Heterogeneous Taxes and Limited Risk Sharing: Evidence from Municipal Bonds*

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ABSTRACT

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ABSTRACT

We evaluate the impacts of tax policy on asset returns using the U.S. municipal bond market. In theory, tax-induced ownership segmentation limits risk-sharing, creating downward-sloping regions of the aggregate demand curve for the asset. In the data, cross-state variation in tax privilege policies predicts differences in in-state ownership of local municipal bonds; the policies create incentives for concentrated local ownership. High tax privilege states have muni bond yields that are more sensitive to variations in supply and local idiosyncratic risk. The effects are stronger when local investors face correlated background risk and/or diminishing marginal non-pecuniary benefits from holding local assets.

1. Introduction

There is considerable evidence that portfolio choice and asset ownership decisions are significantly influenced by investors' tax rates and tax policy in general (see, for example, Poterba and Samwick (2003), Dammon, Spatt, and Zhang (2004), Bergstresser and Poterba (2004), Desai and Dharmapala (2011), and Rydqvist, Spizman, and Strebulaev (2014)). Whether these taxation-induced portfolio decisions ultimately impact asset prices and valuation, however, is still an active area of investigation. On the one hand, the "tax capitalization hypothesis" suggests that asset valuation should be inversely proportional to the effective tax rate applicable to the asset (Brennan (1970)). On the other, most famously, in his Presidential Address to the American Finance Association, Miller (1977) argued that while clienteles with different tax advantages will hold particular types of debt, in equilibrium, there should be no consequences of these tax-induced ownership structures on debt pricing.

In this paper, we use the U.S. municipal bond market as a laboratory to evaluate the implications of tax-induced ownership patterns for asset returns. Unlike in much previous work (see, for example, Green (1993), Trzcinka (1982), Green, Hollifield, and Schurhoff (2007), and Ang, Bhansali, and Xing (2010)), our focus is not on the federal income tax exemption but rather on the state income tax privilege, whereby income from in-state municipal bonds are tax exempt for state residents. This privilege policy, which amounts to states essentially paying local investors to under-diversify, varies significantly across states, resulting in different levels of in-state ownership of municipal bonds. We exploit this cross-state variation to demonstrate that an important consequence of tax-induced ownership segmentation is to limit risk-sharing, creating regions of the aggregate demand curve that are "downward-sloping," with a number of important implications for the sensitivity of municipal bond prices to demand and supply shocks (see, for example, Shleifer (1986), and Duffie (2010)).

While we view our primary contribution as empirical, we first build a theoretical model that explores the conjectured economic mechanism. The model combines the tax clientele framework of Miller (1977) with Merton (1987)'s asset pricing model with incomplete information, and shows that when the tax privilege for specific clienteles is high enough, they become the marginal investors for the tax-advantaged asset. Dybvig and Ross (1986) present a model that delivers similar broad implications but they do not study the features of the equilibrium in detail or conduct empirical tests of the implications. The model also bears similarities to Pirinsky and Wang (2011), but differs in a number of ways, most visibly, we derive two distinct equilibrium regions, one of which features full risk sharing, as in Pirinsky and Wang (2011), while the other features tax privileged investors as the marginal investors for the asset.[1]

In the context of municipal bonds, the model predicts that tax privileged investors will more likely act as the marginal investors in states with high tax privilege, putting equilibrium in the latter of the two regions highlighted above. What's more, in this equilibrium region, the model predicts that muni bond yields will be sensitive to variation in bond supply and local idiosyncratic risk. We also extend the model to show that the price effects of supply and local idiosyncratic risk are even more pronounced when the marginal in-state investors face correlated background risk and/or diminishing marginal non-pecuniary benefits associated with holding local assets. In sum, our model demonstrates that tax privilege policy has implications for risk-sharing in equilibrium, which in turn affects muni bond price determination and the resilience of muni yields to shocks.

We test the key predictions of our model in the U.S. municipal bond market, and present evidence of their economic importance. Using data on the holdings of municipal bond funds, we first confirm that tax privilege creates a disproportionately "home-state-biased" bond ownership base, even controlling for other potential determinants of variation in ownership. Specifically, states with high levels of tax privilege issue municipal bonds that are, on average, financed by local investors (we confirm using simple calibrations that this puts equilibrium in the region where they act as the marginal investors). In contrast, municipal bonds issued by states with low tax privilege are purchased and held widely by investors from all over the country.

We then go on to confirm that tax-induced segmentation diminishes the scope for cross-state risk sharing in the municipal bond market. States with higher tax privilege for residents exhibit greater susceptibility of bond prices to measurable muni bond issuance. We also show that such states' bonds are far more sensitive to movements in local idiosyncratic risk, which we measure either by local political uncertainty (i.e., using close elections) or by the realized volatility

[1] We describe several other differences between our work and theirs in greater detail in the Internet Appendix, and briefly summarize them when describing the model.

of stock returns for local firms. These results are present both across states with different privilege policies, as well as across states with the same privilege policy but differing tax rates, and are robust to the introduction of a large set of alternative drivers of municipal bond prices, including state fixed effects. Furthermore, we tackle the issue of potential endogeneity by instrumenting for cross-state variation in the extent of state tax privilege using state-level tax policy that prevailed more than half a century ago, and confirm that our inferences remain strongly significant. Finally, we show using an extension of the model and in related empirical work, that non-pecuniary benefits from in-state holdings, and the degree to which in-state residents' labor income is correlated with the state of the local economy are both sources of amplification of the effects that we posited above.

An important question that naturally arises is the degree to which forward-looking state governments optimize tax policy, trading off a lower cost of debt by engineering a more "local" base against the risk-sharing issues that we identify. It is worth noting that in Miller's (1977) equilibrium, the issuing firm has an incentive to adjust debt supply to the point at which it exhausts the available demand from investors with low marginal tax rates. However, there is no such clear-cut incentive for governments to do so. In fact, the tax privilege offered to local investors is generally thought of by state taxation authorities and market participants as being "revenue neutral." The state faces a borrowing cost that is reduced by $r \cdot \tau$, where r is the borrowing cost that would prevail free of the tax privilege and τ is the relevant state income tax rate. At the same time, the state is thought to lose $r \cdot \tau$ in tax revenue by offering this privilege. In our conversations with market participants, the types of costs associated with tax-induced segmentation that we identify have seemed to come as something of a surprise. To be clear, our model does not endogenize state tax policy or debt supply, taking them as given at the point of our analysis. We simply solve for the optimal asset demands of investors who face different tax-policy induced incentives, and clear markets to derive expressions for the equilibrium returns.

Our results are related to several areas of the finance and economics literature. On the corporate finance side, our model shows that the composition of ownership in a firm's capital structure can have effects on the value of the firm, connecting our work to the substantial body of literature on capital structure in both theory and practice that has exploded since the seminal work of Modigliani and Miller (1958) (for a recent survey of the empirical literature, see Graham and Leary (2011)). Our model has similarities with Auerbach and King (1983), who uphold capital structure irrelevance even in a world of heterogeneous taxes but discuss how borrowing and short-sales constraints can overturn this conclusion. We empirically demonstrate that tax policy can affect capital market outcomes through the formation of clienteles, which connects our work to a series of papers, including Graham (2003), McGrattan and Prescott (2005), and Sialm (2009). These previous papers find that the capitalized value of expected future tax payments by investors gets reflected in firm equity valuations. A new insight from our analysis is that ownership clienteles induced by tax policy can lead to market segmentation, which in turn can affect the risk premium and the cost of external finance. This is a channel which has, with a few notable exceptions (see, for example, Foerster and Karolyi (1999)), been under-emphasized in the extensive literature on this topic, which has tended to focus on issues of adverse selection and moral hazard (see, for example, Myers and Majluf (1984), and DeMarzo, Fishman, He, and Wang (2012)).

Our work also contributes to the rapidly-expanding literature on municipal bond ownership and pricing (see, for example, Fama (1977), Schultz (2013), Bergstresser and Cohen (2015), Cohen, Cornett, Mehran, and Tehranian (2015), and Gao, Lee, and Murphy (2019a)).[2] In particular, the effects of tax clientele may help address the puzzlingly high price of default risk documented by Schwert (2017) and more generally the muni bond puzzle, namely that municipal bond yields, particularly at the long end, are too high relative to those of otherwise similar taxable bonds multiplied by one minus the applicable marginal tax rate (see, for example, Green (1993), Chalmers (1998), and Longstaff (2011)). Although we use the municipal bond market as a laboratory, our main findings on the effects of tax clientele on asset pricing are broader (see related work by Constantinides (1984) on the effects of capital gains tax on stock price seasonality). We show that "downward-sloping demand" for an asset can arise as a consequence of tax policy, highlighting a new channel in an active area of investigation. See, for example, Grossman and Miller (1988), Shleifer and Vishny (1997), Gromb and Vayanos (2002), and

[2]The importance of clientele is also highlighted by the finding of Dougal, Gao, Mayew, and Parsons (2019) that historically black colleges and universities pay significantly higher underwriting fees to issue tax-exempt bonds in the far Deep South, where racial animus is severe.

Greenwood, Hanson, and Liao (2015).[3]

Finally, our work has links with the international finance literature on the price effects of market segmentation (see, for example Errunza and Losq (1985), French and Poterba (1991), Bekaert and Harvey (1995), Baxter and Jermann (1997), Henry (2000), Bekaert and Harvey (2000), and Bekaert, Harvey, Lundblad, and Siegel (2011)). Karolyi and Stulz (2003) provide a survey of the literature. In that literature, implicit and explicit capital barriers affecting cross-border investment generate elevated costs of capital, affect loadings on local versus global risk factors, and have impacts on correlations across global markets. It is worth noting that in the U.S. municipal bond market, there is no restriction preventing the cross-state purchase of bonds, and the usual complications of currencies which bedevil international finance studies are absent. Even so, we find that the incentives created by taxation policy engender a degree of market segmentation in the muni market.

Another connection with international finance is that anecdotal and academic taxonomies of the ownership structure of sovereign debt have emphasized the nationality of bondholders, with an emphasis on the distinction between domestic and foreign bondholders.[4] The academic literature has overwhelmingly recommended that governments attempt to tilt bond ownership towards domestic debt holders (see, for example, Corsetti, Pesenti, and Roubini (2001) and references therein). One important reason for this recommendation is that debt held by foreigners is often denominated in a foreign currency, meaning that currency depreciations can cause self-fulfilling "runs." However, the question remains whether the optimal government bond ownership structure should predominantly comprise domestic bondholders in the face of ownership segmentation and the resulting reduction in resilience to economic shocks.

2. Theoretical Framework

In this section, we present a model based on Merton (1987), but add tax clienteles, an important feature of Miller's (1977) framework. The model provides a foundation for our empirical

[3] Also see Gabaix, Krishnamurthy, and Vigneron (2007), Garleanu, Pedersen, and Poteshman (2009), Greenwood and Vayanos (2014), and Hanson and Sunderam (2014).

[4] Japan, for example, is an economy in which domestic investors hold a significant fraction of government bonds, while in Greece, foreign investors account for a larger fraction of government debt holding.

analysis, and illustrates how asset taxation policy can generate demand segmentation and price effects in the underlying asset.[5] The model resembles Dybvig and Ross (1986), who examine how investors with different marginal tax rates choose assets with different degrees of tax advantage. They arrive at similar broad conclusions on the possibility of clientele effects, given parameter values. However, they do not analyze the segmented equilibrium in detail, or provide empirical evidence in support of the model's predictions.[6]

The model also bears some similarity with Pirinsky and Wang (2011), though it differs in a number of important ways. We describe these differences in detail in the Internet Appendix, but briefly summarize two important ones here. Unlike that model, to match institutional features of the market, we include a large "global" risk-averse investor.[7] We also assume that short sales are proscribed, a relatively common assumption, and more importantly, one which is realistic in the municipal bond setting that we consider.[8,9] The combination of these assumptions and other modelling choices allows us to derive two distinct regions for equilibrium, which means that the model generates predictions for both extensive and intensive margin effects. As we

[5]Foerster and Karolyi (1999) also explore the impacts of the Merton (1987) model on market segmentation, but unlike us, do not consider the impacts of taxation in endogenously generating the segmentation.

[6]Dybvig and Ross (1986) find a clientele effect in prices in one of the three possible equilibria. In that equilibrium, no agent is marginal in all assets (i.e., all agents have inequalities in at least some Kuhn-Tucker conditions, perceiving some assets as having value higher than their shadow price). They state that "much work remains" on this important issue.

[7]Bergstresser and Cohen (2015) show that muni ownership is concentrated among wealthy individuals with the top 0.5% of the population (assets over US$ 10MM) holding 37.5-46.9% of all munis, and that this share has been increasing over time. Such wealthy individuals have high tax elasticity, especially for state taxes, which often manifests itself in residential mobility (Bakija and Slemrod (2004)). Another common form of state tax avoidance by the wealthy is the setting up of non-grantor trusts in tax-free states such as NV and DE. The combination of these important factors motivates our modelling choice.

[8]See Gromb and Vayanos (2010) for an excellent summary of the literature on the costs of selling short. As Dybvig and Ross (1986) discuss, the short-sales constraint is realistic for municipal bonds, which lose their tax advantage when shorted. Moreover, state agencies cannot act as a pseudo arbitrager by issuing more municipal bonds and investing the proceeds, as only municipal bonds whose sale proceeds are hypothecated for specific purposes, e.g., building a hospital, may carry the federal and state income tax exemptions. Finally, in practice, the only cost-effective way to sell municipal bonds short is through municipal bond ETFs, which do not exist until 2007 and, even by the end of our sample period in 2014, hold just about 0.5% of outstanding municipal bonds. Further, municipal bond ETFs are harder to borrow since they are relatively small and are largely held by retail investors.

[9]Without the short-sales constraint (and other frictions such as asymmetric taxation on interest income and expenses), the outside investors can arbitrage by selling the inside asset short and using the proceeds to invest in the market, ultimately equalizing the expected returns of the two assets. Indeed, this is effectively the situation in Pirinsky and Wang (2011), in which the expected pricing effects should be negligible (as in Region 2 in our model). The importance of short-sales constraint implies that in other markets where short selling is easier, our results may only apply in a more muted fashion.

describe towards the end of the paper, in one of these two regions, (an extended version of) our model also delivers novel predictions about how the effects of constraints and preferences of in-state investors affect pricing. We first describe the basic version of the model, subsequently describe how we take it to the data, and finally move to discussing the extensions.

In the baseline setup, we model asset price dynamics in a "small open economy" (similar to an individual U.S. state in our empirical setting), which uses tax privilege policies to incentivize holdings of a particular asset, I, by its own ("inside") residents. In the spirit of Merton (1987), the only other asset in the model is the "market" M, which carries no tax privilege for insiders. The nature of the tax privilege means that the state essentially pays insiders to under-diversify. The remaining investors in the model are outside or "global" investors, who see no difference in tax treatment between the two assets, and possess significantly more capital than insiders. We assume that short sales are proscribed, as mentioned above.

Given our focus on the impacts of asset taxation policy on asset prices, the model does not endogenize either asset supply or tax policy. Taking these variables as given, we solve for the optimal asset demands of inside and global investors, and clear markets to derive expressions for equilibrium expected returns. We then examine the comparative statics of key parameters in the model, and use the resulting expressions to guide our empirical analysis.

The fundamental insight of the model is that when the tax privilege is sufficiently high, inside investors become the marginal investors in the inside asset, and bear substantial idiosyncratic risk as a result. However, the nature of the "segmented" equilibrium means that the aggregate demand for, and the price of, the inside asset become more sensitive to a number of factors. In particular, changes in asset supply driven by issuance, or changes in asset demand arising from movements in idiosyncratic risk significantly shift the equilibrium price of the inside asset. Below, we present the basic structure and main predictions of the model, leaving more complete derivations as well as details of a calibration exercise to the Internet Appendix.

2.1. Asset Structure and Investors

There are two assets, an inside asset (I) and the market (M), whose returns can be described as follows:

$$\tilde{r}_I = \bar{r}_I + \tilde{y} + \tilde{\varepsilon}_I \quad \text{and} \quad \tilde{r}_M = \bar{r}_M + \tilde{y},$$

where $\bar{r}_I$ and $\bar{r}_M$ are the equilibrium expected returns on each asset, $E(\tilde{y}) = 0$, $\text{Var}(\tilde{y}) = \sigma_y^2$, $\text{E}(\tilde{\varepsilon}_I) = 0$, $\text{Var}(\tilde{\varepsilon}_I) = \sigma_I^2$, and $\text{Cov}(\tilde{y}, \tilde{\varepsilon}_I) = 0$. We can interpret $\tilde{y}$ as a systematic risk factor, which affects both assets identically, and $\tilde{\varepsilon}_I$ as idiosyncratic risk, which is specific to the inside asset. As in Merton (1987), we assume that the market for asset M is extremely large, and $\bar{r}_M$ is largely unaffected by the choices of agents in the model.

There are also two investors, which we label as inside (ι) and global (g). The inside investor ι receives a *relative tax privilege* for investing in asset I. In particular, the after-tax returns that ι receives from investing in assets I and M respectively are $\tilde{r}_I$ and $(1-\tau)\tilde{r}_M$. In contrast, the global investor g faces the same tax treatment for assets I and M—we simply normalize this tax rate to zero to simplify the presentation that follows.

Both investors face a simple mean-variance utility maximization problem with short-sales constraints.[10] The two investors' utility functions are identical, with δ relative risk aversion in each case, as in Merton (1987). For each investor, we obtain the following first-order conditions:

$$\omega^\iota = \frac{\bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \lambda^\iota}{\delta(\tau^2\sigma_y^2 + \sigma_I^2)} \text{ and } \omega^g = \frac{\bar{r}_I - \bar{r}_M - \lambda^g}{\delta\sigma_I^2}. \tag{1}$$

where $\omega^{\iota,g}$ are the weights that the inside and local investors, respectively, place on asset I, and λ^j is the Lagrange multiplier that reflects the constraint that ω^j is non-negative.

Equation (1) shows that because in general, $\bar{r}_M > (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2$ (unless the systematic variance is very large), the tax privilege for inside investors causes them to hold relatively higher amounts of asset I than the global investors.

2.2. Market Clearing and Equilibrium

To derive $\bar{r}_I$ in equilibrium, we next clear the market for asset I. Let S_I denote the excess net supply of asset I,[11] and W^ι and W^g denote the wealth of inside and global investors, respectively. We additionally assume that W^ι is sufficient to purchase the entire supply of the

[10] The agents in our model do not face any dynamic costs of underdiversifcation, possibly rising when idiosyncratic local risk is elevated. We do not incorporate more complicated hedging demands that could arise from dynamic risk (and the associated bond price implications). Of course, these complicated dynamics would likely yield additional interesting implcations.

[11] Essentially, given our two investor types, we can think of this supply as net of any price-inelastic demand such as that from index funds.

inside asset I, i.e., $W^\iota > S_I$, and $W^g >> W^\iota$. By imposing that the market for asset I clears (e.g., $W^\iota\omega^\iota + W^g\omega^g = S_I$), the solution can fall into two possible ranges, depending on the relevant parameter values.

Region 1: $(1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 < \bar{r}_I \leq \bar{r}_M$

In this case, investor g will not invest in asset I (the short-sales constraint is binding), and therefore investor ι takes up the entire excess net supply, S_I, bearing all of the idiosyncratic risk, σ_I^2. Market clearing yields:

$$\bar{r}_I = (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota}. \tag{2}$$

where $\gamma = 1 + \tau^2\sigma_y^2/\sigma_I^2 > 1$.

The first term on the right hand side has received much attention in the literature. Authors such as Trzcinka (1982), Ang, Bhansali, and Xing (2010), and Kueng (2018) attempt to check the implied tax rate used to price municipal bonds. However, the tax rate that has usually been "backed out" in these analyses has been hard to reconcile with actual tax rates, suggesting that other forces may be at work, perhaps including the second and third terms in equation (2) above. The second term in the equation is a (smaller, order of τ) variance adjustment to the return on the asset on account of the fact that the inside investor compares the variance of the after-tax market return with that of the tax-exempt asset I. The third term highlights the main channel in this paper. In particular, it shows that investor ι requires additional compensation to bear the idiosyncratic risk associated with her holding the entire stock of the inside asset, in response to the tax privilege incentive. This additional compensation term increases in both the risk, σ_I^2, and the size of the asset I relative to her total wealth, S_I/W^ι.[12]

Region 2: $\bar{r}_M < \bar{r}_I$

If the additional risk compensation that the inside investor ι requires becomes *higher* than the tax privilege, the equilibrium expected return will meet the participation requirement for investor g. Both investors ι and g will then hold asset I (the short-sales constraint is not

[12] This resembles the "shadow cost" of informational incompleteness in Merton (1987).

binding), and share its idiosyncratic risk. Market clearing then yields:

$$\bar{r}_I = \bar{r}_M - \frac{W^\iota}{W^\iota + \gamma W^g}\left(\tau \bar{r}_M - \delta\tau(1-\tau)\sigma_y^2\right) + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota + \gamma W^g}. \tag{3}$$

Interpreting this expression a little loosely, the tax privilege now applies only to the smaller wealth-weighted fraction of investors ι: $(W^\iota/(W^\iota + \gamma W^g))$ while the idiosyncratic risk is shared across both investors $(S_I/(W^\iota + \gamma W^g))$. Since $W^g >> W^\iota$ and $\gamma > 1$, both the tax privilege and risk compensation terms become much smaller under (3) than (2). In the limit $W^g \to \infty$, both terms drop out and $\bar{r}_I = \bar{r}_M$.

The figure below illustrates the two regions and the equilibrium that prevails in each.

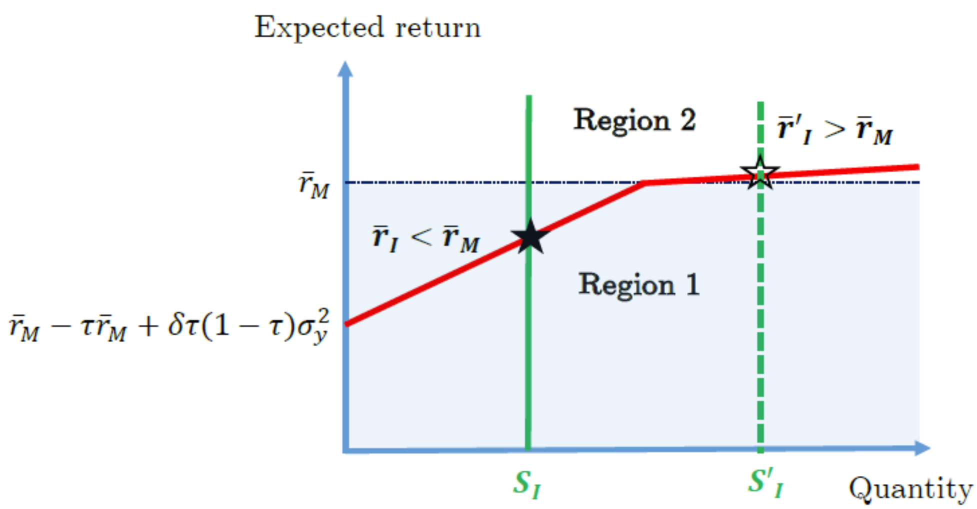

Figure 1: Equilibria with Full and Limited Risk Sharing

Figure 1 shows that the tax privilege creates a kink in the aggregate demand curve, when we move from Region 2, where there is risk-sharing and far less price elasticity of demand, to Region 1 in which investor ι essentially bears the entire idiosyncratic risk of asset I and has a more price elastic demand. The larger the tax privilege τ, the larger is Region 1, and the more likely it is that the equilibrium will fall in that region.

2.3. Comparative Statics and Testable Hypotheses

The level of inside investors' ownership is the principal diagnostic for whether the prevailing equilibrium lies in Region 1 or 2 of the model. In Region 1, ι investors own all of the supply of asset I net of inelastic demand for the asset, while in Region 2, insiders' ownership is lower, as global investors also take up a large part of the net supply of the asset.

The level of tax privilege is the most important determinant of ι investors' incentive to hold a large fraction of the supply of asset I,[13] so we first test *Hypothesis #1*:

> *In-state ownership of asset I should be higher in states with higher tax privilege.*

As we discuss in more detail below, we measure in-state ownership of municipal bonds using the holdings of single state municipal bond funds. Having shown variation in in-state ownership contingent on the tax privilege, we then use the level of in-state ownership to inform us about the relative likelihood of equilibrium in the relevant municipal bond market being in Regions 1 vs. 2.

We next evaluate the comparative statics of equilibrium returns in Region 1 as described in equation (2), and discuss how these predictions change if the equilibrium falls into Region 2. The contrast motivates our difference-in-difference empirical specifications, in which we compare states with high versus low tax-induced in-state ownership with respect to changes in variables that affect demand for and supply of municipal bonds.

Differentiating equation (2) with respect to σ_I^2, we obtain $\frac{\partial \bar{r}_I}{\partial \sigma_I^2} = \delta S_I / W^{\iota} > 0$. The expression motivates *Hypothesis #2*:

> *In high tax privilege-induced inside-ownership states (likely in Region 1), the higher the idiosyncratic risk σ_I^2, the higher are the required risk compensation and the expected return of asset I.*

The same derivative in Region 2 is smaller, as the denominator of the risk pricing term in (3) is significantly larger for very large W^g. Therefore, in our empirical analysis, we evaluate

[13] Differentiating $\bar{r}_I$ in (2) with respect to τ, we obtain $\frac{\partial \bar{r}_I}{\partial \tau} = -\bar{r}_M + \delta(1-2\tau)\sigma_y^2$, which is negative with a set of reasonable parameters for the municipal bond market (we attempt this calibration in the Internet Appendix). Thus, the higher the tax privilege τ, the further $\bar{r}_I$ is pushed below $\bar{r}_M$, making the equilibrium more likely to fall into Region 1.

Hypothesis #2 by comparing municipal bond yields in high and low inside ownership states (Regions 1 vs. 2) across periods of high and low local political risk, or across periods in which local firm equity return volatility differs.

Next, differentiating (2) with respect to S_I, we obtain $\frac{\partial \bar{r}_I}{\partial S_I} = \delta\gamma\sigma_I^2/W^\iota > 0$, which motivates *Hypothesis #3*:

> *In high tax privilege-induced inside-ownership states (likely in Region 1), an increase in supply increases the required risk compensation term and the expected return, as asset I accounts for a larger fraction of investor ι's wealth.*

This is easily seen on the graph as a move along the positively sloping region on the red line in Region 1. In contrast, the slope in Region 2 is almost flat. Therefore, we empirically examine this hypothesis by comparing municipal bond yields in high and low inside ownership states (Regions 1 vs. 2) in response to changes in bond supply, as proxied by variations in net issuance.

Finally, differentiating the above partial derivatives further with respect to the ratio of net supply to wealth, S_I/W^ι, we can show that both effects increase in magnitude as S_I/W^ι increases. In our empirical analysis, we examine whether our results pertaining to *Hypotheses #2* and *#3* are more pronounced in states with a high asset supply relative to a proxy for local wealth.

We subsequently extend the model to analyze the effects of variation in investors' preferences and circumstances on a range of equilibrium outcomes, but first move to empirical tests of the three hypotheses we have just outlined.

3. Test of Model Predictions on Ownership

In the model, differential taxation—determined by the combination of the state's tax rate and tax exemption policies—of in- and out-of-state residents creates differential "tax privilege" incentives to hold any given state's municipal bonds. The model's first prediction (*Hypothesis #1*), is about ownership, which we test next. We describe the data that we use to test each hypothesis as we work through them.

3.1. Municipal Bond Fund Holdings

To measure the degree to which municipal bonds are held in-state, ideally, we need holdings data from all investors (particularly retail investors who account for almost 70% of outstanding municipal bonds). However, such ideal data do not exist; therefore, we use data on municipal bond funds to measure in- vs. out-of-state ownership levels.[14]

We obtain data on municipal bond funds from Morningstar. While Morningstar data extend back earlier in time, our sample period is from 1998 to 2014 given the availability of bond-level CUSIPs (which we use to identify issuing states). For each fund, we have information on total net assets (TNA), inflows and outflows of capital, and returns, all at the monthly frequency. Morningstar also provides detailed holdings of fund assets, available (with rare exceptions) at the semi-annual (at worst) or monthly (at best) frequency depending on the fund and the time period.[15]

These data cover 983 dedicated municipal bond funds, as well as 1,341 mutual funds that hold at least one municipal bond at some point in the sample period. This cross-section more or less covers the universe of mutual funds holding municipal bonds.

Panel A of Figure 2 shows bars (on the left axis), which signify the outstanding amount of tax-exempt municipal bonds with maturity beyond one year. According to the Federal Reserve's Flow of Funds data, the municipal bond market grows from just over $1 trillion in 1998 to about $3 trillion in 2014. The figure also shows that mutual funds hold between 15% and 23% of these bonds (reading off the right-hand axis). Our calculation, combining data on holdings from Morningstar with Bloomberg and Mergent Municipal Bond Database to identify tax-exempt bonds, produces numbers that are very close to the Federal Reserve numbers. This helps to confirm that our data are representative of aggregate mutual fund ownership of municipal bonds.[16]

[14]Bergstresser and Cohen (2015) examine the Surveys of Consumer Finance (SCF) and show that even the richest households (99.5-100 percentiles of wealth) hold a significant fraction of municipal bonds through mutual funds (about 26% in 1998 and 43% in 2013) and that such fractions are even higher for poorer households.

[15]In extremely rare cases where the time between consecutive report dates is greater than one year, we assume that the same fund identifiers are re-used for different funds and do not hold the previously reported positions between the two dates.

[16]In the last two quarters of 2002, over 20% of bonds in the Morningstar holdings data have missing CUSIP. We replace these data using the holdings in the first quarter of 2003.

Morningstar classifies municipal bond funds into three main types: (i) 615 state funds, defined as funds that invest almost exclusively in bonds issued by agencies from a single state, (ii) 318 national funds, defined as funds that invest in bonds issued by multiple states, and (iii) 50 high-yield funds, defined as funds that invest largely in speculative-grade municipal bonds from multiple states. To concentrate on our specific source of tax-induced segmentation, we simply drop the high-yield funds and focus on state and national funds in the remainder of our analysis. In our empirical tests, we implicitly make the assumption that the relative ownership fractions of state and national funds accurately capture the relative ownership fractions of inside ι and global g investors.[17]

Panel B of Figure 2 shows the evolution of aggregate TNA and the number of state and national funds over time. For the first part of the sample, state and national funds hold roughly the same dollar amount (shown on the left axis) of municipal bonds, ranging from just over $100 billion in 1998 to about $160 billion in 2007. In 2008-2009, however, the dollar holdings of state funds as a group appear to stagnate while those of national funds grow significantly after the financial crisis. We find that this divergence is primarily driven by short-term national funds (by Morningstar's definition, with duration of 1-3 years) which experience large inflows due to a shift from tax-exempt money market funds (see Figure IA.1 in the Internet Appendix). This shift lines up well with the runs on traditional money market funds (Kacperczyk and Schnabl (2013)) as well as asset-backed money market instruments such as auction-rate securities.[18] The right axis of the plot shows that the numbers of state and national funds increase in the early part of the sample, reach a peak in 2003, and steadily decline thereafter. Together, the time-series patterns suggest some consolidation among the funds and steadily increasing asset holdings for the average fund in the sample.

Table I shows summary statistics of state and national funds. Columns (1) and (2) (for

[17]The combined ownership of both types of muutual funds does not vary systematically across states with different tax privileges. Thus, we expect measurement errors, if any, in these ownership proxies to bias our inferences towards zero. Nevertheless, we control for the combined ownership in our regressions. In the Internet Appendix, we also show that all of our results hold in a subsample of states that excludes very small states for which our measure of in-state ownership from mutual funds is likely biased. In these very small states, almost no state funds exist likely because of insufficient economies of scale for fund managers rather than any lack of interest among in-state investors.

[18]The collapse of the monoline insurance sector may also play a role. Nanda and Singh (2004) argue that bond insurance is an indirect form of tax arbitrage, which is more valuable for investors in states with greater state tax privilege.

state funds) and columns (5) and (6) (for national funds) report the cross-sectional average and standard deviation of the time-series mean of each of the fund characteristics listed in the rows. Columns (3) and (4) (for state funds) and columns (7) and (8) (for national funds) report the time-series average and standard deviation of the cross-sectional means of the same characteristics. Overall, the averages in columns (3) and (7) are largely similar to those in columns (1) and (5), suggesting that the representation of sample funds is relatively similar over time. Time-series standard deviations are much smaller than cross-sectional standard deviations for virtually all fund characteristics, suggesting that much of the variation in these characteristics comes from the cross section of funds rather than time-series variation in the average fund characteristic. In what follows, we therefore concentrate on describing the cross-sectional variation in time-series averages.

The statistics show that state funds are, on average, far smaller than national funds both in terms of TNA ($279 million vs. $742 million) and the number of bond holdings (113 vs. 218). State and national funds have similar average monthly returns (about 0.3%) but cross-sectional variation in average returns across funds is more than twice as large for national funds. Turning to inflows and outflows, over the sample period state funds experienced a net outflow while national funds experienced a net inflow, consistent with the observed divergence in the aggregate TNA held by these two groups in the latter part of our sample. Finally, in terms of holdings, state funds hold bonds issued by two states, on average, through the sample period, while national funds hold bonds issued by an average of 31 states.[19] Each state represents 79% of the portfolio for state funds, but roughly 6% of the portfolio for national funds, on average over the period. National funds also seem to hold more cash than state funds, possibly to capture short-term market opportunities across many states and to accommodate larger variability in fund flows. Both types of funds invest most of their assets in bonds with maturity longer than 8 years, although the tilt towards the longest-term bonds (greater than 15 years) is more pronounced among state funds than among national funds.

In our tests, we make the assumption that state municipal bond funds are primarily held

[19] State funds are permitted to hold municipal bonds issued outside the state, as long as the tax privilege is substantially passsed through to the investor in the fund. Given the tax code, bonds issued by territories such as Puerto Rico can often be used to meet the requirement as they are tax-exempt for a wide range of investors.

by the residents of the state in question. In support of this assumption, we note that state municipal bond funds are legally required to hold at least 80% of TNA in bonds from which the income is exempt from state income tax for state residents, and explicitly marketed to them. For example, Vanguard CA Intermediate-Term Tax-Exempt Fund (VCAIX) states the following "...This low-cost municipal bond fund seeks to provide federally tax-exempt and California state tax-exempt income and typically appeals to investors in higher tax brackets who reside in California." Published information about national funds is quite different, insofar as they make no mention of state income taxes.

3.2. Tax Privilege and In-State Municipal Bond Holdings

The model predicts that high state income tax privilege will be associated with larger fractions of state municipal bonds held by in-state residents. We investigate this prediction in detail, first by obtaining the privilege policy of each state from various online sources, including www.municipalbonds.com and individual state treasury web sites. We then collect data on state income tax rates from the Tax Foundation (from 2000 onwards) and the NBER Taxsim Program (prior to 2000), and calculate state tax privilege from the highest marginal state income tax rate and the applicable exemption rule for each state. Specifically, tax privilege is defined hereafter as the highest state income tax rate applied to income from municipal bonds issued by other states less the highest state income tax rate applied to income from own state municipal bonds.

Table II sorts all 49 states, for which we have sufficient data to calculate representative state municipal bond yields, into quintiles on the basis of the time-series average of privilege, and reports univariate summary statistics of important tax and ownership variables by privilege quintile. As expected, states in the top (bottom) privilege quintiles have the highest (lowest) marginal state income tax rates of 8.97% (3.82%), confirming that much of the variation in privilege comes from the variation in tax rate. However, the table highlights the importance of focusing on tax privilege as opposed to the "raw" state tax rate. There are some states for which the tax status for bonds issued by the state and those issued by other states are not the usual "exempt" and "taxable," respectively. Such states offer an interesting counterpoint to the rationale for tax-induced segmentation discussed earlier, since they do not privilege in-state holders. For example, for residents in Wisconsin, income from municipal bonds issued by WI as well as those of other states are subject to WI state income tax. The lack of a differential tax rate means that the tax-induced segmentation channel should not apply. Despite a sizeable local tax rate (as high as states in the second privilege quintile), local municipal bond ownership in WI is quite limited due to its zero tax privilege. Illinois, Iowa, Oklahoma, and the District of Columbia offer similar examples.

The main variable capturing in-state ownership is "state fund holding" (*SFH*). We use bond characteristics reported by Bloomberg and Mergent Municipal Bond Database to identify tax-exempt bonds issued by each state, and calculate *SFH* as the ratio of the total dollar amount of state-issued tax-exempt bonds that are held by state funds, divided by the total dollar amount held by both state and national funds.[20] We do so both for all tax-exempt bonds and by maturity group (1-7 years, 8-15 years, and greater than 15 years). Table II shows that states in the top (bottom) privilege quintile also have the highest (lowest) average *SFH* (shown at the bottom of the table) of 37.50% (2.39%), consistent with *Hypothesis #1,* i.e., differences in tax privilege induce sizable differences in ownership structure. States in the middle quintiles lie somewhere in-between but closer to the top as their privilege is closer to that of the top quintile states. The differences in *SFH* between the top and bottom privilege quintiles are economically and statistically significant at all maturities, though they are most pronounced for the longest-maturity bonds. This provides important support for the first prediction of the model, and is also direct evidence of higher in-state holdings, consistent with those inferred through bond yields (Kidwell and Koch (1982), Kidwell and Koch (1983), and Leonard (1998)).

Additionally, as a proxy for the ratio of total net supply to inside investor wealth, $\frac{S_I}{W^\iota}$, we construct the total amount of the state's outstanding debt (from the Census Bureau) divided by the total income of state residents. The "debt-to-income" ratios are slightly higher for states in the top privilege quintile than those in the bottom quintile, highlighting the need to control for the debt-to-income ratios in our analysis. The table also reports the average total holdings of all municipal bond funds in our sample, both state and national, as a fraction of outstanding

[20] We use the most recent reported bond holdings for each fund. Since CUSIPs are missing for many bonds in the last two quarters of 2002, we replace the holdings in 2002Q3 by the most recent holdings up to that point and replace the holdings in 2002Q4 by the next reported holdings, mostly in 2003Q1.

municipal debt. One might argue that *SFH* may be biased if the holdings of mutual funds in general are correlated with state tax privilege. We do not find that it is the case; the total mutual fund holdings are not systematically different across privilege quintiles. Nevertheless, we also control for the total mutual fund holdings in all regressions.

Figure 3 shows time-series variation in *SFH*. Panel A shows that for all years, the average *SFH* is significantly greater in the top privilege states than in the bottom privilege states. Panel B presents *SFH* for Florida and New York. FL provides an interesting laboratory – while its state income tax rate is zero, municipal bonds issued by other states and held by FL residents were originally subject to an intangible property tax (often referred to as a wealth tax), which was gradually decreased from the rate of 0.15% in 1999 to zero in 2007. NY, on the other hand, has significant state tax privileges that remain throughout the sample period, ranging from 6.85% to 8.97%. Consistent with privilege driving *SFH*, we find that 45-71% of municipal bonds issued by NY entities are held by NY state funds while the fraction of Florida-issued bonds held by FL state funds declines from 57% in 1998 to less than 5% in 2014 (the number of FL state funds decreases from 32 to 2), as the preferential tax treatment of FL bonds is gradually phased out.

Panel C presents another interesting laboratory, Utah in comparison with Texas. UT has state income tax of 5-7% but *does not tax* income from municipal bonds issued by other states until the end of 2002. Beginning 2003, UT residents do receive a tax exemption on income from UT bonds, but must pay state income tax on income from bonds issued by most other states (with a few exceptions where there is a reciprocal exemption). TX, in contrast, has zero state income tax rate, which remains throughout the sample. Consistent with the patterns already described, the figure shows that while only about 1-5% of municipal bonds issued by TX are held by Texas state funds (only 2 funds in our sample), the in-state ownership of UT increases significantly from an average of 2% before 2003 to almost 14% in 2005 and remains at that level until the end of our sample period. While they are relatively rare, we will exploit the few special cases, in which tax privilege changes as a result of a change in taxation policies, in our subsequent empirical examination of municipal bond pricing.

Although these simple sorts and descriptive statistics confirm our conjectured relationship between tax privilege and *SFH*, we also test *Hypothesis #1* more rigorously in a multivariate setting. Table III reports the results from a multivariate panel regression of *SFH* (across states and through time) on tax privilege and a host of other controls. For our full sample of 49 states, we run this both with (column (1)) and without (column (4)) state fixed effects, and we employ credit rating cross year-month fixed effects in all models. The empirical estimates continue to provide significant evidence in support of *Hypothesis #1* that tax privilege is positively associated with *SFH* . In terms of magnitudes, an increase from the average level of tax privilege in the bottom quintile of states to that in the top quintile, as reported in Table II, is associated with an increase in *SFH* of approximately 0.34, based on the estimates in column (1) using mostly cross sectional variation, and 0.14, based on the estimates in column (4), which identify this effect only using within-state variation. The effects of tax privilege on *SFH* are even larger (by about 30%-60%) for the 37 states with large (>$10BN outstanding) municipal bond debt levels (columns (2) and (5)), plausibly due to the fact in small high privilege states, like Vermont, the privilege-induced demand is not sufficient to sustain their own state municipal bond funds. The relationship between privilege and *SFH* is also robust even if we drop the states with zero privilege and focus exclusively on the intensive margin (columns (3) and (6)). Finally, in terms of the other control variables, depending upon the inclusion of state fixed effects in the specification, we find mixed evidence that both unemployment and muni bond liquidity, as proxied by overall volume and number of trades, matter for the variation in *SFH*.

Overall, the model implies that variation in the share of local ownership will be affected by variation in tax privilege. The empirical results in this section support this prediction. In what follows, we show that these segmentation effects are also associated with variation in municipal bond pricing, as predicted by the model.

4. Test of Model Predictions on Pricing

In addition to the prediction regarding local ownership, the model also makes several predictions (*Hypotheses #2* and *#3*) regarding bond pricing. Specifically, the sensitivity of yields to movements in local idiosyncratic risk or changes in bond supply is larger for states with high levels of tax-induced ownership (likely in Region 1). In particular, in these segmented states (relative to other states whose bonds are more widely held), municipal bond yields should be significantly higher during periods of elevated uncertainty, and should significantly increase as entities in the state issue more bonds.

4.1. Municipal Bond Price Data

To measure expected returns in our model, we focus on yields and yield spreads (over U.S. Treasuries) at the 10-year maturity (see summary statistics for yields and state-level control variables in Table IA.I in the Internet Appendix). As the variation in *SFH* across tax privilege quintiles is most pronounced in the 8-15 year sector (Table II), we choose the 10-year maturity as a representative, liquid benchmark[21] To estimate state-level yields, we fit a Nelson-Siegel model to Municipal Securities Rulemaking Board (MSRB) transaction prices at the weekly frequency (see details of this procedure in the note to Table IA.I in the Internet Appendix). We then calculate yield spreads as the differences between estimated municipal bond yields and (weekly average) maturity-matched constant maturity Treasury yields from the Federal Reserve Bank of St. Louis (FRED).[22] The average 10-year municipal bond yields differ modestly across states (ranging from 3.9% to 4.4%); they are statistically different (at 8 basis points) between states in the top and bottom privilege quintiles.

We collect credit ratings from S&P for each state's senior, unsecured general obligation bonds. For most states, ratings remain AA- or better throughout our sample period. We also collect additional data that capture the variation across states along other economic and financial dimensions. On average, states in the top privilege quintile have larger GDP and slightly lower unemployment rates than those in the bottom privilege quintile, while their state equity returns and other economic indicators appear similar. In our analyses, we control for

[21] The average maturity of bonds whose *transaction* yields are used for the estimation is also about 10 years. See Table IA.II of the Internet Appendix. We also report there other average bond characteristics that we employ as control variables in our analysis. In addition, we note that among the benchmark maturities (2, 5, 10, 20, and 30 years), the average trading volume, calculated for all bonds with effective maturities within ± 1 year of each benchmark maturity, is highest at 10 years. Finally, in the Internet Appendix (Tables IA.X and IA.XI), we explore the implications of important differences in fund holdings across the yield curve.

[22] In the Internet Appendix (Table IA.III), we compare our estimated yield spreads to those obtained from Bloomberg's Fair Value Curves for the 21 states for which Bloomberg data are available. Given that we do not adjust MSRB yields for embedded call options, our estimated spreads are significantly higher than those from Bloomberg. However, in untabulated results, the estimated yields are not systematically different from Bloomberg's when we derive yield curves only from a smaller subset of non-callable bonds. Further, yield volatilities across MSRB and Bloomberg data are about the same, and the two estimates are highly correlated both in terms of levels and changes.

these variables as well as other national time-varying market conditions to absorb the effects that any of these differences may have on municipal bond prices.

4.2. Price Effects of Local Risk

Hypothesis #2 says that in states with higher levels of tax-induced inside ownership, periods of elevated idiosyncratic risk, σ_I^2, should be associated with larger yields relative to periods characterized by comparative calm. To test this prediction, we regress the weekly state-level 10-year municipal bond yield spread on two candidate measures of local idiosyncratic risk: (i) a close election indicator variable and (ii) a measure of local firm realized equity volatility, and their interactions with segmentation, with which we proxy by either tax privilege directly or *SFH*, our measure of in-state ownership. Our focus is on the interaction terms, which gauge the degree to which the link between idiosyncratic risk and yield spreads is more pronounced in segmented states. Here, we study the *level* of the yield spread rather than its change primarily because we are able to identify periods of elevated local idiosyncratic risk rather than clear week-to-week changes in σ_I^2. Nevertheless, if tax privilege increases the likelihood of being in Region 1 as our model implies, then we should observe a positive coefficient on the interaction between local risk and segmentation.

4.2.1. Timing of Elections and Equity Volatility

We first measure local idiosyncratic risk using close state-level elections, including gubernatorial, state house, and state senate elections. While a number of recent papers (see, for example, Gao and Qi (2013)) have used periods before close gubernatorial elections as a proxy for an increase in local political risk, we significantly expand the number of close elections by considering state-level legislative bodies as well (see Carsey, Niemi, Berry, Powell, and J. M. Snyder (2008)).[23] Specifically, our close election indicator equals one for the three-month period before the election in November for which *any* of the three state-level elections is close. Following the literature, we consider a gubernatorial election close if the vote difference between the winner and loser is 5% or less. For state house or senate elections with several seats simultaneously being decided, the

[23] Thanks to Thomas Carsey for help in guiding us on the collection of state-level house and senate election data. Updated data are located at klarnerpolitics.org.

overall race is deemed *close* if the number of races within a 5% margin is enough to potentially overturn the majority. The literature assumes that since the outcome of a close election is hard to predict *ex-ante* (Lee (2008)), it is possible to associate the periods immediately preceding such elections as periods of heightened political risk.[24,25]

Given that close elections are relatively infrequent for each state (and cluster in November), we consider a second measure of idiosyncratic risk based on realized local firm equity volatility. First, we build a value-weighted daily portfolio return of the listed firms headquartered in the state.[26] We then calculate realized local firm equity volatility as the square root of the sum of squared excess state equity returns (calculated by subtracting the CRSP value-weighted return from the state equity return) over the 5-day trading week (see, for example, Andersen, Bollerslev, Diebold, and Ebens (2001) for the calculation of the daily realized volatility using intraday data, and Christensen and Prabhala (1998) for the calculation of the approximately 18-day realized volatility using daily data). While using just five days to estimate volatility can result in noisy estimates and potentially bias against finding our results, doing so has the advantage of being fully synchronized with our weekly observations and so avoiding overlapping calculation windows.

Table IV and V report the results from the panel regressions of municipal bond yield spread on the close election indicator and realized local firm equity volatility, respectively. In Columns (1) and (2) of each table, we include the local risk measure, tax privilege as a measure of segmentation, along with the interaction between tax privilege and the measure of local risk. Column (2) also includes state fixed effects. While much of the relevant variation in privilege, *SFH*, and bond yield comes the cross section, we acknowledge that there may be some

[24] See Pastor and Veronesi (2012) and Pastor and Veronesi (2013) for relevant theoretical arguments regarding possible asset pricing implications of political risk.

[25] The Internet Appendix (Table IA.I) reports the total numbers of close gubernatorial elections, close state house elections, and close state senate elections during our sample period. In total, the numbers of close elections (reasonably evenly distributed across election types) are 68 and 56 for states in the top and bottom tax privilege quintiles, respectively. This large number of events, distributed across many states, and over time, allows us to identify whether the effects of local political risk on municipal bond yields vary across states with different degrees of privilege-induced market segmentation.

[26] Thanks to an anonymous referee for suggesting the inclusion of realized volatility as an alternative measure of local risk. The median number of publicly listed firms per state is 31, however there is significant cross-state heterogeneity. The interquartile range is 11 to 87 firms per state. While having fewer firms could add some noise, we demonstrate that our key results are robust to the exclusion of small states.

time-invariant unobserved factors at the state level (e.g., culture, politics, etc.), which may drive privilege, *SFH*, as well as bond price resilience.[27] State fixed effects help absorb these confounding forces. Similarly, in Columns (3) and (4), we replace privilege with *SFH* as a measure of segmentation associated with in-state ownership, with Column (4) also including state fixed effects. In each specification, we include a set of control variables, including both various economic indicators and several bond characteristics (using the average of the bonds that enter into our yield-curve estimation), as well as credit rating x calendar year-month fixed effects. We cluster the standard errors by month.

While we use both privilege and *SFH* as measures of segmentation, we contend that *SFH* is the most natural measure for our purposes. Simply testing the model using tax privilege alone, which we do in columns (1) and (2), would not be a full test of the model's predictions. Our contribution is to highlight the specific channel of ownership composition (through segmentation of the market) on price determination, and we view both sets of tests as useful in learning more about the empirical veracity of the channels identified by our model.

In these tables, the main effects of local risk and tax privilege (through segmentation) are as expected. The coefficients on local risk show that periods prior to at least one close election (Table IV) or when local firms experience elevated return volatility (Table V) are associated with significantly higher municipal bond yield spreads. These results simply reconfirm prior work; e.g., the results on gubernatorial elections presented in Gao and Qi (2013).[28] Regardless of the specification, bond yields are lower in states with higher tax privilege, or when the bonds are disproportionately held by in-state investors. Despite the inclusion of other important state-level controls, this direct effect of tax privilege is highly significant, likely capturing the first term in (2), which is not particularly surprising given the extant literature on tax-exempt bonds. The control variables, including the average characteristics of bonds that enter our yield-curve estimation, generally have the expected signs, but are mixed in significance.[29] For

[27] The literature has found difference in bond yields that are related to state level factors. See, for example, Butler, Fauver, and Mortal (2009), Bergstresser, Cohen, and Shenai (2013), and Abakah and Kedia (2019).

[28] In the Internet Appendix (Tables IA.IV and IA.V), we demonstrate the robustness of our results in a few subsamples and by considering several variants for which we build separate 0/1 indicators for close elections – one for each type of election – and find that the results are qualitatively similar. We also build an indicator for a situation in which 2/3 of the election are close, as well as an additional specification where we adjust realized volatility by first stripping out the systematic risk as implied by the CAPM.

[29] We note that, consistent with the evidence of liquidity premia in corporate bond yield spreads (see Longstaff,

example, municipal bond yields are higher when the state has a higher unemployment rate and when we use a greater fraction of callable bonds in estimating the yield curve. This provides comfort that our empirical measures and specifications, while not perfect, perform sufficiently well in capturing relevant variations in municipal bond pricing.

Hypothesis #2 of our model has more novel implications, namely that there will be differential effects of elevated local idiosyncratic risk on bond yields across the two equilibrium regions. We capture these differential effects using the interaction terms between the proxy of idiosyncratic risk and segmentation (either tax privilege or *SFH*). In columns (1) through (4), regardless of the measure of segmentation employed, and both with and without the inclusion of state fixed effects, the coefficients on these interaction terms are significantly positive. Put differently, the yield sensitivity to idiosyncratic risk is larger in states with more segmentation of the demand base (likely in Region 1 of equilibrium), either as measured indirectly using tax privilege, or more directly, using concentrated local ownership. For example, focusing on close elections in Column (3) of Table IV, the increase in the 10-year spread during periods of close election is approximately 4 basis points [0.094*(0.47 – 0.06)] greater in states at the 75th percentile of *SFH* than in those at the 25th percentile. These economic effects range from 3 to 5 basis points across the first four columns of Table IV. In Table V, the same interaction coefficients imply that the effects of an interquartile increase in realized state equity volatility are 1.5-2.5 basis points greater in states at the 75th percentile of *SFH* than in those at the 25th percentile.

Additional Interaction Effects Our model also predicts that the effect of tax-induced ownership segmentation should be more pronounced when the ratio of asset supply to local wealth, S_I/W^ι, is larger. In column (5) of Table IV (for close elections) and Table V (for realized local equity volatility), we test this prediction by adding the triple interaction of the respective idiosyncratic risk measure with segmentation and the debt-to-income ratio, our proxy

Mithal, and Neis (2005), Chen, Lesmond, and Wei (2007), and Ang, Bhansali, and Xing (2010), for example), spreads are also significantly lower for states with more active markets, as measured both by the dollar amount of trading as a fraction of the total debt outstanding, as well as the simple number of bond transactions. Harris and Piwowar (2006) among others show that trading volume is strongly related to municipal bond transaction costs. Schwert (2017), however, shows that the role of liquidity in explaining the municipal bond yield spreads is not as large as one might infer from the literature on municipal bond transaction costs; default risk accounts for the majority of the yield spreads.

for S_I/W^ι. For this specification, we employ *SFH* as our measure of segmentation given its direct link to the ownership mechanism in our model. We do note one caveat, namely that we do not employ state fixed effects here, since the triple interaction already reduces the degrees of freedom, and the introduction of state fixed effects compresses this even further. As noted earlier, much of the variation of relevant variables arises from the cross section.

Column (5) shows that local risk is indeed most significantly associated with elevated yield spreads in those states with both high tax-induced local ownership and a large ratio of asset supply to local wealth. The estimates in column (5) of Table IV suggest that the differential effects, between states at the 75th and those at the 25th percentiles of *SFH*, of close election on the 10-year municipal bond spread is about 3 basis points [0.705*(0.47-0.06)*(0.32-0.22)] higher if these states are at the 75th percentile of the debt-to-income ratio than if they are at the 25th percentile. The same differential effect of an interquartile increase in realized state equity volatility, based on the estimates in Table V, is approximately 1.2 basis points.

4.2.2. Instrumental Variables Approach: 1947 State Income Tax Rates

A potential concern with our approach is that the effects in which we are interested may vary across states due to unobserved factors that also drive current tax and privilege policy. For example, states that experience deteriorating fiscal conditions may raise tax rates, resulting in higher tax privilege and *SFH*. At the same time, the state's municipal bond yields drift higher, especially during periods of uncertain elections due to additional fiscal uncertainty or local firm risk. To address this concern (in addition to including state fixed effects), we collect state income tax rates from 1947 from the Book of the States to use as an instrument. State income/wealth tax was a relatively new concept in 1947, having been introduced only a few years prior, and the privilege policy in each state was introduced along with, or even prior to, the state income/wealth tax. States that had low or no state tax at that time had little need to introduce state tax privilege, and much of the cross-state variation in *current* state tax and privilege policy is by and large a vestige of this history. As a consequence, it is difficult to argue that tax rates from 1947 have direct effects on the observed variation in municipal bond ownership or yields more than fifty years later, other than through the inherited state tax privilege. Table II shows that the tax rates in 1947 are positively associated with the current tax rates, privilege, and *SFH*, suggesting that these historical rates are a relevant instrument.

In support of the assumption that cross-state variation in state tax privilege policy is plausibly exogenous, it is worth noting an important judgment in the U.S. Supreme Court in 2008, which we discuss in more detail in the Internet Appendix. The original lawsuit challenged the Kentucky law of providing the tax privilege to in-state residents on the grounds that this policy engaged in unconstitutional discrimination against interstate commerce. The Court upheld the exemption policy in a 7-2 vote, noting two important determinants. The first is that every single state in the U.S., whether or not it has an income tax, supported the Kentucky policy of differential taxation of in- and out-of state bonds, i.e., that this policy is inextricably linked with the federal structure of the U.S. The Court also noted in its judgement (page 27 of Justice Souter's opinion) the fact that the policy has been in place for almost 100 years (indeed, well before the advent of widespread state income taxation).

In a setup similar to the OLS regressions provided in Tables IV and V (Column (3) without state fixed effects), Columns (6) through (8) of the same tables report results from IV-2SLS regressions of the weekly 10-year municipal bond yield spread on our close election indicators, *SFH*, and an interaction term between *SFH* and the two local risk measures. *SFH* and the interaction variable are now instrumented by the 1947 tax rate and its corresponding interaction variable, respectively.

Columns (6) and (7) of Table IV (for the close election indicator) and Table V (for the realized state equity volatility) report estimates of the first-stage equations. In these equations, *SFH* and the *SFH* x local risk proxy are separately expressed as functions of the state income tax rate in 1947, as well as its interaction with the relevant local risk proxy. In each case, the coefficients of the 1947 tax rate and its interaction with a relevant risk proxy are highly statistically significant. Both sets of first-stage specifications comfortably pass the Kleibergen-Paap rank Wald test, indicating that our instruments sufficiently explain the variation in the endogenous regressors and hence are not weak (see Stock and Yogo (2005a), Stock and Yogo (2005b), and references therein). The effects of tax rates in 1947 are also as expected. States with higher state tax rates in 1947 tend to have higher local ownership of state-issued municipal bonds.

Column (8) of Tables IV and V report estimates of the corresponding second-stage equations.

In both tables, we find that the direct effect of local risk on the yield is statistically insignificant. However, we once again find that the effect of *SFH*, now instrumented with the 1947 tax rate, is negative and highly significant, consistent with the OLS panel regressions presented in Column (3) of each table. This exercise additionally lends credibility to the idea that the differential municipal bond yield spreads across states with high and low local ownership are a reflection, in part, of the first-order effect of high tax rates driving down yields on tax-exempt bonds. Most importantly, we confirm that the coefficients on the interactions between *SFH* and the local risk measures are positive and highly significant.[30] We note that we cannot perform IV analysis with state fixed effects since our IV, the tax rate in 1947, is a state-level variable. That said, we note that the effects of the interaction between segmentation and local risk are very robust to the inclusion of state fixed effects, and we view these as our primary result.

For context on the economic size, we first turn to the close election example in Table IV. Our IV estimates suggest that the increase in the 10-year spread during periods of close election is approximately 18 basis points [0.434*(0.47 – 0.06)] greater in states at the 75th percentile of *SFH* than in those at the 25th percentile. The same differential effect of an interquartile increase in realized state equity volatility, based on our IV estimates in Table V, is about 8.5 basis points. As the number of first stage regressions required will become exponentially large, we do not consider specifications that include the triple interaction with the debt-to-income ratio. Nevertheless, the confirmation of the causal nature of the effect of local risk on the municipal bond spread being evident primarily in states with highly concentrated local ownership is consistent with the two equilibrium regions in our model.

4.3. Price Effects of Supply Variation

In high tax privilege states with concentrated local ownership (Region 1), our model predicts that changes in net bond supply, S_I, will engender a positive change in the municipal bond yield spread. This supply effect occurs through the required risk compensation term, as asset I accounts for a larger fraction of investors ι's wealth, and as a result, should be muted for

[30] In the Internet Appendix (Tables IA.IV and IA.V), we also demonstrate the robustness of our IV-based results in a few subsamples and under different close election indicators and a CAPM-adjusted realized volatility measure.

low tax privilege states with diversified ownership (Region 2). Therefore, we test *Hypothesis #3* by examining whether the variation in asset supply S_I (which we proxy by municipal bond issuance) differentially explains the variation in municipal bond yields across states with high and low privilege and *SFH*.

We compute total weekly issuance, averaged over the past four weeks to smooth out lumpiness in issuance, by simply summing all individual tax-exempt bonds issued in each period (as reported by SDC Platinum), and dividing the sum by the total income of state residents. Net issuance is total issuance less re-funding which accounts for about half of the total issuance amount.[31] The summary statistics in the Internet Appendix (Table IA.I) show that the average annualized net issuance to income ratio varies modestly across states, ranging from 0.62% in Hawaii to 3.06% in New York. States in the top privilege quintile have slightly lower net issuance than those in the bottom quintile (by about 0.12% of income), although the debt-to-income ratios do not significantly differ. We use net issuance as our primary measure of the change in net supply, ΔS_I, and examine whether its effects on bond yields are greater in states with concentrated in-state ownership.

Table VI presents evidence on panel regressions of the weekly *change* in the 10-year spread on net municipal bond issuance. In Columns (1) and (2), we present the results of OLS regressions where segmentation is proxied by tax privilege (without and with state fixed effects, respectively), whereas Columns (3) - (4) present similar OLS regressions where segmentation is proxied by *SFH*. As before, in all specifications, observations are state-weeks, and we include our usual set of control variables, as well as credit rating cross calendar year-month fixed effects.[32]

[31] Refunding is a procedure whereby an issuer refinances outstanding bonds by issuing new bonds (perhaps to manage interests costs or remove restrictive covenants). Both current and advanced refunding are included. This refinancing motive stands in contrast to bond issuance for the purposes of raising new money for new investment projects.

[32] We also consider an alternative supply change proxy for which we take the residual from a panel regression of the net weekly issuance on thirteen lags (one quarter) to remove any persistence from our measure, as well as state dummies to remove any pure cross-state variation in average weekly issuance. We then apply the four-week moving average and normalize the measure by the total income of state residents. The weekly net issuance is highly variable, and our model only captures a small fraction of the variability (5.6% R-squared). About half of the explanatory power comes from state fixed effects and half from the lagged net issuances, whose estimated coefficients range from 0.016 for the 10th lag to 0.073 for the first lag. Additional lags can only slightly improve the explanatory power. We provide a version of Table VI with this alternative measure in the Internet Appendix (Table IA.VI) where the main results are corroborated.

Before discussing the results, it is important for us to address an obvious concern of the possibility of reverse causality. Specifically, a decrease (increase) in yield may induce more (less) issuance. However, given that municipal bond issuance is an inherently political and time-consuming process and that there is no serious tradition of "shelf registration" (pre-registering an offering that includes multiple undefined future issues) in the municipal bond market during our sample period, it is extremely unlikely that this effect would operate at the weekly frequency. Further, suppose that issuers could, in fact, quickly issue more bonds when yields are low, such yield timing behavior should induce a negative association between bond issuance and bond yield spreads, which runs counter to our model's prediction.

In Table VI, Columns (3) and (4), where we use *SFH* as the measure for segmentation, show that an increase in bond supply does, on average, increase yield spreads (though this is not true in Columns (1) and (2) where we focus on tax privilege), consistent with the findings of Greenwood and Vayanos (2010), Greenwood and Vayanos (2014), and Krishnamurthy and Vissing-Jorgensen (2012). However, our focus is on *Hypothesis #3* that this effect is larger in states with concentrated local ownership due to the relatively limited wealth available to absorb new supply at equilibrium prices in Region 1. To test this prediction, we add segmentation, either tax privilege in Columns (1) and (2) or our measure of local ownership, *SFH*, in Columns (3) and (4), as well as their interactions with bond issuance. Across both measures of segmentation and with or without state fixed effects, we find that the interaction term is both positive and highly statistically significant. While the effect of bond issuance on the spread is negligible in states with low in-state ownership, the significant effect observed in states with high in-state ownership suggests the equilibrium in these states is located in the downward sloping part of the demand curve.[33]

In terms of economic magnitude, the coefficients in Column (3) imply that a one standard deviation increase in the weekly net issuance-to-income ratio (about 3% annualized) increases yields by roughly 1.1 basis points [0.03*0.898*(0.47-0.06)] more in states at the 75th percentile of *SFH* than in otherwise similar states at the 25th percentile of *SFH*. This effect ranges from 1

[33] Low tax privilege states that are held more broadly by diversified national funds can be partial substitutes for one another, indirectly absorbing supply shocks between them. This line of thinking is broadly consistent with the gap-filling theory of Greenwood, Hanson, and Stein (2010), whereby corporate issuers act as liquidity providers absorbing supply shocks associated with changes in the maturity structure of government debt.

to 1.5 basis points across the first four columns of Table VI. For an average state with about $50 billion of debt outstanding, the differential effect of 1.1 basis points translates to an increase in interest cost of $5.5 million per year for new issuance (assuming all bonds are issued or refinanced at the increased spread), or a decrease in value of 11 basis points in a week for existing bonds with an average duration of 10 years. In Column (5), we add the triple interaction with debt to income ratio and show that the differential price effect of new issuance is significantly more pronounced in states with larger S_I/W^{ι}, consistent with the model's prediction.

As before, we also instrument *SFH* by the 1947 tax rate. Columns (6) - (7) report estimates of the first-stage equations, in which the endogenous variables (*SFH* and *SFH* x supply change) are separately expressed as a function of state income tax rate in 1947 and its interaction with net issuance. In each case, the coefficients of both the much older tax rate and the interaction term with the bond issuance measure are statistically significant, and together, the first-stage specifications comfortably pass the weak identification tests. In Column (8), we report estimates of the corresponding second-stage equation. We find that the direct effect of bond issuance on the yield change is not statistically significant but the coefficient on the interaction between *SFH* and net issuance is both positive and highly significant. For context on the economic size, the change in the 10-year spread associated with a one-standard deviation increase in bond issuance is roughly 4 basis points [0.03*3.248*(0.47-0.06)] higher in states at the 75th percentile of *SFH* than in states at the 25th percentile of *SFH.* As with the local risk analysis above, we do not consider the triple interaction with the debt-to-income ratio to keep the number of first stage regressions contained. Taken together, we find that municipal bond issuance has significant impact on local bond prices, but these effects are largely restricted to the states in which higher levels of tax privilege act to segment the market and limit cross-state risk-sharing.

4.4. Bond-level Analyses

To further evaluate our hypotheses, we consider an alternative bond-level analysis where more precise controls for individual bond characteristics are possible. We follow Gao, Lee, and Murphy (2019b) in constructing our bond-week sample from MSRB transaction data (translating from their bond-month construction).[34] After various screens, we end up with a sample of 2,539,919 individual bond-week observations.[35] We consider different cases–with and without state fixed effects, and employing different measures of segmentation, but we only show a subset of the key results to keep the table manageable (with other results available upon request). We add a few additional bond-level control variables, again following Gao, Lee, and Murphy (2019b).

Columns (1) (close elections) and (3) (realized volatility) of Table VII confirm *Hypothesis #2*, showing significantly positive relationships between individual-bond spreads and the interaction between local risk and segmentation, as measured using privilege. In both cases, we include state fixed effects to absorb time-invariant state level effects. Further, Columns (2) (close elections) and (4) (realized volatility) show that the relationship is even more pronounced for high debt/income states, as evidenced by significantly positive triple interaction effects. Here, we use *SFH* as a measure of segmentation to highlight our economic channel, consistent with the earlier tables.[36]

For our supply regressions, we calculate the change in yield of each bond between weeks t and t-1. As municipal bonds trade very sparsely, we allow for the use of lags of up to week t-4 to retain as many observations as possible while still capturing the relevant change in yield. This differencing results in a smaller sample of 609,136 bond-weeks, with a tilt towards more liquid, regularly traded bonds. Using this sample, Columns (5) and (6) of Table VII confirm our *Hypothesis #3*, showing significantly positive relationships between the change in individual-bond spread and the interaction between net issuance and segmentation. In Column (5), segmentation is measured using tax privilege (and includes state fixed effects) while in Column (6), segmentation is defined as *SFH* (but does not include state fixed effects, as a result of triple interaction). The results show that supply changes are associated with larger

[34] See also Green, Li, and Schurhoff (2010) and Schwert (2017).

[35] We screen the transactions using the same filters as in our Nelson-Siegel yield curve estimations, plus the additional screens imposed by Gao et al. (2019). Individual trades are noisy, especially as many trades are small. We therefore additionally impose that the transaction size must be at least $100,000 par. We then aggregate the yield across transactions in the same bond in the same week by calculating the par-weighted average yield. Again, for accuracy, we also require that there are at least 4 qualified transactions to calculate our weighted average yield.

[36] We do not include state fixed effects here, given the compression of degrees of freedom associated with estimating triple interactions, as mentioned earlier.

positive yield changes in segmented states, and that such effect is even more pronounced for high debt-to-income states (i.e., the estimated triple interaction effect in Column (6)).

As an important aside, we find that the coefficients on bond-level control variables have expected signs, consistent with those of the average bond characteristics we include in our state-week regressions. For example, general obligations bonds tend to have lower yields while callable bonds have higher yields. More importantly, we find that our key results with bond-level regressions are qualitatively and indeed, quantitatively (i.e., in terms of economic magnitudes) very similar to what we observe in our baseline specifications in Tables IV through VI.

While the results from state-level and bond-level regressions are encouragingly similar, we prefer the state-level fixed-maturity analysis conducted earlier as an appropriate venue to test the theory. This is for several reasons. First, in the earlier fixed maturity analysis, every state has essentially the same weight, whereas CA, NY, and TX are weighted far higher at the bond level given, the number and liquidity of bonds issued by these states. Second, the fixed maturity regressions do not impose the assumption that the equilibrium effects of segmentation on yield spreads are the same across all maturities–this is a within-state cross maturity weighting issue. Third, we lose many observations due to the illiquidity of the underlying bonds when we try to calculate weekly yield changes. Finally, while we cannot control for all characteristics, the controls that we employ in the baseline analysis are close to the set of controls employed here and in Gao, Lee, and Murphy (2019b). That having been said, the fact that the results are highly consistent across empirical approaches is again encouraging.

4.5. Time-Series Changes in Tax Privilege

Tax privilege reflects the combination of state income tax rates with the privilege policy favoring local investors. Most of the variation in tax privilege is *cross-state*, which in turn enables us to instrument for it using state tax rates prevailing in 1947. While we view tax privilege as quasi-exogenous from the perspective of both local ownership and municipal bond price resilience and show that our results are robust to using the IV, the largely cross-sectional relationships that we pick up are not immune to the alternatives in which time-invariant unobservable factors at the state level (e.g., culture, politics, etc.) drive the tax rates in 1947, *SFH*, as well as bond price resilience. In this section, we address this remaining concern by directly exploring what little *within-state* variation in tax privilege that there may be.

Within-state variation in tax privilege may come from (i) changes in the privilege policy, or (ii) changes in the state income tax rates. The former are important but rare as the privilege policy is largely a long-standing vestige of a very old tradition (as argued in *Department of Revenue of Kentucky v. Davis*). The latter occur frequently but are relatively small and unlikely to have any immediate detectable impact on ownership structure and prices. Our first approach to isolating the source of within-state variation exploits both sources of variation by simply including state fixed effects in our main panel regressions in Tables IV through VII. The heightened sensitivities of bond yields to local risk and supply are robust to the inclusion of state fixed effects.

Our second approach exploits, as a natural experiment, the few states for which we observe a change in direct tax privilege policy. Specifically, Florida, Indiana, and Utah explicitly adjust their privilege policy during our sample period. We find that these changes appear to have significant impacts on effective tax privilege in these states, and engender large movements in state fund holdings (presented earlier for Florida and Utah in Figure 4), consistent with the new incentives of in-state residents created by the policy shifts. While FL's state income tax rate is zero, municipal bonds held by Florida residents but issued by other states were originally subject to an intangible property tax until 2007. In the opposite direction, IN and UT have positive state income tax rates, but *do not tax* income from any municipal bonds, issued by any state, until the end of 2011 and 2002, respectively. Income from out-of-state municipal bonds acquired on or after January 1, 2012 in the case of IN and January 1, 2003 in the case of UT is taxed at ordinary state income tax rates for state residents. Below, we explore the price effects of local firm equity volatility and supply variation for municipal bonds issued by these three states across the different tax privilege regimes.

Table VIII reports estimated price effects of (i) local risk (where the dependent variable is the municipal yield spread) and (ii) supply changes (where the dependent variable is the change in 10-year municipal bond yield spread) for FL, IN, and UT bonds during periods in which state residents enjoy tax privilege for holding their own state bonds vs. periods in which they do not. In our panel regressions, we include states that share geographic borders with FL, IN, and UT as a control group to absorb potential regional changes that may drive privilege policies or shared economic dynamics. For example, we include Michigan, Illinois, Ohio, and Kentucky as a control group for IN. Our key variables of interest are two indicators. The first is labeled "treatment group" which equals one for the three treatment states and zero for the control group. The second, labeled "treatment period", equals 1 for each treatment state and its corresponding control states when tax privilege is present in that treatment state (and zero otherwise). As in earlier tables, we include a host of fixed effects, including state fixed effects and state group x week fixed effects (where each group contains each treatment state and all control states that share the border with it) and control variables in each case. We cluster the standard errors by month.

In Column (1), we focus on the difference between the interaction of local firm equity volatility[37] with the treatment periods, across the treatment and control groups, i.e., the three-way interactions in entries [A] and [B]. We test the difference between [A] and [B] to contrast the differential effects during the treatment period between the treatment and control states (diff-in-diff). Despite the fact that power is quite limited with only a few states, we find that the positive association between local risk and municipal bond yield spreads is significantly elevated during the periods when tax privilege was in place for the three treatment states; we find no such effects for the control group. In economic terms, the price effects of local risk, as measured by realized local firm equity volatility, increase by about 60% across the three states in the presence of tax privilege.

In column (2), we turn to an examination of the differential effects of supply changes on the change in municipal bond spreads. To again contrast the differential effects during the treatment period between the treatment and control states (diff-in-diff), our focus is on the three-way interactions, shown in entries [C] and [D]. We test the difference between [C] and [D] to confirm that supply changes are significantly positively associated with changes in municipal bond spreads during the periods when tax privilege was in place for the three treatment states, and not otherwise. In economic terms, the price effects of bond issuance, across these states, more than double in the presence of tax privilege.

In sum, we re-examine the implications of our model using *within-state* variation in tax

[37] Note, we cannot perform similar analyses using political risk measures, given these three states do not experience enough close elections to identify the relevant effects.

privilege policy. The results confirm what we have earlier documented using largely *cross-state variation*, indicating that they are not explained by unobserved factors at the state level. Changes in tax privilege significantly drive changes in local ownership, and the price effects associated with concentrated local ownership are largely limited to the periods when states provide an explicit incentive for state residents to hold their own state bonds and bear the inherent local risks.

4.6. Robustness Checks

We consider a few additional exercises to confirm the robustness of our results. In addition to using a few alternative measures of local idiosyncratic risk and supply change, we also consider three subsample analyses: (i) to ensure that our results are not driven by very small states with little debt and potentially no state funds, we exclude states in the bottom quintile of municipal debt levels (i.e., including only the states with average outstanding municipal debt of at least \$10 billion), (ii) to examine the differential effects of *SFH* on the intensive margin, we include only those states for which the state income tax rate and the associated tax privilege are equal, and (iii) to ensure that our results are not driven by credit risk, we control for credit default swap (CDS) spreads and thus include only states and time periods for which CDS data from Bloomberg are available. In all of these cases, we confirm our baseline results. We relegate a detailed description of these exercises to the Internet Appendix.[38,39]

Finally, we perform two additional analyses to further confirm that our results are indeed driven by the lack of risk sharing due to local ownership concentration. First, building on Gao, Lee, and Murphy (2019b),we show that our effects are distinct from those associated with the reduced contagious effects of default in states that are more proactive in their agencies' bankruptcies (Table IA.VIII in the Internet Appendix, which include the interaction between

[38]For subsamples (i) and (ii), Tables IA.IV and IA.V (in the Internet Appendix) reports the results for the price effects of an increase in state-specific risk as measured by close election and realized state equity volatility, where the dependent variable is the 10-year municipal bond yield spread). Table IA.VI reports the effects of supply changes (where the dependent variable is change in 10-year municipal bond yield spread). Table IA.VII reports results on the regressions in which we include CDS data. We also consider versions in which we instrument for *SFH* by using the 1947 tax rate, as permitted by the data.

[39]Finally, we also consider a falsification test based on a sample of taxable municipal bonds. For this very small sample, we find no significant effects associated with the link between direct local ownership and either state-level idiosyncratic risk or local supply changes. These bonds make up less than 5% of the market and are traded very infrequently, so important caveats apply.

proactive state dummy and local risk or supply change in addition to the main term, already included in our main set of tables). Second, we exploit the significant shift in relative holdings of in-state and national investors after the crisis. Although as earlier discussed, the post-crisis drop in in-state ownership at the short end of the yield curve is not a result of tax privilege, its effects on price elasticities should be more pronounced in states with high privilege for which the prevailing equilibria, prior to the drop, were likely in Region 1. In Tables IA.X and IA.XI in the Internet Appendix, we show, consistent with our model's predictions, that the post-crisis increase in the relative ownership of national funds diminishes the price effects of concentrated local ownership at the 2-year maturity but our results at the 10-year maturity remain largely the same both before and after the crisis.

5. Residents' Circumstances and Preferences

In this section, we examine the extent to which our model and associated empirical results might be further refined to account for the presence of additional risks or local investors' preferences, both highlighted by the literature as important sources of deviations from "canonical" portfolio choice.

We begin by modifying our model to include a role for background risk (in the form of uninsurable labor income) faced by inside investors. The effect of background risk on portfolio choice has been an active area of investigation in the literature (see, e.g., Guiso, Jappelli, and Terlizzese (1996), Heaton and Lucas (1997, 2000a, 2000b), and Fagereng, Guiso, and Pistaferri (2018)). In our context, background risk is likely to play a particularly important role, since it is plausible that shocks to inside investors' labor income are correlated with idiosyncratic risk affecting the returns on the inside asset.[40]

We then turn to modeling inside investors' preferences as incorporating a perceived non-pecuniary benefit from investing in local projects and holding local bonds in their portfolios. This possibility is motivated by the literature on underdiversification, which suggests that loyalty is an important factor that helps to explain local bias in investor portfolios (see, for

[40] To take a simple example, consider a situation in which unusual state budget deficits simultaneously affect realized bond returns, as well as state spending capabilities. The latter channel affects the implementation of new projects and therefore the wages of both government and private sector employees.

example, Cohen (2009), and Morse and Shive (2011)).

Both of these model extensions generate a set of unique predictions, which are supported in the data. We describe them in detail below.

5.1. The Effect of Background Risk

We first augment the model by adding labor income of each investor j as $\tilde{L}^j = W^j \tilde{l}^j$ where $\tilde{l}^j = \bar{l}^j + \tilde{\varepsilon}_l^j$, $\text{Var}(\tilde{\varepsilon}_l^j) = \sigma_l^2$ (same for both investors). While the labor income of both investors may be correlated with the systematic shock, $\tilde{y}$, for simplicity, we normalize $\text{Corr}(\tilde{y}, \tilde{\varepsilon}_l^\iota) = \text{Corr}(\tilde{y}, \tilde{\varepsilon}_l^g) = 0$. However, we assume that the labor income of the inside investor ι is also positively correlated with the local idiosyncratic shock $\tilde{\varepsilon}_I$, but the labor income of investor g is not. Let $\rho = \text{Corr}(\tilde{\varepsilon}_I, \tilde{\varepsilon}_l^\iota) > 0$.

Under this modification (see Internet Appendix for details), we obtain the following FOCs:

$$\omega^\iota = \frac{\bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \delta\rho\sigma_I\sigma_l - \lambda^\iota}{\delta(\tau^2\sigma_y^2 + \sigma_I^2)} \text{ and } \omega^g = \frac{\bar{r}_I - \bar{r}_M - \lambda^g}{\delta\sigma_I^2},$$

which again yields a separation of our key predictions into two regions.

Region 1: $(1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 + \delta\rho\sigma_I\sigma_l < \bar{r}_I \leq \bar{r}_M$

The effect of background risk is to increase the hurdle for the inside investor by $\delta\rho\sigma_I\sigma_l$, the extra return that ι now demands to compensate for the background risk in addition to the earlier cost associated with underdiversification. This additional required compensation decreases the range over which the equilibrium remains in Region 1.

Market clearing delivers the following expression for returns:

$$\bar{r}_I = (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 + \delta\rho\sigma_I\sigma_l + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota}. \tag{1}$$

Region 2: $\bar{r}_M < \bar{r}_I$

The expected return $\bar{r}_I$ is given by:

$$\bar{r}_I = \bar{r}_M - \frac{W^\iota}{W^\iota + \gamma W^g}\left(\tau\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \delta\rho\sigma_I\sigma_l\right) + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota + \gamma W^g}$$

where, as before, $\gamma = 1 + \tau^2\sigma_y^2/\sigma_I^2 > 1$. In Region 2, relative to the baseline model, nothing changes significantly since all correlation effects are diluted by the high wealth of global investors, i.e., $W^\iota/(W^\iota+\gamma W^g)$.

The addition of background risk adds the following testable prediction for states in Region 1:[41]

> *Hypothesis #4: The sensitivity of bond yields to state-specific risk should covary positively with the extent of the correlation between residents' income and economic conditions in the state – the sensitivity of $\bar{r}_I$ to σ_I^2 now increases with ρ in equation* (1).

5.1.1. Measuring Background Risk, and Tests

To test *Hypothesis #4*, we measure the dependence of labor income on state-specific economic conditions by collecting state-level data on employment income in the non-tradable and construction sectors (using Mian and Sufi's (2014) industry classification) from the County Business Patterns (CBP) dataset published by the U.S. Census Bureau. Mian and Sufi (2014) argue that workers' labor income in these sectors is more likely dependent on state economic conditions. Henceforth, we take the fraction of employment in these sectors relative to total employment as a measure of ρ.

Table IX reports the results for the test of *Hypotheses #4*. As before, we evaluate our predictions using a difference-in-difference methodology, using states in Region 2 as the benchmark, for which we should not observe the above predictions holding true. In Columns (1) through (4), we modify our standard regressions on the price effects of local idiosyncratic risk by including a role for non-tradable employment. While our main results are unchanged, we document two additional effects. First, the interaction effect between segmentation, as measured by either tax privilege in Columns (1) and (3) or *SFH* in Columns (2) and (4), and non-tradable employment (with a presumed larger ρ) is significantly positive. In states that

[41] This prediction has several corollaries. The first is that to the extent that particular variants of the inside asset/local municipal bonds, for example, general obligation (GO) versus revenue (RV), have different degrees of correlation with state residents' labor income, their yield sensitivities to state-specific risk will differ. In addition, to the extent that rational optimizing states will exercise flexibility, substituting between issuance of hypothecated and non-hypothecated bonds to minimize associated financing costs, we should observe that in equilibrium, the two types of bonds will be issued in different amounts until their yields are equalized. In Table IA.IX in the Internet Appendix, we test this prediction focusing on "essential service" municipal bonds under the assumption that ρ is higher for GO bonds than RV bonds.

have high local ownership, and hence are likely in Region 1, municipal bond yield spreads increase in non-tradable employment, as predicted by the term $\delta\rho\sigma_I\sigma_l$ in equation (1).

Second, whether idiosyncratic risk is measured using a close election indicator in Columns (1) and (2) or realized local equity volatility in Columns (3) and (4), the triple interaction effect of idiosyncratic risk, *SFH*, and non-tradable employment is significantly positive. Consistent with *Hypothesis #4*, an increase in local risk generates significantly greater yield responses, on average, in those same states with both high tax privilege and local ownership along with high non-tradable employment. For example, focusing on close elections in Column (2), the differential effect, between states at the 75th and those at the 25th percentiles of *SFH*, of close election on the 10-year municipal bond spread is about 7 basis points higher if these states are at the 75th percentile of non-tradable employment than if they are at the 25th percentile.

In sum, background risk in the form of uninsurable labor income appears to matter for municipal bond price sensitivities in high privilege and high local ownership states where the local investors are likely the marginal investors for the local bonds.

5.2. Non-Pecuniary Benefits for Inside Investors

We next assume that the inside investor derives additional benefits from investing ω^ι in the inside asset, while the global investor does not (i.e., investor g's maximization problem is unchanged). We model the utility gain from non-pecuniary benefits as additive, captured by the additional utility flow $f(\omega^\iota)$ where $f(0) = 0$, $f'(\omega^\iota) > 0$, and $f''(\omega^\iota) < 0$. A natural choice for $f(\omega^\iota)$, given our current setup, is a standard quadratic utility function of the form: $f(\omega^\iota) = b\omega^\iota - \frac{a}{2}(\omega^\iota)^2$ where parameters b and a together act as an "exchange rate" between pecuniary and non-pecuniary benefits.

Under this modification, the expression for the optimal weight is:

$$\omega^\iota = \frac{b + \bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \lambda^\iota}{a + \delta(\tau^2\sigma_y^2 + \sigma_I^2)}.$$

Region 1 obtains if $(1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 - b < \bar{r}_I \leq \bar{r}_M$. The range over which the supply remains in Region 1 is now bigger due to the downward shift in the participation constraint by

b. Market clearing in Region 1 yields:

$$\bar{r}_I = (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 - b + \frac{(a+\delta\gamma\sigma_I^2)S_I}{W^\iota}. \qquad (2)$$

The expected return $\bar{r}_I$ as a function of supply S_I now shifts up and down with the non-pecuniary benefit b, and the slope of this function now increases in the rate a at which non-pecuniary benefit accumulation marginally diminishes. The latter leads to our final testable *Hypothesis #5:*

> *In states in Region 1, the sensitivity of bond yields to supply change should covary positively with not only the idiosyncratic risk born by the inside investor, but also the rate at which her non-pecuniary benefit accumulation marginally diminishes.*

As before, Region 2 is largely unchanged as the denominator is overwhelmingly large and so the preference of the inside investor is diluted.

Hypothesis #5 also has significant testable implications for municipal bond issuance. To take these implications to the data, we focus on GO bonds and assume that all of them have the same b, i.e., loyalty translates into similar linear increases in utility associated with an additional unit of each kind of bond, but various GO bonds differ in a, the rate at which these benefits dissipate with increments to the portfolio weight. Specifically, we assume that GO bonds with a dedicated purpose have lower a than GO bonds with a general purpose. We argue that the dedicated purpose GO bonds are likely to appeal to residents who care about the community as they are associated with projects that are more visible. In addition, as these bonds are hypothecated for different purposes, they diversify among themselves in the causes that may induce residents' non-pecuniary utility. Therefore, we presume a lower rate of diminishing non-pecuniary utility for such bonds which translates into less attrition in their benefits as they are added to the inside investor's portfolio. Assuming that states optimize the issuance of GO bonds to minimize financing costs, we arrive at *Hypothesis #5A:*

> *States in Region 1 issue relatively more dedicated GO bonds than states in Region 2 (i.e., the fraction of dedicated GO bond to total GO bond issuance is generally greater for states with high privilege).*

5.2.1. Measuring Non-Pecuniary Benefits, and Tests

To test the above additional predictions, we collect annual, state-level data on the number of volunteer hours *per capita* as a proxy for the differing attitudes of state residents towards community service, a good proxy for their sense of local community. The data are from the Current Population Survey (CPS) conducted by the Bureau of Labor Statistics and obtained through the Corporation for National and Community Service. We assume that states with greater levels of volunteer activity are characterized by lower levels of a. In the Internet Appendix, we provide descriptive statistics of these and other state-level variables in Table IA.I.

Table X reports the results. In Columns (1) and (2), we modify our standard regressions on the price effects of bond supply by including a role for the non-pecuniary benefit of local bonds, as measured by the log of one plus the number of volunteer hours per capita. We document two additional effects in states with segmentation (as before, Column (1) using tax privilege and Column (2) *SFH* as our measure of segmentation). Each column also features the interaction effect of segmentation and volunteer hours (significant and negative in both columns) and the triple interaction effect of segmentation, volunteer hours, and supply change (also significant and negative in both columns). The interaction effects show that among states with tax privilege and concentrated local ownership, municipal bond yields are lower when local owners have a stronger attitude towards community service. Most importantly, the triple interaction shows that consistent with *Hypothesis #5*, yield sensitivity to supply changes, which tends to be greater in segmented states, is significantly moderated in states with higher volunteer hours, or in the context of our model, lower rates of diminishing non-pecuniary benefit accumulation (a). Focusing on the estimates in Column (2), the differential effect, between states at the 75th and those at the 25th percentiles of *SFH*, of a standard deviation increase in net issuance raises the 10-year municipal bond spread by about 1.0 basis points less if these states are at the 75th percentile of volunteer hours per capita than if they are at the 25th percentile.

In Columns (3) and (4), we evaluate whether states alter bond issuance depending upon the extent of local volunteerism. Our dependent variable is the ratio of dedicated purpose GO to total GO bond issuance, assuming that dedicated purpose GO bonds have lower a's than general GO bonds and states can, at the margin, choose to support a particular project by issuing a generic GO bond (and potentially allocating funds across several projects) and a bond specifically dedicated to that project. In each column, our focus is on the interaction between volunteer hours and segmentation (as measured by tax privilege in Column (3) and *SFH* in column (4)). The interaction coefficients are positive and highly significant, consistent with *Hypothesis #5A*. High privilege and high local ownership states cater to their local investor base; higher local volunteerism leads to higher fraction of GO bonds being dedicated for specific purposes. An interquartile increase in volunteer hours per capita increases relative levels of dedicated purpose GO bond issuance by about 5% more in states that are at the 75th percentile of *SFH* than those that are at the 25th percentile. This is highly significant given that the mean and standard deviation of the dedicated purpose GO bond issuance is 58% and 42%, respectively.

6. Conclusion

Using a simple model, we demonstrate that differences in tax rates can cause ownership segmentation if the associated tax privilege given to specific groups of investors is sufficiently high. The key insight is that this tax policy-induced segmentation can create regions of the aggregate demand curve for the asset that are "downward-sloping," meaning that the constraints of the clientele induced to hold the asset can affect the sensitivity of asset prices to variations in market conditions.

We test and find support for the model's predictions using data on the U.S. municipal bond market. In states which provide significant tax incentives for state residents to hold local municipal bonds, we find that muni bond yields are more sensitive to elevated local risk as well as to variation in bond issuance. The results are robust to a number of different measurement approaches. Further, by instrumenting our ownership measurement with state-level tax policy that prevailed more than half a century ago, we demonstrate that the key results do not suffer from significant endogeneity concerns.

Our empirical results suggest that a high level of local ownership induced by tax policy may not be an unadulterated good if it impairs cross-state risk sharing. This highlights a hitherto neglected consequence of tax incentives for "inside" debt holdings, namely, that the market for local debt may become segmented from “global” markets, with potentially interesting implications for both public finance and international finance. For public finance, our work suggests that “instantaneous” Ricardian equivalence (lower tax receipts offset by higher bond proceeds from local residents) may not hold if tax-induced segmentation generates lowered resilience to economic shocks and hence higher risk premium. Extrapolating to international finance, our results suggest that markets which have a high holding of sovereign debt by local residents may be less resilient in the face of shocks to the economy.

Our findings could be explained by a tradeoff, insofar as we cannot observe the counterfactual ability of small local issuers to raise funds *absent* in-state tax privilege. Concerns of this nature are potentially warranted, as we document that the number of state funds and their collective holdings decrease substantially in Florida after tax privilege is effectively removed. However, we note that many small issuers exist in states with no tax privilege. For example, Illinois and Texas (no privilege) have percentages of small issuers, both by number and amount, that are similar to California and New York (high privilege). Furthermore, small issuers in Florida account for roughly the same fraction of state issuance over the entire sample period, even after the change in privilege policy. While this is not causal evidence, it is certainly consistent with state tax privilege policy not being first order important in muni bond financing of smaller issuers. There may well be other economic forces, such as the strength of community ties, which we emphasize above, and the availability of local bank financing, that play important roles (see also Dagostino (2018)).

Collectively, our analysis shows that tax policy creates incentives for local investors that result in segmentation of the municipal bond market, which in turn can lead to distortions in the cost of government borrowing. In future research, it would be interesting to explore whether these policies in turn generate unanticipated consequences for economic growth and resilience, and if so, whether there is a closer-to-optimal tax policy that states can, or indeed should, follow in response.

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Table I

Fund-Level Summary Statistics

This table presents summary statistics of state and national municipal bond funds. The data, including fund classifications, are from Morningstar. The sample period is from 1998 to 2014, and the observation frequencies are fund-month for total net assets (TNA), flow, and return, and fund-month or coarser, depending on each fund's reporting frequency, for other variables. High-yield funds, representing approximately 5-10% of TNA, are excluded. Number of holdings is the number of unique bond CUSIPs held by each fund on each report date. Flows and returns are measured as a percentage of prior-month TNA, and cash holdings, average and maximum assets in a state, and assets in bonds in different maturity buckets and in general obligations vs. revenue bonds are measured as a percentage of current-month TNA. Number of states does not count U.S. territories (Puerto Rico and Guam). Average bond maturity is the value-weighted average maturity. Tests of difference in mean between state and national funds are conducted using pooled panel regressions with standard errors clustered by calendar year-month. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	State Funds (N = 615)				National Funds (N = 318)				
	Cross-Sectional Statistics of Time-Series Mean		Time-Series Statistics of Cross-Sectional Mean		Cross-Sectional Statistics of Time-Series Mean		Time-Series Statistics of Cross-Sectional Mean		Pooled Difference (State – National)
	(1) Mean	(2) Std. Dev.	(3) Mean	(4) Std. Dev.	(5) Mean	(6) Std. Dev.	(7) Mean	(8) Std. Dev.	
TNA ($ million)	279	771	345	83	742	1,602	1,018	450	-650.805***
Number of holdings	112.75	105.96	119.91	22.71	218.28	223.14	239.84	87.72	-126.377***
Flow (%)	-0.66	2.38	-0.62	2.12	0.68	4.47	0.21	2.79	-0.718***
Return (%)	0.35	0.07	0.36	0.61	0.31	0.17	0.33	0.51	0.025*
Cash holding (%)	2.12	3.03	1.91	0.70	4.78	6.33	4.19	1.64	-2.409***
Number of states held	2.25	2.49	2.46	0.76	30.60	10.16	31.92	3.02	-29.706***
Average assets in a state (%)	79.37	28.48	78.69	5.62	6.09	13.72	5.78	1.95	72.816***
Maximum assets in a state (%)	87.35	9.52	87.57	3.02	16.86	13.54	16.34	1.19	71.247***
Average bond maturity (years)	15.36	4.64	15.55	0.99	12.91	4.58	13.35	0.90	2.250***
Assets in 1-7 year bonds (%)	15.05	16.03	14.59	3.54	26.15	20.97	24.89	5.27	-10.704***
Assets in 8-15 year bonds (%)	31.61	14.22	31.22	3.17	32.16	17.19	31.91	2.91	-0.581**
Assets in >15 year bonds (%)	42.56	23.60	43.74	4.55	31.67	21.99	33.84	3.68	9.953***
Assets in general obligations bonds (%)	19.71	12.89	18.93	1.71	22.88	12.47	22.07	1.89	-3.195***
Assets in revenue bonds (%)	69.34	13.63	70.43	3.05	66.91	14.56	68.36	2.98	1.872***

Table II

State-Level Summary Statistics on State Tax Privilege and State Fund Holding

This table presents summary statistics on state tax rate, privilege, and fraction of municipal bonds held by state municipal bond funds. Only 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve, are included. States are sorted into quintiles by the (time-series) average of state tax privilege, calculated from the highest state income tax rate and the applicable exemption rule. Highest state income tax rates are from Tax Foundation (2000-2014) and NBER Taxsim program (1998-1999). Privilege is the highest state income tax rate applied to income from municipal bonds issued by other states minus the highest state income tax rate applied to income from the state-issued municipal bonds. State income tax rates in 1947 are from the Book of the States. Debt/Income is the total amount of state's outstanding debt (from the Census Bureau) divided by total income of state residents (from US Internal Revenue Service). All fund holding/Debt is the amount of state-issued municipal bonds held by both state and national funds divided by the total amount of state's outstanding debt. For each state-month, state fund holding (SFH) is the amount of state-issued municipal bonds held by state municipal bond funds, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. For each state, the mean, minimum, and maximum statistics are calculated across all available months. Tests of difference in mean between the top and bottom privilege quintiles are conducted using standard errors clustered by calendar year-month. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels. Note: Mixed1. UT does not tax income from other states' municipal bonds through 2002 but starts taxing it in 2003. Mixed2. FL imposes intangible property tax on income from other states' municipal bonds until 2006 but no longer imposes it starting in 2007. Mixed3. IN does not tax income from other states' municipal bonds through 2011 but starts taxing it in 2012.

State	Tax Status of Bonds Issued by		State Tax (%)	Privilege (%)	State Tax in 1947 (%)	Debt/ Income (%)	All Fund Holding/ Debt (%)	State Fund Holding (%)			
	State	Other States						All	0-7 Year	8-15 Year	15+ Year
Top Privilege Quintile (States with Highest Average State Tax Privilege)											
CA	Exempt	Taxable	10.21	10.21	6.00	28.65	21.57	72.15	60.84	69.47	75.47
OR	Exempt	Taxable	9.51	9.51	8.00	29.03	14.09	62.65	42.78	63.77	69.91
HI	Exempt	Taxable	9.35	9.35	0.00	33.00	23.13	37.97	21.37	43.97	46.31
VT	Exempt	Taxable	9.33	9.33	4.00	24.71	7.84	17.61	30.82	23.73	9.99
RI	Exempt	Taxable	9.06	9.06	0.00	34.24	12.21	26.63	23.45	36.86	19.57
MT	Exempt	Taxable	8.83	8.83	4.00	25.79	7.90	8.26	5.44	13.15	5.31
ME	Exempt	Taxable	8.24	8.24	0.00	25.43	6.06	4.92	10.56	7.85	2.75
NJ	Exempt	Taxable	8.16	8.16	0.00	24.44	16.42	45.99	29.76	43.34	56.99
MN	Exempt	Taxable	7.99	7.99	10.00	25.33	17.11	61.31	41.29	68.27	66.33
Average			8.97	8.97	3.56	27.85	14.04	37.50	29.59	41.16	39.18

Cont'd next page

Table II *-continued*

State	Tax Status of Bonds Issued by: State	Tax Status of Bonds Issued by: Other States	State Tax (%)	Privilege (%)	State Tax in 1947 (%)	Debt/ Income (%)	All Fund Holding/ Debt (%)	State Fund Holding (%): All	0-7 Year	8-15 Year	15+ Year
Second Privilege Quintile											
NC	Exempt	Taxable	7.83	7.83	7.00	20.95	15.43	40.26	22.79	39.68	52.89
ID	Exempt	Taxable	7.82	7.82	8.00	16.37	9.35	21.30	11.72	29.52	19.42
NY	Exempt	Taxable	7.72	7.72	7.00	40.55	21.52	61.75	39.17	56.03	71.84
AR	Exempt	Taxable	7.00	7.00	5.00	21.03	6.92	25.82	12.70	24.17	33.71
SC	Exempt	Taxable	7.00	7.00	5.00	32.50	13.33	23.60	24.09	29.10	21.26
NE	Exempt	Taxable	6.78	6.78	0.00	24.36	10.76	13.97	10.30	18.18	16.28
OH	Exempt	Taxable	6.72	6.72	5.00	22.14	17.70	49.01	29.53	50.30	55.83
WV	Exempt	Taxable	6.50	6.50	0.00	27.99	12.50	33.32	41.41	42.95	23.64
NM	Exempt	Taxable	6.44	6.44	4.00	30.78	13.59	18.45	21.04	24.18	13.85
DE	Exempt	Taxable	6.34	6.34	3.00	29.10	6.87	15.70	7.74	16.41	20.53
Average			7.01	7.01	4.40	26.58	12.80	30.32	22.05	33.05	32.93
Third Privilege Quintile											
KS	Exempt	Taxable	6.26	6.26	4.00	27.16	9.78	32.98	29.82	38.42	31.92
ND	Exempt	Taxable	6.24	6.24	15.00	22.21	10.31	6.49	3.19	9.22	7.75
GA	Exempt	Taxable	6.00	6.00	7.00	19.93	16.70	20.27	12.56	19.29	25.63
KY	Exempt	Taxable	6.00	6.00	5.00	39.86	11.88	49.48	25.23	55.59	54.26
LA	Exempt	Taxable	6.00	6.00	6.00	29.50	14.49	17.04	8.60	15.95	21.61
MO	Exempt	Taxable	6.00	6.00	4.00	24.50	11.50	42.52	17.93	39.51	52.27
TN	Exempt	Taxable	6.00	6.00	6.00	21.03	13.85	27.22	17.99	27.75	36.74
VA	Exempt	Taxable	5.75	5.75	3.00	20.65	14.65	56.59	35.21	61.07	63.27
MA	Exempt	Taxable	5.47	5.47	6.00	34.07	18.80	44.94	30.81	47.34	49.37
CT	Exempt	Taxable	5.39	5.39	0.00	23.44	12.81	49.91	26.38	55.82	62.57
Average			5.91	5.91	5.60	26.24	13.48	34.74	20.77	37.00	40.54

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Table II *-continued*

State	Tax Status of Bonds Issued by: State	Tax Status of Bonds Issued by: Other States	State Tax (%)	Privilege (%)	State Tax in 1947 (%)	Debt/ Income (%)	All Fund Holding/ Debt (%)	State Fund Holding (%): All	0-7 Year	8-15 Year	15+ Year
Fourth Privilege Quintile											
MD	Exempt	Taxable	5.28	5.28	5.00	18.84	18.42	62.35	49.10	69.41	66.70
AL	Exempt	Taxable	5.00	5.00	5.00	24.54	12.83	17.32	7.63	14.26	22.32
MS	Exempt	Taxable	5.00	5.00	6.00	23.35	11.19	8.84	1.98	9.37	12.19
NH	Exempt	Taxable	5.00	5.00	3.47	23.66	8.81	1.65	4.63	4.19	1.19
AZ	Exempt	Taxable	4.82	4.82	4.50	27.29	18.62	39.12	17.75	38.12	49.07
CO	Exempt	Taxable	4.70	4.70	2.00	27.42	19.73	24.33	14.49	21.88	29.75
MI	Exempt	Taxable	4.21	4.21	3.00	26.85	15.47	36.49	22.68	35.85	42.46
UT	Exempt	Mixed1	6.18	4.12	5.00	29.20	10.59	9.01	1.50	14.96	13.63
PA	Exempt	Taxable	2.97	2.97	0.00	31.36	17.58	55.35	31.83	57.89	63.49
FL	Exempt	Mixed2	0.00	1.19	0.00	25.75	14.80	35.83	24.16	33.99	42.06
Average			4.32	4.23	3.40	25.83	14.80	29.03	17.57	29.99	34.29
Bottom Privilege Quintile (States with Lowest Average State Tax Privilege)											
IN	Exempt	Mixed3	3.40	0.60	0.00	23.55	11.95	0.77	0.29	0.81	0.99
AK	No Tax	No Tax	0.00	0.00	0.00	49.74	14.21	0.87	0.48	0.90	1.44
DC	Exempt	Exempt	9.04	0.00	3.00	35.40	31.88	9.24	2.97	9.08	12.37
IA	Taxable	Taxable	8.98	0.00	5.00	18.07	6.52	1.32	0.51	1.79	1.57
IL	Taxable	Taxable	3.47	0.00	0.00	29.32	14.82	0.61	0.44	0.64	0.71
NV	No Tax	No Tax	0.00	0.00	0.00	30.44	14.34	1.25	1.04	1.37	1.39
OK	Taxable	Taxable	6.17	0.00	6.00	20.63	9.06	2.83	0.48	3.16	4.53
TX	No Tax	No Tax	0.00	0.00	0.00	28.32	11.99	2.10	2.81	2.26	1.80
WA	No Tax	No Tax	0.00	0.00	0.00	30.36	10.52	0.69			
WI	Taxable	Taxable	7.10	0.00	7.00	25.16	8.49	4.26	1.42	4.87	5.92
Average			3.82	0.06	2.10	29.10	13.38	2.39	1.09	2.57	3.17
Top - Bottom			5.15***	8.91***	1.46***	-1.25	0.66	35.10***	28.50***	38.59***	36.01***

Table III
Privilege and State Fund Holding

This table reports results from panel regressions of state fund holdings (SFH) on privilege. Observations are state-months. Three different samples are used: (i) 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve ("full sample" in columns (1) and (4)), (ii) 37 states with at least $10 billion in outstanding debt (averaged over 1998-2014) ("excluding debt < $10 billion" in columns (2) and (5)), and (iii) 41 states where privilege is not zero (intensive margin) ("excluding no privilege" in columns (3) and (6)). SFH is the amount of state-issued municipal bonds held by state municipal bond funds, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. Privilege is the highest state income tax rate applied to income from municipal bonds issued by other states minus the highest state income tax rate applied to income from the state-issued municipal bonds. State equity return is value-weighted portfolio return of listed firms headquartered in the state. State unemployment rates are from Bureau of Labor Statistics. State outstanding debts are from Census Bureau. Trading volume (number of trades) is calculated as annualized weekly sum of dollar value (number) of trades in tax-exempt bonds issued by each state, as reported by MSRB. Proactive is a dummy variable that equals one if the state is classified by Gao, Lee, and Murphy (2019b) as being "proactive" in the bankruptcy of their agencies and municipalities, and zero otherwise. All other state-level control variables are defined in Tables II. All models include credit rating x calendar year-month dummies. Models in columns (4)-(6) also include state dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Sample Criteria	Full Sample (1)	Excluding Debt < $10 Billion (2)	Excluding No Privilege (3)	Full Sample (4)	Excluding Debt < $10 Billion (5)	Excluding No Privilege (6)
Privilege (%)	0.038***	0.046***	0.033***	0.015***	0.024***	0.014***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.004)
Debt/Income	0.147	0.111	0.099	-0.233	-0.242*	-0.523***
	(0.123)	(0.139)	(0.132)	(0.140)	(0.140)	(0.158)
All fund holding/Debt	0.371	0.728	0.815*	-0.165	-0.231	-0.896*
	(0.345)	(0.564)	(0.455)	(0.357)	(0.457)	(0.472)
State equity return	-0.034	0.022	-0.030	-0.014	0.005	-0.005
	(0.032)	(0.041)	(0.040)	(0.018)	(0.020)	(0.021)
Unemployment rate	-0.019***	-0.032***	-0.021***	-0.012***	-0.013***	-0.012***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
ln(Trading volume/Debt)	-0.112***	-0.178***	-0.161***	-0.008*	-0.001	-0.022***
	(0.007)	(0.010)	(0.007)	(0.004)	(0.005)	(0.005)
ln(# of trades)	0.081***	0.092***	0.118***	0.004	0.001	0.015***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Proactive	-0.040	0.016	-0.078***			
	(0.025)	(0.025)	(0.025)			
Credit rating x Y-M dummies	YES	YES	YES	YES	YES	YES
State dummies	NO	NO	NO	YES	YES	YES
Number of states	49	37	41	49	37	41
Observations	9,996	7,548	8,160	9,996	7,548	8,160
R-squared (total)	0.520	0.597	0.430	0.902	0.923	0.884

Table IV

Pricing of Local Risk Based on Close Election

This table reports results from OLS (columns (1)-(5)) and IV-2SLS (columns (6)-(8)) panel regressions of municipal bond yield spreads on close election dummy and its interactions with two state segmentation measures, privilege (%) (columns (1)-(2)) and state fund holdings (SFH) (columns (3)-(8)). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices (Nelson-Siegel model) and constant maturity Treasury yield from FRED at the 10-year maturity. In IV-2SLS regressions, SFH is instrumented by state income tax rate in 1947. Columns (6)-(7) report estimates of the first-stage equations, in which SFH and SFH x Risk are expressed as a function of state income tax rate in 1947 and its interaction with close election. Column (8) reports estimates of the second-stage equation. Close election dummy equals one for the three-month period before the election in November if at least one out of the maximum of three state-level elections (gubernatorial, state house, and state senate) is close. Each race is considered close if the vote difference between the winner and loser is 5% or less. For state house or senate with several seats being elected, the election is close if the number of close races is enough to overturn the majority. Market equity return is CRSP value-weighted return. Term spread is the difference between 10-year and 2-year constant maturity Treasury yields. Bond issue size is the offering amount ($ million), bond age is the number of years from the offering date to the date of each transaction, GO dummy equals one if the bond is a general obligations bond, callable dummy equals one if the bond is callable, bank qualified dummy equals one if the bond's interest payments are tax-exempt for banks, and insured dummy equals one if the bond is insured. These bond characteristics are averaged across bonds whose transactions are used in the estimation of weekly state yield curve. All other state-level control variables are defined in Tables II and III. All models include credit rating x calendar year-month dummies. Models in columns (2) and (4) also include state dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Close Elec. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Main Variables								
Close election	0.111***	0.088***	0.054*	0.066**	0.055**	-0.070***	0.138***	-0.037
	(0.032)	(0.033)	(0.028)	(0.029)	(0.027)	(0.016)	(0.009)	(0.038)
Seg.	-0.007***	-0.005***	-0.197***	-0.181***	-0.198***			-0.458***
	(0.001)	(0.002)	(0.013)	(0.040)	(0.013)			(0.079)
Close election x Seg.	0.007**	0.014**	0.094**	0.080*	0.097**			0.434***
	(0.003)	(0.007)	(0.046)	(0.045)	(0.046)			(0.133)

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Table IV *-continued*

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Close Elec. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Close election x Debt/Income					-0.083			
					(0.629)			
Seg. x Debt/Income					-0.113			
					(0.088)			
Close election x Seg. x Debt/Income					0.705**			
					(0.332)			
Tax 1947						0.009***	-0.000*	
						(0.000)	(0.000)	
Close election x Tax 1947						0.012***	0.033***	
						(0.003)	(0.002)	
Control Variables								
Debt/Income	-0.131	-0.043	-0.133	-0.091	-0.116	0.162***	0.002	-0.117
	(0.089)	(0.080)	(0.080)	(0.083)	(0.095)	(0.055)	(0.004)	(0.083)
All fund holding/Debt	0.266	0.136	0.273	0.109	0.266	1.561	0.095	0.474*
	(0.179)	(0.385)	(0.175)	(0.405)	(0.176)	(1.103)	(0.071)	(0.257)
Term spread	-0.147**	-0.155**	-0.150**	-0.155**	-0.149**	-0.014***	0.001	-0.154**
	(0.061)	(0.062)	(0.061)	(0.062)	(0.061)	(0.004)	(0.001)	(0.061)
Market equity return	-0.342	-0.194	-0.261	-0.185	-0.255	0.198	0.022	-0.222
	(1.049)	(1.078)	(1.052)	(1.079)	(1.052)	(0.162)	(0.017)	(1.049)
State equity return	-0.155	-0.159	-0.159	-0.161	-0.161	0.003	-0.001	-0.158
	(0.190)	(0.189)	(0.190)	(0.189)	(0.190)	(0.026)	(0.005)	(0.189)
Unemployment rate	0.027***	0.030***	0.023***	0.028***	0.023***	-0.020***	-0.000	0.019***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.001)	(0.000)	(0.002)

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Table IV *-continued*

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Close Elec. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege (1)	Privilege (2)	SFH (3)	SFH (4)	SFH (5)	SFH (6)	SFH (7)	SFH (8)
ln(# of trades)	-0.032***	-0.005	-0.016***	-0.004	-0.015***	0.055***	0.000	-0.002
	(0.005)	(0.021)	(0.005)	(0.021)	(0.005)	(0.002)	(0.000)	(0.004)
Proactive	-0.003		-0.005		-0.005	0.034	-0.001	0.004
	(0.005)		(0.004)		(0.004)	(0.023)	(0.001)	(0.005)
Average Characteristics of Bonds used in Estimations								
ln(Issue size)	0.022	0.003	0.017	0.003	0.017	-0.020	-0.000	0.011
	(0.014)	(0.005)	(0.014)	(0.005)	(0.014)	(0.013)	(0.000)	(0.015)
ln(Age)	0.161***	0.164***	0.176***	0.165***	0.176***	0.043***	0.001	0.184***
	(0.018)	(0.026)	(0.017)	(0.026)	(0.017)	(0.006)	(0.001)	(0.016)
GO fraction	-0.265***	-0.272***	-0.250***	-0.269***	-0.252***	0.089***	-0.001	-0.229***
	(0.015)	(0.022)	(0.014)	(0.022)	(0.015)	(0.008)	(0.002)	(0.015)
Callable fraction	0.313***	0.319***	0.305***	0.311***	0.305***	0.136***	0.007**	0.339***
	(0.030)	(0.038)	(0.029)	(0.038)	(0.029)	(0.012)	(0.003)	(0.031)
Bank qualified fraction	0.038	-0.142**	0.017	-0.143**	0.021	-0.189***	-0.002	-0.026
	(0.044)	(0.060)	(0.044)	(0.060)	(0.044)	(0.017)	(0.002)	(0.039)
Insured fraction	-0.015	-0.092**	-0.020	-0.090**	-0.020	-0.188***	-0.005*	-0.076*
	(0.029)	(0.036)	(0.029)	(0.036)	(0.029)	(0.011)	(0.003)	(0.039)
Credit rating x Y-M dummies	YES	YES	YES	YES	YES	YES	YES	YES
State dummies	NO	YES	NO	YES	NO	NO	NO	NO
Kleibergen-Paap rank Wald stat.						F(2, 203) = 317 (S-Y crit. val. at 10% maximal size = 7.03)		
Observations	43,747	43,747	43,747	43,747	43,747	43,747	43,747	43,747
R-squared (total)	0.925	0.930	0.926	0.930	0.926	0.414	0.637	0.926

Table V

Pricing of Local Risk Based on Realized State Equity Return Volatility

This table reports results from OLS (columns (1)-(5)) and IV-2SLS (columns (6)-(8)) panel regressions of municipal bond yield spreads on realized state equity return volatility and its interactions with two state segmentation measures, privilege (%) (columns (1)-(2)) and state fund holdings (SFH) (columns (3)-(8)). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices (Nelson-Siegel model) and constant maturity Treasury yield from FRED at the 10-year maturity. In IV-2SLS regressions, SFH is instrumented by state income tax rate in 1947. Columns (6)-(7) report estimates of the first-stage equations, in which SFH and SFH x Risk are expressed as a function of state income tax rate in 1947 and its interaction with close election. Column (8) reports estimates of the second-stage equation. Realized state equity return volatility is calculated as square root of the sum of squared daily excess state equity returns over the 5-day trading week, where excess state equity return equals state equity return minus market equity return. State equity return is value-weighted portfolio return of listed firms headquartered in the state, and market equity return is CRSP value-weighted return, including dividends. All control variables are defined in Tables II, III, and IV. All models include credit rating x calendar year-month dummies. Models in columns (2) and (4) also include state dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Real. Vol. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege (1)	Privilege (2)	SFH (3)	SFH (4)	SFH (5)	SFH (6)	SFH (7)	SFH (8)
Main Variables								
Realized vol.	3.000***	2.641***	3.110***	4.188***	3.142***	-2.101***	0.159***	0.524
	(0.799)	(0.783)	(0.664)	(0.674)	(0.664)	(0.205)	(0.006)	(1.651)
Seg.	-0.014***	-0.008***	-0.251***	-0.222***	-0.256***			-0.588***
	(0.001)	(0.002)	(0.018)	(0.037)	(0.017)			(0.125)
Realized vol. x Seg.	0.267***	0.283**	4.430***	3.562***	5.036***			14.736***
	(0.046)	(0.142)	(0.800)	(0.793)	(0.824)			(5.532)
Realized vol. x Debt/Income					0.093			
					(2.585)			
Seg. X Debt/Income					-0.065			
					(0.156)			
Realized vol. x Seg. x Debt/Income					21.734**			
					(8.673)			

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Table V *-continued*

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Real. Vol. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tax 1947						0.007***	-0.000***	
						(0.001)	(0.000)	
Realized vol. x Tax 1947						0.106***	0.009***	
						(0.034)	(0.001)	
Control Variables								
Debt/Income	-0.107	-0.001	-0.120	-0.010	-0.189**	0.185***	-0.003***	-0.038
	(0.078)	(0.078)	(0.079)	(0.080)	(0.083)	(0.043)	(0.001)	(0.046)
All fund holding/Debt	0.246	0.168	0.210	0.176	0.224	1.556	0.021	0.455*
	(0.169)	(0.378)	(0.165)	(0.394)	(0.166)	(1.100)	(0.020)	(0.249)
Term spread	-0.146**	-0.148**	-0.148**	-0.148**	-0.147**	-0.014***	-0.000***	-0.149**
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.004)	(0.000)	(0.060)
Market equity return	-0.146	-0.148	-0.075	-0.141	-0.067	0.129	0.002	-0.049
	(1.047)	(1.058)	(1.055)	(1.058)	(1.055)	(0.140)	(0.003)	(1.052)
State equity return	-0.132	-0.127	-0.134	-0.127	-0.132	-0.007	-0.001	-0.129
	(0.183)	(0.181)	(0.184)	(0.181)	(0.183)	(0.024)	(0.001)	(0.184)
Unemployment rate	0.025***	0.029***	0.021***	0.027***	0.022***	-0.020***	-0.000***	0.016***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.001)	(0.000)	(0.002)
ln(Trading volume/Debt)	-0.039*	-0.034	-0.054**	-0.034	-0.052**	-0.111***	-0.002***	-0.070***
	(0.023)	(0.034)	(0.023)	(0.035)	(0.023)	(0.006)	(0.000)	(0.023)
ln(# of trades)	-0.017**	-0.021	-0.001	-0.020	-0.002	0.048***	0.001***	0.005
	(0.007)	(0.020)	(0.007)	(0.020)	(0.007)	(0.003)	(0.000)	(0.006)
Proactive	-0.006		-0.008		-0.009	0.034	-0.001	-0.005
	(0.004)		(0.005)		(0.006)	(0.023)	(0.001)	(0.009)

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Table V *-continued*

	OLS					IV-2SLS		
Dependent Variable:	Spread10Y	Spread10Y	Spread10Y	Spread10Y	Spread10Y	SFH (1st Stage)	SFH x Real. Vol. (1st Stage)	Spread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average Characteristics of Bonds used in Estimations								
ln(Issue size)	0.003	0.003	0.017	0.003	0.017	-0.020	-0.000	0.012
	(0.004)	(0.005)	(0.014)	(0.005)	(0.014)	(0.013)	(0.000)	(0.015)
ln(Age)	0.168***	0.151***	0.182***	0.151***	0.182***	0.039***	0.001***	0.183***
	(0.018)	(0.025)	(0.017)	(0.025)	(0.017)	(0.006)	(0.000)	(0.017)
GO fraction	-0.247***	-0.269***	-0.235***	-0.268***	-0.230***	0.085***	0.001***	-0.221***
	(0.015)	(0.022)	(0.014)	(0.022)	(0.016)	(0.008)	(0.000)	(0.014)
Callable fraction	0.300***	0.321***	0.297***	0.314***	0.301***	0.140***	0.001***	0.333***
	(0.029)	(0.037)	(0.029)	(0.037)	(0.029)	(0.012)	(0.000)	(0.030)
Bank qualified fraction	0.038	-0.146**	0.025	-0.148**	0.023	-0.190***	-0.003***	-0.005
	(0.041)	(0.059)	(0.041)	(0.059)	(0.042)	(0.016)	(0.000)	(0.037)
Insured fraction	-0.016	-0.086**	-0.017	-0.084**	-0.017	-0.190***	-0.003***	-0.063*
	(0.029)	(0.035)	(0.029)	(0.035)	(0.029)	(0.011)	(0.000)	(0.038)
Credit rating x Month dummies	YES	YES	YES	YES	YES	YES	YES	YES
State dummies	NO	YES	NO	YES	NO	NO	NO	NO
Kleibergen-Paap rank Wald stat						F(2, 203) = 317 (S-Y crit. val. at 10% maximal size = 7.03)		
Observations	43,747	43,747	43,747	43,747	43,747	43,747	43,747	43,747
R-squared (total)	0.925	0.931	0.926	0.931	0.926	0.417	0.424	0.926

Table VI
Price Effects of Supply Change

This table reports results from OLS (columns (1) – (5)) and IV-2SLS (columns (6) – (8)) panel regressions of *change* in municipal bond yield spreads on net change in municipal bond supply and its interactions with two state segmentation measures, privilege (%) (columns (1)-(2)) and state fund holdings (SFH) (columns (3)-(8)). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices (Nelson-Siegel model) and constant maturity Treasury yield from FRED at the 10-year maturity. In IV-2SLS regressions, SFH is instrumented by state income tax rate in 1947. Columns (6)-(7) report estimates of the first-stage equations, in which SFH and SFH x Risk are expressed as a function of state income tax rate in 1947 and its interaction with close election. Column (8) reports estimates of the second-stage equation. Supply change equals annualized 4-week moving average of net weekly issuance, normalized by total income of state residents as reported to Internal Revenue Service. Net issuance data are from SDC Platinum (gross issuance – refunding). All control variables are defined in Tables II, III, and IV. All models include credit rating x calendar year-month dummies. Models in columns (2) and (4) also include state dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	OLS					IV-2SLS		
Dependent Variable:	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	SFH (1st Stage)	SFH x Supply Chg. (1st Stage)	ΔSpread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege (1)	Privilege (2)	SFH (3)	SFH (4)	SFH (5)	SFH (6)	SFH (7)	SFH (8)
Main Variables								
Supply chg.	-0.133	-0.116	0.304***	0.243**	0.317***	-0.433***	0.164***	-0.329
	(0.103)	(0.103)	(0.097)	(0.096)	(0.097)	(0.157)	(0.005)	(0.218)
Seg.	-0.004***	-0.003***	-0.020***	-0.001	-0.020***			-0.009
	(0.000)	(0.001)	(0.006)	(0.014)	(0.006)			(0.042)
Supply chg. x Seg.	0.144***	0.127***	0.898***	0.784***	0.713***			3.248***
	(0.019)	(0.019)	(0.249)	(0.250)	(0.252)			(0.828)
Supply chg. x Debt/Income					-0.151			
					(0.536)			
Seg. X Debt/Income					-0.019			
					(0.049)			
Supply chg. x Seg. x Debt/Income					4.174**			
					(1.627)			

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Table VI *-continued*

	OLS					IV-2SLS		
Dependent Variable:	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	SFH (1st Stage)	SFH x Supply Chg. (1st Stage)	ΔSpread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tax 1947						0.006***	-0.000***	
						(0.001)	(0.000)	
Supply change x Tax 1947						0.134***	0.028***	
						(0.030)	(0.001)	
Control Variables								
Debt/Income	-0.001	-0.054	0.001	-0.064	0.045**	0.174***	0.004***	-0.007
	(0.014)	(0.059)	(0.014)	(0.059)	(0.021)	(0.026)	(0.001)	(0.015)
All fund holding/Debt	-0.112	-0.150	-0.108	-0.132	-0.114	0.043	0.001	-0.118
	(0.129)	(0.149)	(0.130)	(0.149)	(0.130)	(0.046)	(0.001)	(0.083)
Term spread	-0.027	-0.030	-0.027	-0.030	-0.026	-0.007*	-0.000	-0.027
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.004)	(0.000)	(0.019)
Market equity return	-4.701***	-4.707***	-4.708***	-4.711***	-4.709***	0.225	0.007*	-4.724***
	(0.766)	(0.763)	(0.765)	(0.763)	(0.765)	(0.180)	(0.004)	(0.758)
State equity return	-0.026	-0.026	-0.027	-0.027	-0.027	-0.008	-0.000	-0.027
	(0.031)	(0.032)	(0.031)	(0.032)	(0.031)	(0.027)	(0.001)	(0.031)
Unemployment rate	-0.003***	-0.003**	-0.003***	-0.002**	-0.004***	-0.021***	-0.000***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
ln(Trading volume/Debt)	-0.006	-0.005	-0.007	-0.007	-0.006	-0.109***	-0.002***	-0.001
	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.004)	(0.000)	(0.005)
ln(# of trades)	0.007*	0.008	0.005	0.007	0.005	0.069***	0.001***	0.003
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.006)	(0.000)	(0.005)
Proactive	-0.009***		-0.008***		-0.009***	0.029	0.001	-0.005***
	(0.002)		(0.001)		(0.001)	(0.022)	(0.001)	(0.002)

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Table VI *-continued*

	OLS					IV-2SLS		
Dependent Variable:	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	ΔSpread10Y	SFH (1st Stage)	SFH x Supply Chg. (1st Stage)	ΔSpread10Y (2nd Stage)
Measure of ***Segmentation***:	Privilege	Privilege	SFH	SFH	SFH	SFH	SFH	SFH
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Average Characteristics of Bonds used in Estimations								
ln(Issue size)	0.004	0.001	0.003	0.001	0.003	-0.002	-0.000	0.003
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.002)
ln(Age)	0.090***	0.096***	0.089***	0.097***	0.089***	0.058***	0.002***	0.083***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.000)	(0.006)
GO fraction	-0.061***	-0.122***	-0.062***	-0.122***	-0.064***	0.069***	0.001***	-0.064***
	(0.006)	(0.010)	(0.006)	(0.010)	(0.006)	(0.007)	(0.000)	(0.006)
Callable fraction	0.129***	0.170***	0.128***	0.172***	0.128***	0.135***	0.004***	0.115***
	(0.011)	(0.014)	(0.011)	(0.014)	(0.011)	(0.013)	(0.000)	(0.011)
Bank qualified fraction	-0.033***	-0.068***	-0.031**	-0.068***	-0.029**	-0.151***	-0.002***	-0.027**
	(0.012)	(0.020)	(0.012)	(0.020)	(0.012)	(0.017)	(0.000)	(0.012)
Insured fraction	-0.058***	-0.055***	-0.054***	-0.054***	-0.056***	-0.220***	-0.003***	-0.041***
	(0.008)	(0.011)	(0.008)	(0.011)	(0.008)	(0.010)	(0.000)	(0.012)
Credit rating x Month dummies	YES	YES	YES	YES	YES	YES	YES	YES
State dummies	NO	YES	NO	YES	NO	NO	NO	NO
Kleibergen-Paap rank Wald stat						F(2, 190) = 168 (S-Y crit. val. at 10% maximal size = 7.03)		
Observations	40,864	40,864	40,864	40,864	40,864	40,864	40,864	40,864
R-squared (total)	0.063	0.071	0.062	0.070	0.062	0.434	0.626	0.062

Table VII

Robustness Checks Using Bond-Week Data

This table report estimated price effects of close election (columns (1)-(2), dependent variable = 10-year bond spread), realized state equity volatility (columns (3)-(4), dependent variable = 10-year bond spread), and supply change (columns (5)-(6), dependent variable = *change* in 10-year bond spread) in states with differing degrees of segmentation, as measured by privilege (%) (columns (1), (3), and (5)) and state fund holdings (SFH) (columns (2), (4), and (6)). Observations are bond-weeks. Bond yields are par-weighted average yields across all transactions on the same bond in each week. Transaction data are from MSRB, screened using the same filters as in the Nelson-Siegel yield curve estimations, plus the additional filters as in Gao et al. (2019b), plus the requirements that transaction size must be at least $100,000 par and the number of qualified transactions must be at least 4 in each week. Spread is the difference between bond yield and weekly average maturity-matched interpolated constant maturity Treasury yield from FRED. Change in bond spread is calculated using the latest lagged bond spread up to 4-week lag, depending on data availability. Close election dummy is defined as in Table IV, realized state equity volatility is defined in Table V, and supply change is measured by net issuance, as defined in Table VI. Control variables are defined in Tables II, III, and IV. Bond issue size is the offering amount ($ million), bond age is the number of years from the offering date to the date of each transaction, GO dummy equals one if the bond is a general obligations bond, callable dummy equals one if the bond is callable, bank qualified dummy equals one if the bond's interest payments are tax-exempt for banks, insured dummy equals one if the bond is insured, and prefunded dummy equals one if the bond has been prerefunded as of each transaction date. Years to maturity and years to call are the number of years from each transaction date until the maturity date and the first call date, respectively. All models include state, (bond-level) credit rating x calendar year-month dummies. Models in columns (1), (3), and (5) also include state dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	Spread10Y		Spread10Y		ΔSpread10Y	
Measure of ***Risk*** or ***Supply Chg***:	Close Election		Realized Volatility		Net Issuance	
Measure of ***Segmentation***:	Privilege (1)	SFH (2)	Privilege (3)	SFH (4)	Privilege (5)	SFH (6)
Main Variables						
Risk	0.065***	0.027*	2.922***	2.107***		
	(0.016)	(0.016)	(0.482)	(0.334)		
Seg.	-0.011***	-0.169***	-0.009***	-0.103***	0.001	-0.010***
	(0.002)	(0.008)	(0.002)	(0.011)	(0.000)	(0.002)
Risk x Seg.	0.010***	0.082***	0.417***	4.728***		
	(0.002)	(0.030)	(0.054)	(0.751)		
Risk x Debt/Income		-0.040		-4.703*		
		(0.189)		(2.722)		
Seg. x Debt/Income		0.029		-0.141		-0.006
		(0.105)		(0.144)		(0.023)
Risk x Seg. x Debt/Income		0.847**		53.161***		
		(0.364)		(8.231)		
Supply chg.					0.313	0.210
					(0.366)	(0.330)
Supply chg. x Seg.					0.108***	1.865**
					(0.035)	(0.795)

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Table VII *-continued*

Dependent Variable:	Spread10Y		Spread10Y		ΔSpread10Y	
Measure of ***Risk*** or ***Supply Chg***:	Close Election		Realized Volatility		Net Issuance	
Measure of ***Segmentation***:	Privilege (1)	SFH (2)	Privilege (3)	SFH (4)	Privilege (5)	SFH (6)
Supply chg. x Debt/Income						0.942
						(1.414)
Supply chg. x Seg. x Debt/Income						9.976*
						(5.322)
Control Variables						
Debt/Income	1.011***	0.075	0.973***	0.525***	0.032	-0.012
	(0.078)	(0.046)	(0.075)	(0.067)	(0.020)	(0.010)
All fund holding/Debt	0.219	0.042	0.138	0.042	-0.031	-0.029
	(0.146)	(0.052)	(0.150)	(0.053)	(0.029)	(0.022)
Term spread	0.005	0.004	0.007	0.005	-0.018**	-0.014*
	(0.082)	(0.079)	(0.082)	(0.078)	(0.009)	(0.008)
Market equity return	-2.723**	-2.506**	-2.726**	-2.497**	-3.602***	-3.656***
	(1.330)	(1.230)	(1.329)	(1.231)	(0.405)	(0.404)
State equity return	0.139	0.125	0.140	0.120	-0.012	-0.007
	(0.118)	(0.105)	(0.117)	(0.105)	(0.049)	(0.043)
Unemployment rate	0.053***	0.046***	0.053***	0.047***	0.000	0.000
	(0.003)	(0.002)	(0.003)	(0.002)	(0.001)	(0.000)
ln(Trading volume/Debt)	0.028	-0.015	0.026	-0.013	-0.004	0.006
	(0.020)	(0.014)	(0.020)	(0.014)	(0.006)	(0.005)
ln(# of trades)	0.013***	0.027***	0.014***	0.029***	-0.000	-0.002***
	(0.004)	(0.002)	(0.004)	(0.002)	(0.001)	(0.000)
Proactive		-0.018***		-0.017***		-0.002*
		(0.004)		(0.004)		(0.001)
Bond Characteristics						
ln(Issue size)	-0.037***	-0.039***	-0.037***	-0.039***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)
ln(Age)	0.169***	0.168***	0.169***	0.168***	0.020***	0.019***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.001)	(0.001)
GO dummy	-0.080***	-0.079***	-0.081***	-0.079***	-0.004***	-0.004***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.001)	(0.001)
Bank qualified dummy	-0.117***	-0.112***	-0.117***	-0.112***	-0.013***	-0.012***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.002)	(0.002)
Insured dummy	0.026**	0.032***	0.025**	0.032***	-0.007***	-0.007***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.001)	(0.001)
Years to maturity	0.050***	0.050***	0.050***	0.050***	0.001***	0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
1/Years to maturity	0.293***	0.293***	0.293***	0.293***	0.000	-0.001
	(0.055)	(0.055)	(0.055)	(0.055)	(0.007)	(0.007)

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Table VII *-continued*

Dependent Variable:	Spread10Y		Spread10Y		ΔSpread10Y	
Measure of ***Risk*** or ***Supply Chg***:	Close Election		Realized Volatility		Net Issuance	
Measure of ***Segmentation***:	Privilege (1)	SFH (2)	Privilege (3)	SFH (4)	Privilege (5)	SFH (6)
Callable dummy	0.114***	0.120***	0.114***	0.120***	0.007***	0.007***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.002)	(0.002)
Callable dummy x Years to call	0.007***	0.006***	0.007***	0.006***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Callable dummy x 1/Years to call	0.008***	0.008***	0.008***	0.008***	0.001**	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Prerefunded dummy	-0.630***	-0.632***	-0.630***	-0.632***	-0.018***	-0.018***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.003)	(0.003)
Credit rating x Y-M dummies	YES	YES	YES	YES	YES	YES
State dummies	YES	NO	YES	NO	YES	NO
Observations	2,539,919	2,539,919	2,539,919	2,539,919	609,136	609,136
R-squared (total)	0.377	0.334	0.376	0.341	0.025	0.035

Table VIII

Price Effects for FL, IN, and UT Bonds with and without State Tax Privilege

This table reports estimated price effects of realized state equity volatility (column (1), dependent variable = 10-year bond spread) and supply change (column (2), dependent variable = change in 10-year bond spread) for FL, IN, and UT bonds during periods in which state residents enjoy privilege for holding their state-issued bonds vs. periods in which they do not. Observations are state-weeks. Only FL, IN, UT, and the states that share border with them (GA, AL, MS, MI, IL, OH. KY, ID, NV, AZ, NM, CO, and WY) are included. Realized state equity volatility is calculated as square root of the sum of squared *daily* excess state equity returns over the 5-day trading week. Excess state equity return equals state equity return minus market equity return. Supply change equals annualized 4-week moving average of net weekly issuance, normalized by total income of state residents as reported to Internal Revenue Service. Net issuance data are from SDC Platinum (gross issuance – refunding). Treatment group dummy equals one for FL, IN, and UT, and control group dummy equals one for the neighboring states. Treatment period dummy equals one in and before 2006 for FL and its neighbors, in and after 2012 for IN and its neighbors, and in and after 2003 for UT and its neighbors. Control variables in columns (1) and (2) are the same as those in Tables III and V, respectively. All models include state, state dummies, credit rating x calendar year-month dummies, and group x week dummies, where group is defined as each treatment state and its associated control states. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	Spread10Y (1)	ΔSpread10Y (2)
Realized vol. x Treatment group	3.619***	
	(1.487)	
Treatment group x Treatment period	-0.071***	
	(0.019)	
[A] Realized vol. x Treatment group x Treatment period	2.300***	
	(0.395)	
Realized vol. x Control group	3.926**	
	(1.360)	
Control group x Treatment period	0.015	
	(0.013)	
[B] Realized vol. x Control group x Treatment period	-0.581	
	(0.863)	

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Table VIII *-continued*

Dependent Variable:	Spread10Y (1)	ΔSpread10Y (2)
Supply change x Treatment group		0.142**
		(0.064)
Treatment group x Treatment period		0.010
		(0.010)
[C] Supply change x Treatment group x Treatment period		0.223***
		(0.069)
Supply change x Control group		0.129***
		(0.042)
Control group x Treatment period		-0.017
		(0.013)
[D] Supply change x Control group x Treatment period		0.027
		(0.057)
Control variables	As in Table IV	As in Table VI
State dummies	YES	YES
Credit rating x Year-Month dummies	YES	YES
Group x Week dummies	YES	YES
F test of H0: [A] = [B]	3.88**	
F test of H0: [C] = [D]		34.31***
Observations	13,393	12,508
R-squared (total)	0.894	0.070

Table IX

Price Effects of Correlated Background Risk

This table studies effects of close election (columns (1)-(2)) and realized state equity volatility (columns (3)-(4)) across states with differing correlations between bond return and residents' labor income, as measured by non-tradable employment, and differing degrees of segmentation, as measured by privilege (%) (columns (1) and (3)) and state fund holdings (SFH) (columns (2) and (4)). Observations are state-weeks. Dependent variable is 10-year bond spread. For each state in a given year, non-tradable employment is the fraction of employment in the non-tradable and construction sectors, calculated using Census Bureau's County Business Patterns (CBP) data and Mian and Sufi (2014)'s industry classification. Close election dummy is defined as in Table IV, and realized state equity volatility is defined in Table V. Control variables, defined in Tables II, III, and IV, are omitted for brevity. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses.

Measure of ***Local Risk***:	Close Election		Realized State Equity Volatility	
Measure of ***Segmentation***:	Privilege	SFH	Privilege	SFH
	(1)	(2)	(3)	(4)
Seg.	-0.007***	-0.198***	-0.010***	-0.238***
	(0.001)	(0.013)	(0.001)	(0.019)
Non-tradable employment	-0.101	0.083	-0.122	0.072
	(0.071)	(0.084)	(0.169)	(0.110)
Seg. x Non-tradable employment	0.172**	0.818***	0.083*	0.458*
	(0.075)	(0.164)	(0.043)	(0.249)
Risk	0.103***	0.065**	3.039***	3.688***
	(0.032)	(0.028)	(0.859)	(0.661)
Risk x Seg.	0.006*	0.091*	0.259***	3.428***
	(0.003)	(0.049)	(0.061)	(0.819)
Risk x Non-tradable employment	-0.353	-0.376	-2.311	-1.742
	(0.775)	(0.486)	(6.243)	(4.297)
Risk x Seg. x Non-tradable employment	0.186**	2.058**	3.254***	25.817**
	(0.089)	(1.026)	(0.712)	(12.592)
Control variables	As in Table IV		As in Table V	
Credit rating x Year-Month dummies	YES	YES	YES	YES
Observations	43,747	43,747	43,747	43,747
R-squared (total)	0.925	0.926	0.925	0.926

Table X

Price and Issuance Effects of State Residents' Non-Pecuniary Benefits

This table studies bond price elasticities of supply and bond issuance patterns across states whose residents exhibit differing attitude towards community service, as measured by per-capita volunteer hours. Data on volunteer hours by state (2002-2014) are from the Current Population Survey (CPS) conducted by Bureau of Labor Statistics (BLS). Per-capita volunteer hours in 1998-2001 are assumed to equal those in 2002. Columns (1) and (2) report results from state-week panel regressions of change in 10-year bond spread on change in supply, as defined in Table VI, its interaction with privilege (%) (column (1)) or state fund holdings (SFH) (column (2)), and its triple interactions with (logged) per-capita volunteer hours. Columns (3) and (4) report results from state-week panel regressions of dedicated purpose general obligation (GO) bond issuance on privilege (%) (column (3)) or SFH (column (4)), and their interaction with (logged) per-capita volunteer hours. Dedicated purpose GO bond issuance is calculated as net dedicated purpose GO bond issuance ($ million) divided by net total GO bond issuance ($ million). GO bonds are considered dedicated purpose if the Bond Buyer's use of proceeds is not for "general purpose or improvement." Net issuance is gross issuance minus refunding. All control variables are defined in Table VI. All models include credit rating x calendar year-month dummies. Columns (1) and (2) also include average characteristics of bonds used in the estimation of weekly state yield curve, as in Table VI but omitted for brevity. Standard errors, clustered by calendar year-month, are reported in parentheses.

Dependent Variable:	ΔSpread10Y		Dedicated Purpose GO/ Total GO Issuance	
Measure of ***Segmentation***:	Privilege (1)	SFH (2)	Privilege (3)	SFH (4)
Main Variables				
Seg.	-0.003***	-0.021***	0.010***	0.090***
	(0.000)	(0.006)	(0.001)	(0.019)
ln(Volunteer hours)	0.028***	0.019	-0.023	-0.030
	(0.006)	(0.012)	(0.033)	(0.029)
Seg. x ln(Volunteer hours)	-0.367***	-0.042**	0.059***	0.585***
	(0.106)	(0.019)	(0.005)	(0.087)
Supply chg.	-0.137	0.304***		
	(0.102)	(0.097)		
Supply chg. x Seg.	0.147***	0.857***		
	(0.019)	(0.249)		
Supply chg. x ln(Volunteer hours)	0.060	0.076		
	(0.165)	(0.165)		
Supply chg. x Seg. x ln(Volunteer hours)	-0.156*	-2.186***		
	(0.082)	(0.696)		

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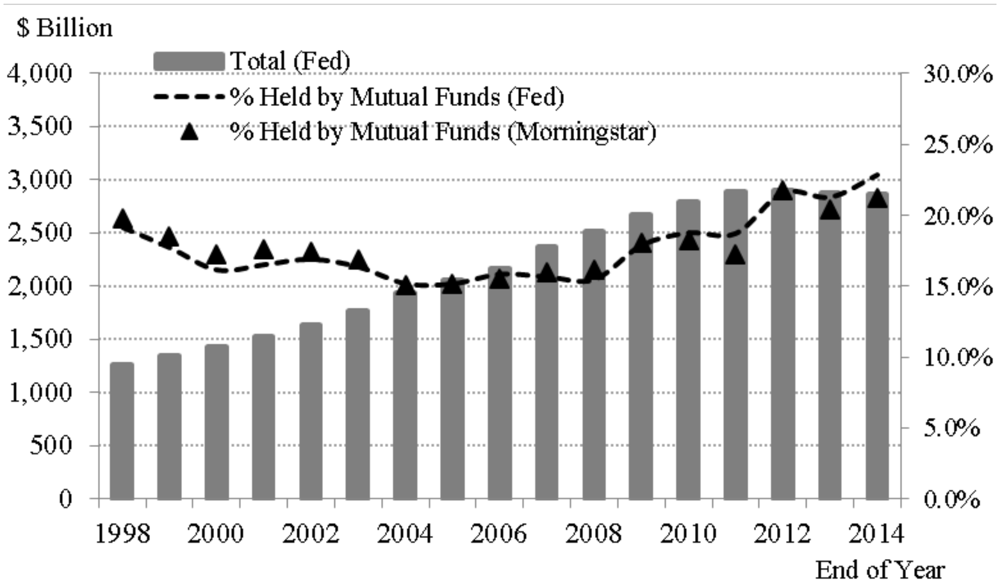
Table X *-continued*

Dependent Variable:	ΔSpread10Y		Dedicated Purpose GO/ Total GO Issuance	
Measure of ***Segmentation***:	Privilege (1)	SFH (2)	Privilege (3)	SFH (4)
Control Variables				
Debt/Income	0.012	0.001	-0.038	-0.021
	(0.018)	(0.018)	(0.073)	(0.080)
All fund holding/Debt	-0.108	-0.117	0.117	0.189
	(0.093)	(0.129)	(0.132)	(0.142)
Term spread	-0.027	-0.027	0.004	-0.001
	(0.019)	(0.019)	(0.009)	(0.009)
Market equity return	-4.710***	-4.704***	0.404	0.500
	(0.765)	(0.765)	(0.466)	(0.476)
State equity return	-0.027	-0.025	-0.038	-0.042
	(0.031)	(0.031)	(0.067)	(0.066)
Unemployment rate	-0.003***	-0.003***	0.032***	0.022***
	(0.001)	(0.001)	(0.004)	(0.004)
ln(Trading volume/Debt)	-0.006	-0.006	-0.108***	-0.126***
	(0.004)	(0.004)	(0.014)	(0.015)
ln(# of trades)	0.005	0.007	-0.018***	-0.010**
	(0.004)	(0.004)	(0.005)	(0.005)
Proactive	-0.010***	-0.010***	0.037***	0.038***
	(0.002)	(0.002)	(0.010)	(0.010)
Controls for average characteristics of bonds used in yield estimations	YES	YES	NO	NO
Credit rating x Month dummies	YES	YES	YES	YES
Observations	40,864	40,864	20,913	20,913
R-squared (total)	0.062	0.064	0.073	0.072

Panel A: Aggregate Market and Value Held by Mutual Funds



Panel B: State vs. National Municipal Bond Mutual Funds

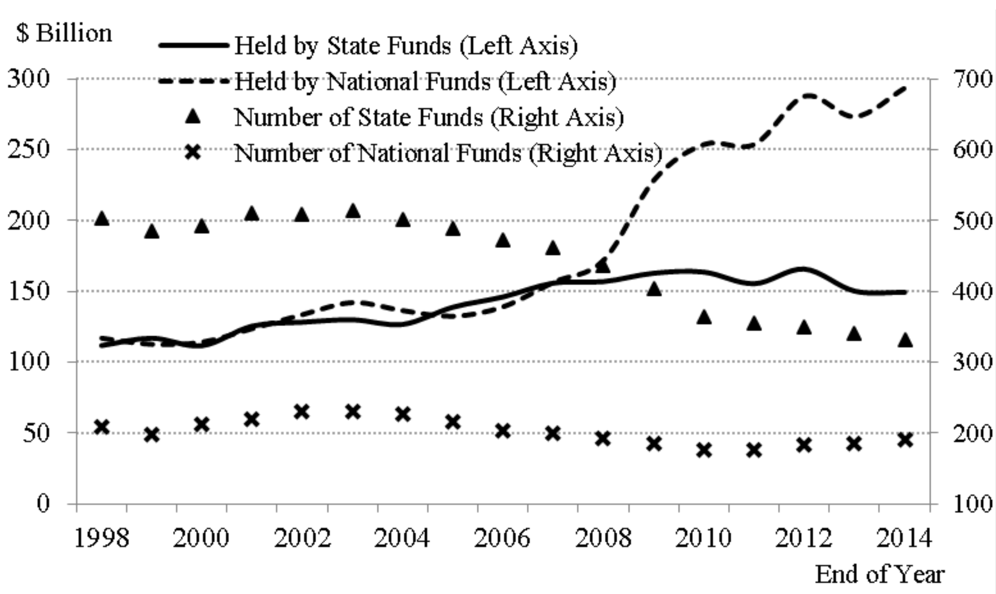
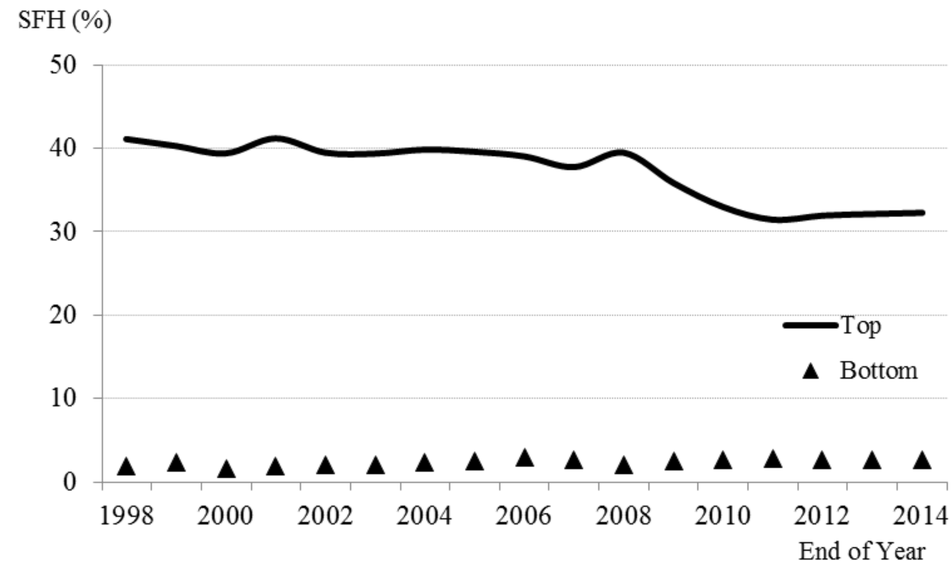


Figure 2. Tax-exempt municipal bond market and mutual funds over time. This figure presents the total outstanding amount of tax-exempt municipal bonds over the sample period from 1998 to 2014. Panel A plots the total outstanding amount and the amount held by mutual funds, as reported by the Federal Reserve, in comparison with the amount held by mutual funds, as reported by Morningstar. Only bonds with maturity 13 months or greater and only open-ended mutual funds are included. The amounts are measured in par value terms ($ billion). Panel B plots the amounts held by state vs. national municipal bond mutual funds and the numbers of these funds, as reported by Morningstar.

Panel A: Average State Fund Holding for States in Top and Bottom Privilege Quintiles



Panel B: Average State Fund Holding for FL and NY

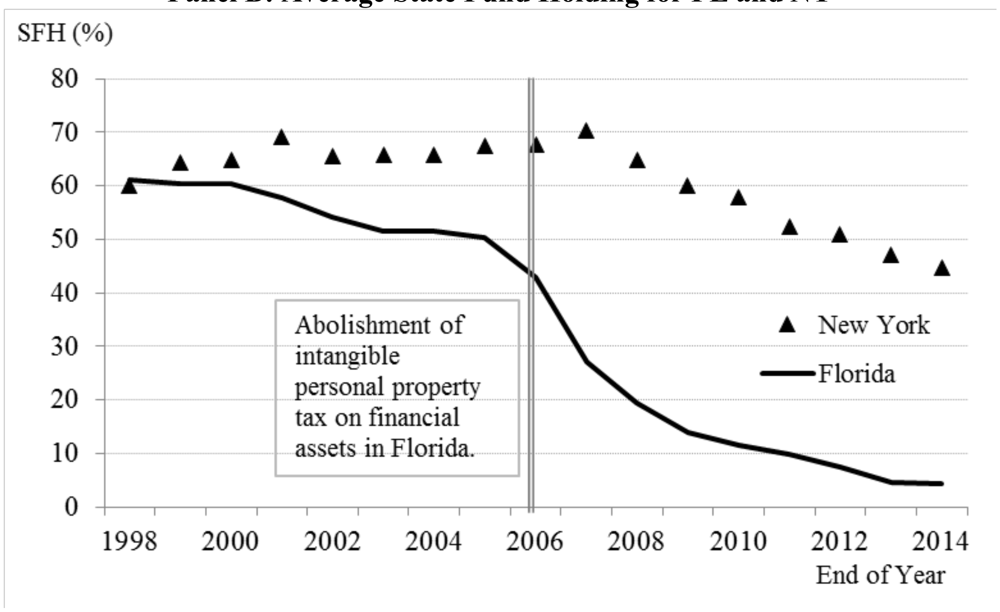


Figure 3. State fund holding for high- and low-privilege states over time. This figure plots SFH for specific groups of states over time. For each state at each time point, SFH is the amount of state-issued municipal bonds held by state municipal bond funds, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. Panel A presents the average SFH for states in the top and bottom quintiles, sorted by the time-series average of state tax privilege. Panel B compares SFH for FL and NY. Both states have significant state income/wealth tax privilege until 2006. Effective from 2007, FL abolished intangible property tax on financial assets, including investments in municipal bonds and bond funds. Panel C compares SFH for UT and TX. Both states have zero state income tax privilege up to 2002. Effective from 2003, UT grants its residents state income tax privilege for holding its own bonds.

Panel C: Average State Fund Holding for UT and TX

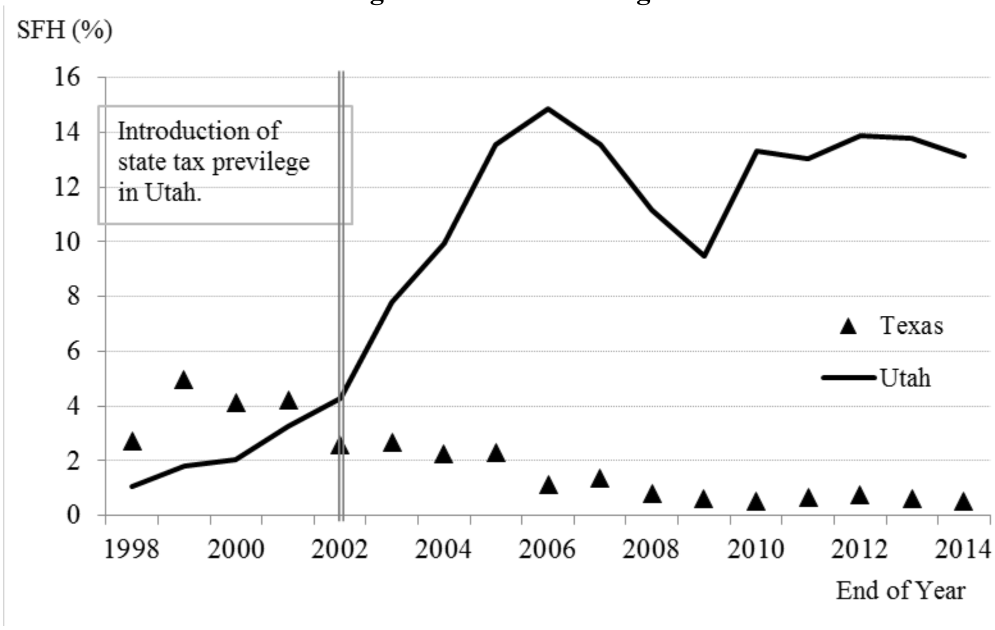


Figure 3 –*continued.*

Internet Appendix for

Heterogeneous Taxes and Limited Risk Sharing: Evidence from Municipal Bonds

1. Baseline Theoretical Framework

1.1. Asset Structure

There are two assets, an inside asset (I) and the market (M), with the following expressions for their returns:

$$\begin{aligned}\tilde{r}_I &= \bar{r}_I + \tilde{y} + \tilde{\varepsilon}_I,\\ \tilde{r}_M &= \bar{r}_M + \tilde{y},\end{aligned}$$

where $E(\tilde{y}) = 0$, $\mathrm{Var}(\tilde{y}) = \sigma_y^2$, $\mathrm{E}(\tilde{\varepsilon}_I) = 0$, $\mathrm{Var}(\tilde{\varepsilon}_I) = \sigma_I^2$, and $\mathrm{Cov}(\tilde{y}, \tilde{\varepsilon}_I) = 0$. We can interpret $\tilde{y}$ as a systematic risk factor, which affects both assets identically, and $\tilde{\varepsilon}_I$ as an idiosyncratic risk factor, which is specific to the inside asset. As in Merton (1987), we assume that the market for asset M is extremely large, and $\bar{r}_M$ is largely unaffected by the choices of agents in the model. In what follows, we also denote by S_I the net supply of asset I, net of price-inelastic demand for the asset such as the demand of index funds.

1.2. Investors

There are two investors in the model, which we label as inside (ι) and global (g). We assume that the inside investor ι receives a *relative tax privilege* for investing in asset I. In particular, the after-tax returns that ι receives from investing in assets I and M respectively are $\tilde{r}_I$ and $(1-\tau)\tilde{r}_M$. We also assume that the inside investor's total wealth is W^ι, which is sufficient to purchase the entire supply of the inside asset I, i.e., $W^\iota > S_I$.[1]

The global investor g faces the same tax treatment for assets I and M (without loss of generality, we set this tax rate to zero). The aggregate wealth of the global investor is denoted by W^g, where $W^g >> W^\iota$.

Both investors $j \in \{\iota, g\}$ face the same utility maximization problem, with utility functions

[1] Without loss of generality, we normalize the price of the asset to 1. If one were to push the interpretation slightly, and assume that the inside asset is the debt of a small state, this condition is equivalent to assuming that the state has positive net worth, in the sense that the total assets of state residents are sufficient to cover total state liabilities.

as in Merton (1987):

$$\max_{\omega^j} \ \mathrm{E}(W^j(1+\tilde{r}^j)) - \frac{\delta}{2W^j}\mathrm{Var}(W^j(1+\tilde{r}^j)) - \lambda^j\omega^j \qquad (1)$$
$$\Leftrightarrow \ \max_{\omega^j} \ \mathrm{E}(\tilde{r}^j) - \frac{\delta}{2}\mathrm{Var}(\tilde{r}^j) - \lambda^j\omega^j$$

where δ is the investor's coefficient of relative risk aversion, $\tilde{r}^j$ denotes the return of investor $j \in \{\iota, g\}$, and ω^j is the weight that each investor places on asset I. λ^j is the Lagrange multiplier that reflects the constraint that ω^j is non-negative – this is the short-sales constraint that applies to holdings of the inside asset I.

Investors ι and g differ in the after-tax returns that they receive from asset I relative to asset M, owing to the tax privilege. Their expected after-tax portfolio returns and variances are given by the expressions:

$$E(\tilde{r}^\iota) = \omega^\iota\bar{r}_I + (1-\tau)(1-\omega^\iota)\bar{r}_M \text{ and } E(\tilde{r}^g) = \omega^g\bar{r}_I + (1-\omega^g)\bar{r}_M. \qquad (2)$$

$$\mathrm{Var}(\tilde{r}^\iota) = ((1-\tau+\tau\omega^\iota)\sigma_y)^2 + (\omega^\iota\sigma_I)^2 \text{ and } \mathrm{Var}(\tilde{r}^g) = \sigma_y^2 + (\omega^g\sigma_I)^2. \qquad (3)$$

Substituting (2) and (3) into (1) and differentiating (1) with respect to ω^ι (ω^g) for investors ι (g), we obtain the following first-order conditions:

$$\omega^\iota = \frac{\bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \lambda_\iota}{\delta(\tau^2\sigma_y^2 + \sigma_I^2)} \ \text{ and } \ \omega^g = \frac{\bar{r}_I - \bar{r}_M - \lambda_g}{\delta\sigma_I^2}. \qquad (4)$$

Equation (4) shows that investors ι will compare the (variance-adjusted) tax-privilege-induced extra return on asset I, $\bar{r}_I-(1-\tau)\bar{r}_M-\delta\tau(1-\tau)\sigma_y^2$ with the incremental risk $\delta(\tau^2\sigma_y^2+\sigma_I^2)$ from scaling up the position in asset I.[2] Investors g face a similar tradeoff, but since they do not receive any tax privilege, they require a higher return on asset I than on asset M (per unit of idiosyncratic risk) to hold the inside asset. Because in general, $\bar{r}_M > (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2$ (unless the systematic variance is very large), the tax privilege for inside investors implies that they require a smaller expected return per unit of risk to invest in asset I. That is, the tax

[2] This result is fairly general, since it is possible to show that these portfolio weights only depend on expected returns and the variance of returns under all CRRA utility functions and the assumption that asset returns are normally distributed.

privilege makes asset I relatively more attractive to inside investors than to global investors.

1.3. Market Clearing and Equilibrium

To clear the market for asset I, $\bar{r}_I$ must solve:

$$W^\iota \omega^\iota + W^g \omega^g = S_I. \tag{5}$$

The solution to equation (5) can fall into two possible ranges, depending on parameter values.

Region 1 $(1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 < \bar{r}_I \leq \bar{r}_M$

In this case, investor g will not invest in asset I ($\lambda^g < 0$ and $\omega^g = 0$), and therefore investor ι takes up the entire excess supply (i.e., net of inelastic demand such as from index funds) of asset I, and bears all of the idiosyncratic risk, σ_I^2. Market clearing dictates that:

$$\bar{r}_I = (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota}. \tag{6}$$

where $\gamma = 1 + \tau^2\sigma_y^2/\sigma_I^2$.

The second term of the above equation is a (smaller, order of τ) variance adjustment to the return on the asset on account of the fact that the inside investor compares the variance of the after-tax market return with that of the tax-exempt asset I. The last term is investor ι's required compensation for bearing the idiosyncratic risk of asset I, resembling the implication of the "shadow cost" of informational incompleteness in Merton (1987).

Region 2 $\bar{r}_M < \bar{r}_I$

If the additional risk compensation for the inside investors dominates the return they obtain from the tax privilege, then the equilibrium expected return will meet the participation requirement for investor g. Both investors ι and g will then hold asset I, and share its idiosyncratic risk. Market clearing therefore dictates that:

$$\bar{r}_I = \bar{r}_M - \frac{W^\iota}{W^\iota + \gamma W^g}\left(\tau\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2\right) + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota + \gamma W^g}. \tag{7}$$

Interpreting this expression a little loosely, the tax privilege now applies only to the smaller wealth-weighted fraction of investors ι: $(W^\iota/(W^\iota + \gamma W^g))$ while the idiosyncratic risk is shared across both investors $(S_I/(W^\iota + \gamma W^g))$. Since $W^g >> W^\iota$ and $\gamma > 1$, both the tax privilege and risk compensation terms become much smaller under (7) than (6). In the limit $W^g \to \infty$, both terms drop out and $\bar{r}_I = \bar{r}_M$.

1.4. A Simple Calibration

One important reason that Miller (1977) claims heterogeneous personal taxes do not affect equilibrium prices is because he assumes that debt supply adjusts such that in equilibrium, all otherwise similar debts are priced by the same marginal investors. Put differently, the contention is that supply will increase to the point at which all available tax privileges are exhausted, thus moving equilibrium into Region 2.

We attempt to shed light on this issue by calibrating selected parameters from the model to data from Minnesota and Virginia, two highly rated states (AA+ and above, to avoid effects of default risk on yield) with tax privilege in the top and middle quintiles, respectively. Our primary goal is to ascertain whether these parameters locate equilibrium for states with significant tax privilege in Region 1, as described in the model.

We set $\bar{r}_M = 0.0423$, the average 10-year municipal bond yield across zero privilege states in our sample, and $\sigma_y^2 = 0.0030$, the variance of annual returns on the value-weighted 10-year municipal bond portfolio. We assume that investors' coefficient of risk aversion $\delta = 3$, following a number of studies, for example Das and Uppal (2004).

For Minnesota, we set the average tax privilege $\tau = 0.08$, the wealth of inside investors $W^\iota = \$MM\ 61,292$ (assuming that half of financial assets as reported by the Internal Revenue Service's personal wealth study in 2007 are allocated to general fixed income), and the net supply $S_I = \$MM\ 22,072$ (assuming that 61.31% of total debt as reported by the Census Bureau in 2007 is held in-state). We estimate idiosyncratic variance ($\sigma_I^2 = 0.0006$) as the idiosyncratic variance, from regressing Minnesota municipal bond returns on our measure of $\tilde{r}_M$, which again is constructed as a weighted average of municipal bond returns. We assume that the weights are proportional to the total debt outstanding per state. Using these parameters, we compute $\bar{r}_I = 0.0399 < 0.0423 = \bar{r}_M$, meaning that equilibrium comfortably falls into Region 1 (the sample average yield for Minnesota bonds is 0.0403).

Following the same procedure for Virginia, with $\tau = 0.0575$, $W^{\iota} = \$MM\ 89,859$, $S_I = \$MM\ 26,491$ (assuming that 57.59% of total debt is held in-state), and $\sigma_I^2 = 0.0003$, we get $\bar{r}_I = 0.0402 < 0.0423 = \bar{r}_M$, once again putting equilibrium comfortably into Region 1 (the sample average yield for Virginia bonds is 0.0405). Consistent with this simple calibration, Schultz (2013) shows that relative yields on municipal bonds issued by different states are largely explained by state tax privilege.

2. The Effect of Background Risk

Next, we modify our model to include a role for background risk in the form of uninsurable labor income. The effect of background risk on portfolio choice has been an active area of investigation in the literature (see, e.g., Guiso, Jappelli, and Terlizzese (1996), Heaton and Lucas (1997, 2000a, 2000b), and Fagereng, Guiso, and Pistaferri (2018)). In our context, background risk is likely to play a particularly important role, since it is plausible that shocks to inside investors' labor income is likely to be correlated with idiosyncratic risk affecting the returns on the inside asset.[3]

We therefore augment the model, adding labor income of each investor j as $\tilde{L}^j = W^j \tilde{l}^j$ where $\tilde{l}^j = \bar{l}^j + \tilde{\varepsilon}_l^j$, $\text{Var}(\tilde{\varepsilon}_l^j) = \sigma_l^2$ (same for both investors). While the labor income of both investors may be correlated with the systematic shock, $\tilde{y}$, for simplicity, we normalize $\text{Corr}(\tilde{y}, \tilde{\varepsilon}_l^{\iota}) = \text{Corr}(\tilde{y}, \tilde{\varepsilon}_l^{g}) = 0$. However, we assume that the labor income of the inside investor ι is positively correlated with the local idiosyncratic shock $\tilde{\varepsilon}_I$, but the labor income of investor g is not. Let $\rho = \text{Corr}(\tilde{\varepsilon}_I, \tilde{\varepsilon}_l^{\iota}) > 0$.

Under this modification, the total terminal wealth is now: $\tilde{W}^j = W^j(1 + \tilde{r}^j + \tilde{l}^j)$. As a result, each investor's maximization problem is given by:

$$\max_{\omega^j} \text{E}(\tilde{r}^j + \tilde{l}^j) - \frac{\delta}{2}\text{Var}(\tilde{r}^j + \tilde{l}^j) - \lambda^j \omega^j$$

[3] To take a simple example, consider a situation in which unusual state budget deficits simultaneously affect realized bond returns, as well as state spending capabilities. The latter channel affects the implementation of new projects and therefore the wages of both government and private sector employees.

The expectation and variance of terminal wealth for investor ι are:

$$\begin{aligned}\mathrm{E}(\tilde{r}^{\iota}+\tilde{l}^{\iota}) &= \omega^{\iota}\bar{r}_I+(1-\tau)(1-\omega^{\iota})\bar{r}_M+\bar{l}^{\iota}, \text{ and}\\ \mathrm{Var}(\tilde{r}^{\iota}+\tilde{l}^{\iota}) &= ((1-\tau+\tau\omega^{\iota})\sigma_y)^2+(\omega^{\iota}\sigma_I)^2+\sigma_l^2+2\omega^{\iota}\rho\sigma_I\sigma_l,\end{aligned}$$

and for investor g are:

$$\begin{aligned}\mathrm{E}(\tilde{r}^{g}+\tilde{l}^{g}) &= \omega^{g}\bar{r}_I+(1-\omega^{g})\bar{r}_M+\bar{l}^{g}, \text{ and}\\ \mathrm{Var}(\tilde{r}^{g}+\tilde{l}^{g}) &= \sigma_y^2+(\omega^{g}\sigma_I)^2+\sigma_l^2.\end{aligned}$$

We obtain the following FOCs:

$$\omega^{\iota}=\frac{\bar{r}_I-(1-\tau)\bar{r}_M-\delta\tau(1-\tau)\sigma_y^2-\delta\rho\sigma_I\sigma_l-\lambda^{\iota}}{\delta(\tau^2\sigma_y^2+\sigma_I^2)} \text{ and } \omega^{g}=\frac{\bar{r}_I-\bar{r}_M-\lambda^{g}}{\delta\sigma_I^2},$$

which again yields a separation of our key predictions into two regions.

Region 1: $(1-\tau)\bar{r}_M+\delta\tau(1-\tau)\sigma_y^2+\delta\rho\sigma_I\sigma_l<\bar{r}_I\leq\bar{r}_M$

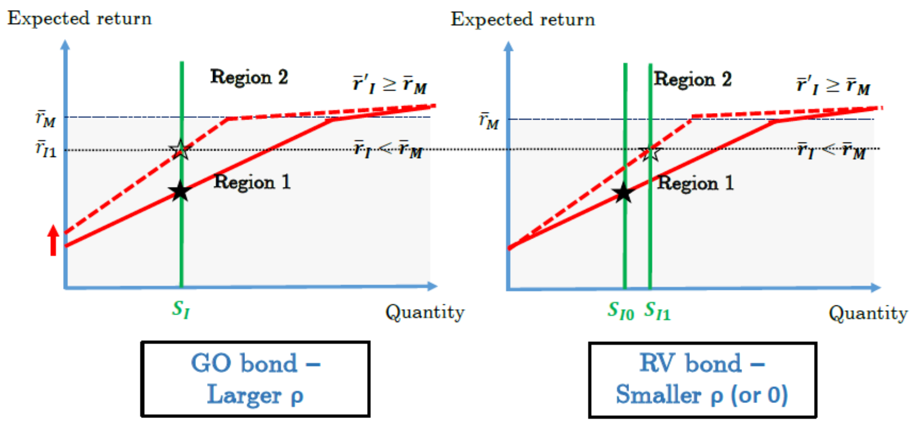
In region 1, where local asset ownership is dominated by local investors, we now obtain an additional term, $\delta\rho\sigma_I\sigma_l$, which is the extra return that investor ι now demands to compensate for the background risk in addition to the earlier cost associated with underdiversification. This additional required compensation/reluctance to absorb the entire supply of the inside asset shifts up the intercept, thus decreasing the range over which the equilibrium remains in region 1.

Market clearing delivers the following expression for returns:

$$\bar{r}_I=(1-\tau)\bar{r}_M+\delta\tau(1-\tau)\sigma_y^2+\delta\rho\sigma_I\sigma_l+\frac{\delta\gamma\sigma_I^2S_I}{W^{\iota}}.$$

For states that in region 1, one new implication from adding correlated uninsurable labor income risk is that the sensitivity of $\bar{r}_I$ to σ_I^2 now increases with ρ.

Region 2: $\bar{r}_M<\bar{r}_I$



The expected return $\bar{r}_I$ is given by:

$$\bar{r}_I = \bar{r}_M - \frac{W^\iota}{W^\iota + \gamma W^g}\left(\tau \bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \delta\rho\sigma_I\sigma_l\right) + \frac{\delta\gamma\sigma_I^2 S_I}{W^\iota + \gamma W^g}$$

where, as before, $\gamma = 1 + \tau^2\sigma_y^2/\sigma_I^2 > 1$. Relative to the baseline model, nothing significantly changes here since all the correlation effects are diluted by $W^\iota/(W^\iota + \gamma W^g)$.

The addition of background risk adds the following predictions for states in region 1. First, the sensitivity of bond yields to state-specific risk should covary positively with the extent of the correlation between residents' income and economic conditions in the state. Second, to the extent that particular variants of the inside asset/local municipal bonds, for example, general obligation (GO) versus revenue (RV), have different degrees of correlation with in-state residents' labor income, their yield sensitivities to state-specific risk will differ. This second prediction, as stated, is difficult to test, as if states are optimizing supply (which is outside of our model), they are likely to exercise flexibility, substituting between the issuance of GO and RV bonds to minimize associated financing costs. To the extent that states indeed do this, in periods with increasing (decreasing) state-specific risk, states with larger ρ will issue relatively more (less) RV vs. GO bonds than states with smaller ρ. To sharpen our empirical design, we focus on a subset of these bonds, discussed below.

The above picture illustrates the third prediction. Starting from the solid lines, where the equilibrium expected returns for both essential services GO and RV bonds are equal. For simplicity, let us assume that these GO bonds have $\rho > 0$ while these RV bonds have $\rho = 0$.

If the local idiosyncratic risk increases, then the demand curves for the two bonds will rotate up and the demand curve for these GO bond will additionally shift up due to the term $\delta\rho\sigma_I\sigma_l$. The new demand curves are depicted by the dashed lines. As we can see, holding the supply constant at S_{I0}, the expected return is now higher for essential services GO bonds than for the RV bonds. If the state needs to issue such bonds, it now has an incentive to issue the RV bonds until the supply reaches S_{I1} and the expected returns of both types equalized at $\bar{r}_{I1}$.

In our empirical work, as before, we evaluate these predictions using a difference-in-difference methodology, using states in Region 2 as the benchmark, for which we should not observe the above predictions holding true.

On the last prediction about bond issuance, depending on the type of issuer and the use of bond proceeds, issuing GO vs. RV bonds may not be a choice available to the state. For example, traditionally, school districts do not generate income to repay their bonds and therefore they must issue GO bonds, to be repaid by property or income taxes. In addition, GO bonds are often regarded as being safer, consequently, they may not be sensitive to small variation in state residents' labor income.

To more carefully examine bond issuance in the presence of these concerns, we focus only on bonds issued for "essential services" (utilities plus transportation), and hypothesize that ρ is greater for the subset of GO bonds vs. similarly defined RV bonds of this type. Municipalities can choose how to fund a particular essential service project, e.g. with service fees or with tax money, and essential service GO and RV bonds only differ in the source of funds for repayment. For GO bonds, the funds come from property or general income taxes, which some practitioners argue are vulnerable to local economic downturns. Municipalities are either legally or politically constrained from raising taxes, especially when the residents' income or property prices decline. On the other hand, essential service RV bonds are repaid by revenue streams from specific services as stated in the official issuance statements. These services are critical to residents, meaning that RV bond issuers also have the ability to increase the service fees should the dedicated revenue stream fall short, and traditionally, they have done so to ensure full debt payments.[4] As a result, essential service RV bonds fit with the theoretical framework above,

[4] See, for example, https://www.municipalbonds.com/investing-strategies/essential-service-revenue-bond-great-alternative-go-bond/.

because they can act as a substitute for GO bonds; in addition, their returns are relatively well protected from local economic downturns.

3. Non-Pecuniary Benefits for Inside Investors

We consider a second modification of our model that incorporates the assumption that inside investors derive non-pecuniary benefits from holding local bonds in their portfolios. This possibility is motivated by the literature on underdiversification, which suggests that loyalty is an important factor that helps to explain local bias in investor portfolios (see, for example, Cohen (2009), and Morse and Shive (2011)).

We assume that the inside investor benefits from investing ω^ι in the inside asset but the global investor does not (i.e., investor g's maximization problem is unaffected). We model the utility gain from non-pecuniary benefits as additive and diminishing, as captured by the additional utility flow $f(\omega^\iota)$ where $f(0) = 0$, $f'(\omega^\iota) > 0$, and $f''(\omega^\iota) < 0$.

Thus, investor ι's maximization becomes:

$$\max_{\omega^j} \mathrm{E}(\tilde{r}^\iota) - \frac{\delta}{2}\mathrm{Var}(\tilde{r}^\iota) + f(\omega^\iota) - \lambda^\iota\omega^\iota$$

With this modification, the local investor's FOC becomes:

$$-f'(\omega^\iota) + \delta\gamma\sigma_I^2\omega^\iota = \bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \lambda^\iota,$$

and the solution depends on $f(\omega^\iota)$. A natural choice for $f(\omega^\iota)$, given our current setup, is a standard quadratic utility function of the form: $f(\omega^\iota) = b\omega^\iota - \frac{a}{2}(\omega^\iota)^2$ where parameters b and a act as an "exchange rate" between pecuniary and non-pecuniary benefits.

The expression for the optimal weight is:

$$\omega^\iota = \frac{b + \bar{r}_I - (1-\tau)\bar{r}_M - \delta\tau(1-\tau)\sigma_y^2 - \lambda^\iota}{a + \delta(\tau^2\sigma_y^2 + \sigma_I^2)}.$$

Region 1 obtains if $(1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 - b < \bar{r}_I \leq \bar{r}_M$. The range over which the supply remains in region 1 is now bigger due to the downward shift in the participation constraint by

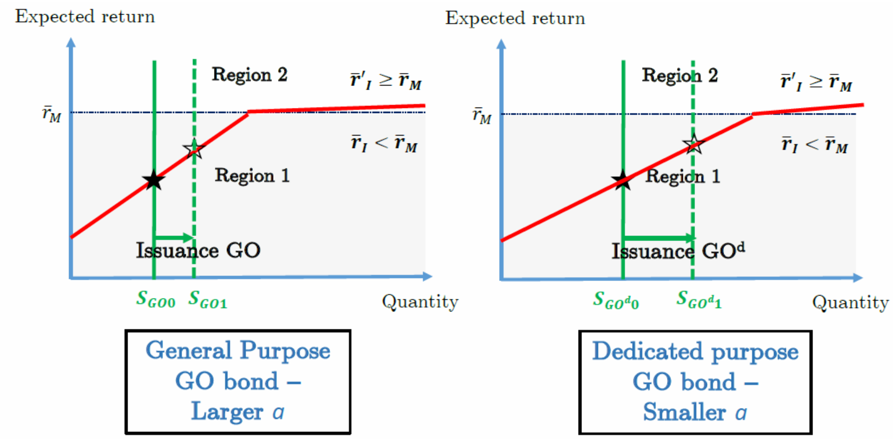
b. Market clearing in region 1 yields:

$$\bar{r}_I = (1-\tau)\bar{r}_M + \delta\tau(1-\tau)\sigma_y^2 - b + \frac{(a+\delta\gamma\sigma_I^2)S_I}{W^\iota}.$$

The expected return $\bar{r}_I$ as a function of supply S_I now shifts up and down with the non-pecuniary benefit b, and the slope of this function now increases in the rate a at which non-pecuniary benefit accumulation marginally diminishes. The latter leads to the following main prediction. In states in Region 1, the sensitivity of bond yields to supply change should increase in the rate at which non-pecuniary benefit accumulation marginally diminishes. As before, Region 2 is largely unchanged as the denominator is overwhelmingly large and so the preference of the inside investor is diluted.

The above prediction has important implications for municipal bond issuance. To take these implications to the data, we assume that all GO bonds have the same b, i.e., loyalty translates into similar linear increases in utility associated with an additional unit of each kind of bond, but various GO bonds differ in a, the rate at which these benefits dissipate with increments to the portfolio weight. Specifically, we assume that GO bonds with a dedicated purpose have lower a than GO bonds with a general purpose. We argue that the dedicated purpose GO bonds are likely to appeal to residents who care about the community as they are associated with projects that are more visible. In addition, as these bonds are hypothecated for different purposes, they diversify among themselves in the causes that may induce residents' non-pecuniary utility. Therefore, we presume a lower rate of diminishing of non-pecuniary utility for such bonds which translates into less attrition in their benefits as they are added to the inside investor's portfolio.

Once again assuming that states optimize issuance of all GO bonds to minimize financing costs, we should observe that states in Region 1 issue relatively more dedicated purpose GO bonds (because their expected returns are less sensitive to supply changes, as illustrated by the picture below) than states in Region 2. That is, the fraction of dedicated purpose GO bonds to total GO issuance is generally greater for states with higher privileges.



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Main Differences with Pirinsky and Wang (2011)

Our model differs from the model of Pirinsky and Wang (2011), henceforth PW, in a number of important ways. First, we include a large "global" risk-averse investor, while in their model, all investors in the market are essentially similar, except for their different locations in specific states. We make this modelling choice to match important evidence about the institutional features of the market. Bergstresser and Cohen (2015) show that muni ownership is concentrated among wealthy individuals with the top 0.5% of the population (assets over US$ 10MM) holding 37.5-46.9% of all munis, and that this share has been increasing over time. Such wealthy individuals have high tax elasticity, especially for state taxes. This elasticity can often manifest itself in residential mobility (see Bakija and Slemrod (2004), for example). Another common form of state tax avoidance by the wealthy is the setting up of non-grantor trusts in such states as NV and DE. This high elasticity to state taxes motivates our modelling choice of some investors as local, while others are effectively global.

Second, we assume that short sales are proscribed in our model. This is a relatively common modelling assumption, and more importantly, one which is a feature of the municipal bond setting that we consider. As Dybvig and Ross (1986) discuss, the short-sales constraint is realistic for municipal bonds, which lose their tax advantage when shorted. Moreover, state agencies cannot act as a pseudo arbitrager by issuing more municipal bonds and investing the proceeds, as only municipal bonds whose sale proceeds are hypothecated for specific purposes, e.g., building a hospital, may carry the federal and state income tax exemptions. Finally, in practice, the only cost-effective way to sell municipal bonds short is through municipal bond ETFs, which do not exist until 2007 and, even by the end of our sample period in 2014, hold just about 0.5% of outstanding municipal bonds.[1]

As a result of these important differences in assumptions, we derive two distinct regions for equilibrium, unlike the single region in PW. This means that we have both extensive and intensive margin predictions arising from the model. Specifically, in one of the two regions (Region 1) in which equilibrium may fall in our model, in-state investors are the marginal investors for their own state bonds while in the other region (Region 2), the idiosyncratic risk of the bond is fully shared among all investors, i.e., both local and global (i.e., the marginal investor is, loosely speaking, a wealth-weighted average of local and global investors). PW essentially looks like Region 2 in our model, and as such, their model predicts that there are essentially no effects of privilege on the pricing of risk. That is, contrary to their empirical results, in their model, supply effects should not depend on the issuing state's privilege policy, as privilege only increases the bond price through the (direct) wealth-weighted tax exemption enjoyed by the in-state investors. Put differently, the wealth or demand effects in their empirical work do not occur through the risk channel, but rather, through the direct tax exemption channel.[2]

[1] Without the short-sales constraint (and other frictions such as asymmetric taxation on interest income and expenses), the outside investors can arbitrage by selling the inside asset short and using the proceeds to invest in the market, ultimately equalizing the expected returns of the two assets. Indeed, this is effectively the situation in PW, in which the expected pricing effects should be negligible (as in Region 2 in our model).

[2] In PW, the equilibrium bond price (for State 1) is given by equation (4) in the main text or equation (A5) in the Appendix. The first term on the right-hand side is the face value of the bond. The second term is the weighted average tax paid by investors in all states, holding the bond issued by State 1. In the third term, the wealth-weighted tax paid by State 1 investors is added back. This is the only effect of privilege on the bond price. The last term is the price of risk term, which given CARA utility, is the product of risk aversion coefficient and the total dollar risk (supply times variance), normalized by the wealth of all investors, both in- and out-of-state. As a result, the presence or absence of tax privilege does not affect the pricing of risk. Mapping these to the empirical tests, their model would predict that

In our model, concentrated in-state ownership and resulting price effects go hand in hand. They are both a direct result of privilege, which makes in-state investors prefer their own state bonds to other investment alternatives. However, privilege and zero state tax are *not* equivalent, as the latter applies to *all* investment alternatives, while privilege *only* applies to state-issued assets. This is not a distinction made in the PW model, since in their setup, privilege and zero state tax rate are equivalent, as the in-state investors' overweighting of their own state bonds is a function of the difference between their own tax paid and the weighted-average tax paid by all investors. That is, the prediction of their model is that both TX and CA, for example, should observe high in-state ownership of their bonds since in both states, residents pay no tax on their own bonds while outside investors do. However, as we later demonstrate, this prediction is refuted by the empirical facts.

Finally, we extend our model to derive novel predictions about the effects of constraints and preferences of in-state investors on pricing (in Region 1, in which they are the marginal investors), including, importantly, the effects of correlated background risk. These predictions are supported in the data.

Our empirical work also differs substantially from PW. First, we demonstrate important tax clientele effects not only for prices (as do PW) but also for *asset holdings*; that is, we find that tax privilege engenders disproportionate *portfolio holdings* among in-state investors. This is important to illustrate the theoretical mechanisms at work, which we outline clearly in our model. Second, while PW treat all tax privileged states as one group, we show that the clientele effects vary even across states with different levels of tax privilege. Put differently, it is not just the fact that some states are privileged but others are not, but rather, it is also important to understand the effects of the degree of tax privilege. This variation along the intensive margin changes the level of state-fund holdings, and by extension the size of the price effects. Third, by exploiting measurable variation in state-level idiosyncratic risk, we pin down the precise channel for the price effects—(lack of) risk sharing—that drives the results. Fourth, we test our model's predictions on the effects of local investors' circumstances and preferences, and provide new results that are novel relative to the previous literature in this space. In these extensions, we show that if local investors become the relevant marginal investors, their preferences (as captured by, say, a non-pecuniary sense of community affiliation) or their exposures to correlated background risk (captured by, say, covariances between muni bond returns and local labor income) become increasingly important in municipal bond price determination. A corollary of this new finding which we also find evidence to support is that states in Region 1 appear to cater to local investors by issuing bonds that appeal to their preferences and circumstances.

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the increase in wealth of in-state investors (or demand) should increase bond price more in states with privilege but the increase in supply should affect bond prices equally in all states, as the prices of risk are all the same.

The Lawsuit that Challenged Differential Taxation of In-State and Out-of-State Municipal Bonds

Below, we review a major lawsuit, "Davis v. Dep't of Revenue of the Fin. & Admin. Cabinet", that threatened the viability of the in-state municipal bond tax exemption. The court documents highlight the benefits of the tax privilege for in-state municipal bond holdings (lower bond yields for in-state issuers) but it does not seem to indicate potential negative effects of the concentrated local clientele that we document in the paper – the greater susceptibility of municipal bond yields to supply variation and heightened sensitivity of muni yields to local political uncertainty.

This class action lawsuit was filed in 2003 by a couple living in Kentucky against the Kentucky Department of Revenue on behalf of all Kentucky residents. The suit claimed that Kentucky's discriminatory taxation of out-of-state bonds violated the dormant commerce clause prohibiting states from discriminating out-of-state businesses. The couple won the lawsuit in the state court, but the decision was repealed by the U.S. Supreme Court.

In the Supreme Court's opinion, the key argument in reversing the state court decision was that every single state in the U.S.– whether or not it has an income tax –supports Kentucky's argument that in-state and out-of-state bonds can be taxed differently. In a brief filed by 49 other states urging the Supreme Court to overturn the Kentucky court and uphold the state preference, states argued that this exemption allows them to compete for a limited pool of investment money. In the support of the exemption, the Court's opinion also mentions the direct benefit of the tax privilege - lower bond yields for in-state issuers, but it does not seem to indicate potential negative effects of the concentrated local clientele: "the ostensible reason for this regime is the attractiveness of tax-exempt bonds at "lower rates of interest . . . than that paid on taxable . . . bonds of comparable risk" (page 3 of the Justice Souter's opinion). "The precise reduction in interest rates depends on the federal and state income tax rates, the credit rating of the issuer, the term of the bond, and market factors. The reduction in interest rates is generally greater the higher are a State's income tax rates." (footnote 5 on page 3 of the Justice Souter's opinion).

The Court also recognizes that the removal of the exemption would decimate single-state municipal bond fund industry as well as clearly indicates that single-state funds exist solely because of this asymmetric taxation. "The system is the raison d'être for virtually all single state funds, and they would cease to be financially viable in the absence of a tax advantage that outweighed their relative lack of diversification vis-à-vis national funds and their reduced asset base". There is a recognition that state funds might be riskier than national funds, but the argument stops there without spelling out possible indirect effects of the concentrated single-state fund ownership on municipal bond yields. As a "the States' tax exemptions "have fostered the growth of funds that hold only the municipal bonds of a single state," which "[a]s compared [with] national tax-exempt bonds funds . . . tend to be higher risk and higher cost" (page 22 of the Justice Souter's opinion).

When examining the effects of the exemption on the inter-state market of municipal bonds, the Court did not seem to think that the interstate market is disadvantaged: "… what is remarkable about the issuers in this and the broader interstate market is that nearly every taxing State believes its public interests are served by the same tax-and-exemption feature, which is supported in this Court by every one of the States (with or without an income tax) despite the ranges of relative wealth and tax rates among them. These facts suggest that no State perceives any local advantage or disadvantage beyond the permissible ones open to a government and to those who deal with it when that government itself enters the market" (page 21 of the Justice Souter's opinion).

The opinion makes a point that states want to continue benefitting smaller municipal issuers and preserve this tax exemption that ”scholarship says often produces a net burden of tax revenues lost over interest expense saved. See, e.g., Brief for Alan D. Viard et al. as Amici Curiae 19 (“[S]tates routinely fail to recoup the cost of the tax subsidy in the form of lower financing rates” (citing Chalmers, Default Risk Cannot Explain the Muni Puzzle: Evidence from Municipal Bonds that are Secured by U. S. Treasury Obligations, 11 Rev. Financial Studies 281, 282–283 (1998)))” (page 23 of the Justice Souter’s opinion). Hence, there is recognition that overall costs of the exemption might be higher than the benefit.

The Supreme Court, however, refused to do a cost-benefit analysis because the net impact would be very difficult to evaluate. The provided costs of the exemption, however, mostly impact out-of-state entities. “First, it harms out-of-state issuers (i.e., other States and their subdivisions) by blocking their access to investment dollars in Kentucky. Second, it similarly harms out-of-state private sellers (e.g., underwriters, individuals, and investment funds) who wish to sell their bonds in Kentucky. Third, it harms the national municipal bond market and its participants by distorting and impeding the free flow of capital” (page 25 of the Justice Souter’s opinion). The costs that impact in-state entities are: “Fourth, it harms Kentucky investors by promoting risky, high-cost investment vehicles. Fifth, it harms the States by compelling them to enact competing discriminatory laws that decrease their net revenues” (page 25 of the Justice Souter’s opinion). However, there is no reference to particular channels through which the exemption decrease states’ net revenues.

The potential negative consequences of the tax exemption on free markets and flow of capital was recognized in Justice Kennedy’s dissent with the Court decision. While three is no direct reference to the potential negative externality of concentrated clientele, he does note that the local protectionist laws “may allow the market, though necessarily distorted by deviation from essential constitutional principles, to continue to cope in a more or less efficient manner; and the damage likely will be limited to the discrete, and now distorted, market for state and municipal bonds. Many economists likely will find it unfortunate, and inefficient, that a specialized business has emerged to profit from a departure from constitutional principles” (page 2 of the Justice Kennedy’s opinion).

In the concluding remarks, the Court states that given “[T]he fact that the system has been in force for a very longtime is of itself a strong reason . . . for leaving any improvement that may be desired to the legislature” (page 27 of the Justice Souter’s opinion).

Table IA.I

State-Level Averages of Bond Yields and Other Macro Variables

This table presents summary statistics on municipal bond yields and other state-level macroeconomic variables. Only 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve, are included. States are sorted into quintiles by the average privilege, calculated from the highest state income tax rate and the applicable exemption rule. Credit ratings are from S&P. Municipal bond yields are estimated using Nelson-Siegel model to fit MSRB transaction prices (details in the note below). Spread is the difference between bond yield and constant maturity Treasury yields from FRED. Equity return is return on value-weighted portfolio of firms headquartered in each state (average number of firms is 73, with the maximum of 666 in CA and the minimum of 3 in ND). CDS spread is from Bloomberg for a generic 10-year contract. Yields, spreads and equity returns are reported as averages of weekly data. State unemployment rates are from Bureau of Labor Statistics. Non-tradable employment is the percentage of employment in the non-tradable and construction sectors, calculated using Census Bureau's County Business Patterns data and Mian and Sufi (2014)'s industry classification. Per-capita volunteer hours (2002-2014) are from Current Population Survey (CPS) conducted by Bureau of Labor Statistics. Per-capita volunteer hours in 1998-2001 are assumed to equal those in 2002. All macroeconomic variables are reported as averages of annual data. Net issuance is calculated as annualized weekly sum of individual bond issuance, excluding issuance for refunding of existing bonds, from SDC Platinum. Trading volume (number of trades) is calculated as annualized weekly sum of dollar value (number) of trades in bonds issued by each state, as reported by MSRB. Numbers of close elections are the total numbers of close gubernatorial, state house, and state senate elections during the period from 1998 to 2014. Each race is considered close if the vote difference between the winner and loser is 5% or less. For state house or senate with several seats being elected, the overall race is close if the number of close races is enough to overturn the majority. The election data are from Wikipedia and klarnerpolitics.org. Tests of difference in mean between the top and bottom privilege quintiles are conducted using standard errors clustered by calendar year or year-month, depending on observation frequency. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	Credit Rating														
State	Worst	Best	10-Yr Yield (%)	10-Yr Spread (%)	Unemp. Rate (%)	Non-Trad. Emp.	Per Cap Volun. Hours	Equity Return (%)	10-Yr CDS (%)	Net Iss./ Income (%)	Par Vol./ Debt (%)	# of Trades ('000)	Close Guber. Elec.	Close House Elec.	Close Senate Elec.
Top Privilege Quintile (States with Highest Average State Tax Privilege)															
CA	BBB	AA-	4.30	0.29	7.24	0.28	34.04	1.01	2.03	2.06	193.66	460	0	1	1
OR	AA-	AA+	4.08	0.06	7.08	0.33	45.70	1.11		1.68	100.47	45	0	6	3
HI	AA-	AA	4.26	0.25	4.31	0.35	36.46	0.75		0.62	96.37	15	0	0	0
VT	AA+	AA+	4.19	0.16	3.94	0.32	46.16	2.37		0.81	207.37	7	0	5	5
RI	AA-	AA	4.23	0.22	6.44	0.27	27.64	0.94		1.62	107.86	14	0	0	1
MT	AA-	AA	4.25	0.22	5.26	0.40	36.29	0.81		0.81	93.00	9	0	4	1
ME	AA-	AA+	4.04	0.02	5.39	0.31	40.25	1.33		1.50	87.01	15	0	5	6
NJ	A+	AA+	4.08	0.07	5.79	0.24	31.59	0.68	1.58	1.92	139.78	171	0	3	1
MN	AA+	AAA	4.03	0.01	4.65	0.26	41.30	0.88	0.77	2.10	95.36	69	0	4	2
Average			4.16	0.15	5.56	0.31	37.71	1.10	1.46	1.46	124.54	89			

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Table IA.I *-continued*

State	Credit Rating Worst	Credit Rating Best	10-Yr Yield (%)	10-Yr Spread (%)	Unemp. Rate (%)	Non-Trad. Emp.	Per Cap Volun. Hours	Equity Return (%)	10-Yr CDS (%)	Net Iss./ Income (%)	Par Vol./ Debt (%)	# of Trades ('000)	Close Guber. Elec.	Close House Elec.	Close Senate Elec.
Second Privilege Quintile															
NC	AAA	AAA	4.09	0.08	6.31	0.30	32.67	0.68		1.25	164.83	66	0	4	1
ID	AA	AA+	4.25	0.22	5.72	0.37	54.62	1.14		1.13	152.80	9	0	0	0
NY	AA	AA	4.13	0.12	6.06	0.24	28.55	0.64	1.43	3.06	199.40	421	0	0	2
AR	AA	AA	4.21	0.19	5.91	0.28	32.31	0.98		1.25	72.32	21	0	2	5
SC	AA+	AAA	4.17	0.15	6.91	0.32	34.06	0.49		1.65	125.70	43	0	0	1
NE	AA+	AAA	4.14	0.13	3.40	0.28	45.43	1.13		1.81	126.42	27	0	0	0
OH	AA+	AA+	4.13	0.11	6.10	0.26	32.28	0.64		1.79	136.77	93	0	2	0
WV	AA-	AA	4.46	0.44	5.76	0.32	33.15	0.92		0.74	79.55	7	0	5	0
NM	AA+	AA+	4.04	0.02	5.42	0.36	38.18	0.78		1.90	132.25	16	0	2	0
DE	AAA	AAA	4.13	0.10	4.69	0.29	33.66	0.63		0.73	180.96	9	0	0	0
Average			4.17	0.16	5.63	0.30	36.49	0.80	1.43	1.53	137.10	71			
Third Privilege Quintile															
KS	AA+	AA+	4.10	0.08	4.57	0.28	40.00	0.78	0.00	2.06	100.70	38	0	0	0
ND	AA-	AAA	4.18	0.15	3.32	0.33	29.91	0.85		1.22	96.35	7	0	3	0
GA	AAA	AAA	4.17	0.16	6.13	0.29	33.21	0.79		1.38	187.48	58	0	0	2
KY	AA-	AA	4.15	0.14	6.18	0.30	30.04	0.98		1.58	106.71	40	0	0	1
LA	A	AA	4.29	0.28	5.73	0.32	29.62	0.39		1.44	153.92	35	0	0	0
MO	AAA	AAA	4.24	0.22	5.69	0.28	36.29	0.96		1.55	172.74	61	0	3	0
TN	AA	AA+	4.15	0.14	6.05	0.28	27.16	0.88		1.17	187.61	41	0	2	2
VA	AAA	AAA	4.05	0.04	4.19	0.31	39.89	0.51	0.67	1.36	112.04	72	0	1	1
MA	AA-	AA+	4.01	-0.01	5.14	0.24	29.68	0.76	1.15	2.24	191.48	99	0	0	0
CT	AA	AA	3.97	-0.05	5.03	0.24	35.14	0.94	1.36	1.72	190.74	67	0	0	0
Average			4.13	0.12	5.20	0.29	33.09	0.78	0.79	1.57	149.98	52			

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Table IA.I *-continued*

State	Credit Rating Worst	Credit Rating Best	10-Yr Yield (%)	10-Yr Spread (%)	Unemp. Rate (%)	Non-Trad. Emp.	Per Cap Volun. Hours	Equity Return (%)	10-Yr CDS (%)	Net Iss./ Income (%)	Par Vol./ Debt (%)	# of Trades ('000)	Close Guber. Elec.	Close House Elec.	Close Senate Elec.
Fourth Privilege Quintile															
MD	AAA	AAA	3.95	-0.07	4.76	0.31	43.51	0.80	0.77	1.49	116.37	58	0	0	0
AL	AA	AA	4.23	0.21	6.04	0.32	33.47	0.42		1.34	175.45	38	0	0	0
MS	AA	AA	4.28	0.25	7.18	0.34	31.14	0.05		1.26	232.14	16	0	0	1
NH	AA	AA+	4.10	0.09	3.95	0.31	34.76	1.37		1.22	153.39	12	0	7	4
AZ	AA-	AA	4.16	0.15	5.95	0.32	33.38	1.07		1.79	125.60	71	0	3	1
CO	AA-	AA	4.13	0.12	5.29	0.31	39.10	0.81		1.76	151.96	50	0	4	4
MI	AA-	AAA	4.28	0.27	7.12	0.27	35.64	0.57	1.64	1.14	131.67	101	0	4	1
UT	AAA	AAA	4.07	0.06	4.34	0.30	85.96	0.62		1.40	171.71	16	0	0	0
PA	AA	AA	4.14	0.13	5.46	0.26	35.59	0.73	1.16	1.65	134.61	162	0	4	0
FL	AA+	AAA	4.23	0.21	5.84	0.28	32.17	0.81	1.22	1.64	130.61	190	0	0	0
Average			4.16	0.14	5.59	0.30	40.47	0.73	1.20	1.47	152.35	71			
Bottom Privilege Quintile (States with Lowest Average State Tax Privilege)															
IN	AA	AAA	4.27	0.26	5.95	0.28	35.79	0.79		1.67	158.20	44	0	5	0
AK	AA	AAA	4.21	0.19	7.09	0.34	52.24	0.91		1.33	244.81	10	0	0	3
DC	AAA	AAA	4.41	0.39	7.15	0.15	41.54	0.10		0.86	239.84	12	0	0	0
IA	AA+	AAA	4.10	0.08	4.38	0.27	39.23	0.99		1.87	164.02	27	0	5	3
IL	A-	AA	4.40	0.39	6.57	0.24	32.18	0.74	2.27	1.55	148.07	113	0	0	1
NV	AA	AA+	4.33	0.32	6.91	0.30	29.07	1.19	1.48	1.27	145.03	23	0	1	4
OK	AA	AA+	4.15	0.13	4.56	0.29	35.91	1.09		1.69	106.36	22	0	1	1
TX	AA	AAA	4.20	0.19	5.42	0.29	35.59	0.67	0.82	2.05	164.03	239	0	2	2
WA	AA	AA+	4.15	0.13	6.65	0.31	46.98	1.00	0.90	1.61	119.06	67	0	4	4
WI	AA-	AA	4.15	0.14	5.20	0.26	36.31	0.88	0.99	1.87	100.28	47	0	2	6
Average			4.24	0.22	5.99	0.27	38.48	0.84	1.29	1.58	158.97	60			
Top - Bottom			-0.08***	-0.08***	-0.43***	0.03	-0.77	0.26	0.17	-0.12**	-34.43***	29***			

Fitting the Nelson-Siegel Model to MSRB Transaction Data: We estimate, for each state-week, the parameters – β_1, β_2, β_3, and λ – of the following Nelson-Siegel model:

$$y(t) = \beta_1 + \beta_2\left[\frac{1 - e^{-t/\lambda}}{t/\lambda}\right] + \beta_3\left[\frac{1 - e^{-t/\lambda}}{t/\lambda} - e^{-t/\lambda}\right]$$

by minimizing the mean squared errors of yield, $y(t)$, using all qualified transactions within a week on tax-exempt bonds issued by all agencies in the state (t denotes years to maturity of the bond). We operate at the weekly frequency to minimize the impact of noise from relatively few daily transactions in some small states. We include both general obligations and revenue bonds that meet the following criteria. First, the bonds have fixed coupon rates. Second, the bonds do not have sinking fund provisions or are not puttable. Third, the bonds have maturities between half a year and forty years, and are not within three months from being called or redeemed. Fourth, the bonds are not within one year from default. Finally, we remove transactions with implied yields in the 10% tails in each calendar year, as our goal is to get the yield estimates that are representative of the market in each week for senior unsecured municipal bonds issued by each particular state.

Table IA.II

State-Level Averages of Characteristics of Bonds Used in Yield Estimations

This table presents summary statistics on characteristics of bonds whose transactions are used to fit the yield curves (Nelson-Siegel model). Only 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve, are included. States are sorted into quintiles by the (time-series) average of state tax privilege, calculated from the highest state income tax rate and the applicable exemption rule. Bond characteristics are first averaged across all bonds used to fit the state-level yield curve in each week, and then averaged across all weeks in the sample period. Years to maturity is the number of years from each transaction date to the maturity date of the bond. Years to call is the number of years from each transaction date to the next call date of the bond. Effective years to maturity is the years to maturity or years to call, whichever implies the lower yield for a given transaction price. Coupon is coupon rate of the bond as a percentage of par value. Issue size is the original offering amount of the bond. Age is the number of years from the offering date to the date of each transaction. General obligations fraction is the fraction of bonds that are general obligations bonds. Callable fraction is the fraction of bonds that are callable. Insured fraction is the fraction of bonds that are insured (by insurance companies). Bank qualified fraction is the fraction of bonds whose interest payments are tax-exempt for banks. Tests of difference in mean between the top and bottom privilege quintiles are conducted using standard errors clustered by year-month. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

State	Privilege (%)	Years to Maturity	Years to Call	Effective Years to Maturity	Coupon	Issue Size ($ Million)	Age (Years)	General Obligations Fraction	Callable Fraction	Insured Fraction	Bank Qualified Fraction
Top Privilege Quintile (States with Highest Average State Tax Privilege)											
CA	10.21	11.52	6.44	9.53	4.54	54.20	2.96	0.39	0.63	0.63	0.04
OR	9.51	10.61	7.21	8.57	4.31	7.39	2.10	0.45	0.59	0.47	0.09
HI	9.35	11.83	6.60	8.89	4.72	21.54	3.62	0.58	0.60	0.65	0.00
VT	9.33	11.68	6.92	9.12	4.36	8.24	2.71	0.38	0.58	0.41	0.01
RI	9.06	9.37	6.56	7.77	4.39	3.40	2.95	0.32	0.52	0.62	0.06
MT	8.83	11.88	6.24	9.29	4.43	23.67	2.74	0.31	0.68	0.41	0.23
ME	8.24	9.37	7.32	8.08	4.15	5.02	2.11	0.37	0.48	0.40	0.13
NJ	8.16	11.31	7.19	9.39	4.38	17.76	2.51	0.49	0.58	0.59	0.12
MN	7.99	9.89	6.60	8.32	4.13	3.92	2.04	0.61	0.59	0.31	0.24
Average	8.97	10.83	6.79	8.77	4.38	16.13	2.64	0.43	0.58	0.50	0.10

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Table IA.II *-continued*

State	Privilege (%)	Years to Maturity	Years to Call	Effective Years to Maturity	Coupon	Issue Size ($ Million)	Age (Years)	General Obligations Fraction	Callable Fraction	Insured Fraction	Bank Qualified Fraction
Second Privilege Quintile											
NC	7.83	11.34	7.00	9.27	4.38	15.37	2.46	0.40	0.62	0.32	0.02
ID	7.82	10.79	6.15	8.93	4.41	6.45	2.63	0.38	0.57	0.43	0.16
NY	7.72	12.24	6.88	9.63	4.45	26.50	2.54	0.44	0.63	0.49	0.05
AR	7.00	11.16	5.25	9.03	4.20	6.10	1.87	0.41	0.68	0.35	0.20
SC	7.00	11.45	6.85	9.30	4.42	7.52	2.61	0.40	0.67	0.49	0.06
NE	6.78	10.94	5.72	9.17	4.13	6.42	1.56	0.38	0.69	0.27	0.35
OH	6.72	10.01	6.96	8.32	4.31	7.26	2.40	0.49	0.50	0.48	0.12
WV	6.50	11.09	5.91	9.07	4.64	13.20	3.71	0.20	0.55	0.54	0.06
NM	6.44	9.90	5.95	8.30	4.28	10.26	2.36	0.32	0.57	0.45	0.13
DE	6.34	11.58	6.53	8.66	4.42	10.14	2.70	0.43	0.69	0.40	0.02
Average	6.92	11.02	6.25	8.94	4.36	10.92	2.49	0.39	0.62	0.42	0.12
Third Privilege Quintile											
KS	6.26	10.34	6.43	8.53	4.19	5.16	2.03	0.44	0.63	0.41	0.20
ND	6.24	9.31	6.43	7.97	4.11	2.15	1.79	0.21	0.55	0.41	0.19
GA	6.00	11.39	6.66	9.45	4.47	12.90	2.84	0.23	0.59	0.42	0.04
KY	6.00	10.50	7.24	8.87	4.21	8.97	2.41	0.08	0.57	0.43	0.18
LA	6.00	11.91	6.47	9.83	4.57	53.23	2.75	0.34	0.65	0.69	0.09
MO	6.00	11.63	6.16	9.54	4.35	6.67	2.45	0.25	0.65	0.41	0.18
TN	6.00	10.82	6.94	9.06	4.36	11.47	2.41	0.45	0.60	0.39	0.09
VA	5.75	11.10	7.11	9.17	4.34	6.05	2.24	0.37	0.64	0.20	0.01
MA	5.47	10.53	7.17	8.78	4.31	13.73	2.43	0.60	0.53	0.45	0.10
CT	5.39	10.57	6.88	8.57	4.21	10.88	2.26	0.67	0.58	0.39	0.08
Average	5.87	10.86	6.78	9.02	4.31	13.12	2.36	0.36	0.60	0.42	0.12

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Table IA.II *-continued*

State	Privilege (%)	Years to Maturity	Years to Call	Effective Years to Maturity	Coupon	Issue Size ($ Million)	Age (Years)	General Obligations Fraction	Callable Fraction	Insured Fraction	Bank Qualified Fraction
Fourth Privilege Quintile											
MD	5.28	10.88	7.18	8.76	4.27	9.35	2.42	0.54	0.65	0.19	0.01
AL	5.00	11.51	6.77	9.48	4.37	6.43	2.46	0.31	0.65	0.62	0.14
MS	5.00	10.87	6.37	9.27	4.45	13.50	2.90	0.40	0.59	0.50	0.15
NH	5.00	11.10	6.95	9.25	4.35	5.43	2.66	0.53	0.54	0.43	0.11
AZ	4.82	11.06	6.71	8.93	4.50	10.82	2.78	0.38	0.61	0.58	0.04
CO	4.70	10.91	7.21	8.94	4.40	9.93	2.54	0.30	0.55	0.61	0.09
MI	4.21	10.23	6.35	8.48	4.48	7.63	3.01	0.57	0.58	0.61	0.14
UT	4.12	9.47	6.81	8.03	4.31	6.48	2.70	0.38	0.50	0.40	0.12
PA	2.97	10.70	6.19	8.90	4.23	9.03	2.58	0.53	0.64	0.76	0.22
FL	1.19	11.56	6.50	9.41	4.47	13.23	2.95	0.10	0.66	0.72	0.01
Average	4.11	10.82	6.65	8.97	4.38	9.18	2.70	0.40	0.60	0.54	0.10
Bottom Privilege Quintile (States with Lowest Average State Tax Privilege)											
IN	0.60	9.95	6.06	8.56	4.34	8.06	2.54	0.06	0.46	0.56	0.13
AK	0.00	9.94	6.57	8.09	4.44	6.58	2.67	0.45	0.52	0.67	0.02
DC	0.00	11.97	6.59	8.85	4.88	15.46	3.51	0.30	0.61	0.76	0.00
IA	0.00	9.89	6.47	8.48	4.12	6.38	1.57	0.42	0.60	0.29	0.28
IL	0.00	10.35	6.45	8.61	4.61	16.53	2.94	0.59	0.52	0.63	0.14
NV	0.00	11.47	6.49	8.91	4.68	12.39	2.79	0.40	0.66	0.65	0.03
OK	0.00	9.41	6.77	8.01	4.22	7.11	2.44	0.22	0.48	0.50	0.08
TX	0.00	11.60	7.21	9.17	4.44	18.72	2.50	0.54	0.64	0.44	0.12
WA	0.00	10.89	7.08	8.63	4.47	8.64	2.90	0.49	0.58	0.54	0.09
WI	0.00	8.65	6.77	7.51	4.19	4.70	2.01	0.62	0.46	0.40	0.25
Average	0.06	10.41	6.65	8.48	4.44	10.46	2.59	0.41	0.55	0.55	0.11
Top - Bottom	8.91***	0.41	0.14	0.29	-0.06	5.67	0.05	0.02	0.03	-0.05	-0.01

Table IA.III

Comparison between Nelson-Siegel and Bloomberg Estimates of Municipal Bond Yield Spreads

This table reports summary statistics for (i) estimated municipal bond yield spreads obtained by fitting Nelson-Siegel model to MSRB transaction prices (available for 49 states), (ii) estimated municipal bond yield spreads obtained from Bloomberg Fair Value Curves (only available for 21 states), and (iii) differences and correlations between (i) and (ii). Observations are state-weeks. The sample period is from 1998 to 2014. States are sorted into quintiles by the (time-series) average of state tax privilege, calculated from the highest state income tax rate and the applicable exemption rule. Spread is the difference between bond yield and constant maturity Treasury yields from FRED, both at the 10-year maturity. Tests of difference in mean between the top and bottom privilege quintiles are conducted using standard errors clustered by calendar year-month. $*$, $**$, and $***$ refer to statistical significance at 10%, 5%, and 1% levels.

		N-S Spreads [A]		Bloomberg Spreads [B]		Difference [A] - [B]		Correlation of [A] and [B]	
State	Privilege (%)	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Level	Change
Top Privilege Quintile (States with Highest Average State Tax Privilege)									
CA	10.21	0.29	0.95	0.06	0.84	0.24	0.23	0.97	0.69
OR	9.51	0.06	0.70						
HI	9.35	0.25	0.83						
VT	9.33	0.16	0.82						
RI	9.06	0.22	0.84						
MT	8.83	0.22	0.76						
ME	8.24	0.02	0.66						
NJ	8.16	0.07	0.73	-0.24	0.61	0.30	0.30	0.97	0.66
MN	7.99	0.01	0.58	-0.36	0.50	0.37	0.36	0.95	0.50
Average	8.97	0.15	0.76	-0.18	0.65	0.30	0.30	0.96	0.61
Second Privilege Quintile									
NC	7.83	0.08	0.72	-0.40	0.48	0.47	0.47	0.95	0.52
ID	7.82	0.22	0.81						
NY	7.72	0.12	0.73	-0.19	0.54	0.31	0.31	0.96	0.70
AR	7.00	0.19	0.67						
SC	7.00	0.15	0.75	-0.36	0.49	0.52	0.51	0.95	0.46
NE	6.78	0.13	0.64						
OH	6.72	0.11	0.78	-0.27	0.55	0.39	0.38	0.97	0.53
WV	6.50	0.44	0.82						
NM	6.44	0.02	0.63						
DE	6.34	0.10	0.77						
Average	6.92	0.16	0.73	-0.31	0.52	0.42	0.42	0.96	0.55

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Table IA.III *-continued*

State	Privilege (%)	N-S Spreads [A] Mean	N-S Spreads [A] Std. Dev.	Bloomberg Spreads [B] Mean	Bloomberg Spreads [B] Std. Dev.	Difference [A] - [B] Mean	Difference [A] - [B] Std. Dev.	Correlation of [A] and [B] Level	Correlation of [A] and [B] Change
Third Privilege Quintile									
KS	6.26	0.08	0.65						
ND	6.24	0.15	0.66						
GA	6.00	0.16	0.77	-0.39	0.48	0.55	0.55	0.95	0.51
KY	6.00	0.14	0.75						
LA	6.00	0.28	0.83						
MO	6.00	0.22	0.78						
TN	6.00	0.14	0.72	-0.13	0.45	0.27	0.58	0.92	0.50
VA	5.75	0.04	0.66	-0.40	0.48	0.44	0.43	0.96	0.51
MA	5.47	-0.01	0.70	-0.27	0.53	0.26	0.25	0.97	0.63
CT	5.39	-0.05	0.69	-0.30	0.54	0.25	0.24	0.97	0.45
Average	5.87	0.12	0.73	-0.30	0.50	0.35	0.41	0.95	0.52
Fourth Privilege Quintile									
MD	5.28	-0.07	0.65	-0.37	0.53	0.31	0.30	0.96	0.51
AL	5.00	0.21	0.75						
MS	5.00	0.25	0.76						
NH	5.00	0.09	0.71						
AZ	4.82	0.15	0.81						
CO	4.70	0.12	0.75						
MI	4.21	0.27	0.89	-0.06	0.74	0.33	0.33	0.98	0.56
UT	4.12	0.06	0.66						
PA	2.97	0.13	0.74	-0.17	0.63	0.30	0.30	0.96	0.64
FL	1.19	0.21	0.87	-0.17	0.64	0.38	0.38	0.98	0.63
Average	4.11	0.16	0.77	-0.20	0.63	0.33	0.33	0.97	0.58
Bottom Privilege Quintile (States with Lowest Average State Tax Privilege)									
IN	0.60	0.26	0.79						
AK	0.00	0.19	0.73						
DC	0.00	0.39	0.86	-0.01	0.67	0.40	0.40	0.95	0.38
IA	0.00	0.08	0.63						
IL	0.00	0.39	0.94	0.12	0.95	0.26	0.26	0.96	0.51
NV	0.00	0.32	0.86						
OK	0.00	0.13	0.66						
TX	0.00	0.19	0.69	-0.18	0.56	0.37	0.36	0.97	0.70
WA	0.00	0.13	0.69	-0.23	0.49	0.37	0.37	0.97	0.60
WI	0.00	0.14	0.66	-0.22	0.53	0.35	0.35	0.96	0.52
Average	0.06	0.22	0.75	-0.10	0.64	0.35	0.35	0.96	0.54
Q1 – Q5	8.91***	-0.08***		-0.07***		-0.05			

Table IA.IV

Pricing of Local Risk Based on Close Election– Robustness Checks Using Different Risk Measures and Subsamples

(Supplement to Results in Table IV)

This table reports results from OLS and IV-2SLS panel regressions of municipal bond yield spreads on close election dummy and its interactions with state fund holdings (SFH). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices and constant maturity Treasury yield from FRED, both at the 10-year maturity. Three different samples are used: (i) 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve ("full sample" in columns (1)-(4) and (7)-(10)), (ii) 37 states with at least \$10 billion in outstanding debt (averaged over 1998-2014) ("excluding debt < \$10 billion" in columns (5) and (11)), and (iii) 41 states where privilege is not zero (intensive margin) ("excluding no privilege" in columns (6) and (12)). Close election dummy equals one for the three-month period before the election in November for at least one of the three state-level election is close (columns (5), (6), (11), and (12)), at least two out of three state-level elections are close (columns (1) and (7)), or the gubernatorial (columns (2) and (8)), state house (columns (3) and (9)), or state senate (columns (4) and (10)) election is close. Each race is considered close if the vote difference between the winner and loser is 5% or less. For state house or senate with several seats being elected, the overall race is close if the number of close races is enough to overturn the majority. In columns (7) – (12), SFH is instrumented by state income tax rate in 1947 and only the second-stage estimates are reported. All control variables are defined in Tables IV of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	OLS						IV-2SLS (2nd Stage)					
Def. of ***Close Election***:	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)
Sample Criteria	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < \$10 Bil.	Excl. No Privilege	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < \$10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Main Variables												
Close election	0.012	0.010	0.050	0.084**	0.026	0.029*	-0.048	-0.081	-0.027	-0.020	-0.025	-0.050
	(0.031)	(0.027)	(0.046)	(0.034)	(0.016)	(0.017)	(0.038)	(0.052)	(0.054)	(0.043)	(0.025)	(0.037)
SFH	-0.198***	-0.202***	-0.196***	-0.195***	-0.229***	-0.123***	-0.473***	-0.440***	-0.455***	-0.467***	-0.174***	-0.356***
	(0.014)	(0.013)	(0.014)	(0.013)	(0.007)	(0.008)	(0.078)	(0.075)	(0.076)	(0.079)	(0.029)	(0.064)
Close election x SFH	0.130*	0.195***	0.030	0.113**	0.070**	0.097**	0.814***	0.559***	0.332*	0.415***	0.247***	0.308***
	(0.069)	(0.066)	(0.054)	(0.048)	(0.033)	(0.044)	(0.176)	(0.169)	(0.175)	(0.139)	(0.081)	(0.091)
Close election x Debt/Income	-1.331***	0.502	-0.710	0.520	-0.237	0.251						
	(0.390)	(0.567)	(0.465)	(0.327)	(0.292)	(0.194)						
Debt/Income x SFH	-0.150*	-0.126	-0.146	-0.119	-0.124	-0.157						
	(0.090)	(0.089)	(0.091)	(0.088)	(0.101)	(0.098)						
Close election x Debt/Income x SFH	1.661***	0.834**	1.108***	0.953**	0.974**	1.101**						
	(0.627)	(0.420)	(0.414)	(0.482)	(0.467)	(0.556)						

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Table IA.IV *-continued*

	OLS						IV-2SLS (2nd Stage)					
Def. of ***Close Election***:	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)
Sample Criteria	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Control Variables												
Debt/Income	-0.091	-0.102	-0.086	-0.119	0.184***	-0.016	-0.116	-0.117	-0.115	-0.124	-0.195***	-0.067**
	(0.094)	(0.094)	(0.094)	(0.094)	(0.053)	(0.036)	(0.083)	(0.082)	(0.082)	(0.083)	(0.036)	(0.026)
All fund t holding/Deb	0.276	0.263	0.271	0.278	-0.313	0.215	0.403	0.446*	0.495*	0.425	-0.332	0.178
	(0.176)	(0.176)	(0.175)	(0.177)	(0.271)	(0.158)	(0.257)	(0.256)	(0.257)	(0.258)	(0.259)	(0.122)
Term spread	-0.152**	-0.151**	-0.152**	-0.150**	-0.218**	-0.234**	-0.155**	-0.154**	-0.154**	-0.154**	-0.217**	-0.234**
	(0.061)	(0.061)	(0.061)	(0.061)	(0.092)	(0.093)	(0.061)	(0.061)	(0.061)	(0.061)	(0.091)	(0.093)
Market equity return	-0.247	-0.256	-0.238	-0.243	-0.350	-0.383	-0.189	-0.215	-0.177	-0.201	-0.390	-0.363
	(1.056)	(1.056)	(1.052)	(1.053)	(0.769)	(0.775)	(1.056)	(1.049)	(1.053)	(1.052)	(0.758)	(0.771)
State equity return	-0.157	-0.158	-0.158	-0.159	0.147	0.114	-0.156	-0.157	-0.159	-0.157	0.149	0.109
	(0.190)	(0.190)	(0.190)	(0.190)	(0.104)	(0.082)	(0.190)	(0.189)	(0.189)	(0.189)	(0.104)	(0.082)
Unemployment rate	0.024***	0.023***	0.023***	0.023***	0.032***	0.020***	0.018***	0.019***	0.019***	0.019***	0.034***	0.016***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(Trading volume/Debt)	-0.044*	-0.044*	-0.045*	-0.044*	0.002	-0.002	-0.075***	-0.070***	-0.072***	-0.074***	0.002	-0.030***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.009)	(0.008)	(0.023)	(0.023)	(0.023)	(0.023)	(0.009)	(0.010)
ln(# of trades)	-0.015***	-0.015***	-0.015***	-0.015***	-0.018**	0.008	-0.001	-0.003	-0.002	-0.002	-0.015*	0.012
	(0.005)	(0.005)	(0.005)	(0.005)	(0.009)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)	(0.009)	(0.008)
Proactive	-0.005	-0.007	-0.004	-0.004	-0.007*	-0.010***	0.004	0.004	0.001	0.003	-0.009*	-0.010***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)

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Table IA.IV *-continued*

	OLS						IV-2SLS (2nd Stage)					
Def. of ***Close Election***:	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)	Close Majority	Close Guber.	Close House	Close Senate	Close ≥ 1 (Baseline)	Close ≥ 1 (Baseline)
Sample Criteria	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Full Sample	Full Sample	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Average Characteristics of Bonds used in Estimations												
ln(Issue size)	0.017	0.017	0.017	0.017	0.016	0.019	0.011	0.012	0.011	0.011	0.020	0.014
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)
ln(Age)	0.177***	0.176***	0.176***	0.176***	0.159***	0.228***	0.186***	0.184***	0.185***	0.186***	0.169***	0.236***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.014)	(0.014)	(0.016)	(0.016)	(0.016)	(0.016)	(0.014)	(0.014)
GO fraction	-0.251***	-0.252***	-0.249***	-0.251***	-0.255***	-0.288***	-0.227***	-0.232***	-0.228***	-0.226***	-0.236***	-0.273***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.012)	(0.013)	(0.015)	(0.015)	(0.015)	(0.015)	(0.012)	(0.013)
Callable fraction	0.302***	0.303***	0.304***	0.304***	0.338***	0.327***	0.337***	0.336***	0.339***	0.341***	0.330***	0.308***
	(0.030)	(0.030)	(0.029)	(0.029)	(0.020)	(0.019)	(0.031)	(0.031)	(0.031)	(0.031)	(0.020)	(0.019)
Bank qualified fraction	0.020	0.018	0.017	0.021	0.124***	0.032	-0.028	-0.025	-0.027	-0.027	0.108***	0.024
	(0.044)	(0.044)	(0.044)	(0.044)	(0.021)	(0.022)	(0.039)	(0.039)	(0.039)	(0.038)	(0.020)	(0.021)
Insured fraction	-0.022	-0.022	-0.022	-0.020	-0.034**	-0.000	-0.082**	-0.073*	-0.079**	-0.080**	-0.004	-0.044**
	(0.029)	(0.029)	(0.029)	(0.029)	(0.015)	(0.015)	(0.039)	(0.039)	(0.039)	(0.039)	(0.019)	(0.021)
Credit rating x Y-M dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Kleibergen-Paap rank Wald stat.							302.2	332.2	294.1	302.7	465.5	165.3
Number of states	49	49	49	49	37	41	49	49	49	49	37	41
Observations	43,747	43,747	43,747	43,747	33,040	36,604	43,747	43,747	43,747	43,747	33,040	36,604
R-squared (total)	0.925	0.925	0.925	0.926	0.943	0.925	0.925	0.925	0.925	0.926	0.943	0.925

Table IA.V

Pricing of Local Risk Based on Realized Equity Volatility– Robustness Checks Using Different Risk Measures and Subsamples (Supplement to Results in Table V)

This table reports results from OLS and IV-2SLS panel regressions of municipal bond yield spreads on realized state equity volatility, and their interactions with state fund holdings (SFH). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices and constant maturity Treasury yield from FRED, both at the 10-year maturity. Three different samples are used: (i) 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve ("full sample" in columns (1) and (4)), (ii) 37 states with at least $10 billion in outstanding debt (averaged over 1998-2014) ("excluding debt < $10 billion" in columns (2) and (5)), and (iii) 41 states where privilege is not zero (intensive margin) ("excluding no privilege" in columns (3) and (6)). Realized state equity volatility is calculated as square root of the sum of squared daily excess state equity returns over the 5-day trading week. Two measures of excess state equity return are used: (i) state equity return minus expected return given CAPM (where the parameters are estimated on the rolling basis using monthly return data from the previous three years) ("CAPM-adj. vol" in columns (1) and (4)), and (ii) state equity return minus market equity return (baseline as defined in Table IV of the main paper) ("market adj. vol" in columns (2), (3), (5), and (6)). State equity return is value-weighted portfolio return of listed firms headquartered in the state, and market equity return is CRSP value-weighted return, including dividends. In columns (4) – (6), SFH is instrumented by state income tax rate in 1947 and only the second-stage estimates are reported. All control variables are defined in Tables II and III of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	OLS			IV-2SLS (2nd Stage)		
Measure of ***Realized Volatility***:	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Main Variables						
Realized vol.	3.377***	1.163***	2.175***	0.587	3.858***	2.899***
	(0.685)	(0.308)	(0.703)	(1.835)	(0.861)	(1.108)
SFH	-0.274***	-0.204***	-0.123***	-0.619***	0.001	-0.521***
	(0.019)	(0.010)	(0.011)	(0.129)	(0.061)	(0.094)
Realized vol. x SFH	6.062***	2.493***	4.151***	16.578***	10.036***	15.497***
	(0.851)	(0.742)	(1.006)	(6.300)	(3.089)	(4.247)
Realized vol. x Debt/Income	2.127	-2.995	-1.205			
	(2.835)	(4.377)	(1.968)			

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Table IA.V *-continued*

	OLS			IV-2SLS (2nd Stage)		
Measure of ***Realized Volatility***:	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Debt/Income x SFH	-0.017	-0.164	-0.172			
	(0.162)	(0.139)	(0.133)			
Realized vol. x Debt/Income x SFH	21.385**	30.770***	24.869**			
	(9.275)	(8.355)	(10.676)			
Control Variables						
Debt/Income	-0.242***	0.210***	-0.052	-0.036	-0.173***	0.045
	(0.083)	(0.080)	(0.067)	(0.046)	(0.042)	(0.041)
All fund holding/Debt	0.236	-0.331	0.236	0.373	-0.316	0.186
	(0.165)	(0.273)	(0.158)	(0.248)	(0.222)	(0.121)
Term spread	-0.152**	-0.216**	-0.233**	-0.153**	-0.217**	-0.230**
	(0.060)	(0.092)	(0.093)	(0.060)	(0.091)	(0.093)
Market equity return	-0.078	-0.365	-0.394	-0.078	-0.375	-0.363
	(1.052)	(0.762)	(0.768)	(1.045)	(0.749)	(0.763)
State equity return	-0.133	0.152	0.116	-0.130	0.156	0.118
	(0.183)	(0.104)	(0.082)	(0.184)	(0.104)	(0.081)
Unemployment rate	0.021***	0.032***	0.019***	0.016***	0.036***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(Trading volume/Debt)	-0.056**	0.003	-0.003	-0.073***	0.002	-0.015
	(0.023)	(0.009)	(0.008)	(0.024)	(0.009)	(0.010)
ln(# of trades)	-0.000	-0.016*	0.005	0.007	-0.014	0.009
	(0.007)	(0.009)	(0.007)	(0.007)	(0.009)	(0.008)
Proactive	-0.011*	-0.007*	-0.009***	-0.008	-0.011*	-0.010***
	(0.006)	(0.004)	(0.003)	(0.009)	(0.006)	(0.003)

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Table IA.V *-continued*

Measure of ***Realized Volatility***:	OLS			IV-2SLS (2nd Stage)		
	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)	CAPM Adj. Vol	Market Adj. Vol (Baseline)	Market Adj. Vol (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Average Characteristics of Bonds used in Estimations						
ln(Issue size)	0.017	0.016	0.019	0.012	0.020	0.014
	(0.014)	(0.013)	(0.013)	(0.015)	(0.014)	(0.014)
ln(Age)	0.180***	0.159***	0.226***	0.180***	0.169***	0.222***
	(0.017)	(0.014)	(0.013)	(0.018)	(0.015)	(0.014)
GO fraction	-0.226***	-0.257***	-0.289***	-0.217***	-0.241***	-0.263***
	(0.016)	(0.012)	(0.013)	(0.014)	(0.013)	(0.014)
Callable fraction	0.300***	0.335***	0.325***	0.333***	0.325***	0.331***
	(0.029)	(0.020)	(0.019)	(0.030)	(0.020)	(0.020)
Bank qualified fraction	0.026	0.130***	0.039*	-0.006	0.104***	0.037*
	(0.042)	(0.021)	(0.022)	(0.037)	(0.019)	(0.022)
Insured fraction	-0.019	-0.034**	0.001	-0.065*	-0.001	-0.048**
	(0.028)	(0.015)	(0.015)	(0.038)	(0.019)	(0.023)
Credit rating x Year-Month dummies	YES	YES	YES	YES	YES	YES
Kleibergen-Paap rank Wald statistic				38.7	310.4	50.5
Number of states	49	37	41	49	37	41
Observations	43,551	33,040	36,604	43,551	33,040	36,604
R-squared (total)	0.926	0.943	0.925	0.926	0.943	0.925

Table IA.VI

Price Effects of Supply Change – Robustness Checks Using Different Supply Change Measures and Subsamples

(Supplement to Results in Table VI)

This table reports results from OLS and IV-2SLS panel regressions of *change* in municipal bond yield spreads on net change in municipal bond supply and its interactions with state fund holdings (SFH). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices and constant maturity Treasury yield from FRED, both at the 10-year maturity. Three different samples are used: (i) 49 states, for which the number and span of transactions in the MSRB data are sufficient to fit the yield curve ("full sample" in columns (1) and (4)), (ii) 37 states with at least $10 billion in outstanding debt (averaged over 1998-2014) ("excluding debt < $10 billion" in columns (2) and (5)), and (iii) 41 states where privilege is not zero (intensive margin) ("excluding no privilege" in columns (3) and (6)). Two alternative measures of net change in municipal bond supply are (i) net weekly issuance (baseline), and (ii) residual from the regression of net weekly issuance on thirteen lags of itself and state dummies, both averaged over the rolling 4 weeks, annualized, and normalized by total income of state residents as reported to Internal Revenue Service. Net issuance data are from SDC Platinum (gross issuance – refunding). In IV-2SLS regressions in columns (4)-(6), SFH is instrumented by state income tax rate in 1947and only the second-stage estimates are reported. All control variables are defined in Tables II and III of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	OLS			IV-2SLS (2nd Stage)		
Measure of ***Supply Change***:	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Main Variables						
Supply change	0.148	0.060	0.192*	-0.305	-0.265	-0.265
	(0.108)	(0.103)	(0.109)	(0.222)	(0.162)	(0.260)
SFH	-0.017***	-0.015**	-0.018**	-0.011	-0.026	-0.048
	(0.004)	(0.006)	(0.007)	(0.031)	(0.018)	(0.053)
Supply change x SFH	1.271***	0.864***	0.999***	4.294***	2.654***	2.552***
	(0.284)	(0.244)	(0.267)	(0.858)	(0.515)	(0.888)
Supply change x Debt/Income	-0.109	-0.976	-0.407			
	(0.548)	(0.686)	(0.552)			
Debt/Income x SFH	-0.076	0.213***	-0.078			
	(0.049)	(0.062)	(0.053)			

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Table IA.VI *-continued*

	OLS			IV-2SLS (2nd Stage)		
Measure of ***Supply Change***:	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Supply change x Debt/Income x SFH	3.111*	4.307**	4.238***			
	(1.862)	(1.686)	(1.624)			
Control Variables						
Debt/Income	0.034*	-0.064*	0.070***	0.008	-0.068***	0.008
	(0.019)	(0.039)	(0.022)	(0.015)	(0.021)	(0.014)
All fund holding/Debt	-0.114	-0.077	-0.056	-0.128	-0.044	-0.024
	(0.131)	(0.046)	(0.036)	(0.080)	(0.052)	(0.089)
Term spread	-0.027	-0.021	-0.027	-0.027	-0.021	-0.028
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Market equity return	-4.791***	-4.419***	-4.652***	-4.816***	-4.429***	-4.652***
	(0.771)	(0.785)	(0.794)	(0.762)	(0.780)	(0.788)
State equity return	-0.028	-0.040	-0.029	-0.028	-0.038	-0.030
	(0.032)	(0.040)	(0.030)	(0.032)	(0.040)	(0.030)
Unemployment rate	-0.004***	-0.003***	-0.003***	-0.001	-0.002***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln(Trading volume/Debt)	-0.005	-0.003	-0.006	0.008	0.002	-0.007
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.006)
ln(# of trades)	0.006	0.007	0.008*	0.000	0.005	0.010
	(0.004)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)
Proactive	-0.009***	-0.005***	-0.010***	-0.005***	-0.003	-0.007***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)

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Table IA.VI *-continued*

	OLS			IV-2SLS (2nd Stage)		
Measure of ***Supply Change***:	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)	AR(13) Residual of Net Issuance	Net Issuance (Baseline)	Net Issuance (Baseline)
Sample Criteria	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege	Full Sample	Excl. Debt < $10 Bil.	Excl. No Privilege
	(1)	(2)	(3)	(4)	(5)	(6)
Average Characteristics of Bonds used in Estimations						
ln(Issue size)	0.003	0.003	0.003	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(Age)	0.086***	0.073***	0.092***	0.078***	0.066***	0.089***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
GO fraction	-0.065***	-0.040***	-0.084***	-0.070***	-0.044***	-0.079***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.005)	(0.007)
Callable fraction	0.127***	0.089***	0.150***	0.108***	0.079***	0.145***
	(0.011)	(0.010)	(0.013)	(0.011)	(0.010)	(0.014)
Bank qualified fraction	-0.026**	-0.015	-0.048***	-0.017	-0.009	-0.053***
	(0.013)	(0.012)	(0.014)	(0.012)	(0.011)	(0.013)
Insured fraction	-0.057***	-0.048***	-0.047***	-0.027**	-0.040***	-0.047***
	(0.008)	(0.006)	(0.009)	(0.012)	(0.009)	(0.014)
Credit rating x Year-Month dummies	YES	YES	YES	YES	YES	YES
Kleibergen-Paap rank Wald statistic				339.2	371.0	76.7
Number of states	49	37	41	49	37	41
Observations	40,227	30,858	34,192	40,227	30,858	34,192
R-squared (total)	0.062	0.074	0.064	0.062	0.074	0.064

Table IA.VII

Robustness Checks with CDS Spread Controls

(Supplement to Results in Tables IV-VI)

This table report robustness checks for price effects of local risk (columns (1) – (3), dependent variable = 10-year municipal bond yield spread) and supply changes (columns (4) – (5), dependent variable = change in 10-year municipal bond yield spread). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices and constant maturity Treasury yield from FRED, both at the 10-year maturity. Three measures of local risk are used. Close election dummy is defined as in Table IV of the main paper. Realized state equity volatility is defined in two ways, one using excess return over the market return (baseline, as defined in Table V of the main paper) and the other using excess return over the estimated CAPM return (as defined in Table IA.V). Two measures of supply change are used, one based on the net weekly issuance (baseline, as defined in Table VI of the main paper) and the other based on the residual from the regression of net weekly issuance on thirteen lags of itself and state dummies (as defined in Table IA.VI). CDS spread control is CDS spread level in columns (1) – (3) and CDS spread change in columns (4) – (5). CDS spread is from Bloomberg for a generic 10-year contract, and is available only for some states with varying starting dates. All control variables are defined in Tables II and III of the main paper. All models include calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Main Variables					
SFH	-0.307***	-0.345***	-0.336***	-0.000	0.016**
	(0.019)	(0.027)	(0.027)	(0.013)	(0.007)
Risk	-0.020	-0.427	-0.554		
	(0.036)	(0.579)	(0.604)		
Risk x SFH	0.172*	3.979*	3.631		
	(0.098)	(2.246)	(2.196)		
Supply change				0.008	-0.386
				(0.302)	(0.326)
Supply change x SFH				1.680**	2.246***
				(0.795)	(0.849)

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Table IA.VII *-continued*

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Control Variables					
CDS spread or	0.232***	0.231***	0.231***	0.190***	0.180***
CDS spread change	(0.014)	(0.013)	(0.013)	(0.061)	(0.060)
Debt/Income	-0.030	-0.016	-0.031	-0.068***	-0.044*
	(0.056)	(0.059)	(0.058)	(0.023)	(0.023)
All fund holding/Debt	0.151	0.181	0.172	-0.088	-0.063
	(0.141)	(0.144)	(0.148)	(0.075)	(0.074)
Term spread	-0.420***	-0.421***	-0.418***	-0.172*	-0.172*
	(0.116)	(0.115)	(0.116)	(0.095)	(0.095)
Market equity return	-1.725*	-1.707*	-1.727*	-5.306***	-5.301***
	(0.903)	(0.900)	(0.896)	(1.084)	(1.085)
State equity return	0.055	0.061	0.047	-0.087	-0.091
	(0.128)	(0.132)	(0.134)	(0.056)	(0.056)
Unemployment rate	0.046***	0.045***	0.046***	-0.003	-0.003
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)
ln(Trading volume/Debt)	0.033	0.031	0.029	-0.005	-0.001
	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)
ln(# of trades)	0.006	0.006	0.006	-0.005	-0.005
	(0.005)	(0.006)	(0.006)	(0.003)	(0.003)
Proactive	-0.043***	-0.042***	-0.042***	0.002	0.002
	(0.007)	(0.008)	(0.008)	(0.003)	(0.003)
Average Characteristics of Bonds used in Estimations					
ln(Issue size)	0.011	0.011	0.011	0.008	0.008
	(0.007)	(0.007)	(0.007)	(0.005)	(0.005)
ln(Age)	0.272***	0.266***	0.267***	0.058***	0.054***
	(0.024)	(0.025)	(0.025)	(0.019)	(0.019)
GO fraction	-0.217***	-0.219***	-0.218***	-0.073***	-0.073***
	(0.027)	(0.027)	(0.028)	(0.024)	(0.024)

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Table IA.VII *-continued*

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Callable fraction	0.156***	0.166***	0.167***	0.079**	0.079**
	(0.050)	(0.050)	(0.051)	(0.037)	(0.037)
Bank qualified fraction	0.089	0.098	0.093	0.094	0.093
	(0.063)	(0.062)	(0.063)	(0.058)	(0.057)
Insured fraction	0.021	0.027	0.025	-0.052**	-0.053**
	(0.039)	(0.039)	(0.040)	(0.024)	(0.024)
Year-Month dummies	YES	YES	YES	YES	YES
Number of states	20	20	20	20	20
Observations	5,700	5,700	5,620	5,652	5,652
R-squared (total)	0.858	0.857	0.857	0.112	0.112

Table IA.VIII

Differentiation from Price Effects of Being Proactive in Bankruptcy

(Supplement to Results in Tables IV-VI)

This table report robustness checks for price effects of local risk (columns (1) – (3), dependent variable = 10-year municipal bond yield spread) and supply changes (columns (4) – (5), dependent variable = change in 10-year municipal bond yield spread). Observations are state-weeks. Yield spread is the difference between municipal bond yield estimated from MSRB transaction prices and constant maturity Treasury yield from FRED, both at the 10-year maturity. Three measures of local risk are used. Close election dummy is defined as in Table IV of the main paper. Realized state equity volatility is defined in two ways, one using excess return over the market return (baseline, as defined in Table V of the main paper) and the other using excess return over the estimated CAPM return (as defined in Table IA.V). Two measures of net change in municipal bond supply are used, one based on the net weekly issuance (baseline, as defined in Table VI of the main paper) and the other based on the residual from the regression of net weekly issuance on thirteen lags of itself and state dummies (as defined in Table IA.VI). Proactive is a dummy variable that equals one if the state is classified by Gao, Lee, and Murphy (2019) as being "proactive" in the bankruptcy of their agencies and municipalities, and zero otherwise. All control variables are defined in Tables II and III of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Main Variables					
SFH	-0.165***	-0.193***	-0.198***	-0.020***	-0.006
	(0.016)	(0.009)	(0.009)	(0.006)	(0.004)
Risk	0.042*	2.833***	2.922***		
	(0.025)	(0.767)	(0.776)		
Risk x SFH	0.096**	3.897***	4.178***		
	(0.048)	(0.904)	(0.927)		
Supply change				0.075***	0.002
				(0.019)	(0.023)
Supply change x SFH				0.783***	0.974***
				(0.192)	(0.197)
Proactive State Controls					
Proactive	-0.005	-0.010	-0.010	-0.010***	-0.008***
	(0.004)	(0.007)	(0.007)	(0.002)	(0.001)
Risk x Proactive	-0.045*	-0.412	-0.494		
	(0.027)	(0.309)	(0.332)		
Supply change x Proactive				-0.029	-0.015
				(0.021)	(0.027)

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Table IA.VIII *-continued*

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Other Control Variables					
Debt/Income	-0.110***	-0.105***	-0.106***	0.006	0.015
	(0.023)	(0.023)	(0.023)	(0.014)	(0.014)
All fund holding/Debt	0.013	0.036	0.040	-0.039	-0.041
	(0.053)	(0.053)	(0.053)	(0.030)	(0.031)
Term spread	-0.230**	-0.230**	-0.231**	-0.027	-0.027
	(0.092)	(0.092)	(0.092)	(0.019)	(0.019)
Market equity return	-0.579	-0.537	-0.557	-4.704***	-4.788***
	(0.770)	(0.758)	(0.764)	(0.765)	(0.772)
State equity return	0.130	0.132	0.127	-0.028	-0.028
	(0.085)	(0.085)	(0.085)	(0.031)	(0.032)
Unemployment rate	0.024***	0.023***	0.023***	-0.004***	-0.004***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
ln(Trading volume/Debt)	-0.002	-0.006	-0.007	-0.006	-0.005
	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)
ln(# of trades)	-0.012***	-0.007***	-0.007***	0.005	0.007
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Debt/Income	-0.110***	-0.105***	-0.106***	0.006	0.015
	(0.023)	(0.023)	(0.023)	(0.014)	(0.014)
Average Characteristics of Bonds used in Estimations					
ln(Issue size)	0.020	0.020	0.019	0.003	0.003
	(0.013)	(0.013)	(0.013)	(0.002)	(0.002)
ln(Age)	0.204***	0.206***	0.206***	0.090***	0.086***
	(0.010)	(0.010)	(0.010)	(0.007)	(0.007)
GO fraction	-0.250***	-0.246***	-0.244***	-0.060***	-0.064***
	(0.012)	(0.012)	(0.011)	(0.006)	(0.006)
Callable fraction	0.287***	0.286***	0.285***	0.128***	0.127***
	(0.017)	(0.017)	(0.017)	(0.011)	(0.011)

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Table IA.VIII *-continued*

Dependent Variable:	Spread10Y			ΔSpread10Y	
Main Explanatory Variable:	Local Risk Proxied By:			Supply Change Proxied By:	
	Close Election (1)	Realized State Equity Vol. (Market-Adj) (2)	Realized State Equity Vol. (CAPM-Adj) (3)	Net Issuance (4)	AR(13) Residual of Net Issuance (5)
Bank qualified fraction	0.021	0.021	0.021	-0.035***	-0.028**
	(0.020)	(0.020)	(0.020)	(0.012)	(0.012)
Insured fraction	-0.005	-0.005	-0.006	-0.055***	-0.056***
	(0.015)	(0.015)	(0.015)	(0.008)	(0.008)
Credit rating x Year-Month dummies	YES	YES	YES	YES	YES
Number of states	49	49	49	49	49
Observations	43,747	43,747	43,551	40,864	40,227
R-squared (total)	0.926	0.926	0.926	0.062	0.062

Table IA.IX

Issuance Effects of Correlated Background Risk

This table studies effects of local risk on issuance across states with differing degrees of segmentation and differing correlations between bond return and residents' labor income, as measured by non-tradable employment. Observations are state-weeks. Dependent variable is essential service revenue bond issuance as a fraction of total essential service bond issuance (including both general obligations and revenue bonds). Municipal bonds are classified as essential service bonds if the Bond Buyer's Use of Proceeds is for electric power, transportation, or other utilities. Only net issuance, gross issuance minus refunding, is considered. For each state in a given year, non-tradable employment is the fraction of employment in the non-tradable and construction sectors, calculated using CBP data and Mian and Sufi (2014)'s industry classification. Local risk is measured realized state equity volatility, and segmentation is measured by either privilege (column (1)) or SFH (column (2)). Change in realized state equity volatility is the change from last week to current week of the 4-week moving average of realized state equity volatility. All control variables are defined in Table II, III, and IV of the main paper. All models include credit rating x calendar year-dummies. Standard errors, clustered by calendar year-month, are reported in parentheses.

Measure of ***Segmentation***:	Privilege	SFH
	(1)	(2)
Main Variables		
Seg.	0.008***	0.139***
	(0.002)	(0.030)
Non-tradable employment	2.478***	1.926***
	(0.290)	(0.250)
Seg. x Non-tradable employment	0.098**	3.812***
	(0.041)	(0.550)
ΔRealized vol.	-0.904	-0.399
	(1.576)	(1.430)
ΔRealized vol. x Seg.	0.173	1.866
	(0.285)	(3.905)
ΔRealized vol. x Non-tradable employment	-4.726	-6.501
	(5.140)	(4.481)
ΔRealized vol. x Seg. x Non-tradable employment	14.335**	69.205**
	(7.192)	(29.078)
Control Variables		
Debt/Income	0.257**	0.264**
	(0.107)	(0.109)
All fund holding/Debt	0.004	-0.172
	(0.167)	(0.181)
Term spread	0.002	0.002
	(0.013)	(0.014)
Market equity return	0.704	0.800
	(0.700)	(0.699)

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Table IA.IX *-continued*

Measure of ***Segmentation***:	Privilege	SFH
	(1)	(2)
State equity return	0.016	-0.006
	(0.073)	(0.071)
Unemployment rate	0.020***	0.023***
	(0.005)	(0.005)
ln(Trading volume/Debt)	0.119***	0.142***
	(0.021)	(0.022)
ln(# of trades)	0.004	0.010
	(0.007)	(0.006)
Proactive	-0.049***	-0.063***
	(0.016)	(0.016)
Credit rating x Year-Month dummies	YES	YES
Observations	11,045	11,045
R-squared (total)	0.122	0.124

Discussion of Cause and Effects of Changes in Mutual Fund Holdings around the Financial Crisis

In Figure 2 (Panel B), we observed a sharp increase in the total assets under management for national funds after the financial crisis. Prior to that moment, the total assets under management across state and national funds closely track each other. Here, we explore this divergence more carefully. Specifically, our model predicts that price elasticities should decrease as the assets are more widely held by diversified (national) investors. To the extent that the relative holdings of in-state and national investors shift significantly after the crisis, this episode offers potentially important variation that we may be able to use to further test the effects of local ownership on risk sharing although the change in local ownership that we investigate here is not driven by tax privilege.

We begin by examining the potential cause of the curious acceleration of national funds' TNA. Figure IA.1 provides finer resolution on the evolution of TNA at short (Panel A) vs. long (Panel B) maturities. The short- and long-term classifications are determined by Morningstar, corresponding to an average duration across the two groups of funds of about 1-3 and 6-10 years, respectively. This level of disaggregation shows that the sizeable increase in national funds' assets under management is largely attributable to short-term funds. To place this in context, the crisis witnesses runs on traditional money market funds and asset-backed money market instruments, such as auction-rate securities (ARS) and variable rate demand obligations (VRDO), which provide a significant fraction of funding for municipalities. Investors appear to shift money from tax-exempt money market funds to short-term national municipal bond funds, drastically diminishing the presence of state municipal bond funds at the short end of the yield curve. For example, according to the Flows of Fund reports, the amount of municipal debt held by tax-exempt money market funds declines from about $500 billion at the end of 2007 to about $280 billion at the end of 2014, a decrease that is of similar magnitude to the increase in TNA of national municipal bond funds. At the monthly frequency, the reallocation lines up well with the widening yield spreads between commercial paper and insured bank deposits that drives the reaching-for-yield behavior among taxable money market funds described by Kacperczyk and Schnabl (2013).

The events associated with the acceleration of national funds' assets suggest that such acceleration is plausibly exogenous for the purpose of our analysis, in the sense that it should affect the differential price effects across states only by decreasing the likelihood that the marginal investors in each state are local. However, whether this is the case is very difficult to pin down given the complexity of the financial crisis and therefore we would like to caution our readers not to over-interpret our results presented below.

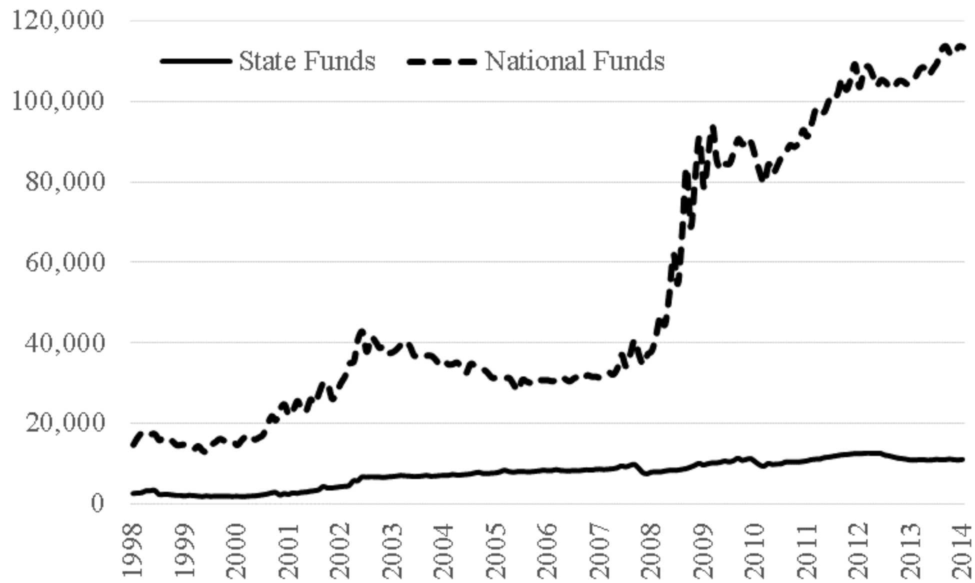
We use this increase in short-term national fund holdings to further test the predictions of our model, from which we would expect the price effects associated with concentrated ownership to be significantly smaller at short maturities following the financial crisis. On the contrary, since state funds remain an important clientele for long-term municipal bonds, our model predicts that we should not observe comparable effects at long maturities. To test these predictions, we run our two main regressions (yield spreads regressed on periods prior to close elections and changes in yield spreads on variation in supply) for 2- and 10-year bond spreads, separately. In each, we introduce an indicator variable for the periods before the crisis (1998-2007, Before dummy = 1 and 0 otherwise) and another for after the crisis (2010-2014, After dummy = 1 and zero otherwise). We drop observations in 2008-2009 to avoid the transition period. As in Tables IV - VI, we include a host of fixed effects and control variables in each case, and cluster standard errors at the calendar year-month level.

Table IA.X reports the results for the price effects associated with periods of elevated idiosyncratic risks. Our variable of interest is the interaction between the close election indicator or realized state equity volatility, SFH, and the pre-crisis vs. post-crisis indicators. Columns (1) - (3) present results for the long-term 10-year spread, whereas columns (4) - (6) present results for the short-term 2-year spread. Consistent with our hypothesis, we find that the heightened sensitivity of short-term municipal bond yields to local risk for states with concentrated, local ownership are present in the pre-crisis period, but not in the post-crisis period. In contrast, for long-term municipal bonds, the price effect of local risk continues to be significant across both the pre- and post-crisis periods. These results suggest the potential for important within-state market segmentation (or preferred habitat) across the yield curve in the post-crisis period.

Table IA.XI presents evidence on the same experiment conducted on the price effects associated with supply variation (net issuance) for short-term and long-term bonds, respectively. Columns (1) and (2) present results for the change in the long-term 10-year spread (across our two issuance measures), whereas columns (3) and (4) present results for the change in the short-term 2-year spread. Consistent with the model's predictions, the differential price effects of supply variation in states with high tax-induced local ownership become insignificant after the crisis at short maturities but remain significant at long maturities.

In sum, after 2009, the differential effects of local political risk and supply variation almost entirely disappear for short-term 2-year municipal bonds where diversified national funds become increasingly important owners, but remain largely unchanged for long-term 10-year bonds where ownership patterns are unaffected. Taken together, we conclude that the reduction in concentrated ownership for short-term municipal bonds following the financial crisis generates price effects as predicted by our model.

Panel A: TNA of Short-Term Municipal Bond Funds



Panel B: TNA of Long-Term Municipal Bond Funds

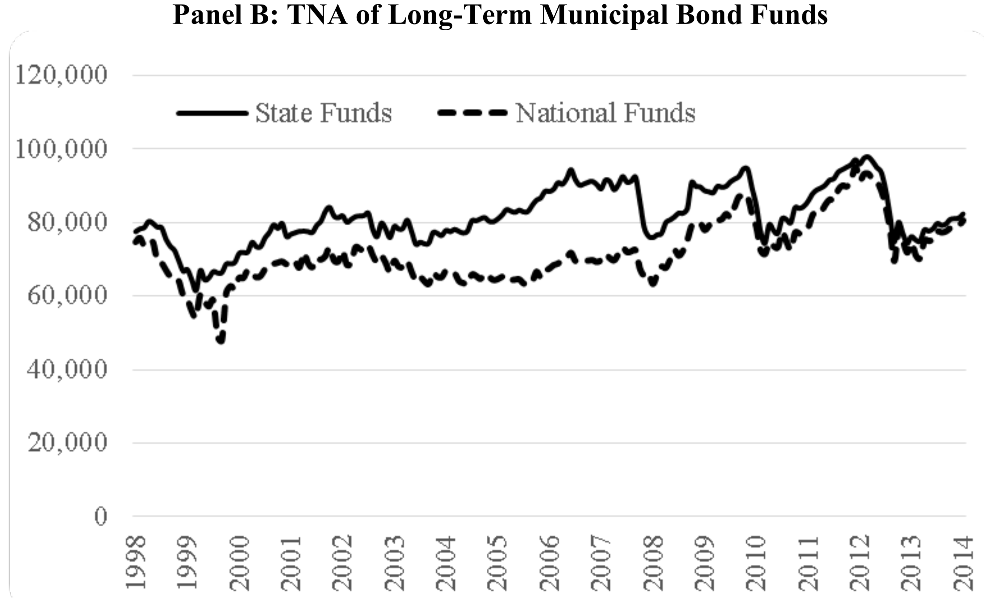


Figure IA.1. Total net assets of short- and long-term state and national municipal bond funds over time. This figure plots total net assets (TNA) of all short-term (Panel A) and long-term (Panel B) state and national municipal bond funds at the monthly frequency from 1/1998 to 12/2014. Fund classifications, state vs. national and short-term vs. long-term, are from Morningstar. Funds that are classified as intermediate-term and those that are not specifically classified as short-term or long-term are not included.

Table IA.X

Pricing of Local Risk Before and After Financial Crisis

This table report results from OLS panel regressions of 2-year (columns (4) – (6)) and 10-year (columns (1) – (3)) municipal bond yield spreads on different local risk measures and their interactions with state fund holdings (SFH), for the periods before the crisis (1998-2007, before dummy = 1) and after the crisis (2010-2014, after dummy = 1). The crisis witnesses runs on money market funds and asset-backed money market instruments, such as auction-rate securities (ARS) and variable rate demand obligations (VRDO), which provide a significant fraction of funding for municipalities. Investors appear to shift money from tax-exempt money market funds to short-term *national* municipal bond funds, diminishing the presence of *state* municipal bond funds at the short end of the yield curve. Three local risk measures are used. Close election dummy is defined as in Table IV of the main paper. Realized state equity volatility is defined in two ways, one using excess return over the market return (baseline, as defined in Table V of the main paper) and the other using excess return over the estimated CAPM return (as defined in Table IA.V). All models include the same control variables as in Table IV/V of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	Spread10Y			Spread2Y		
Measure of ***Local Risk***:	Close Election	Realized State Equity Vol. (Market-Adj)	Realized State Equity Vol. (CAPM-Adj)	Close Election	Realized State Equity Vol. (Market-Adj)	Realized State Equity Vol. (CAPM-Adj)
	(1)	(2)	(3)	(4)	(5)	(6)
Before x Risk	0.058*	1.748***	1.989***	0.028	2.824***	2.953***
	(0.033)	(0.606)	(0.607)	(0.043)	(0.823)	(0.849)
Before x SFH	-0.222***	-0.275***	-0.292***	-0.239***	-0.264***	-0.278***
	(0.015)	(0.016)	(0.018)	(0.021)	(0.024)	(0.025)
[A] Before x Risk x SFH	0.112**	3.560***	4.780***	0.304***	4.407***	4.412***
	(0.046)	(0.769)	(0.841)	(0.089)	(0.935)	(0.967)
After x Risk	0.067	3.442***	3.306***	-0.025	5.281***	5.403***
	(0.048)	(0.820)	(0.827)	(0.085)	(1.218)	(1.196)
After x SFH	-0.323***	-0.340***	-0.343***	-0.190***	-0.100*	-0.101*
	(0.019)	(0.031)	(0.034)	(0.032)	(0.056)	(0.055)
[B] After x Risk x SFH	0.119*	4.379***	4.624**	0.087	1.041	1.335
	(0.064)	(1.598)	(1.905)	(0.197)	(1.426)	(1.551)
Control variables			As in Tables IV/V			
Credit rating x Year-Month dummies	YES	YES	YES	YES	YES	YES
F test of H0: [A] = [B]	0.02	0.47	0.08	2.83*	3.58*	4.46**
Number of states	49	49	49	49	49	49
Observations	41,248	41,249	41,248	41,248	41,249	41,248
R-squared (total)	0.926	0.928	0.928	0.902	0.902	0.902

Table IA.XI

Price Effects of Supply Change Before and After Financial Crisis

This table report results from OLS panel regressions of changes in 2-year (columns (3) – (4)) and 10-year (columns (1) – (2)) municipal bond yield spreads on different measures of net change in municipal bond supply and their interaction with state fund holdings (SFH), for the periods before the crisis (1998-2007, before dummy = 1) and after the crisis (2010-2014, after dummy = 1). The crisis witnesses runs on money market funds and asset-backed money market instruments, such as auction-rate securities (ARS) and variable rate demand obligations (VRDO), which provide a significant fraction of funding for municipalities. Investors appear to shift money from tax-exempt money market funds to short-term *national* municipal bond funds, diminishing the presence of *state* municipal bond funds at the short end of the yield curve. Two measures of net change in municipal bond supply are used, one based on the net weekly issuance (baseline, as defined in Table VI of the main paper) and the other based on the residual from the regression of net weekly issuance on thirteen lags of itself and state dummies (as defined in Table IA.VI). All models include the same control variables as in Table VI of the main paper. All models include credit rating x calendar year-month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

Dependent Variable:	ΔSpread10Y		ΔSpread2Y	
Measure of ***Supply Change***:	Net Issuance	AR(13) Residual of Net Issuance	Net Issuance	AR(13) Residual of Net Issuance
	(1)	(2)	(3)	(4)
Before x Supply change	0.394***	0.217*	0.668***	0.271
	(0.104)	(0.120)	(0.214)	(0.226)
Before x SFH	-0.019***	-0.015***	-0.085***	-0.038***
	(0.007)	(0.005)	(0.014)	(0.011)
[A] Before x Supply change x SFH	0.760***	0.853**	3.498***	4.200***
	(0.256)	(0.410)	(0.703)	(0.775)
After x Supply change	0.287	0.262	0.682	0.678
	(0.236)	(0.258)	(0.417)	(0.410)
After x SFH	-0.026**	-0.012	-0.054**	-0.026
	(0.013)	(0.008)	(0.024)	(0.017)
[B] After x Supply change x SFH	1.288***	1.673**	0.538	0.935
	(0.349)	(0.789)	0.671)	(0.740)
Control variables	As in Table VI			
Credit rating x Year-Month dummies	YES	YES	YES	YES
F test of H0: [A] = [B]	1.67	1.80	7.19***	7.01***
Number of states	49	49	49	49
Observations	38,414	37,777	38,414	37,777
R-squared (total)	0.059	0.060	0.032	0.031