The Efficiency of Municipal Bond Tax Shields

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Abstract

U.S. states exempt residents from taxation on the interest income of local municipal bonds. I evaluate the efficiency of these tax shields. I use changes in millionaire taxes to calibrate an equilibrium model of the municipal bond market with state competition over tax shields. I show that state tax shields raise resident demand for local municipal bonds but impose negative externalities on other states and distort risk-sharing across municipal investors. Welfare could be significantly improved by repealing state tax shields. Reducing state tax shields by 1 percentage point raises aggregate welfare by about 0.07% of state GDP.

Keywords: *Portfolio Choice, Municipal Bonds, Tax Policy, State/Local Borrowing, Tax Shields, Millionaire Taxes*

JEL: *H2, G38, G12, G14, G23, G28, H71, H74*

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1 Introduction

Governments often use taxation to steer investment choices. A notable example is the municipal bond market, a critical source of funding for U.S. states and municipalities. Most states shield their residents from taxes on interest earned on local municipal bonds, but not municipal bonds issued in other states. These policies reduce local municipal financing costs but reduce state tax revenues and impose negative externalities on other states. This paper quantifies the welfare costs of state tax shields for municipal bonds.

To assess how taxation affects investor utility and bond portfolio allocation, I calibrate a two-period equilibrium model of the U.S. municipal bond market with strategic setting of tax shields by state authorities. I show that, in equilibrium, states fully shield local municipal bonds from taxes, which distorts risk-sharing between municipal investors across states and reduces tax revenues for other states because tax shields lead municipal investors to overweight local bonds. A social planner would raise welfare by eliminating state tax shields of local bond income. Raising tax rates on local bond income by 1 percentage point (p.p.) raises aggregate welfare across states by an estimated 0.07% of state GDP per year. The average decline in bond return correlation that would generate these welfare gains, absent tax changes, is about 10% (0.1 p.p.).

I calibrate the model using data on the impact of introducing "millionaire" taxes, which are recent increases in state income taxes on top earners that have been applied by several states. I find that a 1 p.p. increase in millionaire taxes raises resident flows into local municipal bonds by about 0.5% of the total net assets of single-state municipal bond mutual funds relative to local bond demand in other states. I also show that cross-state municipal bond demand is a sufficient statistic for the welfare impact of state tax shields, after accounting for their impact on state tax revenues.

To estimate investor demand in the municipal bond market, I take advantage of mu-

nicipal bond funds designed for tax-sensitive residents. By the end of 2021, municipal bond mutual funds reached nearly $1 trillion in total net assets (TNA), accounting for a quarter of all outstanding municipal bonds. The market has seen a significant rise in mutual funds that hold municipal bonds issued within a single state, targeting investment by that state's residents. I combine data from CSRP on these single-state mutual funds with municipal bond transaction data from the MSRB database, bond issue information from Mergent Municipal Bond Database, and fund ratings from Morningstar.

In the first part of my analysis, I exploit announcements of higher millionaire taxes in several states to quantify the impact of state tax policies on the demand of state residents for municipal bonds. A staggered difference-in-differences analysis shows that state tax shields amplify resident demand for local municipal bonds in treated states relative to other high-tax states by about 0.5% of single-state fund TNA over the subsequent three years. Raising millionaire taxes by 1 p.p. reduces the yield spreads of local bonds relative to out-of-state bonds by an estimated 13 basis points.

I then analyze the efficiency of state tax shields in a two-period equilibrium model of bond tax shields, bond pricing, and investor demand. In the first period, states issue one-period municipal bonds and set tax rates on bond interest income. Debt issuance and taxes fund public services. In the second period, residents with mean-variance preferences trade bonds, pay taxes on their bond income, and consume local public services. Each state maximizes the certainty-equivalent utility of its residents, which combines the utility derived from their investment portfolios with the utility associated with public services.

States set separate tax rates on out-of-state and local bond income. A tax "shield" corresponds to setting the tax rate on local municipal bond income to zero. I show an asymmetric equilibrium in which the larger state, by quantity of investors, sets a higher tax rate on out-of-state bonds than the smaller state. Because each state's provision of

public services is proportional to its investor mass, the larger state has greater financing needs and imposes higher taxes on out-of-state bonds than the smaller state.[1]

In the game played by state tax authorities, states set inefficiently low tax rates on local bond income. Higher bond income tax rates affect portfolio choices by reducing the after-tax returns of municipal bonds while leaving the variance of the return unchanged, thereby reducing equilibrium bond prices. When a state raises its tax rate on local bonds, state residents overweight the other state's bonds. As a result, I show that the welfare of residents in the other state rises because of the increase in its tax revenues and the utility that its residents derive from their bond portfolios ("portfolio utility"). I also show that states set inefficiently high tax rates on out-of-state bond income and that a marginal reduction of those tax rates, e.g., through a tax treaty, is strictly welfare-improving.

I then calibrate and test the model. The elasticities of bond yield spreads and resident flows with respect to state income tax rates, identified using millionaire tax announcements, allow me to calibrate agent risk aversion. The resulting calibrated model suggests that residents of the two states have comparable risk aversion. Building on the approach of Ben-David, Li, Rossi, and Song (2022a), I show in supplementary tests that changes in Morningstar ratings cause demand shifts that vary with state tax policies, consistent with the calibrated model. Lastly, I show that incorporating migration and endogenizing bond issuance to meet fixed required levels of public services do not overturn the welfare benefit of repealing the larger state's tax shield.

To evaluate the cross-state externalities of state tax shields, I perform a counterfactual analysis of tax policy proposals. Although upheld by the Supreme Court as recently as 2008,[2] municipal tax shields have long been called into question (e.g., Department

[1] This aligns with the insight from the literature in public economics on fiscal federalism that smaller jurisdictions have limited fiscal policy options relative to larger ones (Kleven, Landais, Muñoz, and Stantcheva, 2020).

[2] The court case of the Department of Revenue of Kentucky v. Davis is the most recent challenge to state tax shields considered by the Supreme Court, who sided with state governments over municipal

of the Treasury (1984)). The debate over tax shields has gained new relevance with the impending expiration of the Tax Cuts and Jobs Act (TCJA) in 2026, with some proposals to repeal municipal bond tax shields in order to fund future tax cuts (Pomerleau and Schneider, 2024). My analysis reveals that a utilitarian social planner who values all residents' utilities equally would repeal state tax shields on local bond income, based on a plausibly calibrated model, because the benefits of increased public services in both states would outweigh any implied reduction in bond portfolio utility. More generally, this paper challenges the relevance of the core argument put forth by advocates of state tax shields that these policies reduce municipal financing costs by raising resident demand for local municipal bonds, as suggested by the amicus brief filed by all 50 states in the Department of Revenue of KY. v. Davis (2008). I find that although state tax shields reduce local municipal financing costs, they also reduce the aggregate welfare of municipal investors via a bond demand externality.

1.1 Related Literature

In quantifying the cross-state externalities of state tax shields, this paper contributes to the literature in finance and public economics on municipal bonds, taxation, and jurisdictional competition. The paper is also formally related to the literature in international finance on home bias.

First, in quantifying the effects of taxation on the equilibrium pricing and demand of municipal bonds and the associated welfare effects, this paper builds on and contributes to the literature on the municipal bond market. For instance, Garrett, Ordin, Roberts, and Suárez Serrato (2023) show that municipal borrowing costs are determined by the interaction of the tax treatments of municipal bonds and imperfect competition in bond issuance auctions. Fleckenstein and Longstaff (2023) document tax-related convenience

investors in favor of state tax shields.

yields in municipal bonds and link those yields to investor risk aversion. These papers follow a long-standing literature on municipal bonds that examines equilibrium demand and prices (Green, 1993; Cestau, Hollifield, Li, and Schürhoff, 2019; Farrell, Murphy, Painter, and Zhang, 2023; Babina, Jotikasthira, Lundblad, and Ramadorai, 2021; Cornaggia, Cornaggia, and Israelsen, 2018; Haughwout, Hyman, and Shachar, 2022; Adelino, Cheong, Choi, and Oh, 2023) and municipal debt and distress (Gao, Lee, and Murphy, 2019; Ivanov and Zimmermann, 2024). Within this subject, a few pioneering papers, such as Poterba and Verdugo (2011), have called into question the efficiency of federal tax shields of municipal bonds. Poterba and Verdugo (2011) use the Survey of Consumer Finances to evaluate the foregone tax revenues associated with federal tax shields under various assumptions of household behavior. This paper, in contrast, evaluates the welfare impact of state tax shields in a calibrated model of the municipal bond market and state tax competition.

Second, following the seminal work of Domar and Musgrave (1944); Tobin (1958), and Miller (1977), a large literature in finance has scrutinized the impact of taxation on investment decisions and portfolio choices (Dybvig and Ross, 1986; Dammon and Spatt, 2012; Bergstresser and Poterba, 2002; Sialm and Starks, 2012; Langenmayr and Lester, 2018; Moussawi, Shen, and Velthuis, 2024; Dávila, 2023; Ivanov, Pettit, and Whited, 2024; Fleckenstein, Gandhi, and Gao, 2019). This paper contributes to this literature by quantifying the welfare effects of state taxation in the municipal bond market.

Third, the globalization boom at the turn of the century triggered a large literature in public economics on competition between jurisdictions over various issues, from environmental and labor standards to trade and capital taxation (Radaelli, 2004; Keen and Konrad, 2013). I build on the insights of this literature in the first period of my model, in which states set tax rates strategically. My findings regarding the relationship between optimal taxation and the relative investor mass are closest to the results of Bucovetsky

(1991), which were extended by Wilson (1991). But while those models apply to a production economy, I focus on equilibrium bond investment. Lastly, this paper is related to recent work in international finance on home bias (Lewis, 1999; Karolyi and Stulz, 2003).

The remainder of the paper proceeds as follows. Section 2 describes the institutional setting of the municipal bond market and the data sample. Section 3 identifies the elasticities of resident bond demand and municipal bond yield spreads with respect to state income tax rates. I outline the theoretical model in Section 4 and take it to the data in Section 5 by calibrating the model and quantifying the cross-state externalities of state tax shields. In Appendices B and C, I respectively test the model using Morningstar ratings and extend the model to include migration and endogenous bond issuance.

2 Institutional Setting and Data

In this section, I discuss the rise of municipal bond funds, review some of their institutional details, and outline the sample construction.

U.S. states tax the interest income of municipal bonds issued outside their borders. Almost all states, however, exempt the interest income of municipal bonds issued within their borders from state taxes (Babina et al., 2021). Municipal bonds are issued by more than 50,000 distinct authorities,[3] from public utility companies and school districts to county and state authorities. A state's tax shield applies to *all* municipal issuers within that state and increases the incentives of state residents to hold local municipal bonds relative to out-of-state municipal bonds.

The tax-induced demand for local municipal bonds has generated a proliferation of bond mutual funds that cater to tax-sensitive municipal investors. The most prominent

[3] This MSRB factsheet has more facts on the municipal bond market.

of these are single-state funds, which primarily invest in municipal bonds issued within a single state and are explicitly marketed to its residents. For instance, the product summary of VCITX, one of Vanguard's municipal California funds, states that it "is intended for California residents only." The municipal bond market has also seen the rise of national funds, which invest in municipal bonds issued by states across the country. These funds may especially appeal to residents of low-tax states, for whom single-state funds have no significant state tax advantages (Babina et al., 2021).

I proxy resident bond demand with flows to single-state mutual funds. Using mutual funds to proxy for resident demand is supported by the fact that the share of total municipal debt held by municipal bond mutual funds has been consistently around 25% since 2005.[4] This sizable and persistent market share suggests the suitability of these funds to proxy for household demand for municipal bonds. In addition, no other data source on municipal investor holdings at the state level exists. Figure 1 confirms the validity of this proxy, as states with higher income tax rates tend to have greater resident demand for municipal bonds than out-of-state investor demand, which is estimated using national fund holdings. In Section 3, I identify the causal effect of state tax rates on resident demand.

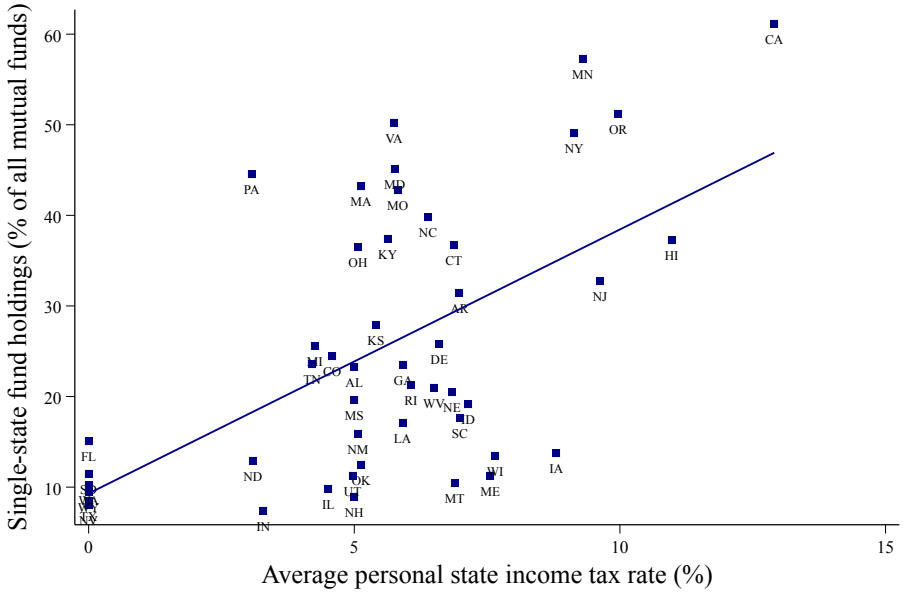
I also proxy cross-state municipal bond demand with the holdings of single-state mutual funds. Typically mandated to invest in bonds issued within their state, single-state funds do hold some bonds issued outside their state, as shown in Figure 2. For instance, Vanguard cautions potential investors of VCITX that "[...] at least 80% of the fund's assets will be invested in securities whose income is exempt from federal and California state taxes." On average, bonds issued outside the state of a single-state fund account for about 6.2% of TNA of these funds.

My primary data sources are the CRSP Quarterly Update, which has comprehensive

[4] My analysis of the Federal Reserve's flow of funds supports this fact.

Figure 1: Greater Demand by Single-State Funds in Higher-Tax States

Note: This figure shows a scatterplot of the average state personal income tax rate over 2008-2023, in percent, on the horizontal axis. The vertical axis shows the average aggregate resident holdings in a state, calculated over 2008-2023. Each dot corresponds to a state. Resident holdings are calculated as the aggregate holdings of single-state municipal mutual funds in municipal debt issued in a state, normalized by the aggregate holdings of both single-state and national municipal mutual funds in the state. The state personal income tax rates are verified using data from the Tax Foundation. A linear trend line is also fitted to the scatterplot.

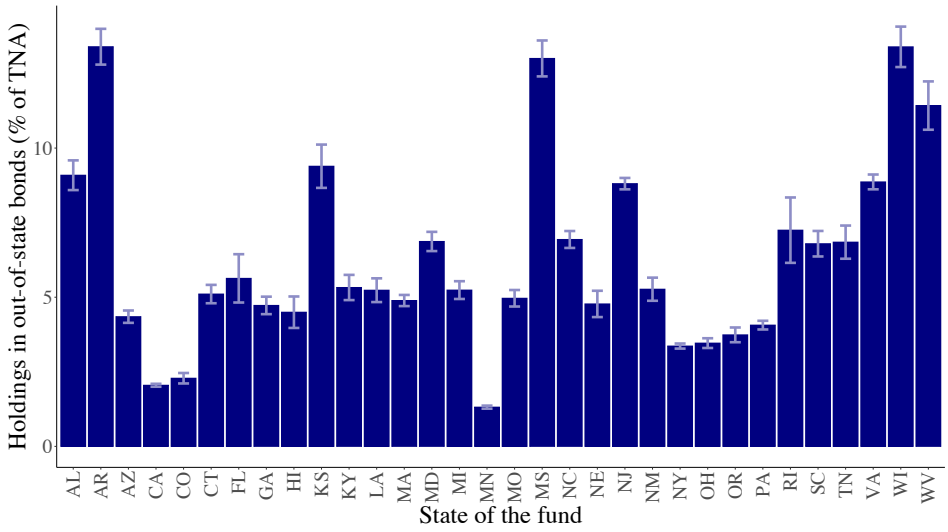


coverage of mutual funds; the MSRB database, which provides comprehensive transaction data on municipal bonds; and Mergent Municipal Bond Database, which reports information on bond characteristics. Because municipal bond mutual funds started gaining significant traction in 2008,[5] I restrict my attention to the sample period 2008–2024. In the CRSP dataset, I identify municipal bond mutual funds with Lipper objective codes and collect data on fund characteristics and portfolio holdings. I construct quarterly fund flows as the sum of monthly fund flows within each quarter. I match the CRSP and MSRB datasets using the eight-digit CUSIP codes of bonds held by municipal mutual funds. I complement these data with bond characteristics from Mergent Municipal Bond Database and fund ratings from Morningstar.

[5] See Figure E1 for more information.

Figure 2: Substantial Out-of-State Holdings of Single-State Funds

Note: This figure presents out-of-state bond holdings of single-state funds in percent of TNA, aggregated by fund and averaged by state. Error bars are shown around these averages. States with at least five single-state mutual funds are included.



I clean the data in several steps. For the MSRB data on bond trades, I follow Schwert (2017) by keeping trades of bonds whose coupon rates are below 20%, whose coupon rates and yield rates are not missing, with maturities between 1 and 100 years, and with at least 10 trades over the sample period. I drop bond trades that occur on holidays. Using data from Mergent Municipal Bond Database, I exclude insured and federally-taxable bonds to create a sample of bonds with comparable risk premia. I also drop bonds whose sales were cancelled or pre-refunded, variable-rate bonds, and bond trades within three months of issuance. I keep bonds with embedded options but ensure that the results of Section 3 are robust to their exclusion.

Whenever possible, I identify the state of a bond and a fund. Within the universe of municipal bond mutual funds in Morningstar, I identify national funds as those categorized as "US Fund Muni National," "US Fund High Yield Muni," and "US Fund Miscellaneous Fixed Income." I classify all other funds as single-state funds. I assign a state to a single-state fund based on the fund's name and to a bond based on the bond

issuer's name, which includes the issuer's state in Mergent Municipal Bond Database.[6]

I calculate daily federal-tax-adjusted spreads of municipal bonds as

$$\text{Spread} = \frac{y}{1 - t_f} - r_f,$$

where y is a bond's yield calculated using the MSRB database, t_f is the marginal federal tax rate on the top income bracket published by the Tax Policy Center, and r_f is the maturity-matched Treasury note yield published by the Federal Reserve. This tax adjustment accounts for the fact that municipal bond interest income is deductible from federal taxes. Without state tax adjustments, spreads indicate the returns earned by out-of-state municipal bond investors. Following Green, Li, and Schürhoff (2010), I construct municipal bond yields for each day from bond transactions by taking the average of that day's highest yield on sales by dealers to customers and lowest yield on purchases by dealers from customers. If yields on customer sales or purchases are not available, I use the average yield on transactions among dealers, if available. Otherwise, I do not calculate a yield for the bond on that day.

The sample consists of 9,349,240 fund-bond-quarter observations for 198,368 municipal bonds issued by 15,853 municipalities and held by 3,056 mutual funds. Table 1 presents the summary statistics of this sample. I trim spreads and flows at the 0.5% and 99.5% percentiles. The average bond holding of single-state funds is 0.57% of TNA. Single-state funds are, on average, 15 years old and have an average Morningstar rating of 2.9 out of 5. They have about $180 million in TNA and negative net inflows of about $0.65 million. Moreover, the average yield spread and coupon of municipal bonds are 0.98% and 4.82%. Their average time to maturity is 14 years.

[6] I drop single-state funds for Delaware because of name confusion between the state of Delaware and the Delaware Funds offered by Macquarie Investment Management.

Table 1: Summary Statistics of Key Variables

Note: This table presents summary statistics of key variables. Reported statistics are mean, standard deviation, minimum, maximum, and number of observations. Reported variables are the bond holdings of single-state funds; the age, Morningstar rating, TNA, and quarterly flows of single-state funds; and the coupon rate, spread, and time to maturity of municipal bonds.

	Mean	Std. Dev.	Min	Max	Observations
Holding (% of TNA)	0.57	0.70	0	35.05	3,494,294
Fund-quarter observations					
Age (months)	182.80	108.12	0	563.50	85,025
Morningstar rating	2.94	1.10	1	5	72,603
TNA ($ million)	179.96	641.74	0.1	17,380.2	55,509
Flows ($ million)	-0.65	16.59	-284.71	339.72	75,830
Bond-quarter observations					
Coupon (%)	4.82	0.94	0	13	727,560
Spread (%)	0.98	2.11	-20.04	13.47	720,330
Time to maturity (years)	14.01	8.35	1.08	84	221,424

3 The Impact of State Taxes on Municipal Bonds

Using a causal identification strategy, I now quantify the impact of state tax policies on investor demand for municipal bonds. I find that a 1 p.p. increase in state income tax rates on the top income bracket raises resident flows into local municipal bonds by about 0.5% of total net assets relative to bond demand in other states. My identification strategy relies on a difference-in-differences analysis around the dates on which higher "millionaire taxes" were announced by several high-tax states. I also show that millionaire tax announcements reduce cross-state municipal bond demand across the market.

"Millionaire taxes" are higher tax rates on top earners, typically those with annual incomes of at least $1,000,000, that were introduced by several states in recent years: California (November 2012), New Jersey (September 2020), New York (April 2021), and Massachusetts (November 2022). In California and Massachusetts, these millionaire taxes re-

sulted from ballot measures. In New York and New Jersey, they resulted from legislation to raise state revenues after the COVID-19 crisis.[7]

I hypothesize that higher tax rates in the top income bracket raise resident flows into local municipal bonds in millionaire-tax states. This creates inflows to single-state mutual funds and reduces local bond yield spreads relative to out-of-state bond yield spreads. To analyze the resulting impact on resident flows into local bonds, I use a staggered difference-in-differences approach around the announcements of higher millionaire taxes as treatments, with a specification at the municipal issuer-quarter level:

$$\text{Single-State Fund Flows}_{it} = \alpha_t + \alpha_i + \beta \times \mathbb{1}(\text{Millionaire Tax})_{it} + \epsilon_{it}, \tag{1}$$

where $\text{Single-State Fund Flows}_{it}$ is the value-weighted flows to single-state funds holding bonds of municipal issuer i at time t, in percent of TNA. I calculate value-weighted flows by aggregating single-state fund flows, weighted by a fund's TNA, and scaling them by aggregate lagged fund TNA. $\mathbb{1}(\text{Millionaire Tax})$ is the announcement date of a millionaire tax hike in the state of the municipal issuer. The window of the specification is $[-4; 13]$ quarters around the announcement dates. I allow for quarter and issuer fixed effects, α_t and α_i respectively, using the Borusyak, Jaravel, and Spiess (2024) estimator. The residual term is ϵ_{it}. I cluster observations at the state level.

The level of treatment is the municipal issuer. The treatment group consists of municipal issuers in millionaire-tax states. I include in the control group not-yet-treated issuers and issuers in other high-tax states (D.C., Hawaii, Idaho, Maine, Minnesota, North Carolina, Oregon, Rhode Island, Vermont, and Wisconsin) to create a sample of issuers with comparable default risk. The resulting sample represents 5,223 municipal issuers

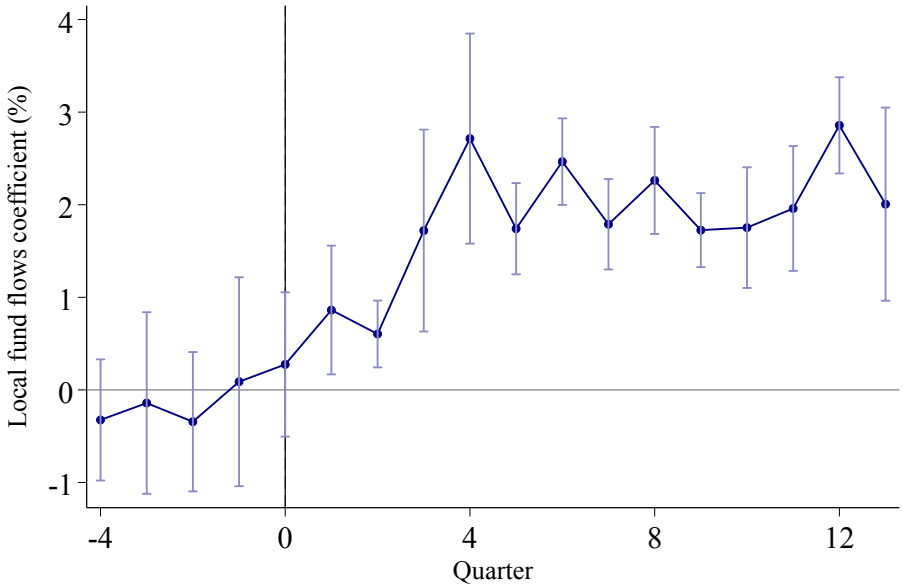
[7] See this link for more information on the tax change in Massachusetts, this link for more information on the tax changes in California and New Jersey, and this link for information on the tax change in New York. I exclude tax policy changes in Washington D.C. because the district exempts out-of-state bonds from taxation.

across 14 states. As standard in difference-in-differences identification, the identification assumption is parallel trends for the demand of control and treated municipal issuers in the absence of millionaire taxes. I discuss this assumption below.

The hypothesis is that $\beta > 0$, meaning that resident flows into the municipal bonds of issuers in high-tax states increases following the announcements of millionaire taxes, relative to the demand of other high-tax state residents for their local municipal bonds. Given the typical delays between the announcements and implementations of these tax changes (about 4 quarters on average), estimates of β may not peak until several quarters after the initial announcements. This could delay the observed causal effects of the announced tax change.

Figure 3: Higher Millionaire Tax Rates Raise Resident Flows into Local Bonds

Note: This figure presents the dynamic results of Equation (1). The outcome variable is the value-weighted single-state fund flows holding bonds of a municipal issuer in a millionaire-tax state. I use the Borusyak et al. (2024) estimator in estimating these dynamic staggered difference-in-differences coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.



Estimation results are shown in Figure 3. Pre-trends are insignificant and relative to demand for the bonds of control issuers, local demand for the bonds of treated issuers

starts to significantly increase immediately upon announcement, reaching nearly 3% of TNA within three years. These estimates are statistically significant and economically important. Figure E2 shows that the persistence of these estimates depends on the announcement type. Legislative announcements are followed by a very gradual increase in resident flows into local bonds. In contrast, electoral announcements are followed by an sharp rise in resident flows that slowly reverts over time. On average, increasing state income tax rates by 1 p.p. raises local demand for the bonds of treated issuers by about 0.52% of TNA relative to local demand for the bonds of control issuers (Table 2 and Figure E3).

The estimate of β could be contaminated in several ways. First, fiscal revenues, rather than the demand channel, could affect the estimate of state income taxes on resident flows. For instance, if investors infer from the tax changes higher state revenues, then the identification assumption could be violated. However, the additional tax revenue caused by these millionaire taxes is only about 0.15% of state GDP, on average and across states. I can also exploit bond ratings as indicators of the future fiscal outlook of municipal issuers. Figure E4 shows that bond ratings of treated and control issuers evolve similarly after millionaire tax announcements, which suggests that these announcements do not significantly affect the fiscal situations of municipal issuers.

Second, states might exploit the increase in resident flows caused by tax hikes to reduce debt, which would also violate the identification assumption. I directly test whether supply plays a role in driving the fund-flow response by excluding state governments, identified using their 6-digit CUSIP codes, from the set of treated issuers. Figure E5 shows that the results are robust to this exclusion.

Third, millionaire tax announcements could generate income effects by reducing the wealth of top earners, which also affects their bond allocations. However, the negative wealth effects of millionaire taxes would reduce savings in municipal bonds, causing a

downward bias in the average treatment effect. Moreover, recent work in public finance finds that this effect is minor (Rauh, 2022; Rauh and Shyu, 2024).

Fourth, an omitted variable, such as state fiscal shortfalls, could affect both the tax hikes and also resident flows. However, fiscal shortfalls would push resident flows downwards, all else equal, also causing a downward bias in the average treatment effect of state income taxes on resident flows for local municipal bonds.

To support the demand hypothesis, I also show that the bond yield spreads of treated municipal issuers decline relative to control municipal issuers by about 22 basis points following the announcements of higher millionaire taxes (Table 2 and Figure E6). Table 2 also quantifies the elasticity of bond yield spreads and resident flows into local bonds with respect to state income tax rates. Raising state tax rates by 1 p.p. is followed by a decrease in the yield spreads of local bonds of about 13 basis points relative to out-of-state bonds, in addition to inflows to single-state funds in millionaire-tax states of about 0.52% of TNA, relative to funds in other high-tax states.

Table 2: Demand Impact of Millionaire Tax Announcements

Note: This table presents the impact of millionaire tax announcements on bond yield spreads and flows of single-state mutual funds as outcome variables. Treatment consists of millionaire-tax announcements (rows 2 and 3) and the corresponding change in average state tax rates for the top bracket (rows 4 and 5). Each row corresponds to a specification and each column corresponds to a point estimate. Flows correspond to the aggregate flows of single-state funds holding bonds of municipal issuers, weighted and scaled by fund TNA. Spread corresponds to the average federal-tax-adjusted yield spread, in percent. The columns Pre_t for $t = [1, 4]$ report the coefficients on the pre-trends for quarter $-t$ relative to the announcement dates. Observations are clustered at the state level. * corresponds to $p < 0.10$, ** corresponds to $p < 0.05$, and *** corresponds to $p < 0.01$.

Treatment	*Dep. variable*	β	Pre_1	Pre_2	Pre_3	Pre_4	*Obs*
$\mathbb{1}$(Millionaire Tax)	Flows (% of TNA)	7.036*** (0.452)	0.332 (1.295)	1.484 (1.227)	0.108 (1.071)	-0.941 (0.695)	39,626
	Spread (%)	-0.224** (0.094)	0.259*** (0.101)	0.029 (0.180)	0.043 (0.166)	0.183 (0.171)	41,532
Δ(Millionaire Tax)	Flows (% of TNA)	0.520*** (0.065)	-0.765*** (0.597)	-0.149 (1.387)	-1.192*** (0.837)	0.292 (1.627)	13,369
	Spread (%)	-0.131** (0.050)	-0.381*** (0.106)	0.182 (0.069)	-0.067 (0.156)	0.108 (0.198)	10,873

In addition to raising resident flows into local municipal bonds, announcements of higher millionaire taxes reduce the cross-state municipal bond demand of all municipal investors. To show this, I evaluate the impact of millionaire tax announcements on the demands of residents of millionaire-tax states for out-of-state bonds and residents of other states for bonds issued in millionaire-tax states. I respectively proxy these demands with the out-of-state bond holdings of single-state funds in millionaire-tax states and the holdings of other states' single-state funds in bonds issued within millionaire-tax states. Accordingly, I evaluate:

$$\text{Out-of-State Holdings}_{ft} = a_t + a_f + \beta_1 \times \mathbb{1}(\text{Millionaire Tax})_{ft} + \epsilon_{ft}, \tag{2}$$

$$\text{Out-of-State Holdings}_{it} = b_t + b_i + \beta_2 \times \mathbb{1}(\text{Millionaire Tax})_{it} + \nu_{it}, \tag{3}$$

where Out-of-State-Holdings$_{ft}$ stands for the average out-of-state holdings of single-state fund f at time t in percent of TNA. The treatment variable, $\mathbb{1}(\text{Millionaire Tax})_{ft}$, is a dummy for whether the fund's state announced higher millionaire tax rates at time t. Similarly, Out-of-State-Holdings$_{it}$ stands for the average holdings of other states' single-state funds in bonds of issuer i at time t in percent of TNA. An issuer is treated if it is located in a millionaire-tax state. The windows of both specifications are $[-4; 13]$ quarters around announcements. I let a_t, b_t, a_f, and b_i correspond to quarter, fund, and issuer fixed effects using the Borusyak et al. (2024) estimator. The residuals are ϵ_{ft} and ν_{it}. I cluster observations at the state level.

The announcements of higher millionaire tax rates is the treatment in both specifications. In Equation (2), single-state funds in high-tax states that announced higher millionaire tax rates are treated relative to single-state funds in other high-tax states. In Equation (3), issuers in millionaire-tax states are treated relative to issuers in other high-tax states.

Estimation results for these specifications are shown in Figure 4. Relative to funds in other high-tax states, funds in millionaire-tax states significantly and gradually reduce their out-of-state bond holdings. Table 3 shows that on average, those holdings decline by about 0.05% of TNA in the three subsequent years. For reference, the average out-of-state bond holdings of single-state funds in this sample are about 0.5% of TNA. In addition, residents of other states significantly and gradually reduce their holdings of bonds in millionaire-tax states, relative to bonds of other high-tax states. On average, those holdings decline by about 0.06% of TNA. Hence, municipal investors are less diversified after millionaire tax announcements.[8]

[8] Assuming municipal investors in other states reallocate their holdings to local municipal bonds, this corresponds to an average decline in the tax revenues of other states of about 12.4% (0.063/0.507).

Figure 4: Higher Millionaire Tax Rates Reduce Cross-State Municipal Bond Demand

Note: This figure presents the dynamic results of Equations (2) and (3). Equation (2) corresponds to the "Funds in millionaire-tax states" set of coefficients, while Equation (3) corresponds to the 'Funds in other states" set of coefficients. Outcome variables are out-of-state fund holdings in percent of TNA. For funds in non-millionaire-tax states, out-of-state bonds are those issued by municipal issuers in millionaire-tax states. I use the Borusyak et al. (2024) estimator in estimating the coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

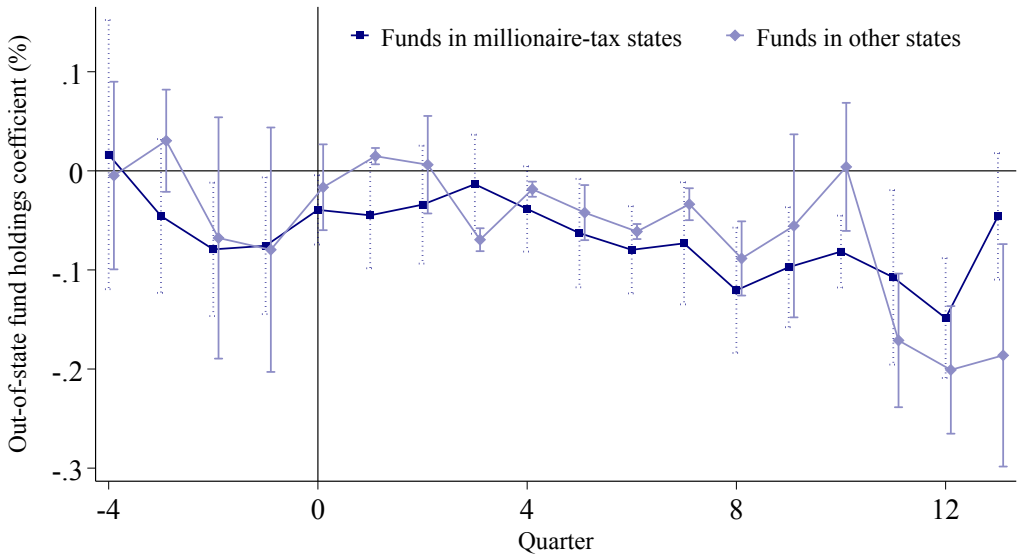


Table 3: Millionaire Tax Announcements Reduce Cross-State Municipal Bond Demand

Note: This table presents the pooled results of Equations (2) and (3) in the second and third rows, respectively. Out-of-State-Holdings$_{ft}$ corresponds to the average out-of-state bond holdings of single-state fund f located in a high-tax state and measured in percent of TNA. Out-of-State-Holdings$_{it}$ corresponds to the average holdings of other states' single-state funds in bonds of municipality i located in a high-tax state and measured in percent of TNA. The columns Pre_t for $t = [1, 4]$ report the coefficients on the pre-trends for quarter $-t$ relative to the announcement dates. Observations are clustered at the state level. * corresponds to $p < 0.10$, ** corresponds to $p < 0.05$, and *** corresponds to $p < 0.01$.

Sample	*Dep. var.*	*Coefficient*	Pre_1	Pre_2	Pre_3	Pre_4	*Obs.*	*Mean dep. var.*
Funds in millionaire-tax states	Out-of-State Holdings$_{ft}$	-0.048*** (0.003)	-0.080 (0.063)	-0.068 (0.062)	0.030 (0.026)	-0.005 (0.048)	10,902	0.549
Funds in other states	Out-of-State Holdings$_{it}$	-0.063*** (0.022)	-0.074** (0.036)	-0.078** (0.035)	-0.044 (0.040)	0.018 (0.069)	26,584	0.507

4 A Theoretical Model of the Municipal Bond Market

I have shown that millionaire tax announcements impact resident and cross-state municipal bond demand. To quantify the cross-state externalities of state tax shields and evaluate their effects on equilibrium bond prices, demand, and state tax policies, I now develop a two-period equilibrium model of pricing and investment in the municipal bond market, coupled with the strategic setting of tax shields by state authorities.

In the first period, to finance the provision of public services, states $\mathcal{H}$ and $\mathcal{L}$ issue one-period municipal bonds in fixed supplies, S_H and S_L respectively, and set tax rates on the bond interest income of their residents. Bonds mature at the end of the second period. In the second period, residents of the two states trade the municipal bonds, pay taxes on their bond income, and consume local public services. Total bond payoffs, principal plus interest, have a joint normal probability distribution with correlation $\rho \in (-1, 1)$, respective means μ_H and μ_L, and respective variances σ_H^2 and σ_L^2. This is an abstraction; bonds actually have bounded positive payoffs that consist of capital gains and coupon payments. I ignore the tax rate on capital gains.

Each state maximizes the certainty-equivalent utility of its residents subject to its budget constraint. I assume that public services in each state are financed with debt issuance and expected tax revenue. State $\mathcal{H}$ sets respective non-negative tax rates τ_H and T_H on the interest income of out-of-state and local bonds. Implementing a tax shield therefore corresponds to setting $T_H = 0$. Analogously, State $\mathcal{L}$ sets respective non-negative tax rates τ_L and T_L on the interest income of out-of-state and local bonds.

In the second period, a unit mass of investors with discount factor ℓ and mean-variance preferences trades the municipal bonds. A fraction ϕ of investors resides in State $\mathcal{H}$, has risk-aversion coefficient γ_H, and consumes a per-capita amount G_H of State $\mathcal{H}$'s public services. The mean of the after-tax municipal bond portfolio payoffs of State

$\mathcal{H}$'s residents is

$$\Pi_H = D_H^H(1-T_H)(\mu_H - P_H - R_f) + D_H^L(1-\tau_H)(\mu_L - P_L - R_f),$$

where $R_f = 1 - 1/\ell$ is the risk-free rate implied by the discount factor ℓ. D_H^H and D_H^L are the per-capita respective demands of State $\mathcal{H}$'s residents for the bonds of States $\mathcal{H}$ and $\mathcal{L}$, which trade at respective prices P_H and P_L. The remaining fraction $1-\phi$ of agents resides in State $\mathcal{L}$, has risk-aversion coefficient γ_L, and consumes a per-capita amount G_L of State $\mathcal{L}$'s public services. The mean of the after-tax municipal bond portfolio payoffs of those residents is

$$\Pi_L = D_L^L(1-T_L)(\mu_L - P_L - R_f) + D_L^H(1-\tau_L)(\mu_H - P_H - R_f),$$

where D_L^L and D_L^H are the per-capita respective demands of State $\mathcal{L}$'s residents for the bonds of States $\mathcal{H}$ and $\mathcal{L}$. The variances of the after-tax municipal bond portfolio payoffs, $\mathbb{V}_H$ and $\mathbb{V}_L$, are straightforwardly computed.[9]

I will characterize an asymmetric equilibrium in which both states shield local bond income from taxation and State $\mathcal{H}$ sets a higher tax rate on out-of-state bonds than State $\mathcal{L}$ ($\tau_H^* \geq \tau_L^*$) if State $\mathcal{H}$ is sufficiently large, in that

$$\phi \geq \max\left(\frac{\gamma_H}{\gamma_H + 2\gamma_L}, \zeta(\Theta)\right), \tag{4}$$

[9] Taxes on bond coupon payments do not affect bond payoff variances, which are driven by capital gains. The respective variances of the after-tax bond portfolio payoffs of residents of State $\mathcal{H}$ and State $\mathcal{L}$ are

$$\mathbb{V}_H = \frac{\gamma_H}{2}\left(D_H^{H2}\sigma_H^2 + D_H^{L2}\sigma_L^2 + 2\rho D_H^H D_H^L \sigma_H \sigma_L\right), \qquad \mathbb{V}_L = \frac{\gamma_L}{2}\left(D_L^{L2}\sigma_L^2 + D_L^{H2}\sigma_H^2 + 2\rho D_L^L D_L^H \sigma_L \sigma_H\right).$$

where

$$\zeta(\Theta) \equiv \frac{-2\gamma_H\left(1+\frac{\rho S_H\sigma_H\gamma_H}{S_L\sigma_L\gamma_L}\right)+\sqrt{4\gamma_H^2\left(1+\frac{\rho S_H\sigma_H\gamma_H}{S_L\sigma_L\gamma_L}\right)^2+4\frac{S_H\sigma_H\rho\gamma_H^2}{S_L\sigma_L\gamma_L}\left(\gamma_L-2\gamma_H-\frac{S_H\sigma_H\rho\gamma_H^2}{S_L\sigma_L\gamma_L}\right)}}{2\left(\gamma_L-2\gamma_H-\frac{S_H\sigma_H\rho\gamma_H^2}{S_L\sigma_L\gamma_L}\right)}.$$

In Appendix Section C, I endogenize investor masses by allowing residents to move out of a state. I calibrate the migrating mass to IRS data and find that incorporating migration does not substantially affect equilibrium allocations and prices given low observed out-migration rates, which have been less than 3% since 2018 according to the IRS state-to-state migration data.

4.1 Second Period

At bond prices P_H and P_L and given the vector $\theta = (\mu_H, \mu_L, \sigma_H, \sigma_L, \rho)$ of bond payoff parameters, the optimal portfolio allocation of $\mathcal{H}$-residents to State $\mathcal{H}$'s bonds is

$$D_H^H(P_H, P_L, \gamma_H, \theta, T_H, \tau_H) = \frac{1}{\gamma_H(1-\rho^2)}\left(\frac{(1-T_H)(\mu_H - P_H - R_f)}{\sigma_H^2} - \rho\frac{(1-\tau_H)(\mu_L - P_L - R_f)}{\sigma_H\sigma_L}\right).$$

In choosing their allocations to State $\mathcal{H}$'s bonds, $\mathcal{H}$-residents therefore compare the Sharpe ratios of State $\mathcal{H}$'s and State $\mathcal{L}$'s bonds, applying tax rate T_H to the former bonds and τ_H to the latter bonds. As expected, the optimal allocations to State $\mathcal{H}$'s bonds decline with the risk aversion of $\mathcal{H}$-residents, γ_H, and the payoff volatility of State $\mathcal{H}$'s bonds, σ_H. The remaining optimal portfolio allocations of $\mathcal{H}$-residents and $\mathcal{L}$-residents are outlined in Appendix Section A.

Market clearing dictates that

$$\phi D_H^H + (1-\phi)D_L^H = S_H, \qquad \phi D_H^L + (1-\phi)D_L^L = S_L.$$

Solving the equilibrium reveals that investors do not short bonds (Appendix Section D.1). The equilibrium bond prices are

$$P_H^*(\gamma_H, \gamma_L, T_H, \tau_L, \phi, \theta, S_L, S_H) = \mu_H - R_f - \frac{S_H\sigma_H^2 + \rho S_L \sigma_H \sigma_L}{\omega_H(T_H, \tau_L, \gamma_H, \gamma_L, \phi)}, \tag{5}$$

$$P_L^*(\gamma_H, \gamma_L, \tau_H, T_L, \phi, \theta, S_L, S_H) = \mu_L - R_f - \frac{S_L\sigma_L^2 + \rho S_H \sigma_H \sigma_L}{\omega_L(\tau_H, T_L, \gamma_H, \gamma_L, \phi)}, \tag{6}$$

where

$$\omega_H(T_H, \tau_L, \gamma_H, \gamma_L, \phi) = \frac{\phi(1-T_H)}{\gamma_H} + \frac{(1-\phi)(1-\tau_L)}{\gamma_L},$$
$$\omega_L(\tau_H, T_L, \gamma_H, \gamma_L, \phi) = \frac{\phi(1-\tau_H)}{\gamma_H} + \frac{(1-\phi)(1-T_L)}{\gamma_L}.$$

This equilibrium is unique given tax rates. While a bond's price depends on the supplies and payoff variances of bonds in both states, the only tax rates that affect a bond's price are those on its interest income. Moreover, both bond demands and prices are decreasing in the tax rates on bond income. This contrasts with the seminal insight of Domar and Musgrave (1944) and Tobin (1958) that taxing an asset raises its portfolio share. Unlike this paper, taxation in those foundational papers allowed the government to share the risks borne by private investors by reducing both the after-tax return and variance of a risky asset.

Lemma 1. *The equilibrium price of a bond is declining in either of the two tax rates on its interest income.*

4.2 First Period

States $\mathcal{H}$ and $\mathcal{L}$ simultaneously choose non-negative tax rates (τ_H, T_H) and (τ_L, T_L) on resident interest income derived from out-of-state and local bonds, respectively. In practice, states can establish reciprocity agreements to set differential tax rates on income

that their residents derive from specific states.[10] States maximize the welfare of their residents subject to their budget constraints. Given the setting above, I ignore state tax revenues from non-interest income and focus exclusively on each state's reliance on bond tax revenues and bond issuance to meet its fiscal needs. I hold bond supply fixed for now, although I endogenize each state's bond issuance in Appendix Section C.

With lump-sum taxation, the objective function of State $\mathcal{H}$ is

$$\max_{T_H,\tau_H} \quad U_H(T_H,\tau_H,T_L,\tau_L) = \max_{T_H,\tau_H} \quad \phi\left(\Pi_H(\Theta) - \frac{\gamma_H}{2}\mathbb{V}_H(\Theta) + G_H\right),$$

where $\Theta = (\gamma_H,\gamma_L,\mu_H,\mu_L,\sigma_H,\sigma_L,\rho,\phi,S_H,S_L,R_f)$ is the vector of model parameters. This objective function is subject to the budget constraint that the provision of the public services, whose price is fixed and normalized to unity, must equal the state's total debt issuance and the expected tax revenue that it collects from its residents:

$$\underbrace{\phi G_H}_{\text{Provision of public services}} = \underbrace{S_H P_H^*(\Theta)}_{\text{Debt financing}} + \underbrace{\phi D_H^{L*}\tau_H(\mu_L - P_L^*(\Theta)) + \phi D_H^{H*}T_H(\mu_H - P_H^*(\Theta))}_{\text{Expected tax revenue}}.$$

Because residents consume public services provided by the state government and municipalities in the state, this budget constraint aggregates the debt issuance of both municipalities and the state.[11] Substituting this budget constraint into State $\mathcal{H}$'s objective function, we can write State $\mathcal{H}$'s maximization problem as

$$\max_{T_H,\tau_H} \phi \underbrace{\left(\Pi_H(\Theta) - \frac{\gamma_H}{2}\mathbb{V}_H(\Theta)\right)}_{\text{Portfolio utility}} + \underbrace{\phi\left(D_H^{L*}\tau_H(\mu_L - P_L^*(\Theta)) + D_H^{H*}T_H(\mu_H - P_H^*(\Theta)\right) + S_H P_H^*(\Theta)}_{\text{Public services utility}}.$$

[10] Currently 16 states and the District of Columbia have reciprocity agreements with other states (see this source for more information). The type of income allowed under reciprocity varies across states. For instance, Kentucky's reciprocal agreement with Indiana covers income derived from commissions, unlike its reciprocal agreements with Illinois, Ohio, and West Virginia.

[11] My analysis of the most recent version of the Census' Annual Survey of State and Local Government Finances shows that state borrowing consists of around 36% of total local and state borrowing.

We can similarly define the optimization problem of State $\mathcal{L}$.

When raising interest income tax rates, states balance two effects: lower portfolio utility and increased provision of public services. Increasing a tax rate distorts the portfolio allocations of residents away from the bonds whose tax rates increase, which reduces portfolio utility. On the other hand, higher tax rates expand the tax base of the state, raising its expected tax revenue. These combine to determine whether a state's tax policies raise the welfare of its residents, holding the other state's tax rates fixed.

State tax policies also alter the welfare of residents in the other state. The net effect on their welfare is determined by the change in their portfolio utility and their state's tax revenues. Raising any tax rate increases the risk premium of the affected bonds and their share in the portfolios of the other state's residents, which raises their portfolio utility. I show below, however, that the total impact on their welfare depends on the tax hike. For instance, raising $T \in \{T_H, T_L\}$ increases cross-state bond demand across the market, which raises the other state's tax revenues and imposes a positive externality on its residents. In contrast, raising $\tau \in \{\tau_H, \tau_L\}$ reduces cross-state bond demand and imposes a negative externality on the other state's residents because the ensuing decline in their state's tax revenue dominates the increase in their portfolio utility.

These forces shape the competition between state tax authorities over tax policies. Proposition 1, whose proof is in Appendix Section D.2, shows that there is a Nash equilibrium in the taxation of local bond income, and similarly for the taxation of out-of-state bond income.

Proposition 1. *If local bond income is tax exempt, there is unique Nash equilibrium* (τ_H^*, τ_L^*) *for out-of-state tax rates. Similarly, given out-of-state tax rates* τ_H *and* τ_L*, there is unique Nash equilibrium* (T_H^*, T_L^*) *for local tax rates.*

Moreover, the tax-rate reaction curves are downward-sloping, per the proposition

below, whose proof is in Appendix Section D.3. This strategic substitution[12] is intuitive because each state's tax actions symmetrically affect investor demand in both states: any local bond income taxation raises cross-state bond demand for all investors, while any out-of-state bond income taxation reduces this demand.

Proposition 2. *The out-of-state tax rates τ_H^* and τ_L^* are strategic substitutes, as are the local tax rates T_H^* and T_L^*.*

We can further characterize these equilibrium tax rates. Setting maximal tax shields is a dominant strategy for both states because the ensuing rise in debt financing (equivalently, the decline in debt financing costs) dominates the associated decline in expected tax revenue for each state. Proposition 3 states this result. Its proof is in Appendix Section D.4.

Proposition 3. $T_H^* = 0$ *and* $T_L^* = 0$.

We can determine which state sets a higher tax rate on out-of-state bonds in equilibrium. Proposition 4 shows that because State $\mathcal{H}$ is larger than State $\mathcal{L}$ in investor mass (Condition (4)), τ_H^* exceeds τ_L^*. This result is similar to other findings in the public economics literature on tax competition (e.g., Theorem 1 in Bucovetsky, 1991) and is driven by the larger state's greater fiscal needs. Its proof is in Appendix Section D.5.

Proposition 4. $\tau_H^* \geq \tau_L^*$.

As typical in theories of tax competition, this model carries a social inefficiency in the form of an externality (Bucovetsky, 1991; Keen and Konrad, 2013; Dell'Ariccia and Marquez, 2006). To analyze the externality generated by the optimal tax policy, I compare the problem of the independent states to the problem of a social planner who

[12] Tax rates are strategic substitutes if the derivative of the marginal utility of State i with respect to the tax rate of State j is negative for $i \neq j \in \{\mathcal{H}, \mathcal{L}\}$ (Tirole, 1988).

sets tax rates for both states. Suppose the planner places Pareto weights η and $1-\eta$ on the utilities of residents of State $\mathcal{H}$ and State $\mathcal{L}$ respectively. The planner then solves

$$\max_{\tau_H^c, \tau_L^c, T_H^c, T_L^c} \quad \eta U_H(\tau_H^c, \tau_L^c, T_H^c, T_L^c) + (1-\eta) U_L(\tau_H^c, \tau_L^c, T_H^c, T_L^c), \tag{7}$$

subject to each state's budget constraint. Let $(\tau_H^{c*}, \tau_L^{c*}, T_H^{c*}, T_L^{c*})$ denote the solution to the planner's problem. Proposition 5 below, whose proof is in Appendix Section D.6, shows that the social planner would repeal tax shields and reduce tax rates on out-of-state bond income. In equilibrium, inefficiencies arise from the fact that taxes affect the bond portfolio allocations of all investors. Higher tax rates on out-of-state bond income for one state impose a negative externality on the other state by reducing its expected tax revenue. This outweighs the higher portfolio utility of its residents. In contrast, higher tax rates on local bond income generate a positive externality on the other state, raising its expected tax revenue and increasing the portfolio utility of its residents.

Proposition 5. *States choose higher tax rates on out-of-state bond income than a social planner, in that $\tau_H^* > \tau^{c*}$ and $\tau_L^* > \tau^{c*}$. States also choose lower tax rates on local bond income than the social planner, in that $T^{c*} > T_H^*$ and $T^{c*} > T_L^*$.*

In this strategic setting, states can also improve welfare by entering tax treaties by which each state reduces or eliminates the income tax on the other state's bonds. Building on Proposition 5, Corollary 1 shows that tax treaties are welfare-improving. Such treaties can be unilateral or bilateral. For example, Utah implements a unilateral treaty which exempts from taxation municipal bond income generated in any state that exempts Utah's municipal bonds from taxation (Utah Code § 59–10–114). Treaties of this form are also prevalent in labor income taxation. For example, New Jersey and Pennsylvania have a treaty over labor income taxation.

Corollary 1. *A marginal reduction of tax rates on out-of-state bonds in both states (e.g., through*

a tax treaty) would strictly raise aggregate welfare.

Lastly, Proposition 6, whose proof is in Appendix Section D.7, shows that knowing the change in cross-state municipal bond demand is sufficient for identifying the aggregate welfare effect of either state's tax policies on all residents. This arises because diversification drives the model's bond demand externality: raising local bond income taxation raises cross-state bond demand and aggregate welfare, while raising out-of-state bond income taxation reduces cross-state bond demand and aggregate welfare. For any tax rate $t \in \{\tau_H, T_H, \tau_L, T_L\}$, we can define aggregate welfare as

$$U(\tau_H, T_H, \tau_L, T_L) = U_H(\tau_H, \tau_L, T_H, T_L) + U_L(\tau_H, \tau_L, T_H, T_L).$$

The change in investor demand for out-of-state bonds is sufficient for welfare analysis, up to a scalar determined by tax rates, investor mass, and bond risk premium $\mu_i - P_i$ of State i's bonds for $i \in \{\mathcal{H}, \mathcal{L}\}$. Applying this result, Figure 4 and Table 3 show that millionaire tax announcements reduce the aggregate welfare of municipal investors.

Proposition 6. *The aggregate marginal welfare impacts of state tax policy changes are proportional to the sum of the marginal changes of investor demands for out-of-state bonds:*

$$\frac{dU(\tau_H, T_H, \tau_L, T_L)}{dt} = \kappa_1(t)\frac{dD_H^L(\Theta)}{dt} + \kappa_2(t)\frac{dD_L^H(\Theta)}{dt},$$

where $\kappa_1(t) = \phi\tau_H(\mu_L - P_L(t))$ *and* $\kappa_2(t) = (1-\phi)\tau_L(\mu_H - P_H(t))$ *for any tax rate* $t \in \{\tau_H, T_H, \tau_L, T_L\}$.

5 Taking the Model to the Data

I now use millionaire tax announcements to calibrate the model. Model calibration of risk-aversion coefficients exploits the elasticities of bond yield spreads and resident

flows with respect to state income tax rates. I show that reducing state tax shields by 1 p.p. raises aggregate welfare by about 0.07% of state GDP per year. This is equivalent to reducing bond return correlation by about 10% (0.1 p.p.), absent tax changes.

5.1 Model Calibration

I map the identified elasticities of bond yield spreads and resident flows with respect to state tax rates to two theoretical moments. These elasticities allow me to infer the risk aversion of municipal investors, a key set of parameters that govern welfare analysis.

Most model parameters are directly informed by the data and calibrated to the sample of bonds held by single-state municipal mutual funds between 2008 and 2023, as detailed in Table 4. The time horizon of the model is a year. State $\mathcal{L}$ corresponds to states with at least one single-state fund over the sample period and in the lowest tax quartile: Alabama, Arkansas, Arizona, Colorado, Connecticut, Florida, Kansas, Kentucky, Louisiana, Michigan, Mississippi, North Dakota, New Mexico, Ohio, Oklahoma, Pennsylvania, Tennessee, and Utah. The majority of these states shield their local municipal bonds from state income taxes and have an average interest income tax rate of 4.76% on the top bracket, using data that I collect from the Tax Foundation and manually validate with state taxation authorities.

With these parameters in hand, I check Condition (4) and calibrate the risk-aversion coefficients γ_H and γ_L using the identified estimates of the elasticities of single-state fund flows and bond yield spreads with respect to state income tax rates (Table 2). Because higher millionaire taxes correspond to raising tax rates on all but local bond income, I map these tax hikes to changes in the tax rate on out-of-state bond income, τ_H, while holding constant all other tax rates. Supposing that the theoretical equilibrium repre-

sents the market, then the two elasticities respectively map to two theoretical moments:

$$\frac{dD_H(\Theta)}{d\tau_H}, \qquad \frac{d\left(y_L(\Theta) - R_f\right)}{d\tau_H}, \tag{8}$$

where $D_H = D_H^H + D_H^L$ is the total demand of $\mathcal{H}$-residents and y_L the yield-to-maturity of State $\mathcal{L}$'s bonds with an average coupon rate C_L and time to maturity Γ_L. We can write the theoretical change in the yield-to-maturity of a coupon bond[13] as

$$\frac{dy_L(\Theta)}{d\tau_H}\left(\frac{\Gamma_L(C_L - P_L\Theta)y_L(\Theta))}{1+y_L(\Theta)} - P_L(\Theta) + \frac{100}{(1+y_L(\Theta))^{\Gamma_L}}\right) = \frac{dP_L(\Theta)}{d\tau_H}y_L(\Theta). \tag{9}$$

Using the method of moments, I find that $\gamma_H = 22.0$ and $\gamma_L = 13.8$. Therefore, the model implies comparable risk-aversion for residents of the two states. The elasticity of bond yield spreads to state tax rates is particularly informative of risk aversion because it governs the substitution effects of bond portfolio allocations for $\mathcal{H}$-residents. With CARA utility, these substitution effects dominate any potential income effects, which are informed by the elasticity of the total demand of $\mathcal{H}$-residents to state tax rates.

What if agents had CRRA preferences instead? We can use the calibrated absolute risk aversion above to assess relative risk aversion, which is the product of absolute risk aversion and wealth. Proxying for agent wealth with average personal consumption expenditures,[14] I find respective relative risk aversion coefficients for $\mathcal{H}$-residents and $\mathcal{L}$-residents of 26.6 and 4.6, driven by higher average consumption in State $\mathcal{H}$ ($1.2 trillion) relative to State $\mathcal{L}$ ($0.3 trillion).

[13] This derivation starts from Equation (6.5) in Berk and DeMarzo (2020).

[14] I calculate personal consumption expenditures for States $\mathcal{H}$ and $\mathcal{L}$ in 2023 using the BEA's data.

Table 4: Summary of Calibrated Parameters

Note: This table presents a list of calibrated parameters, their theoretical descriptions, the respective empirical targets, and parameter values. The time horizon of the model is a year.

Parameter	*Description*	*Target*	*Value*
τ_H	State $\mathcal{H}$'s tax rate on the interest income of State $\mathcal{L}$'s bond	Average income tax rate in the highest bracket in high-tax states	9.03%
τ_L	State $\mathcal{L}$'s tax rate on the interest income of State $\mathcal{H}$'s bond	Average income tax rates in the highest bracket in low-tax states	4.76%
T_H	State $\mathcal{H}$'s tax rate on the interest income of its own bond	Presence of a tax shield for local municipal bonds in high-tax states	0
T_L	State $\mathcal{L}$'s tax rate on the interest income of its own bond	Presence of a tax shield for local municipal bonds in low-tax states	0
(μ_H, σ_H)	State $\mathcal{H}$'s bond payoff mean and volatility	The annualized compound return relative to par of municipal bonds in high-tax states and their standard deviation	$(\$104.02, 3.54\%)$
(μ_L, σ_L)	State $\mathcal{L}$'s bond payoff mean and volatility	The annualized compound return relative to par of municipal bonds in low-tax states and their standard deviation	$(\$103.96, 3.34\%)$
ρ	Correlation of bond payoffs	The minimum 1-year rolling correlation of monthly bond returns across high-tax and low-tax states	0.9
S_H	State $\mathcal{H}$'s bond supply	TNA of single-state mutual funds in high-tax states	\$85.3 billion
S_L	State $\mathcal{L}$'s bond supply	TNA of single-state mutual funds in low-tax states	\$22.1 billion
Γ_L	State $\mathcal{L}$'s bond maturity	Maturity of coupon bonds in low-tax states	15 years
(C_L, y_L)	Coupon rate and yield-to-maturity of State $\mathcal{L}$'s bond (Equation (9))	Coupon and yield of coupon bonds with a maturity of 15 years in low-tax states	$(4.9\%, 2.7\%)$
ϕ	Fraction of $\mathcal{H}$-residents	Average share of single-state funds in high-tax states relative to single-state funds in low-tax states since 2020	0.84
R_f	Risk-free rate	Average market yield on 10-year Treasury securities at constant maturity	2.58%
(γ_H, γ_L)	Risk-aversion coefficients of $\mathcal{H}$-residents and $\mathcal{L}$-residents	Elasticities of bond yield spreads and single-state fund flows with respect to state income tax rates	$(22.0, 13.8)$

5.2 Evaluation of Cross-State Externalities of State Tax Shields

To evaluate the cross-state externalities of state tax shields, I conduct counterfactual analysis on the level of state tax rates on local bond income. Repealing the tax exemption of interest income has been proposed as a way to make the tax cuts of the TCJA perma-

nent (Pomerleau and Schneider, 2024).[15] For this reason, I use the plausibly calibrated model to evaluate three counterfactual tax policies: reducing the tax shield of State $\mathcal{H}$ by 1 p.p., reducing the tax shield of State $\mathcal{L}$ by 1 p.p., and reducing the tax shields of both states by 1 p.p. Throughout the analysis, I hold bond supplies S_H and S_L constant, although I conduct robustness on this assumption in Appendix Section C.

I assess counterfactual tax policies using the change in annual certainty-equivalent welfare for each of the counterfactual scenarios. I calculate this welfare over the typical holding period of municipal bonds in municipal bond mutual funds, which is about four years. I then calculate welfare on a present value basis and express it per year in percent of state GDP. In support of Proposition 5, I find that repealing the tax rate on the interest income of local bonds reduces investment in local bonds and creates positive externalities.

Figure 5 confirms that the proposed tax policies are welfare-improving. Repealing State $\mathcal{H}$'s tax shield increases the welfare of $\mathcal{L}$-residents by about 0.15% of State $\mathcal{L}$'s GDP, on average per year. Similarly, repealing State $\mathcal{L}$'s tax shield increases the welfare of $\mathcal{H}$-residents by about 0.04% of state $\mathcal{H}$'s GDP. A social planner who simultaneously repeals both tax shields would raise aggregate welfare by about 0.07% of state GDP per year. Although the change in certainty-equivalent welfare is comparable across the two states in nominal terms, scaling by state GDP accrues the majority of the benefit to $\mathcal{L}$-residents.

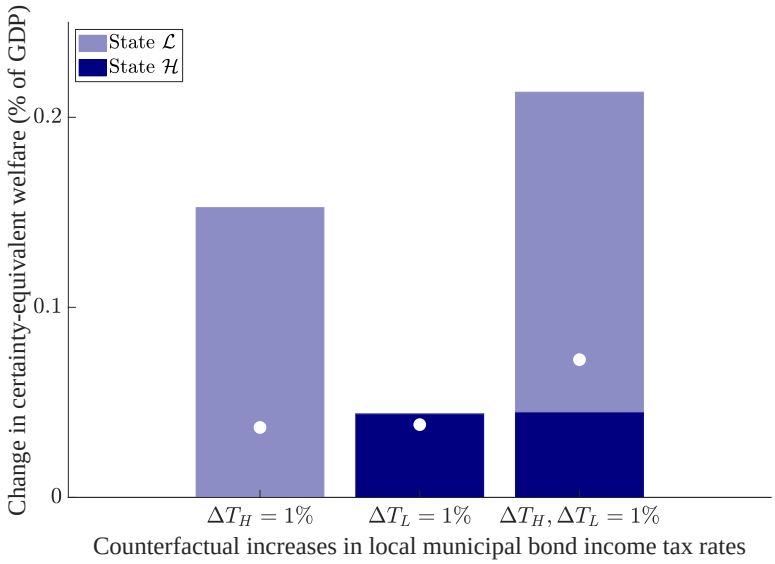
These welfare effects are driven by diversification gains to municipal investors and are therefore sensitive to risk aversion.[16] Moreover, because the welfare derived from investor holdings of municipal bonds is only a fraction of the welfare derived from the portfolio problem, the welfare impacts above might be overstated. Although this does not negate the presence of a fiscal externality of state tax shields on the expected tax rev-

[15] See, for instance this Bondbuyer article for a summary of the policy debate.

[16] For instance, if $\gamma_H = \gamma_L = 5$, then repealing both tax shields would raise aggregate welfare by about 0.01% of average state GDP.

Figure 5: Welfare Assessments of Tax Policy Proposals

Note: This figure presents the results of counterfactual evaluation for State $\mathcal{H}$ in dark blue and State $\mathcal{L}$ in light blue using three scenarios: 1) raising T_H by 1 p.p., 2) raising T_L by 1 p.p., and 3) setting $T_H = T_L = 1$ p.p. Dots present the average change in aggregate welfare, annuitized and expressed per year in percent of aggregate state GDP. I assess the results of these counterfactual tax policies using the annual change in the welfare of a state's residents in certainty-equivalent terms and on a present value basis, normalized by state GDP in 2023. Aggregate welfare is expressed in percent of aggregate state GDP. State GDP is from the Bureau of Economic Analysis' annual nominal GDP series SAGDP2N.

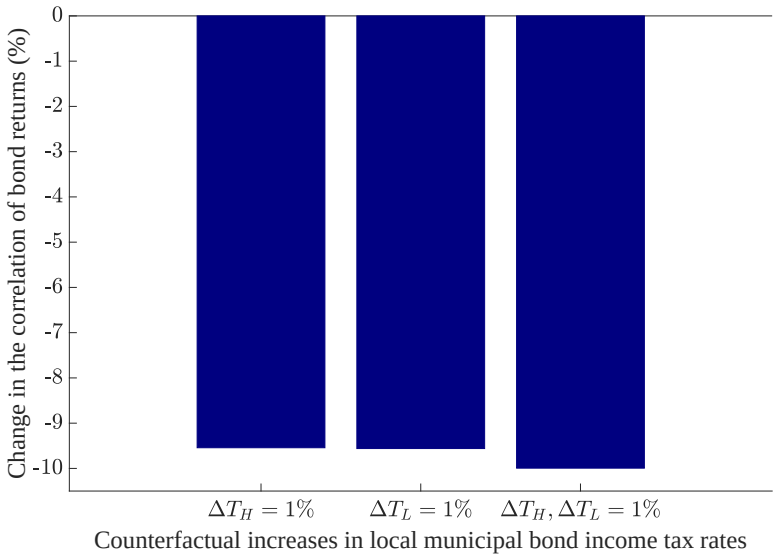


enues of other states, I address these concerns by calculating the change in bond return correlation required to generate similar diversification gains, absent tax policy changes. This ensures the robustness of the analysis to potential model mis-specification. Figure 6 shows that to generate equivalent welfare gains to reducing all state tax shields by 1 p.p., an average decline of bond return correlation from its current level of about 10% (0.1 p.p.) is required. This estimate is robust to alternative risk aversion calibrations.[17]

[17] Supposing an alternative calibration of $\gamma_H = \gamma_L = 5$ barely alters the required decline in bond return correlation, which would be about 9.6%.

Figure 6: Equivalent Changes in Bond Return Correlation

Note: This figure presents the equivalent changes in bond return correlation required to generate the welfare impacts of Figure 5, absent any tax changes and relative to the average 1-year rolling correlation of monthly bond returns across high-tax and low-tax states. The counterfactual scenarios considered are raising T_H by 1 p.p., raising T_L by 1 p.p., and setting $T_H = T_L = 1$ p.p.



6 Conclusion

I show that state tax shields in the municipal bond market reduce local municipal and state financing costs but distort cross-state risk-sharing and impose negative externalities on other states. A calibrated two-period equilibrium model of the municipal bond market, with state competition over tax shields, elucidates the inefficiencies created by state tax policies and shows that raising tax rates on local bond income by 1 p.p. across states would raise the aggregate welfare of all municipal investors by about 0.07% of state GDP per year. To generate similar welfare gains absent tax changes, bond return correlation would need to decline by about 10% (0.1 p.p.). The impact of the growth of municipal bond mutual funds on municipal bond liquidity and the cross-state consequences of corporate state tax policies merit additional scrutiny in future work.

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The Efficiency of Municipal Bond Tax Shields Online Appendix

This section presents the online appendix of *The Efficiency of Municipal Bond Tax Shields.* Section A presents the equilibrium bond allocations of agents in the second period of the model. Section B generates model implications and tests them using changes in Morningstar ratings. Section C presents additional counterfactual analyses and model extensions on migration and bond issuance. Section D presents model proofs. Lastly, Section E presents additional figures.

A Model Equilibrium Equations

The optimal portfolio allocations of $\mathcal{H}$-residents and $\mathcal{L}$-residents are:

$$D_H^H(P_H, P_L, \gamma_H, \theta, T_H, \tau_H) = \frac{1}{\gamma_H(1-\rho^2)\sigma_H}\left(\frac{(1-T_H)(\mu_H - P_H - R_f)}{\sigma_H} - \rho\frac{(1-\tau_H)(\mu_L - P_L - R_f)}{\sigma_L}\right),$$

$$D_H^L(P_H, P_L, \gamma_H, \theta, T_H, \tau_H) = \frac{1}{\gamma_H(1-\rho^2)\sigma_L}\left(\frac{(1-\tau_H)(\mu_L - P_L - R_f)}{\sigma_L} - \rho\frac{(1-T_H)(\mu_H - P_H - R_f)}{\sigma_H}\right),$$

$$D_L^L(P_H, P_L, \gamma_L, \theta, T_L, \tau_L) = \frac{1}{\gamma_L(1-\rho^2)\sigma_L}\left(\frac{(1-T_L)(\mu_L - P_L - R_f)}{\sigma_L} - \rho\frac{(1-\tau_L)(\mu_H - P_H - R_f)}{\sigma_H}\right),$$

$$D_L^H(P_H, P_L, \gamma_L, \theta, T_L, \tau_L) = \frac{1}{\gamma_L(1-\rho^2)\sigma_H}\left(\frac{(1-\tau_L)(\mu_H - P_H - R_f)}{\sigma_H} - \rho\frac{(1-T_L)(\mu_L - P_L - R_f)}{\sigma_L}\right).$$

B Model Validation with Morningstar Ratings

I use Morningstar ratings to test how large the demand of municipal investors for out-of-state bond holdings is and whether demand shifts of municipal investors in different states vary with state tax policies.

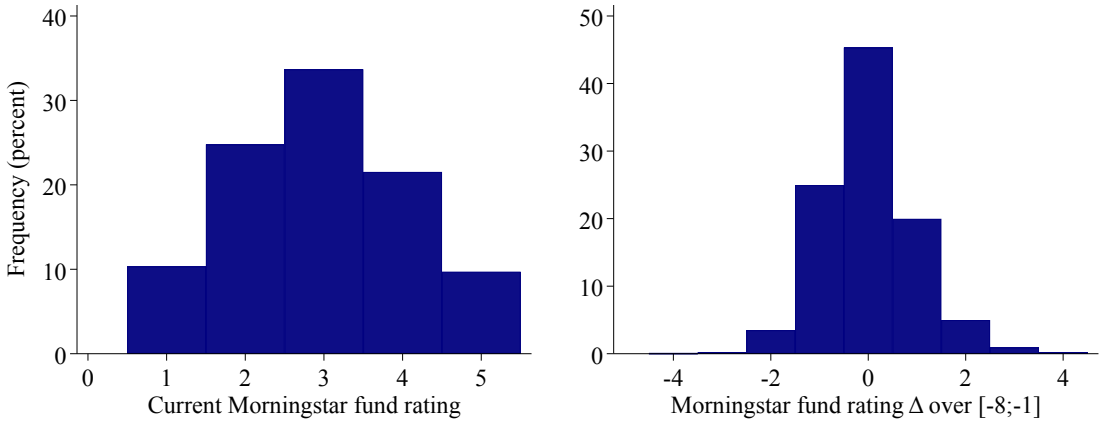
Morningstar ratings, which are among the signals that best explain mutual fund flows, are based on trailing risk-adjusted returns (Ben-David, Li, Rossi, and Song, 2022b). I let an increase in these "stars" correspond to an improved perception of the underlying bond payoffs: an increase in their mean, a decline in their variance, or both. The shift in perceptions therefore causes bond prices to adjust by shifting the demand curve outwards. Hence, I interpret an upgraded (downgraded) single-state fund as having an upward (downward) shift in the mean price of its underlying holdings relative to a single-state fund whose ratings didn't change.

To validate this assumption of how investors perceive Morningstar ratings, I test whether these shifts are increasing in the incremental change in stars. Specifically, I

identify the simultaneous impact of this change in stars on fund flows and yield spreads of candidate bonds that are in the fund's consideration set. I adjust yield spreads for federal and state tax rates to indicate the returns earned by resident municipal investors. For causality, I follow the literature in relying on changes in these stars over the prior eight quarters because any information contained in these changes should be stale, so it should not be correlated with any omitted determinants of current demand (Ben-David et al., 2022a). Figure B1 plots the distribution of these ratings and the eight-quarter change in their values. The figure shows that 65.63% of the sample consists of fund-quarter observations that do not see an upgrade. In contrast, one-star changes respectively make up 14.77% and 17.28% of the sample. Two-star changes constitute the remaining 2.32% of observations.

Figure B1: Distribution of Morningstar ratings

Note: This figure presents the distribution of Morningstar ratings in the left panel and the distribution of the change of these ratings over the prior eight quarters in the right panel.



Accordingly, we can simultaneously identify with two-stage least squares:

$$\text{Flows}_{ft} = \sum_{r=-1}^{2} a_r \times \mathbb{1}(\Delta \text{MR}_{f,t-8:t-1} = r) + bX_{ft} + \alpha_{fy} + \alpha_{iy} + \alpha_{st} + \nu_{ft}, \tag{10}$$

$$\Delta\text{Spread}_{ft}^{TA} = \sum_{r=-1}^{2} c_r \times \mathbb{1}(\Delta \text{MR}_{f,t-8:t-1} = r) + dX_{ft} + \alpha_{fy} + \alpha_{iy} + \alpha_{st} + \epsilon_{ft}, \tag{11}$$

where Flows_{ft} stands for flows to the single-state mutual fund f in quarter t in percent of the fund's TNA. I proxy the set of candidate bonds in which the fund invests with its bond holdings, so that $\Delta\text{Spread}_{ft}^{TA}$ is the change in the average yield spread of bonds held by the fund relative to the prior quarter, adjusted by average state tax rates in the top bracket. The main explanatory variable is $\mathbb{1}(\Delta MR = r)_{f,t-8:t-1}$, a dummy for the fund's change in Morningstar ratings over the prior eight quarters, assessed for group $r \in [-1;2] \in \mathbb{Z}$ relative to funds that were downgraded by two stars. X_{ft} are fund-level controls. I let α_{fy}, α_{iy} and α_{st} be fund-year, Morningstar-rating-year, and state-

quarter fixed effects. The fixed effects ensure that the coefficients a_r and c_r correspond to average effects over all Morningstar ratings categories.[18] The error terms are ν and ϵ. Observations are clustered at the fund level.

The identification assumption is that fund stars are uncorrelated with unobserved demand factors that are not absorbed by fund-year fixed effects. Saturating the specifications with fixed effects therefore allows me to compare outcome variables within the same fund and year but across quarters when fund ratings differed. If the identification assumption holds, then the coefficients c_r for $r \in [-1; 2]$ are the empirical counterparts of the average shifts in the yield spreads of the underlying bonds.

The results of the identification strategy are reported in Table B1. Bond yield spreads in the portfolios of funds that get upgraded by two stars decline by about 24 basis points relative to funds that get downgraded by two stars. Moreover, upgrades in mutual fund ratings map to downward shifts in bond yield spreads, which suggests that interpreting this demand shock as triggering a shift in the distributions of bond payoffs seems plausible. Flows also increase monotonically, albeit less significantly, with star upgrades.

In light of this interpretation, I test two hypotheses assuming that the tax shields are in place. First, I test whether investors have non-trivial diversification motives. Second, to verify the demand channel of taxation, I test whether investor demand shocks depend on the level of the tax shield.

[18] There isn't enough statistical power to test the effect on demand of star changes conditional on each Morningstar category separately.

Table B1: Morningstar Ratings Trigger Demand Shocks

Note: This table presents the results of Equations (10) and (11) using two-stage least squares. The sample consists of single-state mutual funds. The dependent variables are average fund flows, expressed in percent of TNA, and the change in the tax-adjusted (federal and state) yield spread of a fund's underlying bonds, in percent. The independent variables consist of dummy variables for the magnitude of the change in Morningstar ratings of the fund over the past 8 quarters, such that $\Delta MR = -1$ means a rating downgrade of 1 star over that time period, and analogously for the remaining variables. The omitted category corresponds to rating downgrades of 2 stars. Included are fund-year, state-date, and rating fixed effects. Observations clustered at the fund level. * corresponds to $p < 0.10$, ** corresponds to $p < 0.05$, and *** corresponds to $p < 0.01$.

Fund sample	Single-state funds	
Dep. var.	Flows (% of TNA)	ΔSpread^{TA} (%)
	(1)	(2)
$\mathbb{1}(\Delta MR = -1)$	0.463	-0.194***
	(0.533)	(0.068)
$\mathbb{1}(\Delta MR = 0)$	0.628	-0.170**
	(0.541)	(0.069)
$\mathbb{1}(\Delta MR = 1)$	1.097*	-0.131*
	(0.580)	(0.070)
$\mathbb{1}(\Delta MR = 2)$	1.353*	-0.237**
	(0.752)	(0.098)
Observations	26,831	26,832
Fund-year, state-date FEs	✓	✓
Morningstar-rating FEs	✓	✓

B.1 Strong Diversification Motives

In line with the assumption that upgrades in fund ratings make the underlying set of candidate bonds more desirable, raising their prices, I denote by π those price shifts so that

$$\frac{\partial P_H}{\partial \pi} > 0, \quad \frac{\partial P_L}{\partial \pi} > 0.$$

Then, following changes in the Morningstar ratings of single-state funds in high-tax states, we can write the demand function D_H^L as

$$D_H^L(P_H(\pi,\Theta), P_L(\Theta), \Theta) = \frac{(1-\tau_H)(\mu_L - P_L(\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_L^2} - \rho\frac{(1-T_H)(\mu_H - P_H(\pi,\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_H\sigma_L}.$$

Analogously, following changes in the Morningstar ratings of single-state funds in low-tax states, we can write the demand function D_L^H as

$$D_L^H(P_H(\Theta), P_L(\pi,\Theta),\Theta) = \frac{(1-\tau_L)(\mu_H - P_H(\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_H^2} - \rho\frac{(1-T_L)(\mu_L - P_L(\pi,\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_L\sigma_H}.$$

Then, holding all else constant, the first hypothesis is

$$\frac{\partial D_H^L(P_H(\pi,\Theta), P_L(\Theta),\Theta)}{\partial\pi} > 0, \qquad \frac{\partial D_L^H(P_H(\Theta), P_L(\pi,\Theta),\Theta)}{\partial\pi} > 0,$$

namely that local investors increase their holdings of the other state's bonds in both states in response to changes in the payoff distribution of local bonds. The empirical counterparts of these derivatives are the coefficients λ_H and λ_L in

$$\Delta\text{Out-of-State-Holdings}_{ft} = c_j + \lambda_j \Delta\text{MR}_{f,t-8:t-1} + \eta_j X_{ft} + \alpha_f + \alpha_i + \alpha_{st} + \epsilon_{ft}, \qquad (12)$$

for $j \in \{\mathcal{H}, \mathcal{L}\}$. ΔOut-of-State-Holdings is the change in holdings, in percent of TNA, of the single-state mutual fund f in other states' bonds in quarter t relative to the preceding quarter. $\Delta\text{MR}_{f,t-8:t-1}$ is the change in the fund's Morningstar rating in the previous eight quarters, and X_{ft} are fund-quarter controls. I let α_f, α_i, and α_{st} correspond to fund-, rating- and state-quarter fixed effects and c correspond to the intercept. Observations are clustered at the fund level. The hypothesis above then has the empirical counterpart

$$\lambda_H > 0, \quad \lambda_L > 0.$$

Note that despite the fact that the price shift π is identical across bonds of high-tax and low-tax states, the coefficients λ_H and λ_L could differ because of the differing tax treatments. The table below shows that both coefficients are significantly positive. Higher ratings significantly raise a fund's holdings of other states' bonds by about 9.5% of TNA in low-tax states and about 4.1% of TNA in millionaire states.

Table B2: Non-Trivial Diversification Motives

Note: This table presents the results of Equation (12), estimated separately for low-tax states and millionaire states (which introduced millionaire tax rates). The outcome variable is out-of-state holdings of single-state mutual funds, expressed in percent of TNA. $\Delta \text{MR}_{f,t-8:t-1}$ is the change in a fund's Morningstar rating in the previous eight quarters. Included are fund, rating, and state-quarter fixed effects, in addition to fund-quarter controls (the average coupon rate, Amihud measure, logged par traded, and number of bonds in the fund's portfolio, the average logged TNA of the fund, and the fund's Morningstar measure of excess returns). Observations are clustered at the fund level. * corresponds to $p < 0.10$, ** corresponds to $p < 0.05$, and *** corresponds to $p < 0.01$.

Bond sample	Diversified	
State sample	Low-tax states	Millionaire states
	(1)	(2)
$\Delta MR_{f,t-8:t-1}$	0.095***	0.041**
	(0.035)	(0.016)
Observations	5,865	9,583
Fund, rating state-date FEs	✓	✓
Controls	✓	✓
R^2	0.49	0.18

B.2 Increasing Demand Shocks With Tax Incentives

Analogously to the preceding section and supposing $T_H = T_L = 0$, we can write the aggregate demand of $\mathcal{H}$-residents as

$$D_H(P_H(\pi,\Theta),P_L(\Theta),\Theta) = \frac{(1-T_H)(\mu_H - P_H(\pi,\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_H^2} - \rho\frac{(1-\tau_H)(\mu_L - P_L(\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_H\sigma_L} + \frac{(1-\tau_H)(\mu_L - P_L(\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_L^2} - \rho\frac{(1-T_H)(\mu_H - P_H(\pi,\Theta) - R_f)}{\gamma_H(1-\rho^2)\sigma_H\sigma_L}.$$

Similarly, the aggregate demand of $\mathcal{L}$-residents is

$$D_L(P_H(\Theta),P_L(\pi,\Theta),\Theta) = \frac{(1-T_L)(\mu_L - P_L(\pi,\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_L^2} - \rho\frac{(1-\tau_L)(\mu_H - P_H(\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_H\sigma_L} + \frac{(1-\tau_L)(\mu_H - P_H(\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_H^2} - \rho\frac{(1-T_L)\mu_L - P_L(\pi,\Theta) - R_f)}{\gamma_L(1-\rho^2)\sigma_H\sigma_L}.$$

I hypothesize that the aggregate demand shock of residents in response to changes in the payoff distribution of local bonds increases with the level of the tax shield, holding

all else constant, in that

$$\frac{\partial D_H(P_H(\pi,\Theta),P_L(\Theta),\Theta)}{\partial \pi} \geq \frac{\partial D_L(P_H(\Theta),P_L(\pi,\Theta),\Theta)}{\partial \pi},$$

assuming that

$$\frac{1}{\gamma_H \sigma_H}\left(\frac{\rho}{\sigma_L}-\frac{1}{\sigma_H}\right) \geq \frac{1}{\gamma_L \sigma_L}\left(\frac{\rho}{\sigma_H}-\frac{1}{\sigma_L}\right).$$

This assumption, which I validate in the calibration below, allows the demand for diversification to drive the aggregate demand shock more in the high-tax state than the low-tax state. The empirical counterparts of these derivatives are the coefficients κ_H and κ_L in

$$\text{Flows}_{ft} = c_j + \kappa_j \Delta \text{MR}_{f,t-8:t-1} + \eta_j X_{ft} + \alpha_f + \alpha_i + \alpha_{st} + \epsilon_{ft}, \tag{13}$$

for $j \in \{\mathcal{H}, \mathcal{L}\}$. Flows_{ft} is the flows to the single-state mutual fund f in quarter t in percent of the fund's TNA. All other variables are defined as before. The hypothesis has the empirical counterpart of

$$\kappa_H > \kappa_L.$$

This hypothesis is confirmed in the table below, which shows that the difference between the two coefficients is statistically significant at the 5%. Moreover, κ_H is significant at the 5% level, while κ_L is statistically insignificant. For millionaire states, raising fund ratings by 1 star increases its flows by about 1.5% of TNA, an economically large effect given that the average outflows in high-tax states are 1.7% of TNA.

Table B3: Increasing Demand Shocks with Tax Incentives

Note: This table presents the results of Equation (13), estimated separately for low-tax states and millionaire states. The outcome variable is the average flows to single-state mutual funds, expressed in percent of TNA. $\Delta\text{FundRatings}_{f,t-8:t-1}$ is the change in a fund's Morningstar rating in the previous eight quarters. Included are fund, rating, and state-quarter fixed effects, in addition to fund-quarter controls (the average coupon rate, Amihud measure, logged par traded, and number of bonds in the fund's portfolio, the average logged TNA of the fund, and the fund's Morningstar measure of excess returns). The last row presents a test of the difference in coefficients for low-tax and millionaire states. Observations are clustered at the fund level. * corresponds to $p < 0.10$, ** corresponds to $p < 0.05$, and *** corresponds to $p < 0.01$.

State sample	Low-tax states	Millionaire states
	(1)	(2)
$\Delta MR_{f,t-8:t-1}$	0.555	1.541***
	(0.349)	(0.388)
Observations	7,861	12,462
State-date FEs	✓	✓
Fund FEs	✓	✓
R^2	0.35	0.24
$\kappa_H - \kappa_L$	0.986**	
	(0.445)	

C Model Analyses and Extensions

I evaluate additional counterfactual scenarios on the level of state tax rates on out-of-state bond income. Additionally, the model's first period and counterfactual analyses hold bond supplies and investor base fixed. What if we instead allow for resident migration and endogenous bond supply? I consider each of these cases separately. I find that resident migration is too small to alter results, while endogenizing bond supply does not dispute the presence of inefficiencies and the need to eliminate the tax shields of high-tax states.

C.1 Additional counterfactual analysis

I assess counterfactual scenarios on raising tax rates on out-of-state bond income. Figure C1 shows that raising tax rates on out-of-state bond income harms all residents, validating Proposition 5. An increase in τ_H by 1 p.p. reduces the welfare of $\mathcal{L}$-residents by about 0.08% of the average GDP of State $\mathcal{L}$. Raising τ_L by 1 p.p. reduces the welfare of $\mathcal{H}$-residents by about 0.02% of state GDP. Lastly, simultaneously repealing the tax shields of both states reduces aggregate welfare about by 0.2% of average state GDP. Tax rates on out-of-state bonds are therefore inefficiently high.

C.2 Migration

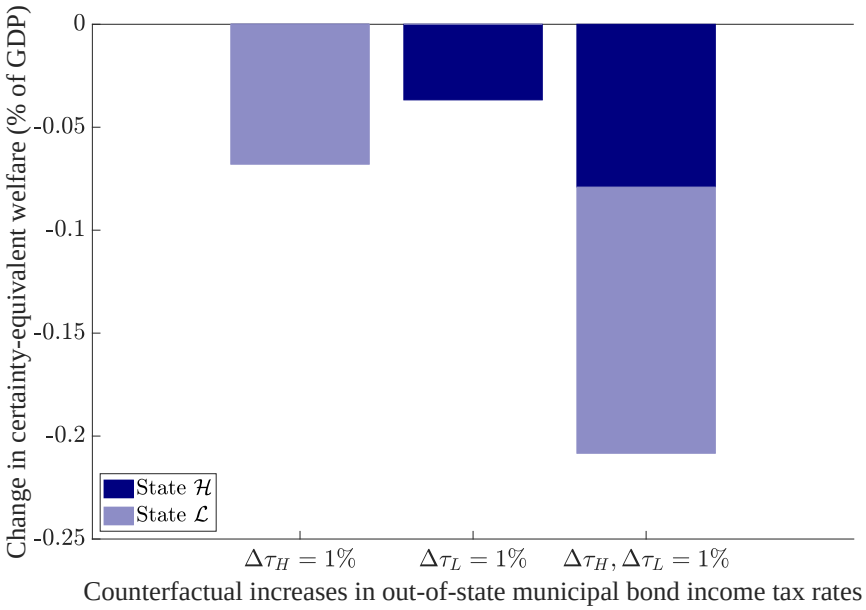
I allow $\mathcal{H}$-residents and $\mathcal{L}$-residents to migrate out of their states towards other states, despite the fact that recent research in public economics has shown mixed evidence at best on the link between migration and taxation (Kleven et al., 2020). We can incorporate migration into the model in the following way.

Consider $\mathcal{H}$-residents first, and suppose they have independently distributed risk-aversion coefficients, drawn from an exponential CDF $F_H(\cdot)$ over some interval $[\underline{\gamma_H}, \overline{\gamma_H}]$. Similarly, the risk-aversion coefficients of $\mathcal{L}$-residents are independently drawn from an exponential CDF $F_L(\cdot)$ over $[\underline{\gamma_L}, \overline{\gamma_L}]$. I assume that migration happens to a third state outside this model whose public services are comparable to a resident's current location. Therefore, residents decide to migrate out of the two states if their portfolio utility falls below reservation utilities $\underline{U}_H$ and $\underline{U}_L$.

Equilibrium is characterized by thresholds γ_H^* and γ_L^* of risk-aversion coefficients for $\mathcal{H}$-residents and $\mathcal{L}$-residents, respectively. In equilibrium, $\mathcal{H}$-residents whose risk-aversion coefficients fall below γ_H^* will migrate out of State $\mathcal{H}$. Similarly, $\mathcal{L}$-residents whose risk-aversion coefficients fall below γ_L^* will migrate out of State $\mathcal{L}$. These threshold coefficients are determined by the indifference condition of the marginal resident in

Figure C1: Welfare Assessments of Tax Policy Proposals

Note: This figure presents the results of counterfactual evaluation for State $\mathcal{H}$ in dark blue and State $\mathcal{L}$ in light blue using three scenarios: raising τ_H by 1 p.p., raising τ_L by 1 p.p., and raising both tax rates by 1 p.p. I assess the results of these counterfactual tax policies using the annual change in the welfare of a state's residents in certainty-equivalent terms and on a present value basis, normalized by state GDP in 2023. Aggregate welfare is normalized by aggregate state GDP. State GDP is from the Bureau of Economic Analysis' annual nominal GDP series SAGDP2N.



each state between staying and migrating:

$$\underline{U}_H = \Pi_H(\gamma_H^*) - \frac{H^*}{2}\mathbb{V}_H(\gamma_H^*),$$
$$\underline{U}_L = \Pi_L(\gamma_L^*) - \frac{L^*}{2}\mathbb{V}_L(\gamma_L^*).$$

Solving for γ_H^* and γ_L^*, I calibrate the certainty-equivalent of reservation utility to $\underline{U}_H = 0.8$ and $\underline{U}_L = 2.8$ in billions of dollars. Then, the migrating rates for each state would be determined by

$$m_H = 1 - e^{-\lambda_H \gamma_H^*},$$
$$m_L = 1 - e^{-\lambda_L \gamma_L^*},$$

where $m_H = 2.34\%$ and $m_L = 1.46\%$ are the migration rates out of States $\mathcal{H}$ and States $\mathcal{L}$ towards other states, as calculated using the IRS state-to-state migration data since 2018, and λ_H and λ_L are the parameters of the CDFs $F_H(\cdot)$ and $F_L(\cdot)$. I let the set of third states be all other states in the U.S. that are considered neither high-tax nor low-tax in

the model. Calibrating these equations yields four parameters:

$$\gamma_H^* = 2.9, \qquad \gamma_L^* = 4.9,$$
$$\lambda_H = 0.001, \qquad \lambda_L = 0.001.$$

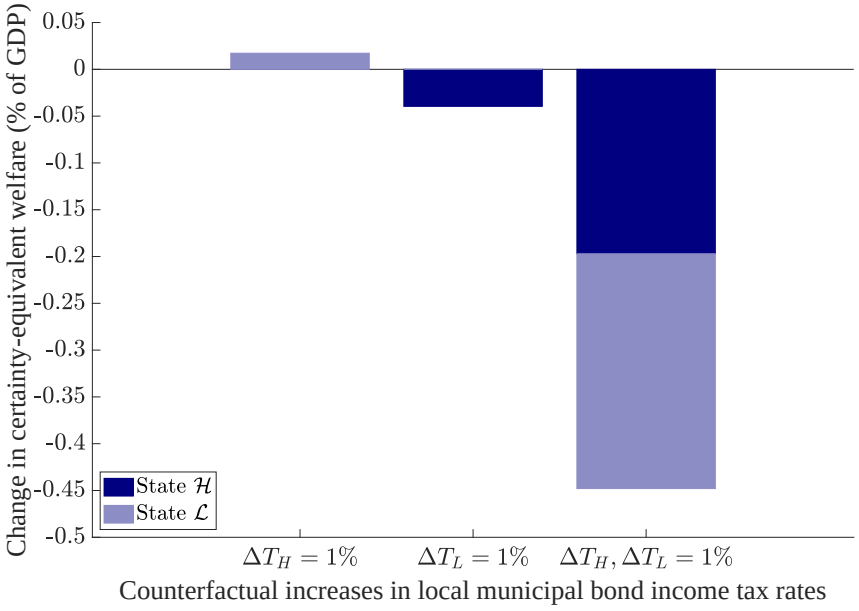
To fit the data, the model assigns $\mathcal{L}$-residents and $\mathcal{H}$-residents comparable scale parameters and thresholds of risk aversion. But given the small migration rates, incorporating an endogenous investor base does not significantly change the model's results.

C.3 Bond Issuance

Following tax hikes, states might endogenously alter their issuance of bonds S_H and S_L instead of raising their supply of public services. I consider the same counterfactual tax policies as Section 5.2 and recalculate counterfactual equilibria holding fixed public services. Figure C2 plots the change in certainty-equivalent welfare following counterfactual scenarios. The figure reveals that despite the fact that the direction of the externalities now differs, eliminating the tax shield of the high-tax state still exerts a positive externality on State $\mathcal{L}$'s residents. The tax hike reduces the prices of all bonds in the market, which raises the portfolio utility of State $\mathcal{L}$'s residents. In contrast, raising T_L exerts a negative externality on $\mathcal{H}$-residents.

Figure C2: Counterfactual Evaluation with Endogenous Bond Issuance

Note: This figure presents the results of counterfactual evaluation for State $\mathcal{H}$ in dark blue and State $\mathcal{L}$ in light blue using four scenarios and endogenizing supply. I assess the results of these counterfactual tax policies using the change in certainty-equivalent utility of a state's residents and fixing the level of public services in each state. The three counterfactual policies considered are raising T_H by 1 p.p., raising T_L by 1 p.p., and setting $T_L = T_H = 1$ p.p. I calculate the change in welfare on a present value basis and normalize it by state GDP in 2023, obtained from the Bureau of Economic Analysis' annual nominal GDP series SAGDP2N. Aggregate welfare is normalized by aggregate state GDP.



D Model Proofs

D.1 The Absence of Bond Shorting

To prevent investors from shorting bonds, we can write the conditions accompanying the no-shorting assumption as:

$$S_H\sigma_H\left(\frac{1-\tau_L}{\omega_H}-\rho^2\frac{1-T_L}{\omega_L}\right)+\rho S_L\sigma_L\left(\frac{1-\tau_L}{\omega_H}-\frac{1-T_L}{\omega_L}\right)>0, \tag{14}$$

$$S_H\sigma_H\left(\frac{1-T_H}{\omega_H}-\rho^2\frac{1-\tau_H}{\omega_L}\right)+\rho S_L\sigma_L\left(\frac{1-T_H}{\omega_H}-\frac{1-\tau_H}{\omega_L}\right)>0, \tag{15}$$

$$S_L\sigma_L\left(\frac{1-\tau_H}{\omega_L}-\rho^2\frac{1-T_H}{\omega_H}\right)+\rho S_H\sigma_H\left(\frac{1-\tau_H}{\omega_L}-\frac{1-T_H}{\omega_H}\right)>0, \tag{16}$$

$$S_L\sigma_L\left(\frac{1-T_L}{\omega_L}-\rho^2\frac{1-\tau_L}{\omega_H}\right)+\rho S_H\sigma_H\left(\frac{1-T_L}{\omega_L}-\frac{1-\tau_L}{\omega_H}\right)>0. \tag{17}$$

We can rearrange the first and second inequalities to obtain lower bounds on $S_H\sigma_H$, from which we notice that assuming $\tau_L \geq T_H$ and $\tau_H \geq T_L$ makes the second inequality the binding one, hence the restriction in Condition (1). Similarly for the third and fourth inequalities. This compresses the system of four inequalities into two, conditional on $\tau_L \geq T_H$ and $\tau_H \geq T_L$. This yields the bounds specified in the condition below.

Condition 1. *Assume that the relative size of the debt markets of State $\mathcal{H}$ to State $\mathcal{L}$ is sufficiently large, as specified by*

$$\frac{S_H}{S_L} > \max\left(\zeta_1(\Theta), \zeta_2(\Theta)\right), \tag{18}$$

$$\textit{where} \quad \zeta_1(\Theta) \equiv \frac{-\sigma_L}{\rho\sigma_H} \frac{(1-T_L)\omega_H - (1-\tau_L)\omega_L}{(1-T_L)\omega_H - \rho^2(1-\tau_L)\omega_L},$$

$$\textit{and} \quad \zeta_2(\Theta) \equiv \frac{-\rho\sigma_L}{\sigma_H} \frac{(1-T_H)\omega_L - (1-\tau_H)\omega_H}{(1-T_H)\omega_L - \rho^2(1-\tau_H)\omega_H}.$$

Examine the numerators of the terms on the right-hand side. We can write the numerators of the large ratios as:

$$(1-T_L)\omega_H - (1-\tau_L)\omega_L = \frac{\phi}{\gamma_L}\left((1-T_H)(1-T_L) - (1-\tau_H)(1-\tau_L)\right) \geq 0,$$

$$(1-T_H)\omega_L - (1-\tau_H)\omega_H = \frac{1-\phi}{\gamma_L}\left((1-T_H)(1-T_L) - (1-\tau_H)(1-\tau_L)\right) \geq 0.$$

So clearly, both $\zeta_1(\Theta), \zeta_2(\Theta) \leq 0$. These conditions therefore do not bind.

D.2 Proof of Proposition 1

Proof. We can write the first-order conditions of States $\mathcal{H}$ and $\mathcal{L}$ as:

$$\frac{dD_H^H}{d\tau_H}(\mu_H - P_H) + \frac{dD_H^L}{d\tau_H}(\mu_L - P_L) - D_H^L\frac{dP_L}{d\tau_H} = \gamma_H\left(D_H^H\frac{dD_H^H}{d\tau_H}\sigma_H^2 + D_H^L\frac{dD_H^L}{d\tau_H}\sigma_L^2 + \rho\sigma_H\sigma_L\left(\frac{dD_H^H}{d\tau_H}D_H^L + \frac{dD_H^L}{d\tau_H}D_H^H\right)\right),$$

$$\frac{dD_L^L}{d\tau_L}(\mu_L - P_L) + \frac{dD_L^H}{d\tau_L}(\mu_H - P_H) - D_L^H\frac{dP_H}{d\tau_L} = \gamma_L\left(D_L^L\frac{dD_L^L}{d\tau_L}\sigma_L^2 + D_L^H\frac{dD_L^H}{d\tau_L}\sigma_H^2 + \rho\sigma_H\sigma_L\left(\frac{dD_L^L}{d\tau_L}D_L^H + \frac{dD_L^H}{d\tau_L}D_L^L\right)\right),$$

$$\frac{dD_H^H}{dT_H}(\mu_H - P_H) + \frac{dD_H^L}{dT_H}(\mu_L - P_L) + (S_H - D_H^H)\frac{dP_H}{dT_H} = \gamma_H\left(D_H^H\frac{dD_H^H}{dT_H}\sigma_H^2 + D_H^L\frac{dD_H^L}{dT_H}\sigma_L^2 + \rho\sigma_H\sigma_L\left(\frac{dD_H^H}{dT_H}D_H^L + \frac{dD_H^L}{dT_H}D_H^H\right)\right),$$

$$\frac{dD_L^L}{dT_L}(\mu_L - P_L) + \frac{dD_L^H}{dT_L}(\mu_H - P_H) + (S_L - D_L^L)\frac{dP_L}{dT_L} = \gamma_L\left(D_L^L\frac{dD_L^L}{dT_L}\sigma_L^2 + D_L^H\frac{dD_L^H}{dT_L}\sigma_H^2 + \rho\sigma_H\sigma_L\left(\frac{dD_L^L}{dT_L}D_L^H + \frac{dD_L^H}{dT_L}D_L^L\right)\right).$$

These equations reduce to best response functions. Solving each pair of tax rates on local bond income and out-of-state bond income yields unique sets of optimal tax rates (τ_H^*, τ_L^*) and (T_H^*, T_L^*). □

D.3 Proof of Proposition 2

Proof. To determine the slope of the reaction curves, we can show that the second-order derivatives of each state with respect to tax rates are negative.

$$\frac{\partial^2 U_H}{\partial \tau_H \partial \tau_L} = \frac{dP_H}{d\tau_L}\left(\frac{S_H \phi^2 \rho^2}{\gamma_H \omega_L^2} + \frac{\phi^2 \rho S_L \sigma_L}{\gamma_H \omega_L^2}\right) \leq 0,$$
$$\frac{\partial^2 U_L}{\partial \tau_H \partial \tau_L} = \frac{dP_L}{d\tau_H}\frac{\rho(1-T_L\tau_L)}{\gamma_L(1-\rho^2)\sigma_L}\frac{S_H\sigma_H + \rho S_L \sigma_L}{\omega_H^2}\frac{1-\phi}{\gamma_L} \leq 0,$$
$$\frac{\partial^2 U_H}{\partial T_H \partial T_L} = \phi\frac{dP_L}{dT_L}\frac{1}{\gamma_H(1-\rho^2)\sigma_L}\left(\frac{S_L\sigma_L\rho^2(1-T_H\tau_H)\phi}{\gamma_H\omega_H^2} + \frac{\rho S_H \sigma_H (1-T_H\tau_H)\phi}{\gamma_H \omega_H^2}\right) \leq 0,$$
$$\frac{\partial^2 U_L}{\partial \tau_H \partial \tau_L} = \frac{dP_H}{dT_H}\frac{1-T_L\tau_L}{\gamma_L(1-\rho^2)\sigma_H}\frac{S_L\sigma_L + \rho S_H\sigma_H}{\omega_L^2}\frac{\rho(1-\phi)}{\gamma_L} \leq 0.$$

□

D.4 Proof of Proposition 3

Proof. Fix state choices of tax rates on out-of-state bond income, τ_H and τ_L, and State $\mathcal{L}$'s choice of T_L. Suppose State $\mathcal{H}$ sets a tax rate on local bond income of T_H. I will show that State $\mathcal{H}$ will always want to deviate and lower the tax rate on local bond income by ϵ, for small ϵ. In deciding whether to deviate to a lower tax rate, State $\mathcal{H}$ optimizes its welfare function $U_H(\tau_H, T_H)$, whose first-order condition with respect to T_H can be calculated as

$$\frac{dU_H}{dT_H} = \underbrace{\left(\frac{\rho\tau_H(\mu_L - P_L)}{\sigma_L} - \frac{T_H(\mu_H - P_H)}{\sigma_H}\right)\left(\mu_H - P_H + (1-T_H)\frac{dP_H}{dT_H}\right)}_{\text{Additional tax revenues}}$$
$$+ \underbrace{(S_H - D_H^H T_H)\frac{dP_H}{dT_H}}_{\text{Debt financing}},$$

applying the Envelope theorem to the portfolio utility of state residents and the second-period's equilibrium to obtain prices. In choosing T_H, State $\mathcal{H}$ then compares the foregone tax revenues from deviating, $D_H^L\tau_H(\mu_L - P_L) + D_H^H T_H(\mu_H - P_H)$, to the additional debt financing that the state can now raise in the debt market, $S_H P_H$. I ignore $D_H^H(\mu_H - P_H)$ because that is the average response to tax rate hikes that is unchanged by an ϵ tax hike, while this proof focuses on marginal responses to a change of ϵ in tax rates. Using the derivatives in the first-order condition above and factoring out $\mu_H - P_H$,

we can compare additional expected tax revenue from raising T_H, proportional to

$$\left(\frac{\rho\tau_H(\mu_L - P_L)}{\sigma_L} - \frac{T_H(\mu_H - P_H)}{\sigma_H}\right)\left(1 - \frac{\phi(1-T_H)}{\gamma_H\omega_H}\right)\frac{1}{\gamma_H(1-\rho^2)\sigma_H},$$

or equivalently,

$$\left(\rho(\tau_H - T_H)S_L\sigma_L + (\rho^2\tau_H - T_H)S_H\sigma_H\right)\left(1 - \frac{\phi(1-T_H)}{\gamma_H\omega_H}\right),$$

to lower debt financing $-\frac{\phi}{\gamma_H\omega_H}(S_H - D_H^H T_H)$, proportional to

$$-\frac{\phi}{\gamma_H\omega_H}\left(S_H - \frac{T_H}{\gamma_H(1-\rho^2)\sigma_H}(S_H\sigma_H(1 - T_H - \rho^2(1-\tau_H)) + \rho S_L\sigma_L(\tau_H - T_H)\right).$$

Matching coefficients on the supply parameters, the magnitude of the debt financing force outweighs that of expected tax revenue if

$$\phi\left(1 - \frac{T_H(1 - T_H - \rho^2(1-\tau_H))}{\gamma_H(1-\rho^2)}\right) > \frac{\rho^2\tau_H - T_H}{\gamma_H(1-\rho^2)}\left(\gamma_H\omega_H - \phi(1-T_H)\right),$$

and

$$\frac{\phi}{\gamma_H\omega_H} > 1 - \frac{\phi(1-T_H)}{\gamma_H\omega_H}.$$

To determine whether these conditions hold, we first need to characterize the best response functions of the two states. Proposition D.1 shows that if τ_L is sufficiently large and $T_L = 0$, State $\mathcal{H}$ sets a larger tax rate on out-of-state bonds than local bonds, and analogously for State $\mathcal{L}$. The proposition's proof is in Appendix Section D.8.

Proposition D.1. *Suppose* $T_L = 0$ *and* $\tau_L \geq \max\left(\mathcal{B}_1(\Theta), \mathcal{B}_2(\Theta)\right)$, *where*

$$\mathcal{B}_1(\Theta) = \frac{\gamma_H(1-\rho^2)(1-\phi^2)}{\gamma_L\phi\rho^2 + \gamma_H(1-\rho^2)(1-\phi^2)}, \quad \mathcal{B}_2(\Theta) = S_H\frac{2\gamma_L\phi(1-\phi) + \gamma_H(3 - 4\phi + \phi^2)}{\rho\gamma_L\phi\sigma_L + 2\gamma_H S_H(1-\phi)\sigma_H}.$$

Then $\tau_H(\tau_L) \geq T_H(\tau_L)$. *Analogously, given* $T_H = 0$ *and a sufficiently large* τ_H, $\tau_L(\tau_H) \geq T_L(\tau_H)$.

This proposition and the lower bounds on ϕ outlined in Condition (4) make the conditions above hold. Note that the bounds in Proposition D.1 can be verified using the optimal tax rates on out-of-state bond income, as calculated in Proof D.5. State $\mathcal{H}$ therefore always finds it better to deviate to a lower tax rate on local bond income. This drives down the optimal choice T_H^* to 0. Analogously, State $\mathcal{L}$ collects additional

expected tax revenue from raising T_L by small ϵ of

$$\Big(\rho S_H \sigma_H(\tau_L - T_L) + S_L\sigma_L(\rho^2\tau_L - T_L)\Big)\left(1 - \frac{(1-\phi)(1-T_L)}{\gamma_L\omega_L}\right)\frac{1}{\gamma_L(1-\rho^2)\sigma_L}.$$

In contrast, the decline in debt financing is proportional to

$$-\frac{(1-\phi)}{\gamma_L\omega_L}\left(S_L - \frac{T_L}{\gamma_L(1-\rho^2)\sigma_L}(S_L\sigma_L(1-T_L-\rho^2(1-\tau_L)) + \rho S_H\sigma_H(\tau_L - T_L))\right).$$

Then State $\mathcal{L}$ deviates downwards from a fixed level of T_L if

$$\begin{aligned}
0 &< (1-\phi)S_L \\
&- (1-\phi)\frac{T_L}{\gamma_L(1-\rho^2)\sigma_L}(S_L\sigma_L(1-T_L-\rho^2(1-\tau_L)) - (1-\phi)\frac{T_L}{\gamma_L(1-\rho^2)\sigma_L}\rho S_H\sigma_H(\tau_L - T_L)) \\
&- \Big(\rho S_H\sigma_H(\tau_L - T_L) + S_L\sigma_L(\rho^2\tau_L - T_L)\Big)(\gamma_L\omega_L - (1-\phi)(1-T_L))\frac{1}{\gamma_L(1-\rho^2)\sigma_L} \\
&= (1-\phi)S_L - S_L\sigma_L\left((1-\phi)\frac{T_L(1-T_L-\rho^2(1-\tau_L))}{\gamma_L(1-\rho^2)\sigma_L} + \frac{(\rho^2\tau_L - T_L)\phi(1-\tau_H)}{\gamma_H(1-\rho^2)\sigma_L}\right) \\
&- \rho S_H\sigma_H(\tau_L - T_L)\left(\frac{T_L(1-\phi)}{\gamma_L(1-\rho^2)\sigma_L} + \frac{(\rho^2\tau_L - T_L)\phi(1-\tau_H)}{\gamma_H(1-\rho^2)\sigma_L}\right).
\end{aligned}$$

This is because the coefficients on $S_L\sigma_L$ and $S_H\sigma_H$ are close to 0 (tax rates are very small and divided by scalars of risk aversion, which exceeds 1). Therefore, starting from a fixed T_L, State $\mathcal{L}$ has an incentive to deviate downwards, which leaves $T_L^* = 0$ as the only optimal solution. □

D.5 Proof of Proposition 4

Proof. Ignoring the risk-free rate, we can write the difference in optimal tax rates as:

$$\begin{aligned}
\tau_H^* - \tau_L^* = -\frac{(1-\rho^2)}{\sigma_1}\Bigg(&\frac{S_H\rho\sigma_H\gamma_H^2(1-\phi)^2 + S_L\sigma_L\gamma_L\phi(2\gamma_H(\phi-1) - \gamma_L\phi)}{S_L\sigma_L(2\gamma_H(1-\phi) + \gamma_L\phi(1-\rho^2)) + 2\gamma_H S_H\rho\sigma_H(1-\phi)} \\
&+ \frac{S_H\sigma_H\gamma_H(1-\phi)(\gamma_H(1-\phi) - 2\gamma_L\phi) - S_L\rho\sigma_L\gamma_L^2\phi^2}{\gamma_H S_H\sigma_H(1-\rho^2)(1-\phi) + 2\gamma_L\phi(\sigma_H S_H + \rho\sigma_L S_L)}\Bigg),
\end{aligned}$$

where $\sigma_1 = \gamma_H + \gamma_L\phi(L-H)$. If

$$\phi \geq \frac{\gamma_H}{\gamma_L(\gamma_H - \gamma_L)},$$

then σ_1 is positive. The denominators of the expressions between the parentheses are both positive. For the numerators to be negative, we need these two conditions to hold:

$$0 \geq \rho S_H \sigma_H \gamma_H^2 (1-\phi)^2 - S_L \sigma_L \gamma_L \phi (2\gamma_H (1-\phi) + \gamma_L \phi),$$
$$0 \geq \gamma_H (1-\phi) - 2\gamma_L \phi.$$

Between the second inequality and assuming that $\sigma_1 \geq 0$, we get two lower bounds on ϕ, out of which the second inequality is the binding one. The first inequality can be rearranged to also consist of a lower bound on ϕ:

$$\phi \geq \frac{-2\gamma_H \left(1 + \frac{\rho S_H \sigma_H \gamma_H}{S_L \sigma_L \gamma_L}\right) + \sqrt{4\gamma_H^2 \left(1 + \frac{\rho S_H \sigma_H \gamma_H}{S_L \sigma_L \gamma_L}\right)^2 + 4\frac{S_H \sigma_H \rho \gamma_H^2}{S_L \sigma_L \gamma_L} \left(\gamma_L - 2\gamma_H - \frac{S_H \sigma_H \rho \gamma_H^2}{S_L \sigma_L \gamma_L}\right)}}{2\left(\gamma_L - 2\gamma_H - \frac{S_H \sigma_H \rho \gamma_H^2}{S_L \sigma_L \gamma_L}\right)}.$$

The minimum of this bound and the one above determines the condition in the equation. □

D.6 Proof of Proposition 5

Proof. This proof proceeds similarly to the proof of Proposition 1 in Dell'Ariccia and Marquez (2006). Consider first the problem of taxing the interest income of out-of-state bonds.

The pair (τ_H^*, τ_L^*) that solves the first-order conditions of the states for taxation on out-of-state bond income would define a Nash equilibrium. Now turn to the case of the social planner, whose first-order condition is

$$\eta \frac{dU_H(\tau_H, \tau_L)}{d\tau_H} + (1-\eta) \frac{dU_L(\tau_H, \tau_L)}{d\tau_L} = 0.$$

This yields the optimal tax rates $(\tau_H^{c*}, \tau_L^{c*})$ in a federal union. Now we can compare the optimal solutions under state and federal equilibria. Take the solution to State $\mathcal{H}$'s problem and substitute it in the first-order condition of the social planner to get

$$\eta \frac{dU_H(\tau_H^*, \tau_L)}{d\tau_H} + (1-\eta) \frac{dU_L(\tau_H^*, \tau_L)}{d\tau_H}.$$

The sign of this expression indicates the magnitude of τ_H^{c*} relative to τ_H^*. The first term is null by optimization. We can write the second term as

$$\frac{dU_L(\tau_H^*, \tau_L)}{d\tau_H} = \frac{dP_L}{d\tau_H} \left(S_L - \frac{(1-T_L^2)}{\gamma_L (1-\rho^2)\sigma_L} \frac{S_L \sigma_L + \rho S_H \sigma_H}{\omega_L} + \rho \frac{1 - T_L \tau_L}{\gamma_L (1-\rho^2)\sigma_L} \frac{S_H \sigma_H + \rho S_L \sigma_L}{\omega_H} \right),$$

where

$$\frac{dP_L}{d\tau_H} = -\frac{\phi}{\gamma_H}\frac{S_L\sigma_L^2 + \rho S_H\sigma_L\sigma_H}{\omega_L^2} \leq 0,$$

and the term in the parentheses can be written as

$$S_L\sigma_L\left(\gamma_L(1-\rho^2) + \rho^2\frac{1-\tau_L T_L}{\omega_H} - \frac{1-T_L^2}{\omega_L}\right) + \rho S_H\sigma_H\left(\frac{1-T_L\tau_L}{\omega_H} - \frac{1-T_L^2}{\omega_L}\right) > 0. \quad (19)$$

We can compare this inequality with the inequality (17) to see which condition is binding. Manipulating their difference results in a negative expression, which indicates that (17) is the binding inequality. Accordingly,

$$\frac{dU_L(\tau_H, \tau_L^*)}{d\tau_H} < 0.$$

The welfare of residents of State $\mathcal{L}$ thus decline when State $\mathcal{H}$ raises τ_H, and we need lower τ_H to satisfy the optimization problem of the social planner. Analogously, take the solution to State $\mathcal{L}$'s problem and substitute it in the first-order condition of the social planner:

$$\eta\frac{dU_H(\tau_H, \tau_L^*)}{d\tau_L} + (1-\eta)\frac{dU_L(\tau_H, \tau_L^*)}{d\tau_L}.$$

The second term is null by optimization. The first term can be written as

$$\frac{dU_H(\tau_H, \tau_L^*)}{d\tau_L} = \frac{dP_H}{d\tau_L}\left(S_H\sigma_H\left(\gamma_H(1-\rho^2) + \rho^2\frac{1-T_H\tau_H}{\omega_L} - \frac{1-T_H^2}{\omega_H}\right) + \rho S_L\sigma_L\left(\frac{1-T_H\tau_H}{\omega_L} - \frac{1-T_H^2}{\omega_H}\right)\right)$$

where

$$\frac{dP_H}{d\tau_L} = -\frac{1-\phi}{\gamma_L}\frac{S_H\sigma_H^2 + \rho S_L\sigma_L\sigma_H}{\omega_H^2} \leq 0,$$

and the term in the parentheses can be rewritten as

$$S_H\sigma_H\left(\gamma_H(1-\rho^2) + \rho^2\frac{1-\tau_H T_H}{\omega_L} - \frac{1-T_H^2}{\omega_H}\right) + \rho S_L\sigma_L\left(\frac{1-T_H\tau_H}{\omega_L} - \frac{1-T_H^2}{\omega_H}\right) > 0. \quad (20)$$

We can compare this inequality with the inequality (15) to see which condition is binding. Manipulating their difference results in a negative expression, which indicates that (15) is the binding inequality. Hence, we need lower τ_L to satisfy the optimization problem of the social planner:

$$\frac{dU_H(\tau_H^*, \tau_L)}{d\tau_L} < 0.$$

Now consider the problem of taxing the interest income of local bonds. The pair (T_H^*, T_L^*) of the solutions of the states would define a Nash equilibrium. The social planner sets (T_H^{c*}, T_L^{c*}) and its first-order condition is

$$\eta \frac{dU_H(T_H, T_L)}{dT_H} + (1-\eta)\frac{dU_L(T_H, T_L)}{dT_L} = 0.$$

This yields the optimal tax rate (T_H^{c*}, T_L^{c*}) in a federal union. Analogously to the problem of taxing out-of-state bond income, I take the solution to State $\mathcal{H}$'s problem and substitute it in the first-order condition of the social planner:

$$\eta \frac{dU_H(T_H^*, T_L)}{dT_H} + (1-\eta)\frac{dU_L(T_H^*, T_L)}{dT_H}.$$

The sign of this expression indicates the magnitude of T^* relative to T_H^*. The first term is null by optimization. The second term can be expanded to:

$$\frac{dU_L(T_H^*, T_L)}{dT_H} = (1-\phi)\frac{dP_H}{dT_H}\left(\rho S_L \sigma_L \left(\frac{1-T_L\tau_L}{\omega_L} - \frac{1-\tau_L^2}{\omega_H}\right) + S_H\sigma_H\left(\rho^2\frac{1-T_L\tau_L}{\omega_L} - \frac{1-\tau_L^2}{\omega_H}\right)\right),$$

where

$$\frac{dP_H}{dT_H} = -\frac{\phi}{\gamma_H}\frac{S_H\sigma_H^2 + \rho S_L\sigma_L\sigma_H}{\omega_H^2} < 0,$$

and the term in the parentheses can be rewritten as

$$S_H\sigma_H\left(\frac{1-\tau_L^2}{\omega_H} - \rho^2\frac{1-T_L\tau_L}{\omega_L}\right) + \rho S_L\sigma_L\left(\frac{1-\tau_L^2}{\omega_H} - \frac{1-T_L\tau_L}{\omega_L}\right) > 0.$$

Taking Condition (14), shuffling the terms with tax rates to the right-hand side and multiplying by τ_L, which is positive yet smaller than 1, hence preserving the order of the inequality, yields this inequality. Hence, the social planner then needs to set a higher T_H to satisfy its optimization problem:

$$\frac{dU_L(T_H^*, T_L)}{dT_H} > 0.$$

Similarly, take the solution to State $\mathcal{L}$'s problem and substitute it in the social planner's problem:

$$\eta \frac{dU_H(T_H, T_L^*)}{dT_L} + (1-\eta)\frac{dU_L(T_H, T_L^*)}{dT_L}.$$

The second term is null by optimization. We can expand the first term to:

$$\frac{dU_H(T_H, T_L^*)}{dT_L} = \phi \frac{dP_L}{dT_L}\left(S_L\sigma_L \left(\rho^2 \frac{1-T_H\tau_H}{\omega_H} - \frac{1-\tau_H^2}{\omega_L} \right) + \rho S_H\sigma_H \left(\frac{1-T_H\tau_H}{\omega_H} - \frac{1-\tau_H^2}{\omega_L} \right) \right),$$

where

$$\frac{dP_L}{dT_L} = -\frac{1-\phi}{\gamma_L} \frac{S_L\sigma_L^2 + \rho S_H\sigma_L\sigma_H}{\omega_L^2} < 0,$$

and the term in the parentheses can be rewritten as

$$S_L\sigma_L \left(\frac{1-\tau_H^2}{\omega_L} - \rho^2 \frac{1-T_H\tau_H}{\omega_H} \right) + \rho S_H\sigma_H \left(\frac{1-\tau_H^2}{\omega_L} - \frac{1-T_H\tau_H}{\omega_H} \right) > 0.$$

Taking Condition (16), shuffling the terms with tax rates to the right-hand side and multiplying by τ_H, which is positive yet smaller than 1, hence preserving the order of the inequality, yields this inequality. Hence, we have

$$\frac{dU_H(T_H, T_L^*)}{dT_L} > 0.$$

This proves the proposition. □

D.7 Proof of Proposition 6

Proof. This proof follows Section 2 in Chetty (2009). We can write the aggregate welfare of residents of both states as

$$\begin{aligned} U(\tau_H, T_H, \tau_L, T_L) = {} & \phi[\Pi_H - \frac{\gamma_H}{2}\mathbb{V}_H] + (1-\phi)[\Pi_L - \frac{\gamma_L}{2}\mathbb{V}_L] \\ & + \phi(D_H^H T_H(\mu_H - P_H) + D_H^L \tau_H(\mu_L - P_L)) \\ & + (1-\phi)(D_L^L T_L(\mu_L - P_L) + D_L^H \tau_L(\mu_H - P_H) \\ & + S_H P_H + S_L P_L. \end{aligned}$$

By the Envelope theorem,

$$\frac{dD_j^i(\Theta)}{dT_H} = 0,$$

for any $i = j = \{\mathcal{H}, \mathcal{L}\}$. Assuming fixed supply and ignoring prices because they are transfers, we can write the aggregate welfare impact of State $\mathcal{H}$'s tax shield as

$$\begin{aligned}\frac{dU(\tau_H, T_H, \tau_L, T_L)}{dT_H} &= \phi \frac{dD_H^H(\Theta)}{dT_H} T_H(\mu_H - P_H) + \phi \frac{dD_H^L(\Theta)}{dT_H} \tau_H(\mu_L - P_L) \\ &\quad + (1-\phi) \frac{dD_L^L(\Theta)}{dT_H} T_L(\mu_L - P_L) + (1-\phi) \frac{dD_L^H(\Theta)}{dT_H} \tau_L(\mu_H - P_H),\end{aligned}$$

which corresponds to the expected tax revenue changes perceived by a utilitarian social planner. In the presence of a tax shield, this derivative reduces to

$$\frac{dU(\tau_H, T_H, \tau_L, T_L)}{dT_H} = \phi \frac{dD_H^L(\Theta)}{dT_H} \tau_H(\mu_L - P_L) + (1-\phi) \frac{dD_L^H(\Theta)}{dT_H} \tau_L(\mu_H - P_H).$$

Letting $\nu_H = \mu_H - P_H$ be the risk premium of State $\mathcal{H}$'s bond and $\nu_L = \mu_L - P_L$ the risk premium of State $\mathcal{L}$'s bond, this yields bond risk premia, investor mass, current tax rates, and response of out-of-state bond holdings as determinants of the aggregate welfare change.

Similarly, supposing tax shields are in place, we can write the aggregate welfare impact of State $\mathcal{L}$'s tax shield as

$$\frac{dU(\tau_H, T_H, \tau_L, T_L)}{dT_L} = (1-\phi) \frac{dD_L^H(\Theta)}{dT_L} \tau_L(\mu_H - P_H) + \phi \frac{dD_H^L(\Theta)}{dT_L} \tau_H(\mu_L - P_L),$$

which yields the same set of sufficient statistics. Since risk premia, investor mass, and current tax rates are all scaling parameters, the sign of the welfare change depends on the demand response for out-of-state bonds. Since

$$\frac{dD_H^L(\Theta)}{dT_H}, \frac{dD_L^H(\Theta)}{dT_H}, \frac{dD_H^L(\Theta)}{dT_L}, \frac{dD_L^H(\Theta)}{dT_L} \geq 0,$$

then

$$\frac{dU(\tau_H, T_H, \tau_L, T_L)}{dT_H}, \frac{dU(\tau_H, T_H, \tau_L, T_L)}{dT_L} \geq 0,$$

which confirms part of Proposition 6.

We can apply a similar analysis to the aggregate welfare impact of the two states' tax rates on out-of-state bond income:

$$\begin{aligned}\frac{dU(\tau_H, T_H, \tau_L, T_L)}{d\tau_H} &= (1-\phi) \frac{dD_L^H(\Theta)}{d\tau_H} \tau_L(\mu_H - P_H) + \phi \frac{dD_H^L(\Theta)}{d\tau_H} \tau_H(\mu_L - P_L), \\ \frac{dU(\tau_H, T_H, \tau_L, T_L)}{d\tau_L} &= \phi \frac{dD_H^L(\Theta)}{d\tau_L} \tau_H(\mu_L - P_L) + (1-\phi) \frac{dD_L^H(\Theta)}{d\tau_L} \tau_L(\mu_H - P_H).\end{aligned}$$

Once again, we find that the aggregate welfare change depends on the responsiveness

of investor demand for out-of-state bonds given a change in tax rates. Since

$$\frac{dD_H^L(\Theta)}{d\tau_H}, \frac{dD_L^H(\Theta)}{d\tau_H} \leq 0,$$

and analogously for τ_L, then

$$\frac{dU(\tau_H, T_H, \tau_L, T_L)}{d\tau_H}, \frac{dU(\tau_H, T_H, \tau_L, T_L)}{d\tau_L} \leq 0,$$

which confirms the rest of Proposition 6.

□

D.8 Proof of Proposition D.1

Proof. We can write the difference in $\tau_H(\tau_L) - T_H(\tau_L)$ as a ratio whose numerator is

$$\begin{aligned}
&-\gamma_H\phi(1-\phi) \\
&\Big(\gamma_H S_L\sigma_L(1-\rho^2(1-\phi)+\tau_L^2(1-\phi)-\tau_L(1-\phi)(2-\rho^2)-\phi) \\
&+\gamma_L S_L\phi\sigma_L(2(1-\rho^2)-\tau_L(2-\rho^2))+\gamma_H S_H\rho\sigma_H\tau_L(1-\phi)(\tau_L-1)-\gamma_L S_H\phi\rho\sigma_H\tau_L(1-\phi)\Big) \\
&\Big(S_H\sigma_H\phi(1-\rho^2)(2\gamma_H^2(\gamma_H(1-\tau_L)+\gamma_L\tau_L)+2\gamma_L^2\tau_L(1+\phi)-3\gamma_H\gamma_L\phi\tau_L) \\
&+S_H\sigma_H(\gamma_L\tau_L(\gamma_H(1-\rho^2(1-(1-\phi)\tau_L)+\gamma_L\phi\rho^2\tau_L)-\gamma_H^2(1-\rho^2)(1-\tau_L)(1-\phi^2))) \\
&-4S_H\sigma_H(1-\rho^2)\gamma_L\phi(\gamma_L\phi+\gamma_H(1-\phi))+S_L\sigma_L\gamma_H\gamma_L\rho\tau_L^2(\gamma_H(1-\phi)+\gamma_L\phi)\Big),
\end{aligned}$$

and whose denominator is

$$
\begin{aligned}
&\left(1-\rho^2\right)\times\\
&\Big(\gamma_H^2 S_H\sigma_H((1-\phi)^2-\tau_L(1+\phi^2))+\gamma_H^2 S_L\phi\sigma_L(2\phi(\tau_L(S_H+S_L\rho(2\phi-1))-\rho)+\rho(1+\phi^2)-\phi\rho\tau_L)\\
&+\gamma_L^2\phi^2(2S_H\sigma_H(1-\phi)+2\rho S_L\sigma_L-\rho\sigma_L\tau_L)\\
&+\gamma_H\gamma_L S_H\phi\sigma_H(3-4\phi+\phi^2-2(1-\phi)\tau_L)+3\gamma_H\gamma_L S_L\phi\rho\sigma_L(1-\phi)(3-2\tau_L)\Big)\times\\
&\Big(\gamma_H^2 S_H\rho\sigma_H(1+\phi^2+\tau_L^2+\phi\tau_L(2\phi-2(1+\tau_L)+\phi\tau_L^2))\\
&+\gamma_H^2 S_L\sigma_L(1-2\phi+\phi^2+\tau_L^2-2\phi\tau_L^2+\phi^2\tau_L^2-2\tau_L(1+\phi^2)+4\phi\tau_L)\\
&+2\gamma_L^2 S_L\phi^2\sigma_L(1-\tau_L)+\gamma_L^2 S_H\phi^2\rho\sigma_H(2(1-\phi)-\phi\tau_L(1-\phi))\\
&+\gamma_H\gamma_L S_L\phi\sigma_L\tau_L(\tau_L+\phi(4-\tau_L)-4+3(1-\phi))+\gamma_H\gamma_L S_H\phi\rho\sigma_H(\phi(5\tau_L-4)+(\phi-3)\tau_L^2+3)\Big).
\end{aligned}
$$

We can find sufficient conditions for both the numerator and the denominator to be negative, making the difference in tax rates positive:

$$
\begin{aligned}
0 &\leq 1-\rho^2(1-(1-\phi)\tau_L)+\gamma_L\phi\rho^2\tau_L-\gamma_H(1-\rho^2)(1-\tau_L)(1-\phi^2),\\
0 &\geq \gamma_L\phi(2S_H\sigma_H(1-\phi)-\rho\sigma_L\tau_L)+\gamma_H S_H\sigma_H(3-4\phi+\phi^2-2(1-\phi)\tau_L).
\end{aligned}
$$

These conditions translate to lower bounds on τ_L:

$$
\begin{aligned}
\tau_L &\geq \frac{\gamma_H(1-\rho^2)(1-\phi^2)}{\gamma_L\phi\rho^2+\gamma_H(1-\rho^2)(1-\phi^2)},\\
\tau_L &\geq S_H\frac{2\gamma_L\phi(1-\phi)+\gamma_H(3-4\phi+\phi^2)}{\rho\gamma_L\phi\sigma_L+2\gamma_H S_H(1-\phi)\sigma_H},
\end{aligned}
$$

which corresponds to the conditions in the proposition. An analogous analysis applies to the best response functions of State $\mathcal{L}$. □

E Additional Figures

Figure E1: Aggregate total net assets of municipal bond mutual funds

Note: This figure shows the aggregate assets under management, in billion dollars and over time, of municipal bond mutual funds using data from CRSP Quarterly Update database.

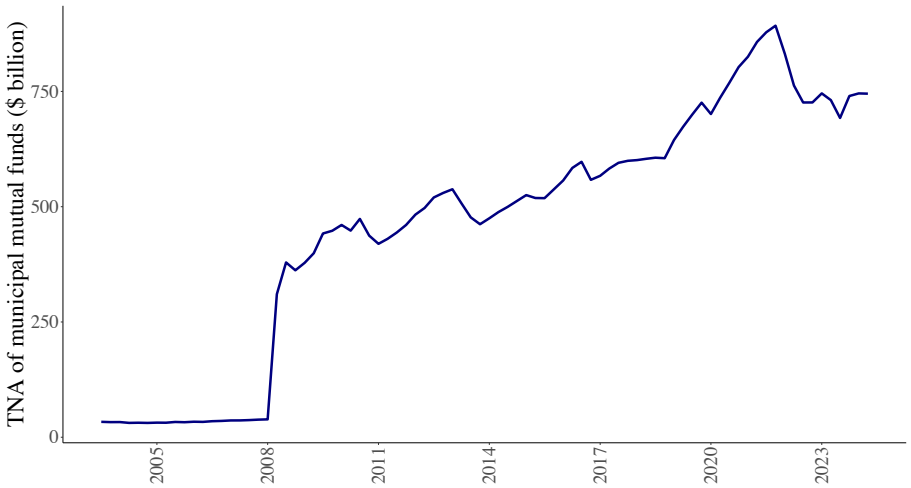


Figure E2: Demand Persistence Depends on the Type of Millionaire Tax Announcements

Note: This figure presents the dynamic results of Equation (1) by type of announcement. The top panel presents results for legislative announcements (New York and New Jersey), while the bottom panel presents the results for electoral announcements (California and Massachusetts). The outcome variable across both panels is the value-weighted single-state fund flows holding bonds of a municipal issuer in a millionaire-tax state. I use the Borusyak et al. (2024) estimator in estimating these dynamic staggered difference-in-differences coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

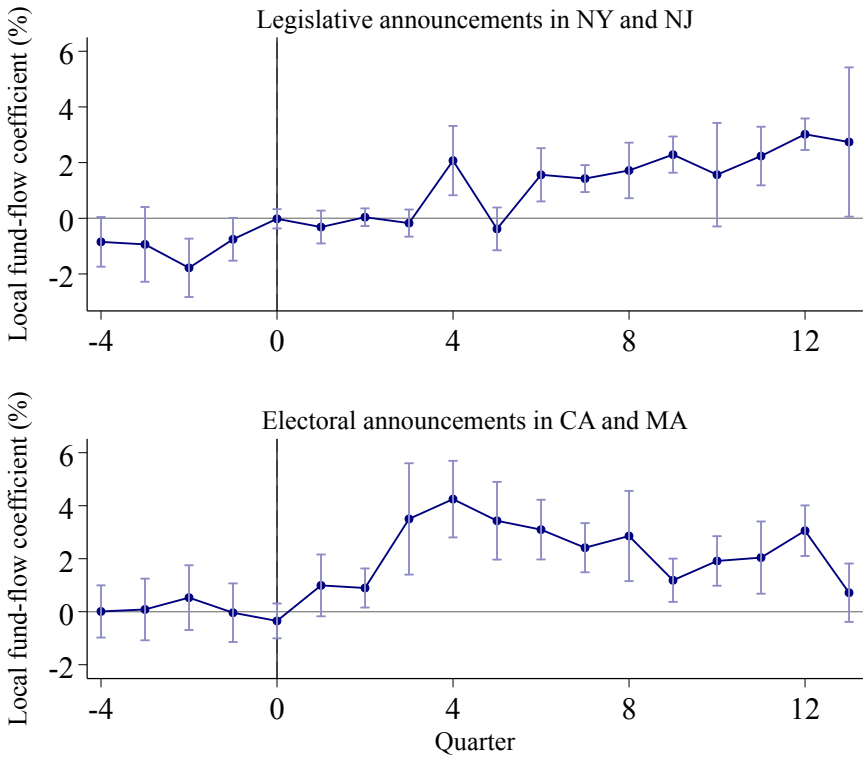


Figure E3: Quantifying the Impact of Millionaire Tax Announcements on Resident Flows

Note: This figure presents the dynamic β estimates of the specification

$$\text{Single-State Fund Flows}_{it} = \alpha_t + \alpha_i + \beta \times \Delta(\text{Millionaire Tax})_{it} + \epsilon_{it},$$

for municipal issuer i at time t, where $\Delta(\text{Millionaire Tax})$ is the change in state income tax rates on the top bracket. All other variables are defined in Section 3. I use the De Chaisemartin and d'Haultfoeuille (2024) estimator in estimating the dynamic staggered difference-in-differences coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

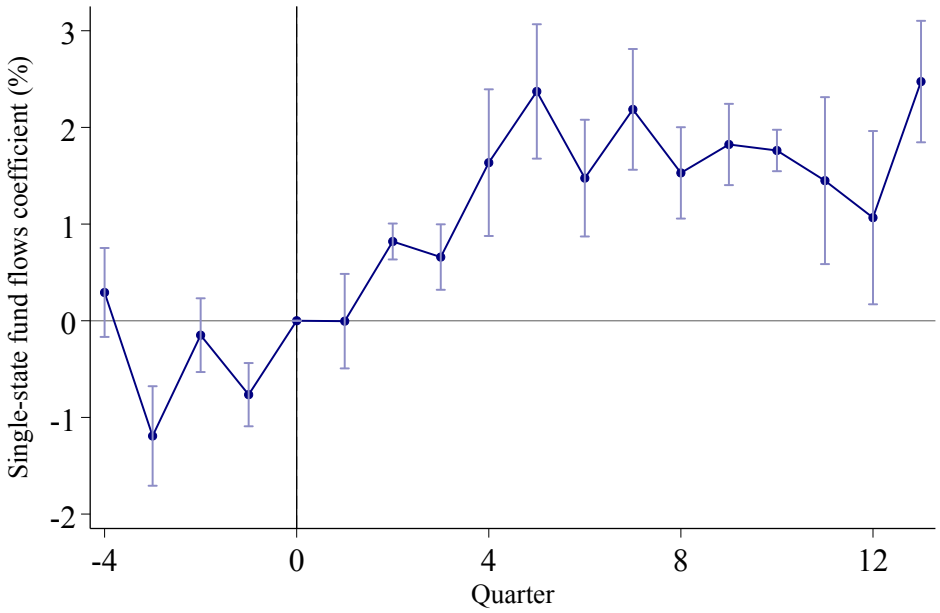


Figure E4: Millionaire Tax Announcements Barely Impact Bond Ratings

Note: This figure presents the dynamic results of

$$\text{Bond Rating}_{it} = \alpha_t + \alpha_i + \beta \times \mathbb{1}(\text{Millionaire Tax})_{it} + \epsilon_{it},$$

where Bond Rating is the rating assigned to municipal issuer i in quarter t and all other variables are defined in the main text. I calculate bond ratings as the average of S&P and Moody's ratings, concorded using a custom concordance file following Haughwout et al. (2022). Bond-quarter ratings are aggregated to the issuer-quarter level by taking the average of bond-quarter ratings. The treatment event is the announcement of higher millionaire tax rates in the state of a municipal issuer. I use the Borusyak et al. (2024) estimator in estimating these dynamic staggered difference-in-differences coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

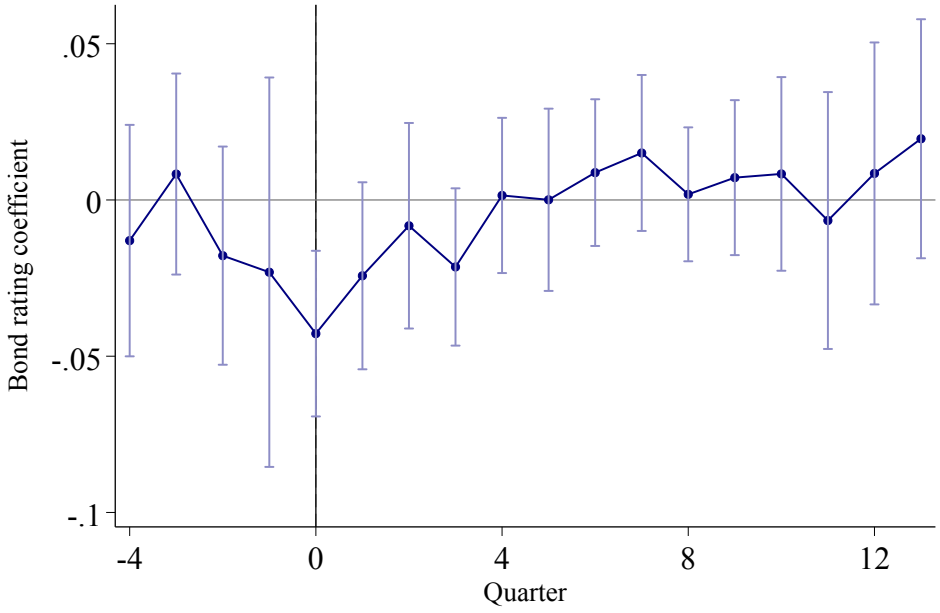


Figure E5: Demand Impact of Millionaire Tax Announcements Is Robust to Excluding State Bonds

Note: This figure presents the dynamic results of

$$\text{Single-State Fund Flow}_{it} = \alpha_t + \alpha_i + \beta \times \mathbb{1}(\text{Millionaire Tax})_{it} + \epsilon_{it},$$

excluding state governments from the set of municipal issuers and where $\mathbb{1}(\text{Millionaire Tax})$ is a dummy for millionaire tax announcements in the state of municipal issuer i at time t. The outcome variable is value-weighted single-state fund flows to bonds of issuer i in quarter t. I use the Borusyak et al. (2024) estimator in estimating the coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

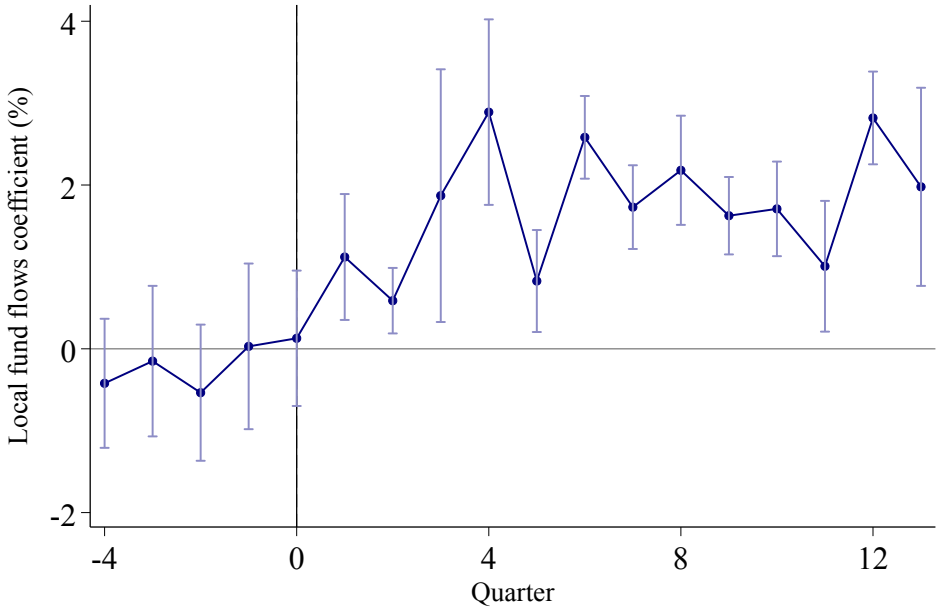


Figure E6: Millionaire Tax Announcements Reduce Relative Bond Yield Spreads

Note: This figure presents the dynamic estimates of the specification

$$\text{Spread}_{it} = \alpha_t + \alpha_i + \beta \times \mathbb{1}(\text{Millionaire Tax})_{it} + \epsilon_{it},$$

for municipal issuer i at time t, where $\mathbb{1}(\text{Millionaire Tax})$ corresponds to the announcement dates of higher millionaire tax rates. All other variables are defined in Section 3. I use the Borusyak et al. (2024) estimator to estimate these coefficients. Quarter 0 corresponds to the announcement dates of millionaire tax rates. Observations are clustered at the state level.

