessments lead to declining accuracy over time. Despite initial precision, assessment values gradually become outdated, creating a widening gap between assessment and market values, especially for the municipalities with lagged reassessments. Studies suggest that a comprehensive reassessment can be helpful for evaluating fair assessments, especially when a comprehensive reassessment has not occurred for a long time (Berry, January 7, 2021; Hou et al., 2023). Particularly, Hou et al. (2023) find that two comprehensive reassessments in Philadelphia in 2014 and 2019 improved uniformity in property taxation across parcels with similar attributes. They further show that the reassessment enhanced fairness in assessments by imposing high property taxes to high priced properties. This improvement in fairness drew significant attention from local residents, as it was seen as a key step toward addressing the controversy over regressive property taxation.[39]

In the U.S., 39 states require comprehensive reassessment for every one to ten years, as listed in the Appendix Table A.7. The mandatory reassessment frequency represents the minimum required frequency; local governments may reassess more often at their own discretion. For example, although Texas mandates reassessment at least once every three years, Dallas conducts them annually. 11 states do not require a comprehensive reassessment on a fixed schedule. Here, reassessments may be triggered by specific events. For instance, California reassesses properties only upon a change in ownership or new construction. Vermont does not impose a regular frequency but instead requires a reassessment when the total assessment value of properties in a municipality falls below 80% of the state's equalized value.

Using this variation, I test how the mandatory reassessment frequency affects the sensitivity effects on the municipal bond yield spreads. I simultaneously estimate equations (2), (3) and (12):

$$R^e_{it} = \sum_{k=0}^{10} \lambda_k \cdot \gamma_i \cdot 1\{\text{Frequency}_s = k\} + u_{it} \tag{12}$$

for a local government i located in a U.S. state s, where local governments are subject to the statewide mandatory reassessment frequency of k years. The frequency ranges

[39] Regressive taxation refers to the controversy that wealthy (poor) neighborhoods are under- (over-) assessed. For example, Chicago faced controversy over inequitable assessments, with the city's wealthier neighborhoods under-assessed compared to lower-income areas (Grotto, 2017). The issue prompted major campaigns for assessment reform.

from one to ten years across 39 states ($k = 1, 2, 3 \ldots 10$), and $k = 0$ indicates that a comprehensive reassessment is not required by the state law. I further have a subsample of six state governments that reassess only upon transactions of properties. Four states have changed the reassessment frequency during the sample. The Appendix Table A.7 shows state-wide mandatory reassessment frequency for each state. Based on this information, the Appendix Table A.8 shows the number of states, cities, and counties for each frequency.

When reassessments are delayed, property tax revenue is lower especially during periods of rising property market values. This revenue shortfall becomes more pronounced with a longer reassessment lag. Consequently, yield spreads are higher for cities and counties with appreciating property values that have not reassessed for a long time. Figure 5 shows the estimated λ with different mandatory minimum reassessment frequencies with 5^{th} and 95^{th} confidence intervals. This figure shows cities and counties that had increased in property market values compared to the previous year.

Among cities and counties with statewide reassessment requirements, a clear pattern emerges: the municipal bond yield spread increases as reassessments become less frequent. Specifically, municipalities that reassess annually show yield spreads that are 8 bps, which is significantly lower than 43 bps with the longest cycle of ten years. These results suggest that delays in updating assessed values raise concerns among investors and elevates borrowing costs. Local governments that reassess only upon transactions without a comprehensive reassessment show high risk premium as much as local government that did not reassess for as long as ten years. The risk premium is indeed larger for local governments that do not require comprehensive reassessment, estimated as 54 bps. The Appendix Figure A.5 shows adjusted R^2 for each reassessment frequency, which is safely above 30% for all frequencies. Finally, the Appendix Figure A.6 presents results that include all cities and counties, regardless of whether property values increased or declined. The estimated sensitivity, λ, is smaller in this broader sample compared to the Figure 5.

6 Conclusion

This study identifies a previously unexplored risk in municipal bonds arising from the sensitivity of property tax revenue growth with respect to property market value growth. A large sensitivity commands an increase in municipal bond yield spreads by 23 bps. The sensitivity premium is stable across different subset of controls, including risks of municipal bonds and other tax revenue of local governments documented in prior studies. Furthermore, this effect is larger for long-term maturity bonds and school district bonds.

The local government variation in the sensitivity is driven by a local government's choice in property assessment values, mill rates, and tax exemptions. Here, I document two frictions based on a statewide legislation. First, a binding cap in increasing assessment values leads to a revenue shortfall. The cities and counties that face binding caps show higher yield spreads. Second, when municipalities experience rising property market values but delay reassessments of properties for a long period, the sensitivity premium increases.

Figures and Tables

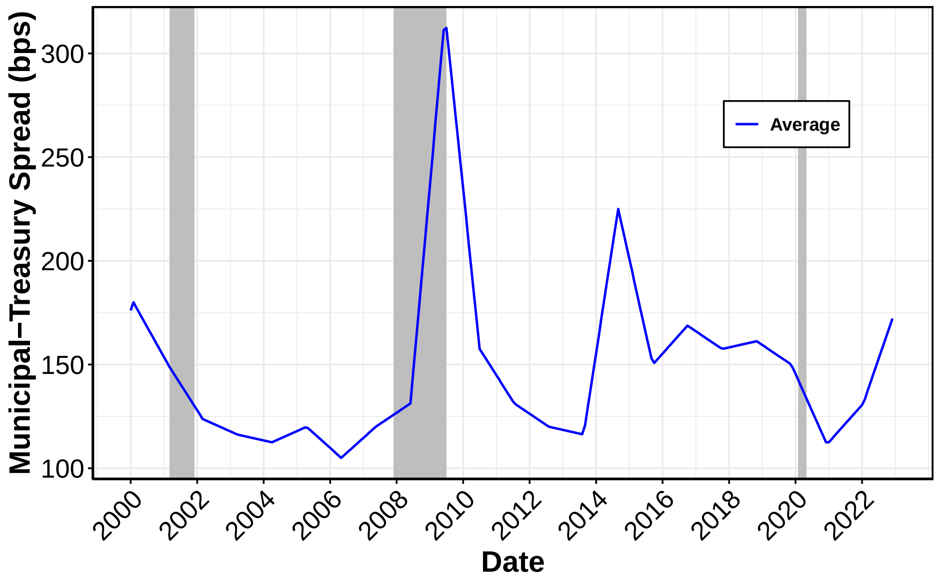

Figure 1: **Average tax-adjusted municipal bond yield spreads**
This figure shows the monthly average of tax-adjusted yield spread of general obligation municipal bonds for counties and cities in the U.S. estimated as in equation (1) from January 2000 to December 2022.

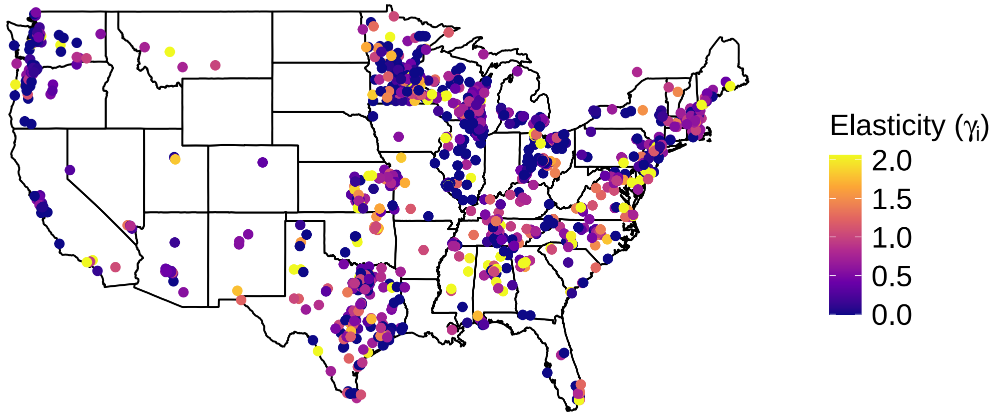

Figure 2: **Map on the sensitivity of property tax revenue**
This figure show a color map of showing each county's γ_i, namely the sensitivity of property tax revenue growth relative to the property market value growth, estimated with GMM using equations (2) to (4). Following Schwert (2017), I exclude nine states that prohibit or limit the issuance of GO municipal bonds. Section 2 shows details on sample construction. While the final sample includes cities, counties, and school districts, this map plots counties only for visual clarity.

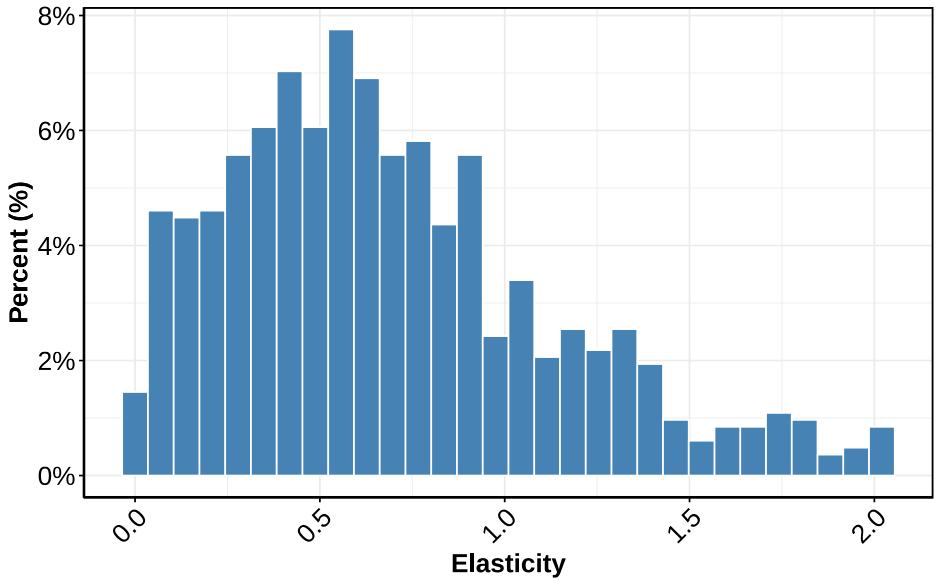

Figure 3: **Distribution on sensitivity**
This figure plots the distribution of γ_i, namely the sensitivity of property tax revenue growth relative to the property market value growth, estimated for counties and cities with GMM using equations (2) to (4).

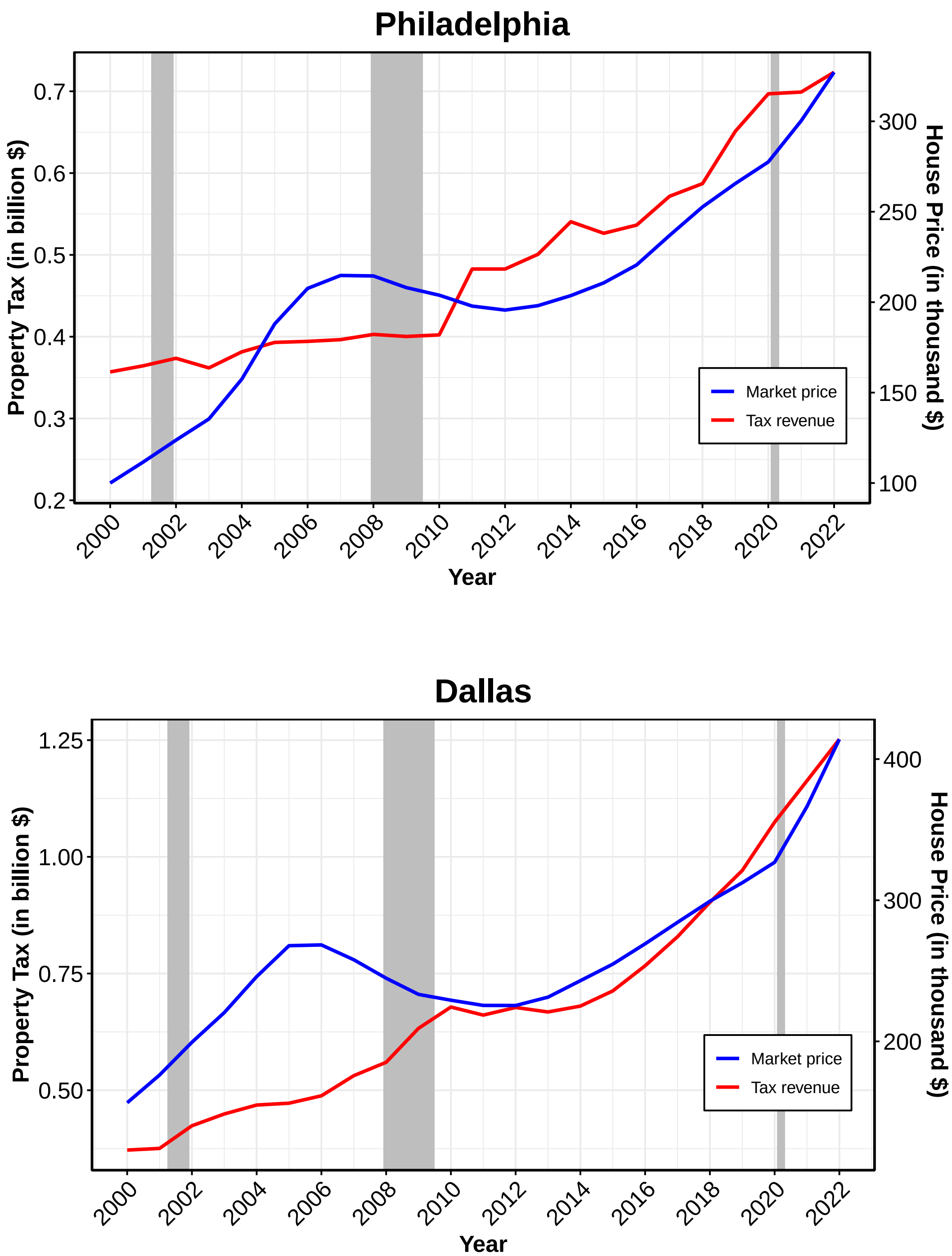

Figure 4: **Property market value growth and property tax revenue growth.** This figure shows the property tax revenue (left) and house price (right) in dollar terms in Philadelphia and Dallas from January 2000 to December 2022. The data for property tax are downloaded from the U.S. Census Bureau's Census of Governments and Annual Survey of State and Local Government Finances. The data for house price are downloaded from Zillow Home Value Index.

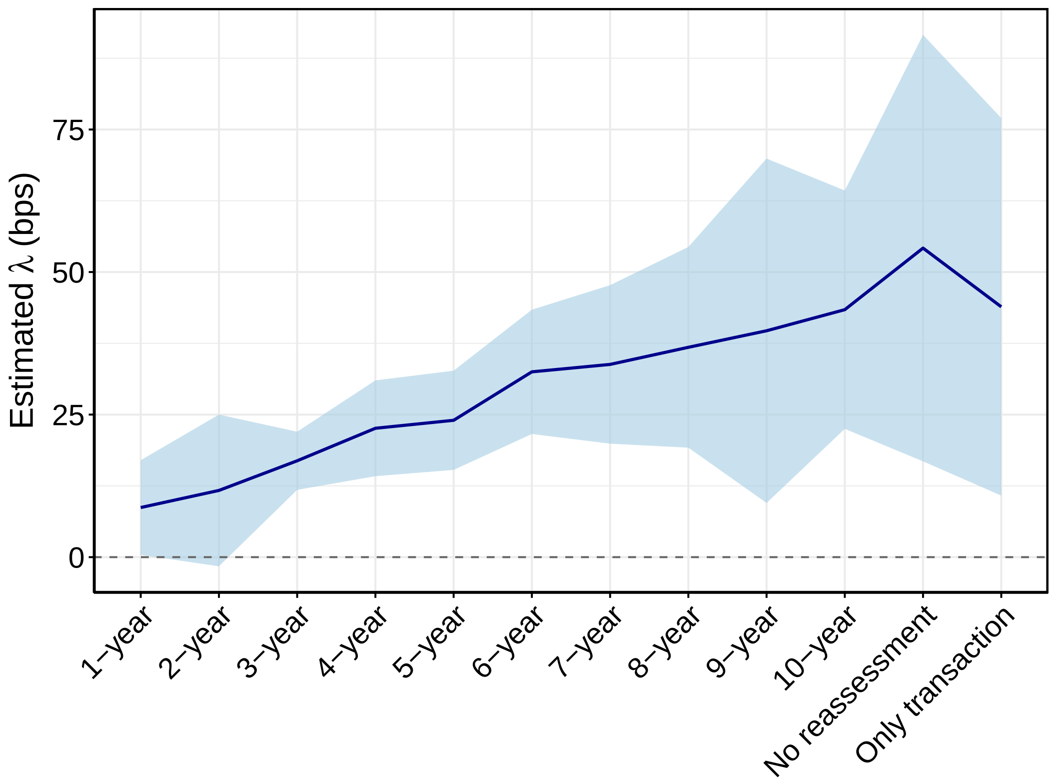

Figure 5: **Yield Spreads for Statewide Mandatory Reassessment Frequency**
This figure plots the estimated λ, namely how the sensitivity affects municipal bond yield spreads, as estimated in equations (2), (3) and (12). The estimation is based on the sample of cities and counties that experienced an increase in property market values relative to the previous year. Here, I estimate how the sensitivity affects the yield spreads depending on the statewide regulation on a minimum mandatory reassessment frequency. In the U.S., 39 states require comprehensive reassessment for every one to ten years, as listed in the Appendix Table A.7. 11 states do not require a comprehensive reassessment on a fixed schedule. Six states require reassessment of properties upon transaction. The Appendix Figure A.5 shows adjusted R^2 for each minimum mandatory reassessment frequency. The Appendix Table **??** shows the number of states, counties, and cities in the underlying data. The Appendix Figure A.6 shows the estimated λ using the entire sample of cities and counties.

	Mean	SD	1^{st}	25^{th}	75^{th}	99^{th}
A: Municipal Bond Characteristics						
Tax-adjusted bond spread (%)	1.43	1.25	-0.03	0.47	2.27	3.97
Tax-adjusted bond yield (%)	4.79	0.81	3.09	4.35	5.43	6.28
Raw yield (%)	2.83	0.48	1.89	2.50	3.27	3.71
Months to maturity	144.85	83.49	25.00	82.00	192.00	374.00
Coupon rate (%)	4.10	1.09	1.05	3.40	5.00	6.00
B: Top Income Tax Rates						
Federal (%)	36.86	1.91	35.00	35.00	38.85	39.60
State (%)	5.58	2.95	0.00	4.60	7.00	13.30
C: Property Values and Tax Revenue						
Sensitivity	0.551	0.591	0.010	0.306	0.857	2.057
House price ($)	230,748	231,186	46,708	115,878	266,785	1,085,966
Assessment value ($)	412,324	354,070	34,194	126,782	606,816	1,516,485
Property tax revenue (Mil., $)	92	918	0.478	5	40	767
Property/Total tax revenue	0.318	0.214	0.021	0.141	0.455	0.859
Net Transfers (Mil., $)	124	1,458	0.028	3	32	1,025
D: Number of Observations						
GO Bonds	**GO Trades**	**Counties**	**Cities**	**States**		
41,234	3,133,784	1,457	6,108	40		
Schl Bonds	**Schl Trades**	**School districts**				
68,001	612,009	2,226				

Table 1: **Descriptive Statistics**
This table reports the mean, standard deviation, 1st, 25th, 75th, and 99th percentiles of the key variables used in this study. The main dependent variable, tax-adjusted bond spread is the tax-adjusted municipal bond yield in the spirit of Schwert (2017) minus the maturity-matched Liu and Wu (2021)'s risk free rate, as shown in equation (1). Panel B presents the summary statistics of top federal income tax rate and the top state income tax rate. The data on income tax rates are collected from Tax Foundation. In Panel C, the sensitivity refers to the sensitivity of property tax revenue growth with respect to property market value for each county and city, estimated with GMM as outlined in Section 3. The residential market value refers to all home prices from Zillow Home Value Index. The residential assessment value for houses is obtained from CoreLogic. Net transfers refers to the intergovernmental transfers to a local government as presented in U.S. Census Bureau's Census of Governments and Annual Survey of State and Local Government Finances. Finally, Panel D presents the number of observations on bonds and trades used in the final sample in the study. Annual data spans from 2000 to 2022.

	Instrument Variable			
	Saiz (2010)	**Guren et al. (2021)**	**Housing units**	**Land development**
ϕ	-0.043***	-0.170***	-0.088***	-0.084***
	(-2.540)	(-6.253)	(-4.679)	(-5.431)
γ	0.300***	0.255***	0.437***	0.308***
	(3.480)	(4.488)	(2.887)	(4.382)
λ	0.222**	0.181***	0.192***	0.207**
	(2.000)	(3.085)	(3.483)	(2.028)
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Adj. R^2	0.536	0.488	0.517	0.491
F-stat	6.452	13.650	21.900	28.530

Table 2: **IV within a GMM Estimation**

This table reports ϕ, γ, and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). ϕ is the exposure of the property market value growth on the IV which is the interaction between the local supply elasticity and national house price fluctuations. γ is the estimated sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I use housing supply elasticity estimates from Saiz (2010) and Guren et al. (2021), as well as supply elasticity measures of housing units and land development from Baum-Snow and Han (2024). I control for year fixed effect and municipal bond characteristics, including the remaining time to maturity, the years passed since issuance, the trading volume relative to the outstanding amount, credit rating, and the bond-month standard deviation of transaction prices. The final sample has 3,133,784 trades in 41,234 bonds from 2000 to 2022. I report t-statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)	(5)	(6)
A: Baseline results						
	γ	λ	γ	λ	γ	λ
	0.433***	0.238***	0.332***	0.191***	0.455***	0.198***
	(4.826)	(4.500)	(4.003)	(3.800)	(5.178)	(3.927)
Controls	All		Economic conditions		Moody's recalibration	
Adj. R^2	0.747		0.566		0.797	
B: Municipal bond risks						
	γ	λ	γ	λ	γ	λ
	0.465***	0.186***	0.433***	0.222***	0.392***	0.231***
	(6.940)	(2.880)	(4.938)	(4.035)	(4.306)	(4.409)
Controls	Liquidity risk		Firm risk		Climate risk	
Adj. R^2	0.612		0.712		0.660	
C: Local market risks						
	γ	λ	γ	λ	γ	λ
	0.423***	0.168***	0.392***	0.197***	0.415**	0.219***
	(4.085)	(3.117)	(4.144)	(4.427)	(2.133)	(3.421)
Controls	Property price volatility		Property price dispersion		Migration risk	
Year FE	Y	Y	Y	Y	Y	Y
Adj. R^2	0.498		0.484		0.446	
Obs.	3,133,784					

Table 3: **Sensitivity and Prices of Risk.**
This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4) across extensive controls. γ is the estimated sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. Here, I use the IV as the interaction between Baum-Snow and Han (2024)'s granular local supply elasticity and national house price fluctuations. In all tests, I add year fixed effect and control for municipal bond characteristics, including the remaining time to maturity, the years passed since issuance, the trading volume relative to the outstanding amount, credit rating, and the bond-month standard deviation of transaction prices. In Panel A, I also control for local government-level economic conditions, such as personal income growth, employment growth, and local GDP growth in columns (3) and (4). I further control for Moody's recalibration in the spirit of Cornaggia et al. (2018) in columns (5) and (6). In Panel B, I control for liquidity risk measured by Amihud (2002)'s price of impact, Feldhütter (2012)'s imputed round-trip cost, and Roll (1984)'s effective bid-ask spread. I also control for Hassan et al. (2019)'s firm-level risk to fiscal budgets, as well as climate risk, measured with EMDAT's hazards and disasters. In Panel C, I control for property price volatility measured as the five-year rolling standard deviation of annual log changes in average property values within each municipality. Property price dispersion is measured as cross-sectional interquartile of log property values. Migration risk is controlled, using domestic net migration data to and from a city and a county in the U.S. I also control for estimates of the unauthorized migration population residing in the U.S. Finally, I present results with all these controls in columns (1) and (2) in Panel A. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications. Annual data spans from 2000 to 2022.

	(1)	(2)	(3)	(4)
	Asymmetric effects			
	Good state of the world		**Bad state of the world**	
	γ^+	λ^+	γ^-	λ^-
	0.406***	0.071	0.323***	0.371***
	(5.350)	(0.534)	(5.310)	(3.929)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.203		0.541	
Obs.	2,381,676		752,108	

Table 4: **Asymmetric Sensitivity Effects in Good and Bad States.**
This table reports state-dependent sensitivity and examine asymmetric effects as outlined in Section 3.1. I estimate γ^+ and λ^+ (γ^- and λ^-) in a good (bad) state of the world. A good (bad) state of the world is defined as counties and cities that experienced an increase (decrease) in property market values compared to the previous year. I then show how these state-dependent sensitivities affect municipal bond yield spreads, as shwon in λ^+ and λ^-. All control variables are same as Table 3. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications. Annual data spans from 2000 to 2022.

	(1)	(2)	(3)	(4)	(5)	(6)
			Liquidity risk			
	Bid-ask spread		**Price of impact**		**Price dispersion**	
Low	γ	λ	γ	λ	γ	λ
	0.275***	0.220***	0.400***	0.249***	0.512***	0.180***
	(3.430)	(3.435)	(4.678)	(4.565)	(5.800)	(4.163)
High	0.322***	0.228***	0.385***	0.275***	0.480***	0.196***
	(3.954)	(3.446)	(3.879)	(3.806)	(6.307)	(5.405)
Controls	All	All	All	All	All	All
Year FE	Y	Y	Y	Y	Y	Y
Adj. R^2 (Low)	0.265		0.340		0.405	
Adj. R^2 (High)	0.334		0.419		0.340	
Obs. (Low)	1,166,130		1,388,946		1,378,162	
Obs. (High)	1,554,840		1,179,308		1,188,367	

Table 5: **Municipal Bonds with High and Low Liquidity Risk**
This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). γ is the sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I use the IV as the interaction between Baum-Snow and Han (2024)'s granular local supply elasticity and national house price fluctuations. However, I do a subsample analysis of municipal bonds that have liquidity above or below than the cross-sectional median. Liquidity of a municipal bond is measured with the bid-ask spread (Roll, 1984), price of impact (Amihud, 2002), and dispersion of traded bond prices around the market consensus (Jankowitsch et al., 2011). Measurement procedures for these variables are discussed in Section D. Note that the first row, low bid-ask spread, low round-trip cost and low price dispersion all indicate low liquidity risk. In all tests, I add year fixed effects and control for municipal bond characteristics, including the remaining time to maturity, the years passed since issuance, the trading volume relative to the outstanding amount, credit rating, and the bond-month standard deviation of transaction prices. All controls from columns (1) and (2) in Panel A of Table 3 are included. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications. The underlying annual sample ranges from 2000 to 2022.

	(1)	(2)	(3)
	Exclusion of key variables		
	Credit rating		**Sensitivity**
	γ	λ	b
	0.250***	0.513***	-0.096***
	(4.353)	(3.031)	(-3.258)
Controls	Y	Y	Y
Year FE	Y	Y	Y
Adj. R^2	0.540		0.464
Obs.	3,133,784		

Table 6: **Sensitivity Effects Excluding Credit Ratings from Control Variables.** This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). γ is the estimated sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I use the IV as the interaction between Baum-Snow and Han (2024)'s granular local supply elasticity and national house price fluctuations. In columns (1) and (2), I exclude credit rating from the control variables, and include all the other controls and year fixed effect, as stated in Table 3. In column (3), I report results on regressing the yield spreads on credit rating, including all the controls and year fixed effect, but excluding the sensitivity of property tax revenue growth respect to property market value growth. The final sample ranges from 2000 to 2022. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)
	A: Sales tax		**B: Income tax**	
	γ	λ	γ	λ
	0.405***	0.188**	0.348***	0.229**
	(4.650)	(1.988)	(6.150)	(2.226)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.462		0.499	
Obs.	2,507,027		2,193,649	
	C: Federal transfers			
	High		**Low**	
	γ	λ	γ	λ
	0.361***	0.206***	0.410***	0.290*
	(4.483)	(2.815)	(4.721)	(1.843)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.364		0.410	
Obs.	1,253,514		1,410,203	

Table 7: **Local Government's Other Sources of Tax Revenue.**
This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). γ is the sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I use the IV as the interaction between Baum-Snow and Han (2024)'s granular local supply elasticity and national house price fluctuations. Here, I include all the control variables listed in Table 3. In Panel A, I further control for sales tax revenue of local governments, after excluding five no-sales tax states. In Panel B, I further control for income tax revenue of local governments, including both corporate and individual income tax, after excluding nine no-income tax states. In Panel C, I do a subsample analysis of local governments that received federal transfers above or below the cross-sectional median each year. The data on federal transfers are obtained from the U.S. Census Bureau's Census of Governments and Annual Survey of State and Local Government Finances. Annual data spans from 2000 to 2022. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)
	High property tax reliance			
	Market values increase		**Market values decrease**	
	γ^+	λ^+	γ^-	λ^-
	0.356***	0.057	0.484*	0.260***
	(2.690)	(0.892)	(1.891)	(2.884)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.136		0.462	
Obs.	1,143,831		423,061	
	Low property tax reliance			
	Market values increase		**Market values decrease**	
	γ^+	λ^+	γ^-	λ^-
	0.199	0.031	0.134***	0.140***
	(1.895)	(1.670)	(2.572)	(2.567)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.159		0.330	
Obs.	1,096,824		470,067	

Table 8: **Local Governments with High and Low Reliance on Property Tax.** This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). γ is the sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I use the IV as the interaction between Baum-Snow and Han (2024)'s granular local supply elasticity and national house price fluctuations. All the control variables are same as stated in Table 3. Here, I use state-dependent sensitivity and asymmetric effects as outlined in Section 3.1. I examine subsamples of local governments, grouped into high and low categories based on whether their share of property tax revenue relative to total tax revenue is above or below the cross-sectional median. The final sample ranges from 2000 to 2022. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)
	A: Personal income			
	Low		**High**	
	γ	λ	γ	λ
	0.360***	0.206***	0.352***	0.293***
	(4.207)	(4.463)	(3.682)	(5.527)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.306		0.275	
Obs.	1,660,906		1,472,878	
	B: State governor and President			
	Co-Party		**Not Co-Party**	
	γ	λ	γ	λ
	0.433***	0.213***	0.478***	0.307***
	(4.842)	(3.759)	(5.461)	(6.707)
Controls	All	All	All	All
Year FE	Y	Y	Y	Y
Adj. R^2	0.379		0.305	
Obs.	1,692,243		1,441,541	

Table 9: **Local Government's Personal Income and Political Alignment.** This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). All the control variables are same as stated in Table 3. In Panel A, I do a subsample analysis of issuers that have personal income lower or higher than its cross-sectional median. In Panel B, I examine counties and cities that are located in the U.S. states in which the state governor and the U.S. president share the same political party affiliation and those that do not. Annual data spans from 2000 to 2022. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)	(5)	(6)
	A: Issuer levels					
	City		**County**		**State**	
	γ	λ	γ	λ	γ	λ
	0.336***	0.237***	0.359***	0.192***	0.353***	0.126***
	(4.366)	(3.324)	(5.998)	(4.417)	(5.724)	(3.287)
Controls	All	All	All	All	All	All
Year FE	Y	Y	Y	Y	Y	Y
Adj R^2	0.419		0.401		0.302	
Obs.	2,022,558		772,548		338,677	
	B: Issuer sizes					
	Urban		**Micropolitan**		**Metropolitan**	
	γ	λ	γ	λ	γ	λ
	0.356***	0.225***	0.323***	0.308***	0.235***	0.330***
	(5.045)	(3.884)	(4.608)	(4.156)	(5.417)	(4.023)
Controls	All	All	All	All	All	All
Year FE	Y	Y	Y	Y	Y	Y
Adj R^2	0.480		0.440		0.398	
	C: Bond types					
	Revenue and GO		**Callable and Insured**		**School districts**	
	γ	λ	γ	λ	γ	λ
	0.484***	0.151***	0.247***	0.498***	0.489***	0.306*
	(6.726)	(4.358)	(5.222)	(3.525)	(7.054)	(1.966)
Controls	All	All	All	All	All	All
Year FE	Y	Y	Y	Y	Y	Y
Adj R^2	0.311		0.434		0.358	
Obs.	5,708,451		613,723		612,009	

Table 10: **Municipal Bonds with Different Issuers and Types.**
This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4). All the control variables are same as stated in Table 3. In Panel A, I present results for bonds issued by cities, counties, and states. Panel B reports results based on the issuer's size. Following the U.S. Census definition, a metropolitan statistical area includes at least one urban area with a population of 50,000 or more; a micropolitan statistical area includes at least one urban area with a population between 10,000 and 50,000; and an urban area is defined as having a population of at least 10,000. Panel C extends the baseline results, which included only GO bonds, by incorporating both revenue and GO bonds. Additionally, while the baseline excludes callable and insured bonds, these bonds are included in Panel C. Finally, I examine yield spreads of municipal bonds issued by school districts in columns (5) and (6) in Panel C. Annual data spans from 2000 to 2022. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)	(5)	(6)
	Exclude Recessions					
	Global Financial Crisis		**Covid-19**		**Both**	
	γ	λ	γ	λ	γ	λ
	0.470***	0.119***	0.318***	0.337***	0.358***	0.217***
	(5.301)	(4.554)	(6.327)	(3.556)	(3.551)	(3.745)
Controls	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Adj R^2	0.429		0.453		0.439	
Obs.	2,452,527		2,725,030		2,043,773	

Table 11: **Sensitivity Effects Excluding Recessions.**
This table reports γ, the sensitivity of property tax revenue growth with respect to property market value growth, and its price of risk, λ, estimated using GMM as outlined in Section 3. However, I exclude the Global Financial Crisis (2007–2009), the COVID-19 pandemic (2020), and both crises. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	A: Alternative yields							
	Raw		**Tax-adjusted**		**Gürkaynak**		**Garrett**	
	γ	λ	γ	λ	γ	λ	γ	λ
	0.295***	0.143***	0.393***	0.280***	0.419***	0.215***	0.455***	0.263***
	(6.645)	(2.524)	(6.437)	(3.199)	(5.271)	(4.800)	(6.992)	(3.642)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Adj R^2	0.325		0.416		0.343		0.431	
Obs.	3,133,784		3,133,784		3,133,784		3,133,784	

	B: Bond maturities					
	>10 years		**5<years<10**		**<5 years**	
	γ	λ	γ	λ	γ	λ
	0.388***	0.308***	0.343***	0.177***	0.327***	0.149***
	(4.097)	(4.428)	(6.186)	(5.241)	(5.156)	(4.426)
Controls	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Adj R^2	0.330		0.181		0.261	
Obs.	1,234,711		908,797		990,275	

Table 12: **Alternative Measures of Municipal Bond Yields.**
This table reports γ, the sensitivity of property tax revenue growth with respect to property market value growth, and its price of risk, λ, estimated using GMM as outlined in Section 3. However, instead of using the main dependent variable— Schwert (2017)'s tax-adjusted yield minus maturity-matched Liu et al. (2017)'s risk-free rate as defined in equation (1)—I use alternative measures in Panel A. These alternative measures include the raw yield, the tax-adjusted yield from Schwert (2017), the tax-adjusted yield from Schwert (2017) minus the maturity-matched risk-free rate from Gürkaynak et al. (2007), and the tax-adjusted yield from Garrett et al. (2023). In Panel B, I use the term structure estimated as described in the Appendix Section C, and present results by maturity bins: greater than 10 years, between 5 and 10 years, and less than 5 years. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

	Sources of sensitivity				
	(1)	(2)	(3)	(4)	(5)
m_{it}	0.021*			0.056***	0.055***
	(1.842)			(4.677)	(4.650)
a_{it}		0.223***		0.307***	0.603***
		(5.586)		(7.102)	(6.542)
d_{it}			-0.109***		-0.257***
			(-3.435)		(-3.625)
Year FE	Y	Y	Y	Y	Y
Adj. R^2	0.174	0.579	0.300	0.678	0.850

Table 13: **Sources of Local Government's Sensitivity.**
This table shows sources of sensitivity for each local government estimated with 3-year rolling GMM using equations (3), (4), and (11) as outlined in Section 5. m_{it} is the headline mill rate for all properties, a_{it} is the average log assessment value, and d_{it} is the average log property tax exemption. The local government provides headline mill rate, as downloaded from the Lincoln Land Institute of Policy. I computed the average log assessment value and log property tax exemption by aggregating property-level data from Corelogic TaxDeeds. The final sample has 3,133,784 trades in 41,234 bonds from 2000 to 2022. I report Newey and West (1986)'s heteroscedasticity adjusted t-statistics.

	(1)	(2)	(3)	(4)	(5)	(6)
	Assessment Caps					
	No cap		**Cap exists**		**Cap exists and binds**	
	γ	λ	γ	λ	γ	λ
	0.330***	0.077***	0.273***	0.287***	0.288***	0.493***
	(3.471)	(3.992)	(3.770)	(4.276)	(5.884)	(4.933)
Controls	All	All	All	All	All	All
Year FE	Y	Y	Y	Y	Y	Y
Adj. R^2	0.566		0.541		0.537	
Obs	1,958,615		1,175,169		740,356	

Table 14: **Sensitivity Effects with Different Property Assessment Caps.** This table reports γ and λ that are simultaneously estimated with GMM using equations (2), (3), and (4) across extensive controls. γ is the sensitivity of property tax revenue growth respect to property market value growth. λ is the sensitivity's price of risk, showing how the sensitivity affects municipal bond yield spreads. I examine: (1) cities and counties without any state-wide caps, (2) cities and counties with the state-wide caps in place, and (3) cities and counties where the state-wide cap is binding, which is defined based on whether the house prices in cities and counties have risen beyond the cap. Appendix Table A.6 lists the caps for each U.S. states. I report t- statistics in parentheses, calculated using a block bootstrap with 200 replications.

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Online Appendix

A Data Cleaning.

I closely follow prior studies, such as Curti et al. (2023), Fleckenstein and Longstaff (2023), and Schwert (2017) and drop municipal bonds that are pre-refunded, variable coupon rates, are taxable, or are subject to the alternative minimum tax. To address outliers, I drop bonds that are transacted fewer than 10 times, have missing coupon or maturity information, coupon rates greater than 20%, maturities exceeding 100 years, bond prices below 50 or above 150, and trades occurring after the bond's maturity. I drop trades with less than a year to maturity, and trades within the first three months after bond issuance. I use non-insured bonds to prevent insurer risk from being mixed with risk in revenue frictions. I use non-callable bonds in my sample to ensure that property taxation risk is not mixed with the risk from embedded options. I confirm that the main findings are robust including callable and insured bonds.

Municipal bonds are illiquid in both issuance and trade in the secondary market. I estimate fundamental prices of municipal bonds by averaging the highest price on customer sales and the lowest price on customer purchases each day following prior studies (Curti et al., 2023; Fleckenstein and Longstaff, 2023; Green, 1993; Schwert, 2017). If customer sales and purchases are not done in one day, then I use the mean price of interdealer trades.

For property tax assessment data, I closely follow (Avenancio-León and Howard, 2022b), and restrict residential properties to single family home, condominium, duplex, and apartment. I restrict the sample to arm's-length resales by excluding all transactions that do not represent a resale, are marked as partial sales, or indicate less than full consideration. In addition, any transaction with a reported value of zero is dropped. I also drop properties that show multiple sales on the same day unless the recorded prices are identical. For each property, we collect the complete time series of assessed values, as reported annually in the administrative assessment records. We drop any year with missing assessment data, as well as any duplicate records for the same property and year that report conflicting assessed values. I further trim the observations with assessment ratio bigger than 3 and smaller than 0.01. Following Bernstein et al. (2019), I drop properties with transaction values lowe rthan $50,000 and higher than $10,000,000.

B Examples of Cities.

New Orleans, New York, Wisconsin, Chicago, and Detroit. Property taxation challenges exist nationwide. In New Orleans, infrequent reassessments before 2020 led to budget deficits due to effectively reduced property taxes despite rising market values (Berry, 2021). In New York, assessment caps constrained property tax revenue despite rapidly rising market values (NYC, July 29, 2020). Wisconsin's assessment values dropped significantly below market values in 2022, creating the largest gap in four decades (Wisconsin, September, 2023). Additionally, Chicago faced controversy over inequitable assessments, with the city's wealthier neighborhoods under-assessed compared to lower-income areas (Grotto, 2017). This controversy was huge, leading to campaigns on major assessment reforms. In Detroit, there was a substantial overtaxation of properties and regressive taxation by overassessing poor neighborhoods and underassessing wealth neighborhoods (Berry, 2021; Hodge et al., 2017; MacDonald, September 29, 2020).[40] It was only after Detroit conducted a comprehensive reassessment in 2017 that property tax equity began to improve (Berry, January 7, 2021).

Philadelphia and Dallas. Philadelphia did not do a comprehensive reassessment of properties from 1980s to 2012 and only relied on reassessments upon transactions (Hou et al., 2023). For decades, the city relied on fractional assessments that only hold upon property transactions, which led to led to poor assessment quality, with properties of similar market value being assessed and taxed at dramatically different amounts. It was not until 2013, with the adoption of the Actual Value Initiative (AVI), that Philadelphia undertook a comprehensive reassessment of all properties for the first time in over 30 years. Since then, the city comprehensively reassessed in 2014, 2019 and 2023. In contrast, Dallas performs comprehensive annual reassessments, surpassing the state-required 3-year minimum.[41] Dallas assesses values of properties based on market values, thus creating the assessment ratio of 1.[42] Specifically, figure 4 shows that in Philadelphia, property tax revenue failed to keep pace with rising market values and dropped sharply during downturns. In contrast, Dallas showed a tighter alignment between market values and tax revenue, with smaller declines even during the Global Financial Crisis.

Washington D.C. Property tax relief is not exclusive to homestead exemption. Rather, relief has significant effects on commercial properties. There are fourteen states where tax rate varies with commercial property value (i.e. $100,000, $1 million, and $25 million) and impose lower tax rate on lower valued properties through property tax relief. For example, Washington D.C. provides exemption of the first $225,000 of business personal property which is a complete exemption for $100,000-valued property but only exempts 0.9% of $1 million-valued property.

Columbus and Jacksonville. Similarly, Columbus, OH decreased local mill rate by 15.8%, which translates into a lower sensitivity, all else equal. In contrast, Jacksonville, FL increased effective tax rate by 10% on average, with 5.4% for residential and 8% for commercial properties in 2021.

[40] For example, home sold for $2,300 in 2010 was still assessed at $42,000, resulting in overtaxation (MacDonald, September 29, 2020). Hodge et al. (2017) show a comprehensive analysis that Detroit's assessment system was highly regressive, with similar homes receiving significantly different assessments, while different homes were given similar assessments.

[41] Texas requires reassessment every three years as stipulated by Texas Property Tax Code S25.18(b). Dallas' policy of reassessment cycle is initiated by the 1979 "Peveto bill."

[42] This law is mandated by Texas §23.01 to appraise all properties at market values. While Texas Tax Code §23.01 generally requires that all taxable property be appraised at market value, several statutory exceptions apply. Agricultural and open-space land is appraised based on its productivity value under §23.41 and §23.51. Residence homesteads with exemptions are subject to a 10% annual cap on assessment value increases under §23.23. In addition, tax deferral is available for senior and disabled homeowners under §33.06, and certain low-income housing and nonprofit properties receive special valuation treatment or full exemption under §11.1825, §11.18, and §11.11.

C Term structure.

I use Diebold and Li (2006)'s reformulation of Nelson and Siegel (1987)'s yield curve, namely the three-factor yield curve model, providing the level, the slope, and the curvature.

$$y_{st}(h) = \underbrace{f_{st}}_{\text{level}} + \underbrace{f_{st}}_{\text{slope}} \cdot \frac{1-e^{-h\chi}}{h\chi} + \underbrace{f_{st}}_{\text{curvature}} \cdot \left(\frac{1-e^{-h\chi}}{h\chi} - e^{-h\chi} \right) + \varepsilon_{st}(h) \tag{A.1}$$

where $y_{st}(h)$ is the continuously compounded yield at maturity h issued by local governments in a U.S. state s in year t. The yield curve is expressed as a linear combination of the level, slope, and curvature components, where f_{1t}, f_{2t}, and f_{3t} are time-varying parameters. The loading on the level factor f_{1t} is a constant, which equally affects yields at different maturities. The loading on the slope factor f_{2t}, given by $\frac{1-e^{-h\chi}}{h\chi}$, begins at 1 when maturity h is near zero and decays monotonically toward 0 as h increases. Lastly, the loading on the curvature factor f_{3t}, expressed as $\frac{1-e^{-h\chi}}{h\chi} - e^{-h\chi}$, starts at 0, rises to a peak at medium maturities, and then decays toward 0.

This study uses equation (A.1) to estimate the yield curve related to maturities from one to thirty years. Diebold and Li (2006) estimate the factor values $\widehat{f_{1t}}$, $\widehat{f_{2t}}$, and $\widehat{f_{3t}}$ by fixing $\chi = 0.0609$, the value that maximizes the loading on the curvature factor. The parameter χ determines the maturity at which the curvature factor reaches its maximum.[43] I follow Diebold and Li (2006) and estimate equation (A.1) using a fixed value of $\chi = 0.0609$, after which I estimate f_{1t}, f_{2t}, and f_{3t} via OLS. By doing so, I obtain a panel of yields across maturities, states, and years, which allows me to examine how sensitivity influences the shape of the yield curve. The estimation results using the term structure are presented in Section 4.2.

D Measurements of liquidity risk

A high value of the price impact measure proposed by Amihud (2002) indicates that trading a municipal bond results in a large price change. Thus, a high value of Amihud measure implies high liquidity risk. Feldhütter (2012) develops a measure of price dispersion based on the deviation of bond transaction prices from a market consensus valuation. This dispersion serves as a proxy for transaction costs: greater price dispersion implies higher round-trip costs and, consequently, higher liquidity risk in municipal bonds. Lastly, Roll (1984) develops a measure of the effective bid-ask spread based on the negative serial covariance of transaction price changes. Here, a larger Roll measure indicates more negative autocovariance in transaction prices, which in turn implies a wider effective bid-ask spread and higher liquidity risk.

[43] Nelson and Siegel (1987)'s parsimonious yield curve is following:

$$y_{st}(h) = b_{1t} + b_{2t} \cdot \frac{1-e^{-\chi_t h}}{\chi_t h} + b_{3t} \cdot e^{-\chi_t h} + \varepsilon_{st}(h), \tag{A.2}$$

b_{1t}, b_{2t}, b_{3t}, and χ_t are time-varying parameters. While Nelson and Siegel (1987) has a time-varying parameter χ_t, Diebold and Li (2006) treat it as fixed and suggest that there is little degradation of model fit. Furthermore, they say that the time-series variation of χ_t has little economic interpretation.

D.1 Roll (1984)'s bid-ask spread.

I use Roll (1984)'s bid-ask spread to measure liquidity risk in municipal bonds. The high bid-ask spread refers to high liquidity risk in municipal bonds. Roll shows that the bid-ask spread can be measured by:

$$\text{Roll}_{b,t} = 2\sqrt{-\text{Cov}(\Delta P_k, \Delta P_{k-1})}, \tag{A.3}$$

where P_k denotes the price of a municipal bond b at trade k. I first estimate the monthly Roll measure, and then aggregate it to yearly using a median. Following Schwert (2017), I drop municipal bonds that have less than four trades within a month.

D.2 Amihud (2002)'s price of impact

I use Amihud (2002)'s price of impact to measure liquidity risk of municipal bonds following Schwert (2017). The price of impact is an average return per volume of trade on a given month for a bond. A high value of Amihud measure indicates that a small trade leads to a large price change, which implies high liquidity risk. Amihud (2002)'s price of impact is computed as:

$$\text{Amihud}_{i,t} = \frac{1}{N_t}\sum_{k=1}^{N_t} \frac{\left|\frac{P_k - P_{k-1}}{P_{k-1}}\right|}{Q_k}, \tag{A.4}$$

where N_t is the number of trades for a municipal bond i on month t, P_k denotes the bond price at trade k, and Q_k is the par amount of that trade. Following Schwert (2017), I drop bonds that have less than two transactions on a given day to estimate the Amihud measure of price of impact. I aggregate the monthly Amihud measure to yearly using a median.

D.3 Jankowitsch et al. (2011)'s price dispersion

Jankowitsch et al. (2011) proposes an alternative measure of liquidity risk, which is the dispersion of traded bond prices around the market consensus valuation. Jankowitsch et al. (2011) calculates the price dispersion as:

$$\text{Bond Price Dispersion}_{i,t} = \frac{\sum_{k=1}^{N_t}(P_k - M_t)^2 Q_k}{\sum_{k=1}^{N_t} Q_k}, \tag{A.5}$$

where N_t is the number of trades for bond i on day t, P_k is the price at trade k, Q_k is the par amount traded, and M_t is the market's consensus valuation. Jankowitsch et al. (2011) defines M_t as the volume-weighted average price for the trading day. Monthly dispersion values are computed by averaging the valid daily estimates within each month. Yearly dispersion are obtained by using the median of monthly dispersions.

E Appendix Figures and Tables.

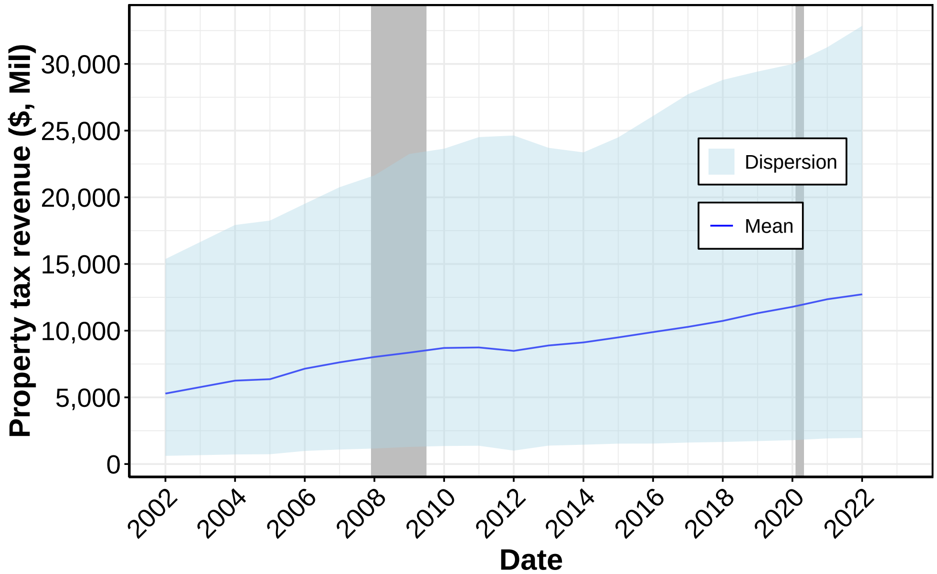

Figure A.1: **Property tax revenue in the U.S.**
This figure plots average property tax revenue of local government in each state, with the 90th - 10th percentile in shade. The data are from the U.S. Census Bureau's Census of Governments and Annual Survey of State and Local Government Finances.

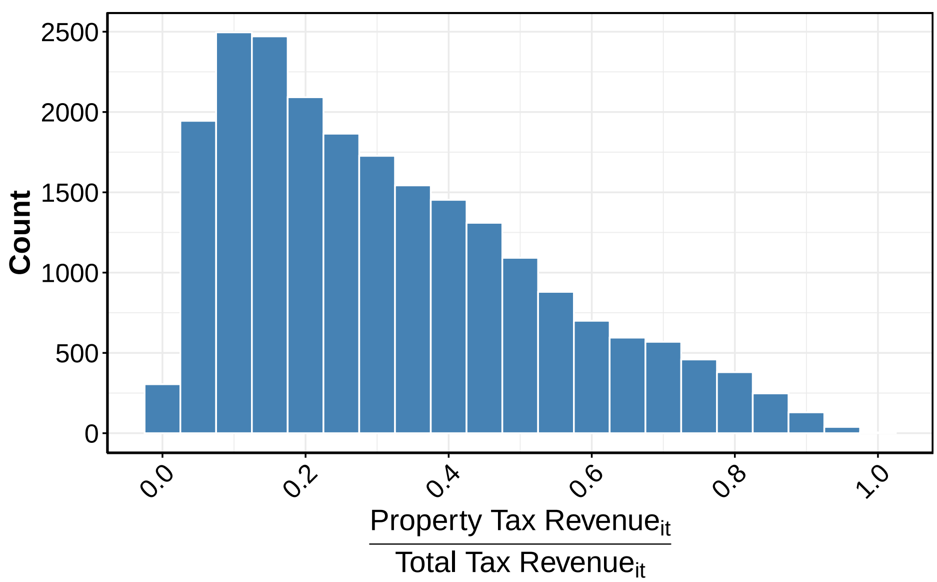

Figure A.2: **Histogram of** $\frac{\text{Property Tax Revenue}_{it}}{\text{Total Tax Revenue}_{it}}$ **for local government** i **in year** t**.**

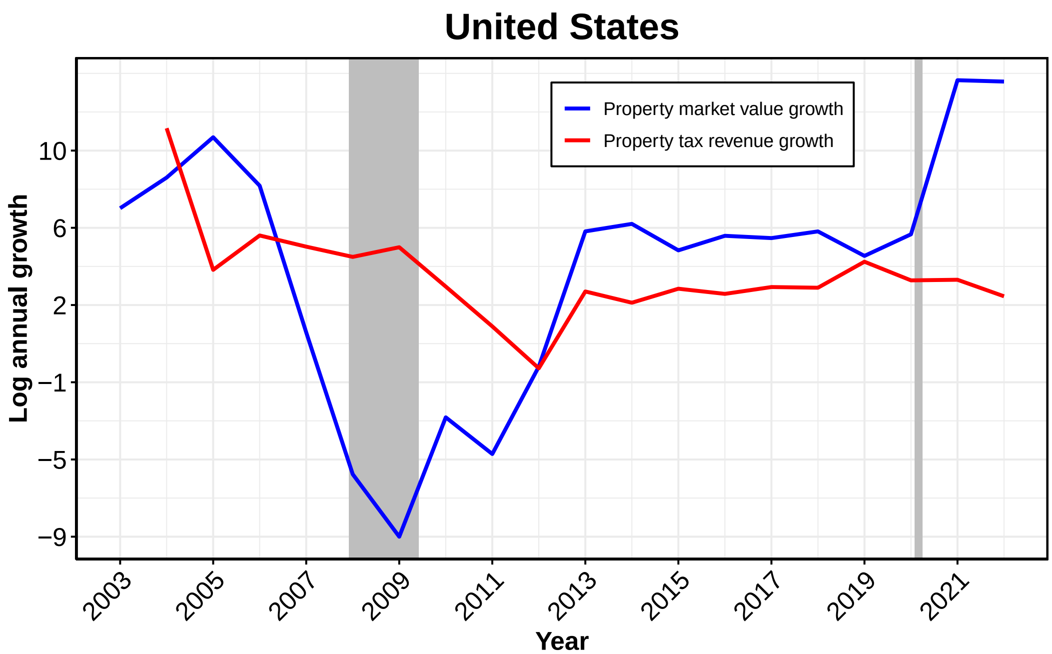

Figure A.3: **Aggregate property market value and tax revenue growths**
This figure shows the log annual growth of aggregate property tax revenue (red) and property market value growth (blue) the U.S.

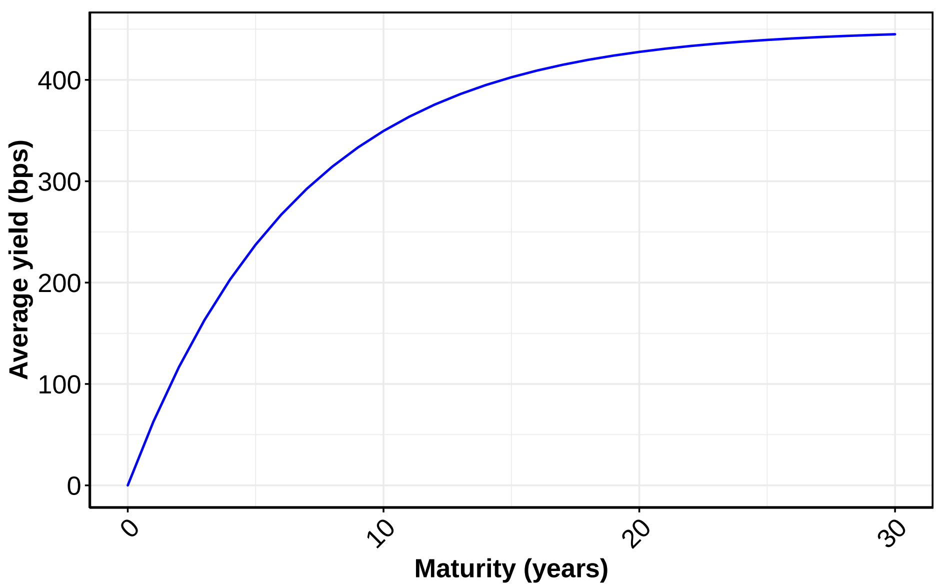

Figure A.4: **Term structure.**
This figure shows term structure of municipal bond yields across 0 to 30 years, estimated using Diebold and Li (2006)'s reformulation of Nelson and Siegel (1987)'s three-factor model, namely, level, slope, and curvature factors, as outlined in Section 2.2.

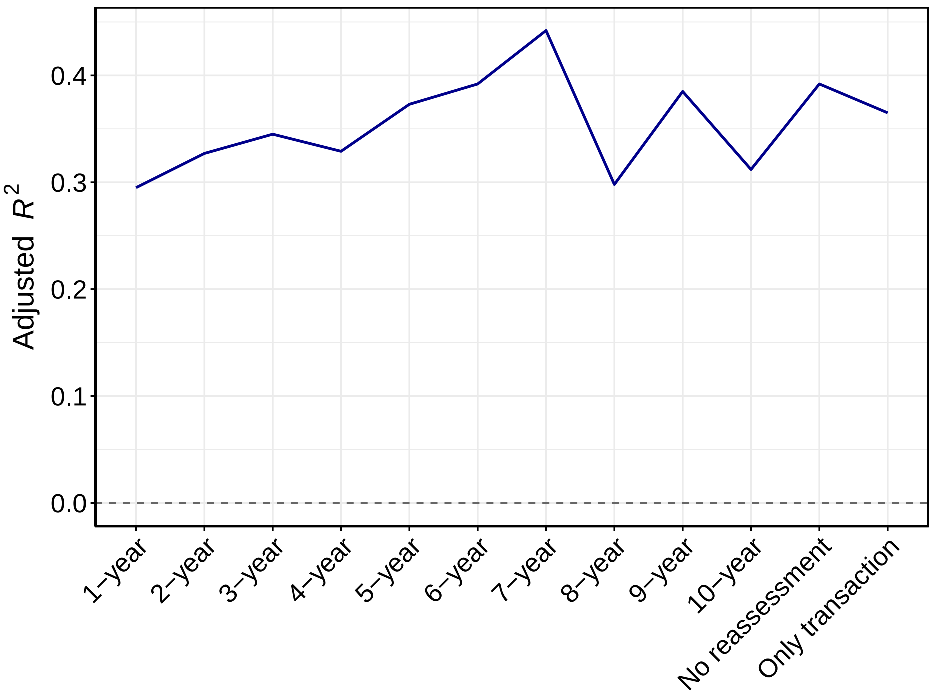

Figure A.5: **Adjusted R^2 for Figure 5**

This figure shows the adjusted R^2 for results presented in Figure 5 estimated with GMM using equations (2), (3) and (12).

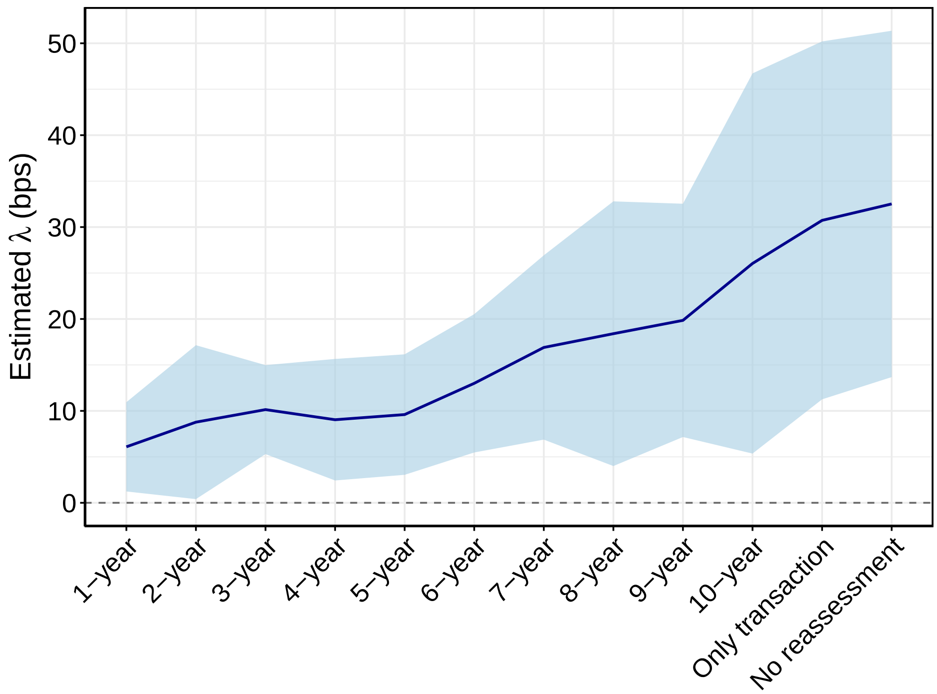

Figure A.6: λ **for Statewide Mandatory Reassessment Frequency with All Sample**

This figure plots the estimated λ, namely how the sensitivity affects municipal bond yield spreads, as estimated in equations (2), (3) and (12). While the Figure 5 reports the λ for cities and counties that experienced increase in property market values, this figure reports the estimation results using the whole sample. Here, I estimate how the sensitivity affects the yield spreads depending on the statewide regulation on a minimum mandatory reassessment frequency. In the U.S., 39 states require comprehensive reassessment for every one to ten years, as listed in the Appendix Table A.7. 11 states do not require a comprehensive reassessment on a fixed schedule. Six states require reassessment of properties upon transaction.

State	Trades	y(1)	y(5)	y(20)	y(30)
Alabama	9887	1.93	2.55	2.71	3.52
Arizona	10331	2.19	2.77	3.85	5.13
Arkansas	5247	2.07	2.57	2.68	3.71
California	74754	1.46	2.09	2.72	3.43
Connecticut	7438	1.95	2.62	3.76	5.62
Delaware	1130	1.79	2.48	3.47	4.09
Florida	29174	2.10	2.25	2.81	3.53
Georgia	12393	1.51	2.03	2.63	3.56
Illinois	10174	2.35	3.12	3.88	5.74
Kansas	6230	1.64	1.94	2.61	3.88
Kentucky	14052	2.06	2.61	2.67	3.53
Louisiana	6265	1.22	2.07	2.66	3.58
Maine	3271	1.84	1.89	2.54	3.49
Maryland	7341	2.02	2.68	2.81	3.77
Massachusetts	10886	1.68	1.92	2.53	3.33
Michigan	10152	2.09	2.76	3.20	3.97
Minnesota	11472	1.99	2.83	2.88	4.07
Mississippi	2988	1.98	2.66	3.61	5.42
Missouri	11782	2.23	2.85	3.28	3.99
Montana	1698	2.12	2.77	3.86	5.81
Nevada	2292	2.37	2.51	2.93	3.72
New Hampshire	1988	1.86	2.61	3.44	5.74
New Jersey	14669	2.14	2.71	2.71	3.51
New Mexico	3710	2.03	2.17	2.59	3.62
New York	31999	1.39	2.11	2.71	3.41
North Carolina	13344	1.15	1.92	2.52	3.51
Ohio	15647	1.91	2.00	2.63	3.61
Oklahoma	6951	1.93	2.68	3.78	5.66
Oregon	5622	1.96	2.59	2.89	3.71
Pennsylvania	19417	2.06	2.62	2.72	3.67
Rhode Island	3657	2.08	2.75	3.46	3.96
South Carolina	8043	1.36	2.01	2.63	3.47
Tennessee	7273	1.99	2.57	3.50	5.20
Texas	34688	1.62	2.00	2.66	3.53
Utah	5881	1.88	2.53	3.50	5.39
Vermont	1992	1.87	2.65	3.55	4.50
Virginia	14838	0.76	1.89	2.53	3.40
Washington	11068	1.57	1.93	2.55	3.41
Wisconsin	8436	1.77	1.97	2.78	4.18

Table A.1: **Average yields by maturity.**
I show the average number of trades for all counties and cities in each state and year. The variable y(h) represents the average yield on municipal bonds with a maturity of h years.

Rating	Code	S&P Global
AAA	0	Extremely strong capacity to meet financial commitments
AA+	1	Very strong capacity to meet financial commitments
AA	2	Very strong capacity to meet financial commitments
AA-	3	Very strong capacity to meet financial commitments
A+	4	Strong capacity but susceptible to economic conditions
A	5	Strong capacity but susceptible to economic conditions
A-	6	Strong capacity but susceptible to economic conditions
BBB+	7	Adequate capacity but subject to adverse economic conditions
BBB	8	Adequate capacity but subject to adverse economic conditions
BBB-	9	Adequate capacity but subject to adverse economic conditions
BB+	10	Less vulnerable in the near-term but faces uncertainties to adverse conditions
BB	11	Less vulnerable in the near-term but faces uncertainties to adverse conditions
BB-	12	Less vulnerable in the near-term but faces uncertainties to adverse conditions
B+	13	More vulnerable to adverse economic conditions
B	14	More vulnerable to adverse economic conditions
B-	15	More vulnerable to adverse economic conditions
CCC+	16	Currently vulnerable on favorable business to meet financial commitments
CCC	17	Currently vulnerable on favorable business to meet financial commitments
CCC-	18	Currently vulnerable on favorable business to meet financial commitments

Table A.2: **S&P Credit Ratings**
This table shows scale of S%P credit ratings on transaction-level municipal bonds, along with their numeric match used in this study. Description is available at S&P Global.

Variable	Mean	Std.Dev	Min	1st Qu.	3rd Qu.	Max
General Revenue	17.41	1.27	14.33	16.50	18.13	22.47
High	18.08	0.83	16.05	17.57	18.57	20.71
Low	16.60	0.86	14.33	16.10	17.21	18.81
Tax Revenue	16.50	1.33	12.71	15.63	17.31	21.59
High	17.22	0.89	14.85	16.67	17.76	19.82
Low	15.64	0.91	12.71	15.10	16.26	17.87
Property Tax Revenue	15.45	1.28	12.65	14.51	16.19	20.29
High	16.23	0.80	14.25	15.62	16.73	18.24
Low	14.54	0.69	12.65	14.08	14.96	16.56
Sales Tax Revenue	15.13	1.86	4.26	14.18	16.22	20.49
High	15.85	1.45	4.26	15.49	16.55	18.43
Low	14.26	1.72	6.98	13.65	15.41	17.38
Individual Income Tax Revenue	15.04	1.82	3.37	14.24	16.10	20.21
High	15.63	1.65	3.37	15.25	16.40	18.80
Low	14.12	1.43	3.93	13.88	14.87	16.29
Corporate Income Tax Revenue	13.21	1.90	0.69	12.44	14.00	18.89
High	13.80	1.82	0.97	13.35	14.62	17.64
Low	12.32	1.44	0.69	11.94	13.05	14.36
Direct Expenditure	17.37	1.27	14.30	16.46	18.09	22.23
High	18.05	0.81	16.02	17.56	18.51	20.42
Low	16.55	0.85	14.30	16.05	17.14	18.57
Short-term Debt Outstanding	11.93	2.25	1.39	10.75	13.32	17.64
High	13.15	1.33	8.57	12.38	13.91	16.76
Low	10.46	1.98	1.39	9.22	11.94	13.90
Long-term Debt Outstanding	17.10	1.38	13.50	16.19	17.80	21.91
High	17.87	0.84	15.56	17.41	18.36	20.14
Low	16.17	0.97	13.50	15.58	16.79	18.32

Table A.3: **Local Government Financial Characteristics**
This table reports summary statistics of the logarithmic values of revenue, expenditure, and outstanding debt amounts for state and local governments. For each variable, first row shows all states, whereas the second (third) row shows states with high (low) γ_i. High (low) states are those with γ_i higher (lower) than its median value. Data are from the U.S. Census Bureau's Census of Governments and Annual Survey of State and Local Government Finances. The final sample has 3,133,784 trades in 41,234 bonds from 2000 to 2022.

(1) Group	(2) Type	(3) Sub-Type
Biological	Epidemic	Infectious disease
Biological	Epidemic	Viral disease
Climatological	Drought	Drought
Climatological	Wildfire	Forest fire
Climatological	Wildfire	Land fire (Brush, Bush, Pasture)
Climatological	Wildfire	Wildfire
Geophysical	Earthquake	Ground movement
Geophysical	Volcanic activity	Lava flow
Hydrological	Flood	Flash flood
Hydrological	Flood	Flood
Hydrological	Flood	Riverine flood
Hydrological	Mass movement	Landslide
Hydrological	Mass movement	Mudslide
Industrial accident	Chemical spill	Chemical spill
Industrial accident	Explosion (Industrial)	Explosion (Industrial)
Industrial accident	Gas leak	Gas leak
Industrial accident	Oil spill	Oil spill
Meteorological	Extreme temperature	Cold wave
Meteorological	Extreme temperature	Heat wave
Meteorological	Extreme temperature	Severe winter conditions
Meteorological	Storm	Blizzard/Winter storm
Meteorological	Storm	Derecho
Meteorological	Storm	Extra-tropical storm
Meteorological	Storm	Hail
Meteorological	Storm	Lightning/Thunderstorms
Meteorological	Storm	Sand/Dust storm
Meteorological	Storm	Severe weather
Meteorological	Storm	Storm
Meteorological	Storm	Tornado
Meteorological	Storm	Tropical cyclone
Miscellaneous accident	Collapse	Collapse
Miscellaneous accident	Explosion	Explosion
Miscellaneous accident	Fire	Fire
Miscellaneous accident	Miscellaneous accident	Miscellaneous accident
Transport	Air	Air
Transport	Rail	Rail
Transport	Road	Road
Transport	Water	Water

Table A.4: **Disasters and Hazards at EMDAT**
This table shows a list of groups of hazards and disasters that occured in the United States of America from 2000 to 2022, available at EMDAT.

	(1)	(2)	(3)
	Party alignment		
	Yes	**No**	**Difference**
State governments	12677879	13290614	-2393350
			(-0.566)
Local governments	10932451	11507005	-1980508
			(-0.672)

Table A.5: **Intergovernmental transfers**
This table compares intergovernmental transfers from the federal government to state and local governments, distinguishing states and periods when the state governor's political affiliation aligns with that of the U.S. president. For local governments, the table reports the combined transfers received by all local governments within each state, aggregated by the state's alignment status.The final sample has 3,133,784 trades in 41,234 bonds from 2000 to 2022.

State	Limit	Notes
Arkansas	5%	
Arizona	5%–10%	Increase in top rate of growth in 2014
California	2%	
Florida	3% or less	Lesser of 3% or inflation
Maryland	10%	
Michigan	5% or less	Lesser of 5% or inflation
Minnesota	15%	Cap removed in 2009
New Mexico	3%	Also 6.1% max over two years
New York	6%	Policy covers the five boroughs of New York City plus Nassau County. In addition to the annual limit, policy provides for a 20% cap over a five-year period.
Oklahoma	3%–5%	Decrease in top rate of growth in 2013
Oregon	3%	
South Carolina	3%	Legislation also provides for 15% limit over a five-year period
Texas	10%	

Table A.6: **Assessment Caps**
This table shows the statewide legislation on upper caps on increasing assessment values compared to the previous year. All municipalities within the state has to follow the law in increasing the property assessment values.

State	Years	State	Years
Alabama	3	Montana	1
Alaska	1	Nebraska	1
Arizona	1	Nevada	5 (1 from 2012)
Arkansas	5 (3 from 2005)	New Hampshire	5
California*	No requirement	New Jersey*	No requirement
Colorado	2	New Mexico*	2
Connecticut	5-10 across counties (5 from 2010)	New York*	No requirement
Delaware*	No requirement (5 from 2023)	North Carolina	8
Florida	5	North Dakota	1
Georgia	1	Ohio	6
Hawaii	No requirement	Oklahoma	4
Idaho	5	Oregon*	No requirement
Illinois	4	Pennsylvania	No requirement (5 from 2014)
Indiana	5	Rhode Island	5-10 across counties
Iowa	2	South Carolina	5
Kansas	No requirement	South Dakota	No requirement
Kentucky	4	Tennessee	6
Louisiana	1	Texas	3
Maine	4	Utah	5
Maryland	3	Vermont	No requirement
Massachusetts	1	Virginia	2 for cities, 4-6 for counties
Michigan	1	Washington	4
Minnesota	4	West Virginia	1
Mississippi	No requirement (4 from 2014)	Wisconsin	5
Missouri	2	Wyoming	4

Table A.7: **State-wide mandatory reassessment frequency**
This table shows minimum reassessment frequency required by the state statute. The panel data is obtained from Tax Foundation and supplemented with Lincoln Land Institute of Policy. "No requirement" indicates that a comprehensive reassessment is not required in a regular frequency. For example, Vermont conducts comprehensive reassessments when the total assessed value of properties falls below 80% of the state-level equalized value, rather than on a regular cycle. Note that the table shows the minimum cycle, and a local government may choose to reassess more frequently than the minimum. * indicates that the state statute requires a reassessment of properties upon transactions of properties and a change of ownership.

Years	**States**	**Counties**	**Cities**
1	9	269	1157
2	4	112	570
3	4	121	647
4	7	196	922
5	15	420	1862
6	3	84	395
7	3	96	452
8	3	101	568
9	2	60	335
10	2	64	373
No requirement	12	327	1212
Only Transaction	5	151	724

Table A.8: **Number of Municipalities by Reassessment Frequency**
This table reports the number of U.S. states, counties, and cities corresponding to each minimum required property reassessment frequency from 2000 to 2022. A complete list of states by reassessment cycle is provided in Appendix Table A.7. The panel data is obtained from Tax Foundation and supplemented with Lincoln Land Institute of Policy. "No requirement" indicates that a comprehensive reassessment is not required in a regular frequency. "Only transaction" indicates that the state statute requires a reassessment of properties upon transactions of properties and a change of ownership but does not require regular comprehensive reassessment.

	Bad state	**Good state**	**Bad - Good**	**(t-stat)**
Assessed value	411187	458682	-47494	(-10.595)
Growth in assessed value (%)	2.84	4.10	-1.26	(-0.736)
Assessment ratio	2.23	2.03	0.20	(9.077)
Mill rate	17.02	17.58	-0.56	(-0.694)
Employment growth (%)	0.57	0.83	-0.26	(-2.532)
Local GDP growth (%)	0.82	1.83	-1.01	(-7.274)
Population growth (%)	0.64	0.67	-0.03	(-1.129)

Table A.9: **Characteristics of Bad and Good States of the World.**
This table reports the average growth in employment, local GDP, and population in local governments, compared to the previous year expressed in percentage, for bad and good states of the world. A bad (good) state of the world is defined as cities and counties that experience decrease (increase) in property tax revenue compared to the previous year. Heteroskedasticity robust t-statistics are shown in parentheses.