Does the Ownership Structure of Government Debt Matter? Evidence from Munis*

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March 2015

ABSTRACT

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*Thanks to Wasin Siwasarit for research assistance.

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ABSTRACT

The U.S. municipal bond market provides a natural laboratory, free of impediments to capital flows across states or currency considerations, to assess how the composition of ownership of government debt affects government bond prices and real economic outcomes. We exploit quasi-exogenous variation in local (in-state) bond ownership arising from variation in state tax privileges for state-resident bondholders. A high in-state holding of local government debt is associated with higher susceptibility of government bond prices to demand and supply shocks, heightened sensitivity of bond prices to local political uncertainty, and difficulty raising capital for public projects during crises.

1. Introduction

The ability of governments to raise capital from investors in the bond market is deeply important to them, and closely tracked by a range of market participants. Dislocations in the bond market have major implications for fiscal policy, including for the provision of government services and public goods – the recent European sovereign debt crisis is a case in point. It seems intuitively important, therefore, for governments and market participants to pay careful attention to the ownership structure of government bonds. As a large body of literature in a range of asset classes has identified, if government debt is concentrated in the hands of particular groups of investors and arbitrage in the government bond market is limited, this could well have impacts on a range of bond market outcomes including pricing and issuance.[1] Such impacts would be magnified if owners are constrained by mandatory limits on their risk-bearing capacity, are underdiversified, face principal-agent problems in managing their investments, or simply exhibit behavioral biases.

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. 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. The academic literature has overwhelmingly recommended that governments attempt to tilt bond ownership towards domestic debt holders.[2] One important reason for this recommendation is that debt held by foreigners is often de-

[1] See Shleifer and Vishny (2011) for a comprehensive survey on fire sales in finance and macroeconomics. For work in this vein on government bond markets, see, for example, Beber, Brandt, and Kavajecz (2009) and Greenwood and Vayanos (2010).

[2] A significant body of work in this area attempts to diagnose the underlying reasons for the Asian crisis (see, for example, Corsetti, Pesenti, and Roubini (2001) and references therein).

nominated in a foreign currency, meaning that currency depreciations can cause self-fulfilling "runs." However, absent (important) currency considerations, the question remains whether the optimal government bond ownership structure should predominantly comprise domestic bondholders.

We study this issue in detail in a setting in which the usual complications of international finance and currencies do not arise, looking carefully at cross-state variation in the ownership structure of U.S. municipal bonds, with a specific focus on ownership by in- and out-of-state bond mutual funds. We use this unique setting to shed light on several broad questions concerning government bond pricing and state and local governments' abilities to raise financing for local economic activity. We find that a high in-state holding of local government debt imposes significant risk on state governments, in terms of higher susceptibility of government bond prices to both demand and supply (issuance) shocks, heightened sensitivity of bond prices to local political uncertainty, and greater difficulty experienced when attempting to raise capital for specific public projects during crises. These results are robust to the introduction of a large set of alternative drivers of municipal bond prices and issuance. We view our findings as suggesting that domestic debt ownership is not an unadulterated good.

Of course, ownership of government bonds is not exogenous. To sharpen our identification, we use the insight that tax policy induces quasi-exogenous state-level variation in bond ownership structure. The extensive literature on capital structure has identified that in theory, bond yields should adjust to the point of capital structure irrelevance even in a world with heterogenous personal income tax rates (see Miller (1977), and Green (1993)).[3] However these theories do predict that there will be tax-induced clienteles of investors holding tax-advantaged

[3]There is early evidence in the municipal bond market that the Miller equilibrium holds (see, for example, Trzcinka (1982)).

bonds – that is, while the theories predict that Modigliani-Miller holds, they admit that a world with heterogenous personal income taxation generates variations in the ownership structure of bonds with differential tax privileges for different groups of investors.

We apply this insight to identify quasi-exogenous variation in the level of in-state versus out-of-state ownership in the U.S. municipal bond market. Perhaps the most critical feature of these bonds is that many of them carry state-tax-advantaged status if held by in-state residents (generally, municipal bonds also carry tax-advantaged status with regards to Federal taxes). This leads to a relatively sizeable incentive for in-state residents to hold locally-issued bonds. We confirm using the data that this creates a disproportionately "home-state-biased" bond ownership base. We go on to confirm that this tax-induced segmentation commensurately diminishes the scope for cross-state risk sharing in the municipal bond market, leading to predictable variation in municipal bond yields, susceptibility of bond prices to demand and supply (issuance) shocks, and the inability to raise debt at favorable terms during crises.

Our results are related to the international finance literature on the price effects of market segmentation (see Tesar and Werner (1995), Bekaert and Harvey (1995), Henry (2000), Bekaert and Harvey (2000), and Froot and Dabora (1999) among others). In that literature, frictions 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 here that in the U.S. municipal bond market, there is no restriction preventing the cross-state purchase of municipal bonds; however, the incentives created by taxation policy do create a disproportionately local municipal bond ownership structure. Additional support for the possible importance of this channel is provided in a more recent strand of the international finance literature, which explores the degree to which implicit barriers generate elevated levels of market segmentation despite the removal of formal barriers (see Bekaert, Harvey, Lundblad,

and Siegel (2011) among others).

The organization of the paper is as follows. Section 2 describes municipal bond funds and the data on these funds that we employ in the study. Section 3 establishes that state taxation policy is a key determinant of bond ownership structure. Section 4 connects the extent of local ownership of municipal bonds to patterns in their prices and their issuance. Section 5 concludes.

2. Municipal bond funds

To conduct our empirical analysis, we collect information on the structure of municipal bond mutual funds, municipal bond attributes, ratings, and yields, state income tax rates, and state-level macroeconomic and financial indicators.

This section describes our data on municipal bond funds. In subsequent sections of the paper, we combine these data with state-level and bond-level information to examine how state tax policy and the consequent cross-state variation in bond ownership by state and national municipal bond funds affects pricing and issuance.

Throughout the paper, our sample period begins in 1998 and extends until the first quarter of 2010, meaning that we report descriptive statistics from 1998 to 2009 in most cases.[4] Since our analysis is largely at the level of states, we aggregate fund- and bond-level data up to the state-month or state-year level in most of our empirical work.

Our primary data on municipal bond funds are from Morningstar. For each fund they provide data on total net assets (TNA), inflows and outflows of capital from funds, and returns, all at the monthly frequency. They also provide detailed holdings of fund assets, available with

[4]Morningstar data cover the period from 1987 to 2009, but bond identifiers such as the bond CUSIP or ISIN, which we need to obtain bond characteristics including the state which issues the bond or the tax-exemption status of the bond, are largely missing in the earlier part of the sample. Therefore, we only use data which begin in 1998.

rare exceptions at the semi-annual (at worst) or monthly (at best) frequency depending on the fund and the time period.[5]

Over our sample period, these data cover 920 dedicated municipal bond funds, as well as 960 mutual funds that hold at least one municipal bond at some point over the period. This cross-section more or less covers the universe of mutual funds holding municipal bonds. Panel A of Figure 1 shows bars (on the left axis) from the Federal Reserve's Flow of Funds data which signify the size (bonds outstanding) of the tax-exempt longer-term municipal bond market. The market grows from just over $1 trillion in 1998 to about $2.2 trillion in 2009.[6] The figure shows that mutual funds hold between 18 and 22% of these bonds over the period, according to the Federal Reserve. Our calculation, using the Morningstar holdings data at the end of each year and Bloomberg data to identify applicable tax-exempt bonds, produces numbers that are very close to the Federal Reserve numbers, confirming that our data are reliable and representative of aggregate mutual fund ownership of municipal bonds.[7]

Morningstar classifies municipal bond funds into three main types: (i) state funds, which are defined as funds that invest almost exclusively in bonds issued by agencies from a single state; (ii) national funds, which are defined as funds that invest in bonds issued by multiple states, and (iii) high-yield funds, which are defined as funds that invest largely in speculative-grade municipal bonds from multiple states.

Of the municipal bond funds in our data, 604 are state funds, 278 are national funds, and only 38 are high-yield funds. To concentrate on the specific source of tax-induced segmentation

[5] The reporting frequency appears to improve over time. There are about 1% of fund-report date observations in which the time between consecutive report dates is greater than 6 months. 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.

[6] These figures include only bonds with maturity at issuance longer than 1 year. The amount of all outstanding municipal debts is about $3.7 trillion in 2009.

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

in which we are interested, we simply drop the high-yield funds and focus on state and national funds in the remainder of our analysis.

Panel B of Figure 1 shows the evolution of aggregate TNA and the number of state and national funds over time. For most 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. The right axis shows that numbers of state and national funds increase in the early part of the sample, reach their peak in 2003, and steadily decline thereafter. Combined with the increasing TNA held by these funds, this suggests a steadily increasing asset holding for the average fund in the sample.

Table I shows summary statistics of state and national funds. The table summarizes the panel of data in two ways, reporting the cross-sectional average and standard deviation of the time-series mean per fund, as well as the time-series average and standard deviation of the cross-sectional mean across funds in each time period.

Columns 1 and 2 (for 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, and 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 the 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

across all funds. In what follows, we therefore concentrate on describing the cross-sectional variation in time-series averages.

The table shows that state funds are, on average, far smaller than national funds both in terms of TNA ($253 million vs. $618 million) and the number of bond holdings (103 vs. 176). State and national funds have virtually identical average monthly returns (0.31%) but cross-sectional variation in average returns across funds is almost three times larger for national funds.

Turning to inflows and outflows, over the sample period, state funds experienced a slight net outflow while national funds experienced a net inflow, consistent with the observed divergence in the aggregate TNA held by these two groups of funds in 2008-2009.

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 30 states. Each state represents 82% 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 15 years, although the tilt towards longer-term bonds is more pronounced among state funds than among national funds.

We now turn to describing how bond holdings correlate with variation in the policies of states, with a particular focus on the differing taxation of bonds held by state and national funds.

3. State tax rates and municipal bond holdings

A key benefit of investing in municipal bonds is that income derived from these bonds is generally exempt from federal income tax.[8] In addition, in-state residents can often claim exemptions from state (and sometimes local) taxation on income from municipal bonds issued by agencies in the same state.

For example, consider a resident of New York. For this individual, the interest income from municipal bonds issued by New York entities[9] is exempt from both federal and New York state income taxes. However, for this New York resident, any interest income deriving from municipal bonds issued by, say, New Jersey entities is only exempt from federal income tax, while New York state income tax will still be due.

This possibility of differential taxation for in- and out-of-state residents can create significant incentives for state residents to hold municipal bonds issued by their states. Naturally, the incentives increase with state income tax rates, as well as the number of bonds issued by a state with such exemptions for in-state residents. Our expectation is that such high state income tax rates will be associated with larger fractions of state municipal bonds held by in-state residents, consistent with Miller equilibrium, and as hypothesized by authors such as Kidwell and Koch (1982), Kidwell and Koch (1983), and Leonard (1998). In addition to individual investors, these incentives also operate for state municipal bond funds in high tax states given their likely clients.[10]

[8] A fraction of municipal bonds are issued for purposes that are outside the realm of pure governmental functions, including some not-for-profit organizations and other "private activity" issuers. These municipal bonds are subject to the federal alternative minimum tax (AMT); however, the vast majority of municipal bonds are non-AMT. They can be held directly or inside of a municipal bond mutual fund.

[9] Only the part of the income that does not exceed the issuance yield; see Ang, Bhansali, and Xing (2010).

[10] Single state municipal bond funds are marketed to local state residents. 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 are quite different

We investigate this hypothesis in detail in our sample. We first obtain data on state income tax rates from the Tax Foundation (from 2000 onwards) and the NBER Taxsim Program (prior to 2000). We use bond characteristics reported by Bloomberg to identify tax-exempt bonds issued by each state. We then sort states into terciles on the basis of the time-series average of the highest marginal state income tax rate. For each state-month, we calculate the "state fund holding" (or *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.[11]

Table II provides summary statistics of tax rates and *SFH* for all tax-exempt bonds, grouped by maturity. The table shows that states in the top (bottom) tax tercile have highest (lowest) marginal state income tax rates of 8.14% (2.16%). Consistent with the hypothesis that tax rates induce differences in ownership structure, states in the top tax tercile also have the highest average *SFH* (shown at the bottom of the table) of 51.44%, followed by states in the middle and bottom tax terciles at 36.42% and 29.13%, respectively.

The same rankings apply to bonds in all maturity groups, with the differences being most pronounced for the longest-maturity bonds. The differences in *SFH* between the top and bottom tax terciles are economically and statistically significant.

The table also shows that if we remove unusual states, for which the tax status for bonds issued by the state and those issued by other states are not "exempt" and "taxable" respectively, the differences in *SFH* are even more pronounced. Such states offer an interesting counterpoint to the rationale for tax-induced segmentation discussed earlier, since they do not privilege in-

insofar as they make no mention of state taxes.

[11] We do so using 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. Furthermore, we include only 21 states for which the representative municipal bond yield curves are available from Bloomberg.

state holders. For example, for residents in District of Columbia, income from municipal bonds issued by the District of Columbia as well as those of other states are exempt from DC income tax. The lack of a differential tax rate means that the tax-induced segmentation channel does not apply in this case. When such cases are removed, evidence of tax-induced segmentation becomes stronger.

Figure 2 shows the relationship between state income tax rates and state fund holdings for the entire cross section of states at two points in time, for two different bond maturity groups. Panel A shows that across all maturities of bonds issued by states, states with higher state income tax rates (with the exception of the unusual states discussed above) issue municipal bonds that are disproportionately held by local investors. The correlations between state tax rate and state fund holding are 0.72 and 0.67, respectively, in 2000 and 2009.[12] Panel B confirms the robustness of this positive association at both the 10-year and 20-year maturity buckets.[13] A closer examination shows that the patterns in holdings of state and national funds are quite similar across bonds issued by the same state but vary greatly across states.

Figure 3 tracks *SFH* for different states over time. Panel A presents the average state fund holding for states in each of the three tax terciles. For all years, the average *SFH* lines up monotonically with the average state income tax rate, i.e., it is highest for the top tax tercile, and lowest for the bottom tax tercile. Panel B presents *SFH* for three sample states, namely, New York, which has state tax rates which range from 6.85% to 8.97%, and Florida and Texas, which have zero state tax rates.

Consistent with the patterns already detected in the data, we find that 62-71% of municipal

[12] At different snapshots during our sample period, the correlations between state tax rate and state fund holdings range from 0.59 to 0.72.

[13] The 10-year bucket contains bonds of maturities between 8- and 15-years, and in 20-year bucket, there are bonds with maturity greater than 15-years.

bonds issued by New York entities are held by New York state funds while only about 1-5% of municipal bonds issued by Texas are held by Texas state funds. Florida provides an interesting laboratory – while its state tax rate is zero, municipal bonds issued by other states and held by Florida residents were originally subject to intangible property tax, which was decreased from the rate of 0.15% in 1999 to zero in 2007. The figure shows that during the period when the preferential tax treatment of bonds issued by Florida is gradually phased out, the fraction of Florida-issued bonds held by Florida state funds declines, from 57% in 1998 to 15% in 2009.

The evidence provided in this section highlights sharp differences in municipal bond holding patterns across states, which line up with the differential taxation rates and exemptions offered to in- and out-of-state residents. States with high levels of taxation issue municipal bonds that are, on average, financed by local investors, while municipal bonds issued by states with low levels of taxation are purchased and held widely by investors from all over the country. Consistent with a Miller equilibrium with heterogenous personal income tax rates, a major determinant of municipal bond ownership structure appears to be the state tax level on personal income.

4. Market implications of local ownership

The international finance literature has demonstrated that one of the main benefits of open markets is risk sharing (see Obstfeld (1994), for example) – one feature of this line of research is that global investors diversify local risks, leading to smaller risk premia and higher asset prices (see Stulz (1981), Errunza and Losq (1985), and Bekaert and Harvey (2000) among others). Any shocks to local asset demand/supply have minimal impact on prices as arbitrage capital moves quickly to restore equilibrium. In segmented markets, on the other hand, shocks to local

asset demand/supply may have significant price impacts and local risks are priced.

The U.S. municipal bond market offers an interesting laboratory to evaluate the implications of market integration in that there are no explicit barriers to capital flows and no foreign exchange risk. As a consequence, one might imagine that the market for municipal bonds issued by different states should be integrated. However, due to tax advantaged nature of locally issued bonds, local bonds are disproportionately held by local residents; that is, an unintended consequence of state-level tax policy may very well be a segmented municipal bond market. The greater the tax advantage, the higher the degrees of local bias and the associated importance of local risks. In the sections to follow, we explore various implications of municipal bond market segmentation.

To begin, we study the price effects engendered by a local asset demand shock, then we turn to an evaluation of the price elasticity associated with a local asset supply shock, and finally, we consider local political risk. We measure these effects by regressing municipal bond yield spreads on various proxies for local shocks and, most important, their interaction with an indicator capturing states with disproportionately large local ownership. If local bias has implications for market segmentation, we would expect the asset price effects to be stronger for states with larger local ownership (and less risk sharing).

Second, we study whether these price effects potentially feed back on the ability of local governments to raise funds, and, if so, whether particular projects are disproportionately affected by this lack of funding. We measure the ability to raise funds by the gross issuance of municipal bonds and proxy for the type of projects by splitting the issuance into two common types: general obligation (GO) and revenue (RV) bonds.

A GO municipal bond is backed by the taxation authority and credit of the issuing jurisdiction. In contrast, RV municipal bonds finance income-producing projects, and are secured

by a specified revenue source, for example, for a local sports venue. Typically, RV bonds can be issued by any government agency or fund that is run in the manner of a business (e.g., operating revenues and expenses).

If local shocks affect capital raising in addition to prices, it is interesting to document whether specific types of projects are disproportionately impacted. RV bonds are backed by cash flows which are completely generated by specific projects, while GO bonds can be repaid through a variety of tax sources. Local investors are already highly exposed to local shocks as a result of their concentrated ownership of local municipal bonds, and RV bonds may well increase their local exposure disproportionately relative to GO bonds. Moreover, RV bonds' cash flows may provide more visible signs of local economic problems. Either way, it is interesting to contrast the effects of shocks on these two types of bonds in the presence of tax-induced segmentation of the ownership base.

Table III reports summary statistics, by state, of the key variables we use in our study. The first two columns show the best and worst representative credit ratings of each state during our sample period. The ratings data are from S&P and are for senior, unsecured GO bonds issued by the state governments. For all but one state, ratings remain AA- or better throughout our sample period. However, California's ratings are A for most of the sample period (even falling to BBB in 2003). States with the same credit rating yield more useful comparisons for our purposes, since they have roughly similar levels of default risk. To avoid additional complications in risk adjustment, we simply drop California from our study at this stage, a choice we plan to revisit in subsequent drafts of this paper.

The next three columns of Table III report the average bond yield spread (over U.S. Treasuries) and the (annualized) 6-month bond return for the 20-year maturity bond. The yield data are from Bloomberg (Fair Value Curves), and the spreads are the differences between mu-

nicipal bond yields and maturity-matched constant maturity Treasury yields from the Federal Reserve Bank of St. Louis (FRED). The average 20-year municipal bond yields do not differ much across states (4.6%-4.9%) and are not statistically different between states in the top and bottom state tax terciles. Yield spreads are generally negative, due to federal, state, and local income tax exemptions, and do not appear to differ materially across states in the three tax terciles. The average 6-month bond returns are somewhat larger than the bond yields – there is a decreasing trend in bond yields over our sample period. They, too, do not differ materially across states.

In the next three columns of Table III, we report three measures of municipal bond issuance: average net annual issuance and average gross issuance of GO and RV bonds. The issuance variables are measured as a fraction of total debt outstanding, where the net issuance is from the Internal Revenue Service and the gross issuance is calculated by summing all individual bonds issued in each period as reported by SDC Platinum. Net issuance is gross issuance less refunding.

The reported statistics show that about half of the total issuance amount is used to refund existing municipal bonds. The average net issuance to outstanding debt ratio does not vary much across states, ranging from 0.05 in Massachusetts to 0.10 in Texas. We take net issuance as annual supply and investigate how it affects prices in states with high vs. low local municipal bond ownership. The gross issuance, again measured as a fraction of outstanding debt, is about equally split between GO and RV bonds, both with cross-state ranges from about 0.04 to 0.14. Across tax terciles, the gross issuance appears larger for the bottom tercile, particularly for RV bonds. We will explore whether shocks in demand for state-issued bonds affect the gross issuance of GO and RV bonds.

The final column reports the total number of close gubernatorial elections, defined as those

in which the difference in percentage vote between the eventual winner and loser is less than 5%. We view these elections as periods in which local political risk is elevated (see Gao and Qi (2013)). The total numbers of close elections are 7, 6, and 7 for states in the top, middle, and bottom tax terciles, respectively. These evenly distributed events allow us to identify whether their effects on municipal bond yields vary across states with different degrees of market segmentation.

States also differ along other economic and financial dimensions, underscoring the need to control for some of these characteristics in our study. On average, states in the top state tax tercile have larger levels of GDP, slightly lower Debt-to-GDP ratios, and slightly lower unemployment rates than those in the bottom tercile, although the differences are not monotonic across the three terciles and appear to be driven by a few states. Monthly equity returns of firms headquartered in different states differ vastly across states, lowest in District of Columbia (0.20%) and highest in California (0.95%), but do not appear to have any noticeable relationship with state income tax rates. Nevertheless, we control for all these variables as well as other national time-varying market conditions to absorb the effects of these conditions on municipal bond prices and issuance.

4.1. Price effects of demand shocks

We begin our analysis with an exploration of the price effects associated with asset demand shocks. We hypothesize that shocks emanating from single state municipal bond funds should have a larger price impact than those from national funds as a consequence of the tax-induced segmentation and higher levels of in-state ownership in high tax states. To identify demand shocks, we rely on a now vast literature on "fire sales" that begins with Shleifer and Vishny (1992).

Coval and Stafford (2007) and Jotikasthira, Lundblad, and Ramadorai (2012), in particular, document sizable price effects around equity market fire sales as mutual funds experiencing extremely large inflows (outflows) tend to significantly expand (decrease) existing positions. We proxy for demand shocks by employing a similar measure of forced trading by single state and national municipal bond mutual funds around periods of extreme investor flow.

To measure flow-induced fire sales and purchases in the municipal bond market, we adapt the *PRESSURE1* measure used in Coval and Stafford (2007). Flow-induced municipal bond sales (purchases) are identified as reductions (increases) in bond positions by state or national funds experiencing severe outflows (inflows). We define unusual levels of flows as those below the 10th percentile ($LoFlow_{i,t} = flow_{i,t} < percentile(10)$), or above the 90th percentile ($HiFlow_{i,t} = flow_{i,t} > percentile(90)$) of mutual fund redemptions/subscriptions across all fund-months. For each state (s)-maturity group (m)-month (t), we calculate pressure from all funds i's in a group G as

$$Pressure_{s,m,t} = \frac{\sum_{i \in G} \left(\max\left(0, \Delta H_{i,s,m,t}\right) | HiFlow_{i,t}\right) - \sum_{i \in G} \left(\max\left(0, -\Delta H_{i,s,m,t}\right) | LoFlow_{i,t}\right)}{Outstanding\ Debt\ OR\ Net\ Issuance}$$

where $\Delta H_{i,s,m,t}$ is the change in fund i's holding of all bonds in maturity group m and issued by state s from time $t-1$ to t,[14] $flow_{i,t}$ is the percentage flow to fund i in period t, and G denotes either state funds (SF) or national funds (NF). Unlike Coval and Stafford (2007), we replace the average volume in the denominator by outstanding municipal debt at the previous year-end or net municipal debt issuance in the current year.

Table IV provides univariate averages of 20-year municipal bond yields (third column) and returns (fourth column) across state months sorted into quintiles on the basis of *Pressure*

[14]Ihe the case where the change in holdings can only be determined over a period greater than one month, we allocate the net change across months on the basis of flows.

for bonds with maturities greater than 15 years. Only state-months with non-zero values of *Pressure* are included. Panel A provides evidence when *Pressure* is scaled by outstanding municipal debt and Panel B provides evidence when *Pressure* is scaled by net municipal debt issuance.

Regardless of how pressure is scaled, several key results emerge. First, pressure emanating from both state and national funds is sizeable in the extremes. The first column of each panel shows the quintile average of the pressure variable upon which the sorting is based. *Pressure* (as a fraction of debt outstanding in Panel A) ranges from 2.5% for purchases (Q1) to -1.2% for sales (Q5) for state funds, and from 2.5% for purchases (Q1) to -1.4% for sales (Q5) for national funds – similar for both types of fund, and large. These comparisons are qualitatively unchanged when *Pressure* is scaled by net issuance (Panel B).

Despite the fact that the range of flow-induced pressure is similar across fund types, we see important differences. In the second column, we show that *Pressure* from state (national) funds is associated with states whose municipal bonds are held disproportionately more (less) by state funds. As a result, the scope for risk sharing and demand shock absorption may be quite different across the two types of shocks. In fact, the difference in yield between periods with fire sales and extreme purchases from state funds is about 0.50%, on average. These differences subsequently reverse, resulting in returns that are 7.20% (in annualized terms) higher following fire sales than following extreme purchases. Note that this magnitude is consistent with the modified duration of 20-year bonds of about 15 years (15 x 0.50% = 7.50%). The price effects are also significant for fire sales and extreme purchases from national funds. Most importantly, the effects are significantly larger for *Pressure* emanating from state funds than from national funds, consistent with our hypothesis. This key result is true regardless of how the flow-induced pressure is scaled.

It is important to acknowledge that our setting may not be as clean as in the earlier studies mentioned above. The exogeneity of fire sales and purchases, particularly from state funds, could be challenged since local bond yield movements and flows from local investors may be driven by common economic conditions in the state. In Table V, we address the concern by conducting panel regressions of the 20-year municipal bond spreads (over U.S. Treasuries) across states on our pressure variables along with controls for a variety of macroeconomic and financial conditions that might directly affect bond spreads. As in Table IV, *Pressure* (scaled by the total amount outstanding) from state and national funds are separately calculated, and all state-months with non-zero pressure are independently sorted into quintiles according to each pressure measure. Furthermore, we control for state-level municipal bond issuance, income tax levels, the U.S. Treasury term spread, the U.S. equity market return, the local equity return for firms headquartered in that state, the state debt/GDP level, and the state unemployment rate. We also include credit rating, state, year, and month fixed effects, and cluster the standard errors by calendar month.

In column (1), we consider the effect of two indicator variables that capture the highest (Q1) and lowest (Q5) quintiles of *Pressure* emanating from *state* funds facing extreme levels of inflows or outflows. As these funds largely hold municipal bonds from only one (relatively high-tax and segmented) state, we hypothesize that the effect of fire sales on yield spreads will be large given the limited capacity for other participants to absorb the demand for liquidity. Controlling for other state-level and national conditions, municipal bond spreads are significantly larger when state funds experience fire sale pressure. The spread difference between state-months with state funds' fire sales and extreme purchases is statistically significant at the 10% level.

In column (2), we consider the effect of two indicator variables that capture the highest (Q1) and lowest (Q5) quintiles of *Pressure* emanating from *national* funds. Since national funds hold

a large cross-section of (relatively low-tax and integrated) states, we hypothesize that the effect of fire sales on yield spreads will be smaller given a larger set of potential liquidity suppliers. Controlling for other state-level and national conditions, municipal bond spreads are also significantly larger, at the 5% level, when national funds experience fire sale pressure (again, the effect on spreads from extreme purchases is not statistically significant). However, the spread difference between state-months with national funds' fire sales and purchases is not statistically significant. Finally, to evaluate whether the relative spread effects are larger for *Pressure* emanating from constrained state or national funds, we consider all four indicator variables together in column (3) along with our control variables. While both fire sale indicators are again statistically significant, the difference-in-difference between fire sales and purchases between state and national funds is statistically significant at the 10% level. On balance, *Pressure* emanating from state funds (particularly selling pressure induced by state fund outflows) is associated with larger municipal bond price effects than *Pressure* emanating from national funds, even after controlling for other state and national conditions. Given the sharp differences in state and national municipal fund holding patterns, we conclude that state taxation policy generates unintended consequences for municipal bond market price determination.

A few auxiliary results are also worth noting. First, spreads are higher during periods of elevated net issuance, suggesting important supply effects may be operating; we will turn to this in the next section. Next, the state tax rate, the U.S. term spread, and the U.S. equity market all have the expected signs on municipal spreads, but are mixed in significance across the three columns. State equity returns have negative coefficients, indicating that spreads are lower when companies in the state are doing well. Spreads are elevated when the state is more indebted, as measured by the state debt-to-GDP ratio. Finally, spreads are also significantly elevated when the state is suffering from high unemployment.

4.2. Price effects of supply shocks

The previous analysis focused largely on the extent to which we observe differential price effects around periods of significant flow-induced demand shocks across segmented or integrated markets. However, in our effort to control for other relevant conditions, we uncovered preliminary evidence of a significant effect of municipal debt issuance on prices. A natural next question to ask is whether the price effect of debt issuance is more or less pronounced in states with municipal bonds that are disproportionately held by state funds. If the high-tax environment *de facto* segments a state resulting in a pool of available capital which is more susceptible to local shocks, new bond issuance may engender a larger price decline if arbitrage is limited, and local bondholders demand a concession for the increase in underdiversification that they experience by absorbing this local supply variation.[15]

Table VI presents evidence on panel regressions of the 20-year municipal bond spreads on net municipal bond issuance (scaled by debt outstanding) and its interaction with an indicator variable that takes a value of one when the state is in the top tercile of state fund holding and zero otherwise. We include the same controls for a variety of macroeconomic and financial conditions as in Table V. We once again include credit rating, state, year, and month fixed effects, and cluster standard errors by calendar month.

Column (1) includes an indicator for high state fund holding, state net issuance scaled by debt outstanding, and our fixed effects. The negative and significant coefficient of the high state fund holding indicator suggests that bond spreads are lower for states that are disproportionately held by in-state investors. Since we include state fixed effects (and in column

[15] In the absence of new information, such price declines are likely associated with downward-sloping demand curves (Shleifer (1986)), which can be caused by institutional impediments to immediate trades, such as time to raise capital from a limited pool (Duffie (2010)). In the context of municipal bond markets, these impediments are likely to be greater for states whose bonds are mostly purchased and held by a limited number of state residents.

(3), the state tax rate), this negative association between yield spreads and local ownership is not a time-invariant effect specific to particular states, nor is it a direct tax effect. Rather, it shows that the same states have lower yield spreads when local ownership is relatively high. More importantly, as in Table V, we show that an increase in supply increases bond spreads consistent with Greenwood and Vayanos (2010), Greenwood and Vayanos (2014), and Krishnamurthy and Vissing-Jorgensen (2012).

In columns (2) and (3), we turn to the interaction effect between net issuance and state fund holdings. In column (2), we add the interaction effect alone, and in column (3) we add it along with all the other control variables. Many of the other effects remain unchanged (including the control variables in comparison to Table V). Most important, the supply effects are significantly greater for states with high state fund holding, consistent with our hypothesis.[16] That said, the economic effects are relatively small; a one standard deviation increase in the net issuance ratio (0.04) only increases yields by roughly 2 basis points (based on estimates in columns (2) and (3)) more in states with high state fund holding than in other states.

Taken together, we find that both municipal bond demand and supply shocks impact local price determination, but that these effects are relatively more pronounced in the states where higher level of taxation appear to segment the market and potentially limit the pool of available funding.

Next, we turn to an examination of the pricing effects of local risks across integrated and segmented municipal bond markets.

[16] States held more broadly by national funds can be partial substitutes, indirectly absorbing supply shocks between each other. 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.

4.3. Pricing of local political risk

An important implication of market integration is a negligible pricing role for diversifiable local risks. In segmented markets, in sharp contrast, local risks will have a greater effect on price determination (see, for example, Errunza and Losq (1985), Bekaert and Harvey (1995), and Bekaert, Harvey, Lundblad, and Siegel (2011)).

Bekaert, Harvey, Lundblad, and Siegel (2011), in particular, focus on the pricing effects of local political risks in segmented markets. In the municipal bond market, if the high tax environment has the unintended consequence of segmenting a state, then local risks may be associated with larger price effects. Building upon the international finance literature, we consider one measure of state-level political risk, close elections (similar to Gao and Qi (2013)), as an example of diversifiable local risk.[17]

Table VII presents evidence on panel regressions of the 20-year municipal bond spreads across states on an indicator variable that takes a value of one in the three months prior to close gubernatorial elections and zero otherwise. We define an election as close if the realized votes between the winner and the loser is less than 5%. It is likely that the outcome is hard to predict *ex-ante*, and therefore the periods immediately preceding such elections are often associated with heightened political uncertainty. Our variable of interest is an interaction of the close election indicator with an indicator variable that takes a value of one when the state is in the top tercile of state fund holdings and zero otherwise. If local risk commands higher premia in segmented markets, we expect the coefficient of this interaction term to be positive. To absorb other potential drivers of bond yields, we include the same macroeconomic and financial control variables and fixed effects as in earlier tables. Standard errors, clustered by

[17] See Pastor and Veronesi (2012) and Pastor and Veronesi (2013) for relevant theoretical arguments.

calendar year-month, are reported in parentheses.

Column (1) includes an indicator for high single state fund holdings, an indicator for close elections, and our fixed effects. Close elections are associated with municipal bond spreads that are about 10 basis points higher, on average, consistent with Gao and Qi (2013). In columns (2) and (3), we turn to the interaction effect between close elections and high state fund holdings. In column (2) we add the interaction effect alone, and in column (3) we add it along with all the other control variables. As we have seen several times, the control variables remain largely unchanged. Most important, the price effect of close elections largely comes from states with high state fund holding. This is consistent with our hypothesis that local risk is priced in segmented markets.[18]

4.4. Fund raising in the presence of demand shocks

As a final exercise, we turn to an exploration of the degree to which flow-induced transaction shocks affect the issuance of particular types of projects. In particular, we study whether the price effects we document above potentially feed back on the ability of local governments to raise funds, and, if so, what type of projects get cut due to the lack of funding.

Using data from SDC Platinum, we measure the ability to raise funds by the gross issuance of municipal bonds and proxy for type of projects by splitting the issuance into two common types: general obligation (GO) and revenue (RV) bonds. Gross issuance is calculated by summing all individual bonds issued in each period. A GO municipal bond is backed by the taxation authority and credit of the issuing jurisdiction. In sharp contrast, RV municipal bonds finance income-producing projects, and are secured by a specified revenue source. Typi-

[18] This is also consistent with the specialized arbitrager hypothesis of Gabaix, Krishnamurthy, and Vigneron (2007), whereby segmentation arises as a result of specialization. In the context of MBS market, they show that MBS market-specific risk is priced, suggesting that the MBS market is segmented from markets for other assets.

cally, RV bonds can be issued by any government agency or fund that is run in the manner of a business (e.g., operating revenues and expenses). If capital market disruptions affect municipal bonds issuance, it is particularly important to document what type of projects are impacted. As discussed earlier, one might imagine a scenario in which RV bonds that are backed fully by specific project revenues become harder to place than GO bonds that can be repaid through a variety of tax sources. If true, taxation impacts government capital raising through an unintended effect on investors' portfolios holdings and capital market segmentation, in additional to the traditional fiscal budget channel.

To address this, Table VIII presents evidence on panel regressions of the gross issuance of GO (in columns (1)-(3)) and RV bonds (in columns (4)-(6)) across states on 0/1 indicators for being in the extreme quintiles of flow-induced transaction pressure, separately, from single state and national funds. For each month, pressure is computed as in Tables IV and V above. We include the same macroeconomic and financial control variables and fixed effects as in earlier tables. Standard errors, clustered by calendar year-month, are reported in parentheses.

Column (1)-(3) show that GO gross issuance is largely unaffected by periods of flow-induced transaction pressure, buying or selling, from either single state or national funds. This is true whether we introduce each type of pressure indicator separately or together. The only significant effect is that GO gross issuance is lower for states with greater levels of indebtedness. In contrast, columns (4)-(6) show that in periods with negative demand shocks (fire sales), states facing demand shocks emanating from single state funds tend to issue significantly fewer RV bonds. The opposite is true for periods with positive demand shocks (extreme purchases). These effects are significantly weaker when the shocks come from national funds, and the difference-in-difference between flow-induced buying and selling across states with shocks from single state vs. national funds is statistically significant at the 10% level. In annualized terms,

states that experience an extreme increase (decrease) in demand from state funds issue 2.2% more (1.5% less) RV bonds, as a percentage of total outstanding debt, than in normal periods. The differential effect of 3.7% is significantly larger than the differential effect of 1.3% (1.4%-0.1%) coming from national funds. To put this effect in perspective, for the state of New York where the average outstanding debt during our sample period is about $200 billion, state agencies issue approximately $617 million (3.7% x $200 billion/12) more of RV bond in the months associated with an extreme increase in demand from state residents than in the months associated with an extreme decrease.

5. Conclusion

The U.S. municipal bond market provides a natural laboratory, free from explicit barriers to capital flows across states and currency considerations, in which we can assess the effects of debt ownership structure on government bond prices and real economic outcomes. Our main finding in this paper is that high levels of domestic ownership of government debt may not be an unadulterated good – states with such high domestic holdings have bonds which are more subject to liquidity and political risk, and face difficulties raising finance to support capital investments during crises. Furthermore, state tax policy has a role to play here – we show that one, perhaps unintended, consequence of tax policy is to segment ownership if it privileges one group of investors relative to another.

One of the main questions that we hope to address in our research agenda going forward is the effects of such financial frictions on real economic outcomes. Clearly, reductions or increases in the cost of government borrowing would have impacts on the provision of government services, and in turn, on subsequent tax policy. A related area of literature offers some insights: Jayaratne

and Strahan (1996), among others, find that during the de-regulation of the U.S. banking system, the relaxation of U.S. cross-state banking and branching restrictions alleviated financing constraints and spurred state level-growth. This leads to some interesting possibilities in our study. If municipal bond holding patterns alter the terms under which local governments access capital, presumably this is in turn associated with significant degrees of variation in economic activity (such as local economic growth and employment). Again, tax policy that generates incentives for local in-state bond holdings serves as a useful instrument in this context. Put differently, perhaps tax policy creates an unanticipated spillover for economic growth through the incentives it creates for local investors to effectively segment the municipal bond market.

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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 2009, and the observation frequencies are fund-month for total net assets (TNA), flow, and return, and fund-quarter or coarser, depending on each fund's reporting frequencies, 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 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.

	State Funds				National Funds			
	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	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
TNA ($ million)	253	733	291	44	618	1,226	732	184
Number of holdings	103.42	101.54	110.43	12.11	175.68	171.40	195.03	41.01
Flow (%)	-0.01	1.08	-0.04	0.54	0.37	1.80	0.24	0.88
Return (%)	0.31	0.09	0.31	0.57	0.31	0.23	0.31	0.50
Cash holding (%)	1.97	3.06	1.77	0.68	4.47	6.35	3.56	1.43
Number of states held	2.00	2.20	2.06	0.51	29.71	10.18	30.44	2.03
Average assets in a state (%)	81.80	27.74	81.48	4.72	5.92	12.65	5.71	1.71
Maximum assets in a state (%)	86.85	10.02	87.22	3.55	16.53	13.11	16.11	1.15
Average bond maturity (years)	15.68	4.65	15.89	0.93	13.45	4.59	13.70	0.70
Assets in bonds with maturity 0-7 years (%)	13.28	14.59	12.79	2.64	23.13	18.67	22.15	3.10
Assets in bonds with maturity 8-15 years (%)	31.71	14.59	31.14	3.67	32.76	16.89	32.85	3.03
Assets in bonds with maturity over 15 years (%)	43.40	23.78	44.80	4.87	32.96	21.91	34.57	3.67

Table II

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

This table presents summary statistics on state tax rate and fraction of municipal bonds held by state municipal bond funds. Only 21 states, for which the Bloomberg yield curve data are available, are included. States are sorted into terciles by the (time-series) average of highest state income tax rate. Highest state income tax rates are from Tax Foundation (2000-2009) and NBER Taxsim program (1998-1999). 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. Unusual states are those for which the tax statuses for bonds issued by the state and by other states are not, respectively, "exempt" and "taxable." 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 tax terciles are conducted using standard errors clustered by calendar year. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	Number of State-months	Tax Status of Bonds Issued by		State Tax Rate (%)			% State Fund Holding			Average % State Fund Holding by Maturity		
State		State	Other States	Mean	Min	Max	Mean	Min	Max	0-7 Yr	8-15 Yr	15+ Yr
Top Tax Tercile (States with Highest Average State Tax Rate)												
CA	156	Exempt	Taxable	9.72	9.30	10.55	77.34	63.88	86.60	66.45	73.84	80.33
DC	156	Exempt	Exempt	9.11	8.50	9.50	7.52	2.61	13.06	2.78	6.56	10.56
NC	156	Exempt	Taxable	8.00	7.75	8.25	42.62	34.98	50.69	25.20	43.01	52.34
NJ	156	Exempt	Taxable	7.91	6.37	10.75	50.77	39.87	61.98	33.95	48.66	59.72
MN	156	Exempt	Taxable	7.88	7.85	8.00	63.00	54.95	69.97	46.70	69.42	64.84
NY	156	Exempt	Taxable	7.37	6.85	8.97	65.57	59.70	70.85	43.00	58.23	74.83
OH	156	Exempt	Taxable	7.01	5.93	7.50	53.27	45.90	60.76	34.44	54.44	58.48
Average				8.14			51.44			36.07	50.59	57.30
Average (excluding DC)				7.98			58.76			41.62	57.93	65.09

Cont'd next page

Table II -*continued*

State	Number of State-months	Tax Status of Bonds Issued by		State Tax Rate (%)			% State Fund Holding			Average % State Fund Holding by Maturity		
		State	Other States	Mean	Min	Max	Mean	Min	Max	0-7 Yr	8-15 Yr	15+ Yr
Middle Tax Tercile												
SC	156	Exempt	Taxable	7.00	7.00	7.00	27.64	17.23	42.53	28.77	34.11	23.86
WI	156	Varies	Taxable	6.91	6.75	7.75	7.99	3.55	11.96	1.98	9.71	10.46
GA	156	Exempt	Taxable	6.00	6.00	6.00	22.68	16.67	25.69	15.15	21.52	27.23
TN	82	Exempt	Taxable	6.00	6.00	6.00	24.09	18.66	30.96	8.22	24.87	35.10
VA	156	Exempt	Taxable	5.75	5.75	5.75	59.62	51.46	65.65	39.28	64.04	64.51
MA	156	Exempt	Taxable	5.54	5.30	5.95	46.14	41.05	50.19	32.81	47.05	50.27
MD	156	Exempt	Taxable	5.10	4.75	6.25	66.78	58.38	74.40	56.45	74.32	67.34
Average				6.04			36.42			26.09	39.37	39.82
Average (excluding WI)				5.90			41.16			30.11	44.32	44.72
Bottom Tax Tercile (States with Lowest Average State Tax Rate)												
CT	156	Exempt	Taxable	5.00	4.50	6.50	54.02	44.86	60.31	30.93	56.25	65.28
MI	156	Exempt	Taxable	4.19	3.90	4.40	42.19	32.91	47.37	27.83	41.10	47.53
IL	156	Varies	Taxable	3.00	3.00	3.00	0.62	0.21	1.41	0.48	0.69	0.66
PA	156	Exempt	Taxable	2.95	2.80	3.07	60.10	50.47	65.45	36.95	61.77	66.76
FL	156	Exempt	Taxable	0.00	0.00	0.00	43.62	14.30	59.15	29.82	42.96	49.00
TX	156	Exempt	Taxable	0.00	0.00	0.00	2.73	0.46	5.21	4.15	2.91	2.17
WA	156	Exempt	Taxable	0.00	0.00	0.00	0.64	0.17	1.90	0.62	0.53	1.01
Average				2.16			29.13			18.68	29.46	33.20
Average (excluding IL and FL)				2.43			31.93			20.09	32.51	36.55
Top - Bottom				5.98***			22.31***			17.39***	21.14***	24.10***
Top - Bottom (excluding unusual states)				5.56***			26.83***			21.53***	25.42***	28.54***

Table III

State-Level Summary Statistics on Bond Yields and Other Macro Variables

This table presents summary statistics on municipal bond yields and other relevant state-level macroeconomic variables. Only 21 states, for which the Bloomberg yield curve data are available, are included. States are sorted into terciles by the (time-series) average highest state income tax rate. Highest state income tax rates are from Tax Foundation (2000-2009) and NBER Taxsim program (1998-1999). Credit ratings are from S&P. Municipal bond yields are from Bloomberg's fair value curve, estimated to fit transaction prices from the Municipal Securities Rulemaking Board (MSRB). Spread is the difference between bond yield and constant maturity Treasury yields from FRED. Return is annualized 6-month return, calculated by revaluing the bond using the prevailing yield curve six months from the current date and adding the coupon income. Equity return is monthly return on value-weighted portfolio of firms headquartered in each state. Yields, spreads, returns, and equity returns are reported as averages of monthly data. State GDP ($ billion) and unemployment rates are from Bureau of Labor Statistics. State debt data are from Census Bureau. Net issuance data are from Internal Revenue Service. Gross issuance of general obligation (GO) and revenue (RV) bonds are calculated as annualized monthly sums of individual bond issuance from SDC Platinum. All macroeconomic variables, except gross issuance of GO and RV bonds, are reported as averages of annual data. For each state, number of close elections is the number of gubernatorial elections during the period from 1998 to 2010, in which the vote difference between the winner and loser is 5% or less. The election data are from Wikipedia. Unusual states are those for which the tax statuses for bonds issued by the state and by other states are not, respectively, "exempt" and "taxable." Tests of difference in mean between the top and bottom tax terciles are conducted using standard errors clustered by calendar year. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	Credit Rating		20-Yr	20-Yr	20-Yr			Unemp.	Equity	Net	GO	RV	No. of
State	Worst	Best	Yield (%)	Spread (%)	Return (%)	GDP	Debt /GDP	Rate (%)	Return (%)	Iss. /Debt	Iss. /Debt	Iss. /Debt	Close Elec.
Top Tax Tercile (States with Highest Average State Tax Rate)													
CA	BBB	AA-	5.01	-0.06	5.24	1,583	0.16	6.97	0.95	0.09	0.09	0.10	1
DC	AAA	AAA	4.94	-0.13	5.98	78	0.09	7.02	0.20	0.10	0.09	0.14	
NC	AAA	AAA	4.69	-0.38	5.79	338	0.11	6.14	0.58	0.09	0.06	0.08	1
NJ	AA-	AA+	4.76	-0.31	5.60	412	0.16	5.58	0.40	0.08	0.10	0.10	1
MN	AAA	AAA	4.71	-0.36	5.98	223	0.15	4.76	0.76	0.09	0.09	0.06	3
NY	AA	AA	4.84	-0.23	5.88	923	0.24	5.86	0.46	0.06	0.07	0.09	0
OH	AA+	AA+	4.80	-0.27	5.75	424	0.13	6.17	0.46	0.07	0.09	0.09	1
Average			4.82	-0.25	5.75	569	0.15	6.07	0.54	0.08	0.08	0.09	
Average (excluding DC)			4.80	-0.27	5.71	651	0.16	5.91	0.60	0.08	0.08	0.09	

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Table III -*continued*

State	Credit Rating Worst	Credit Rating Best	20-Yr Yield (%)	20-Yr Spread (%)	20-Yr Return (%)	GDP	Debt /GDP	Unemp. Rate (%)	Equity Return (%)	Net Iss. /Debt	GO Iss. /Debt	RV Iss. /Debt	No. of Close Elec.
Middle Tax Tercile													
SC	AA+	AAA	4.72	-0.36	5.78	137	0.19	6.72	0.50	0.09	0.05	0.10	1
WI	AA-	AA	4.85	-0.22	5.65	208	0.16	5.23	0.83	0.07	0.09	0.07	2
GA	AAA	AAA	4.73	-0.34	5.80	346	0.11	5.65	0.51	0.10	0.06	0.10	0
TN	AA	AA+	4.48	-0.07	5.60	235	0.13	7.09	0.56	0.08	0.07	0.12	0
VA	AAA	AAA	4.68	-0.39	5.73	332	0.13	3.98	0.44	0.08	0.04	0.08	0
MA	AA-	AA	4.79	-0.28	5.89	313	0.23	5.21	0.68	0.05	0.09	0.07	2
MD	AAA	AAA	4.68	-0.39	5.83	232	0.13	4.63	0.63	0.08	0.07	0.06	1
Average			4.70	-0.29	5.76	258	0.15	5.50	0.59	0.08	0.07	0.09	
Average (excluding WI)			4.68	-0.30	5.77	266	0.15	5.55	0.55	0.08	0.06	0.09	
Bottom Tax Tercile (States with Lowest Average State Tax Rate)													
CT	AA	AA	4.75	-0.32	5.77	191	0.16	5.01	0.66	0.08	0.10	0.05	1
MI	AA-	AAA	4.87	-0.20	5.32	360	0.17	7.29	0.52	0.06	0.06	0.07	1
IL	AA-	AA	4.89	-0.18	5.10	549	0.17	6.32	0.64	0.07	0.07	0.05	2
PA	AA	AA	4.81	-0.26	5.78	466	0.20	5.54	0.55	0.06	0.06	0.06	0
FL	AA+	AAA	4.83	-0.24	5.59	620	0.18	5.81	0.70	0.08	0.02	0.11	1
TX	AA	AA+	4.86	-0.21	5.85	929	0.15	5.77	0.68	0.10	0.12	0.08	0
WA	AA	AA+	4.83	-0.23	5.71	272	0.19	6.38	0.78	0.08	0.06	0.06	2
Average			4.84	-0.23	5.59	484	0.17	6.02	0.65	0.07	0.07	0.07	
Average (excluding IL and FL)			4.83	-0.24	5.68	443	0.17	6.00	0.64	0.07	0.08	0.06	
Top - Bottom			-0.01	-0.01	0.16	85***	-0.02***	0.05	-0.10	0.01*	0.01***	0.02***	
Top - Bottom (excluding unusual states)			-0.03	-0.03**	0.02	207***	-0.01***	-0.08***	-0.04	0.00	0.00	0.02***	

Table IV

Price Effects of Fire Sales and Purchases – Univariate Analysis

This table presents univariate averages of bond yields and returns across state-months sorted into quintiles by trading pressure. For each state-month, pressure is calculated using the same formula as Pressure 1 of Coval and Stafford (2007) but replacing the average volume in the denominator by outstanding municipal debt at the previous year-end (Panel A) or net municipal debt issuance in the current year (Panel B). SFH is the amount of state-issued municipal bonds held by state municipal bond funds at the previous month-end, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. Both yields and returns are at the 20-year maturity. Municipal bond yields are at the end of the month in which pressure is calculated and are from Bloomberg's fair value curve, estimated to fit transaction prices from the Municipal Securities Rulemaking Board (MSRB). Returns are annualized 6-month returns, calculated by revaluing each bond using the prevailing yield curve six months from the current month-end and adding the coupon income. Only state-months with non-zero pressures are included. Averages of all state-months in each quintile are reported. Tests of difference in mean between quintiles 1 and 5 are conducted using standard errors clustered by calendar year-month. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

Panel A: Pressure as Fraction of Outstanding Debt

Pressure Quintile	Pressure (%)	SFH (%)	Yield (%)	Return (%)
From state funds				
1 (Positive)	2.49	59.01	4.62	5.13
2	0.33	56.09	4.69	4.37
3	0.04	54.46	4.74	6.24
4	-0.16	56.76	4.83	8.03
5 (Negative)	-1.20	56.30	5.12	12.33
1 - 5			-0.50***	-7.20***
From national funds				
1 (Positive)	2.54	39.02	4.69	6.90
2	0.50	42.15	4.74	5.99
3	0.09	49.23	4.81	6.88
4	-0.20	51.09	4.90	8.50
5 (Negative)	-1.38	44.00	5.02	10.96
1 - 5			-0.33***	-4.06**
State (1 - 5) - National (1 - 5)			-0.16*	-3.14*
p-value			(0.09)	(0.08)

Table IV *-continued*

Panel B: Pressure as Fraction of Net Issuance

Pressure Quintile	Pressure (%)	SFH (%)	Yield (%)	Return (%)
From state funds				
1 (Positive)	42.95	59.37	4.63	5.56
2	4.07	55.55	4.69	4.01
3	0.33	53.80	4.77	5.95
4	-2.39	58.27	4.92	8.64
5 (Negative)	-18.94	57.30	5.18	11.18
1 - 5			-0.54***	-5.62***
From national funds				
1 (Positive)	36.24	42.08	4.68	6.78
2	5.92	40.39	4.77	6.17
3	0.84	49.84	4.85	6.57
4	-3.14	49.90	4.97	8.77
5 (Negative)	-20.40	43.91	5.10	10.00
1 - 5			-0.42***	-3.21**
State (1 - 5) - National (1 - 5)			-0.12*	-2.40*
p-value			(0.16)	(0.09)

Table V

Price Effects of Fire Sales and Purchases – Multivariate Analysis

This table reports results from panel regressions of municipal bond yield spreads on dummy variables for being in the extreme quintiles of trading pressure from state and national funds. For each state-month, pressure is calculated using the same formula as Pressure 1 of Coval and Stafford (2007) but replacing the average volume in the denominator by outstanding municipal debt at the previous year-end. Pressures from state and national funds (SF and NF pressure, respectively) are separately calculated, and all state-months with non-zero pressures are independently sorted into quintiles according to each pressure. Yield spread is the difference between bond yield from Bloomberg and constant maturity Treasury yield from FRED at the 20-year maturity. Term spread is the difference between 10-year and 2-year constant maturity Treasury yields. Market equity return is CRSP value-weighted return, including dividends. All state control variables are as defined in Table III. All models include credit rating, state, calendar year, and calendar month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	(1)	(2)	(3)
SF Pressure Q1	-0.023		-0.031
	(0.037)		(0.036)
SF Pressure Q5	0.247**		0.227**
	(0.121)		(0.112)
NF Pressure Q1		0.042	0.040
		(0.049)	(0.047)
NF Pressure Q5		0.178**	0.157**
		(0.085)	(0.071)
State net issuance/Debt	0.340***	0.406***	0.379***
	(0.081)	(0.077)	(0.077)
State tax rate	-0.633	-1.055*	-0.825
	(0.601)	(0.569)	(0.584)
Term spread	-0.081*	-0.078*	-0.085**
	(0.041)	(0.040)	(0.041)
Market equity return	-0.236	-0.290	-0.336
	(0.543)	(0.540)	(0.529)
State equity return	-0.429**	-0.427**	-0.382**
	(0.188)	(0.191)	(0.193)
State debt/GDP	0.546***	0.664***	0.598***
	(0.200)	(0.209)	(0.209)
State unemployment rate	0.011***	0.014***	0.012***
	(0.004)	(0.003)	(0.003)
Credit rating dummies	YES	YES	YES
State dummies	YES	YES	YES
Year dummies	YES	YES	YES
Month dummies	YES	YES	YES
F-Test: Pressure Q1 = Pressure Q5	3.08*	1.79	
F-Test: SF Pressure Q1 - SF Pressure Q5 = NF Pressure Q1 - NF Pressure Q5			2.93*
Observations	2,846	2,846	2,846
R-squared (total)	0.753	0.751	0.757

Table VI

Price Effects of Supply

This table reports results from panel regressions of municipal bond yield spreads on net issuance and its interaction with dummy variable for being in the top tercile of state fund holding (SFH). Net issuance data are annual and are from Internal Revenue Service. Outstanding debt data are from Census Bureau. SFH is the amount of state-issued municipal bonds held by state municipal bond funds at the previous month-end, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. In each month, states with available data are sorted into terciles by SFH and the high SFH dummy equals one for states that are in the top tercile. Yield spread is the difference between bond yield from Bloomberg and constant maturity Treasury yield from FRED at the 20-year maturity. Term spread is the difference between 10-year and 2-year constant maturity Treasury yields. Market equity return is CRSP value-weighted return, including dividends. All state control variables are as defined in Table III. All models include credit rating, state, calendar year, and calendar month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. *, **, and *** refer to statistical significance at 10%, 5%, and 1% levels.

	(1)	(2)	(3)
High SFH	-0.012**	-0.051***	-0.046***
	(0.005)	(0.016)	(0.014)
State net issuance/Debt	0.203***	0.037	0.234***
	(0.058)	(0.080)	(0.072)
High SFH x State net issuance/Debt		0.479**	0.376**
		(0.200)	(0.173)
State tax rate			-0.954*
			(0.501)
Term spread			-0.073*
			(0.040)
Market equity return			-0.165
			(0.564)
State equity return			-0.492***
			(0.188)
State debt/GDP			0.526***
			(0.169)
State unemployment rate			0.013***
			(0.003)
Credit rating dummies	YES	YES	YES
State dummies	YES	YES	YES
Year dummies	YES	YES	YES
Month dummies	YES	YES	YES
Observations	2,846	2,846	2,846
R-squared (total)	0.738	0.738	0.746

Table VII

Pricing of Political Risk

This table reports results from panel regressions of municipal bond yield spreads on close election dummy and its interaction with dummy variable for being in the top tercile of state fund holding (SFH). Close election dummy equals one for the three months immediately preceding a gubernatorial election, in which the vote difference between the winner and loser is 5% or less. SFH is the amount of state-issued municipal bonds held by state municipal bond funds at the previous month-end, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. In each month, states with available data are sorted into terciles by SFH and the high SFH dummy equals one for states that are in the top tercile. Yield spread is the difference between bond yield from Bloomberg and constant maturity Treasury yield from FRED at the 20-year maturity. Term spread is the difference between 10-year and 2-year constant maturity Treasury yields. Market equity return is CRSP value-weighted return, including dividends. All state control variables are as defined in Table III. All models include credit rating, state, calendar year, and calendar month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	(1)	(2)	(3)
High SFH	-0.012**	-0.014**	-0.011**
	(0.005)	(0.005)	(0.005)
Close election	0.094**	0.058	0.039
	(0.039)	(0.045)	(0.042)
High SFH x Close election		0.191***	0.195***
		(0.070)	(0.068)
State net issuance/Debt			0.175**
			(0.076)
State tax rate			0.424
			(0.441)
Term spread			-0.073*
			(0.040)
Market equity return			-0.123
			(0.563)
State equity return			-0.533***
			(0.198)
State debt/GDP			0.691***
			(0.187)
State unemployment rate			0.017***
			(0.002)
Credit rating dummies	YES	YES	YES
State dummies	YES	YES	YES
Year dummies	YES	YES	YES
Month dummies	YES	YES	YES
Observations	2,700	2,700	2,700
R-squared (total)	0.736	0.736	0.744

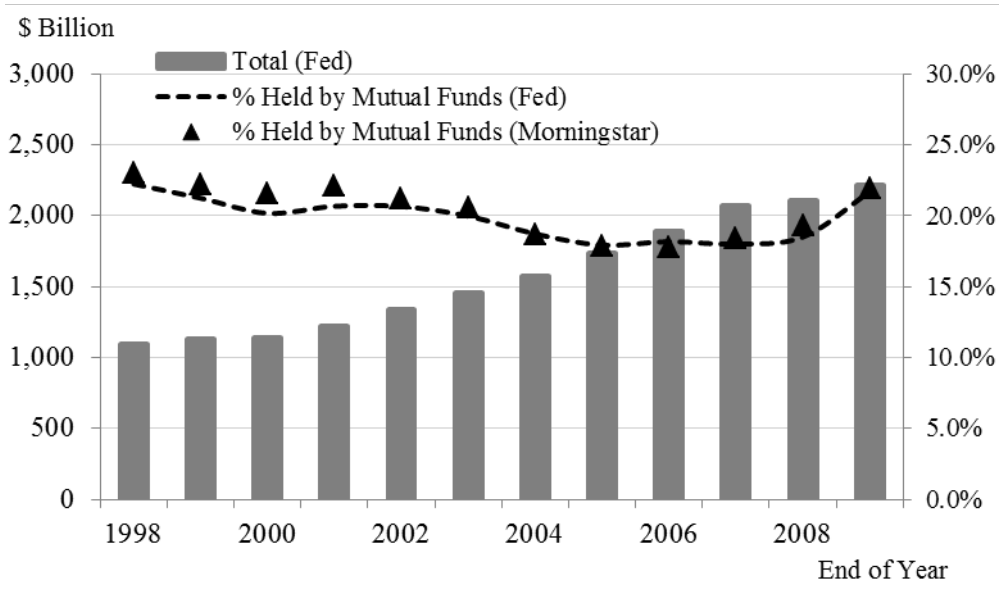
Table VIII

Issuance Effects of Fire Sales and Purchases

This table report results from panel regressions of gross issuance of general obligation (GO) and revenue (RV) bonds on dummy variables for being in the extreme quintiles of trading pressure from state and national funds. For each state-month, pressure is calculated using the same formula as Pressure 1 of Coval and Stafford (2007) but replacing the average volume in the denominator by outstanding municipal debt at the previous year-end. Pressures from state and national funds (SF and NF pressure, respectively) are separately calculated, and all state-months with non-zero pressures are independently sorted into quintiles according to each pressure. For each state-month, gross issuance is the annualized sum of par values of all GO or RV bonds issued within the month by all entities in the state, as reported by SDC Platinum. All state control variables are as defined in Table III. All models include credit rating, state, calendar year, and calendar month dummies. Standard errors, clustered by calendar year-month, are reported in parentheses. ∗, ∗∗, and ∗∗∗ refer to statistical significance at 10%, 5%, and 1% levels.

	GO Gross Issuance/Debt x 12			RV Gross Issuance/Debt x 12		
	(1)	(2)	(3)	(4)	(5)	(6)
SF Pressure Q1	0.002		0.002	0.023***		0.022***
	(0.006)		(0.006)	(0.007)		(0.007)
SF Pressure Q5	-0.009		-0.009	-0.016**		-0.015**
	(0.007)		(0.007)	(0.006)		(0.006)
NF Pressure Q1		-0.005	-0.005		0.015**	0.014**
		(0.005)	(0.005)		(0.006)	(0.006)
NF Pressure Q5		0.002	0.003		-0.000	0.001
		(0.004)	(0.004)		(0.005)	(0.005)
State tax rate	0.265	0.266	0.256	-0.435	-0.395	-0.431
	(0.347)	(0.349)	(0.348)	(0.330)	(0.320)	(0.325)
Term spread	-0.000	-0.000	-0.000	-0.004	-0.005	-0.005
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Market equity return	0.027	0.023	0.025	0.066	0.063	0.067
	(0.048)	(0.048)	(0.048)	(0.051)	(0.052)	(0.052)
State equity return	0.018	0.020	0.018	-0.029	-0.024	-0.028
	(0.039)	(0.039)	(0.039)	(0.037)	(0.037)	(0.037)
State debt/GDP	-0.286**	-0.281**	-0.279**	-0.191	-0.217*	-0.208*
	(0.138)	(0.139)	(0.139)	(0.120)	(0.122)	(0.121)
State unemployment rate	0.000	0.000	0.000	-0.004	-0.004*	-0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Credit rating dummies	YES	YES	YES	YES	YES	YES
State dummies	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Month dummies	YES	YES	YES	YES	YES	YES
F-Test: Pres. Q1 = Pres. Q5	1.49	1.30		16.76***	3.90*	
F-Test: SF Pres. Q1 - SF Pres. Q5 = NF Pres. Q1 - NF Pres. Q5			2.09			3.48*
Observations	2,846	2,846	2,846	2,846	2,846	2,846
R-squared (total)	0.283	0.283	0.283	0.279	0.277	0.282

Panel A: Aggregate Market and Value Held by Mutual Funds



Panel B: State vs. National Municipal Bond Mutual Funds

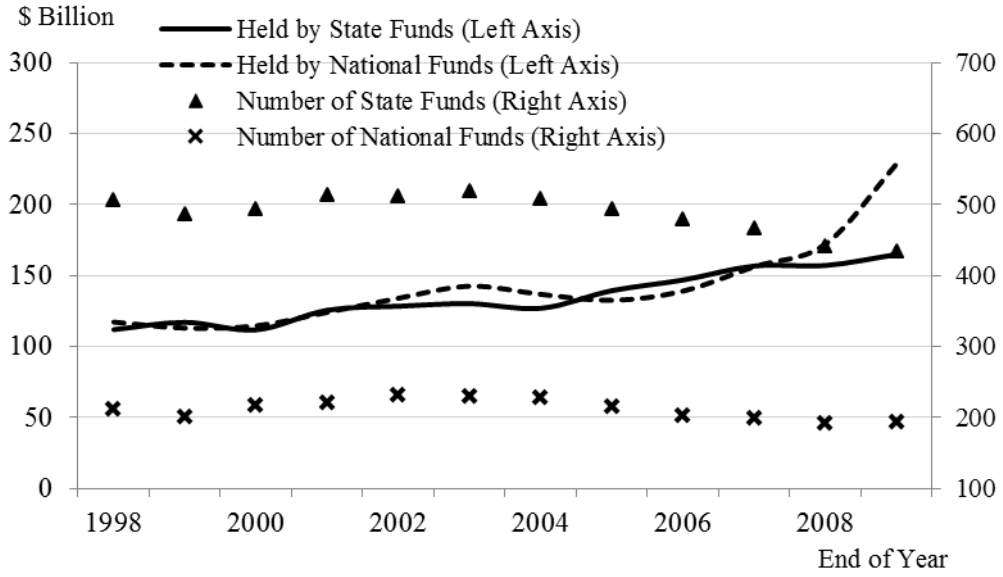
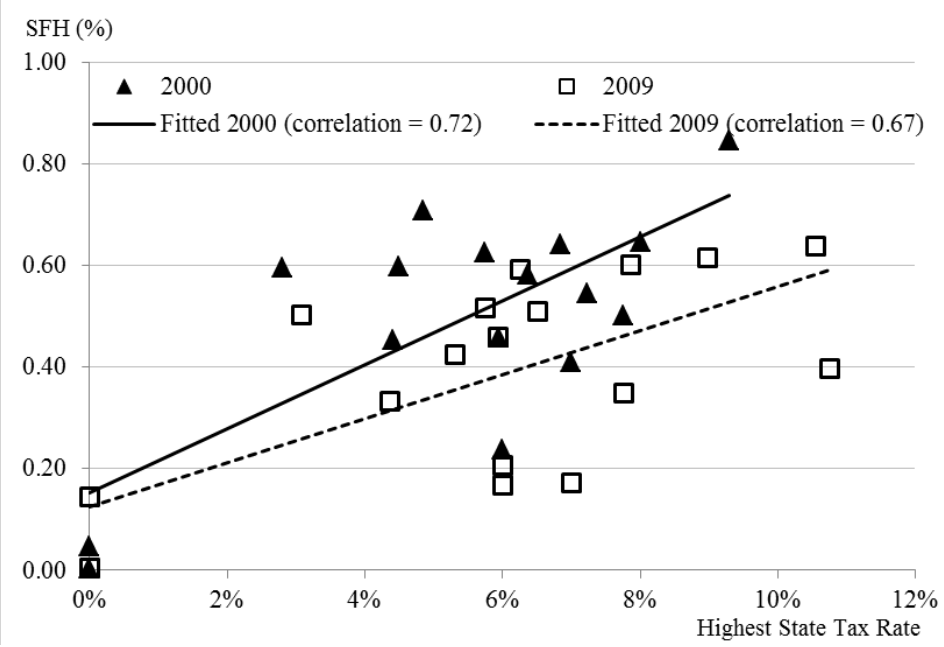


Figure 1. Tax-exempt municipal bond market and mutual funds over time. This figure presents the total outstanding amount of tax-exempt municipal bonds over the sample period from 1998 to 2009. Panel A plots the total outstanding amount and the amount held by mutual funds, as reported by the Federal Reserve, 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: All Maturities in 2000 and 2009



Panel B: 10-Year and 20-Year Maturities in 2009

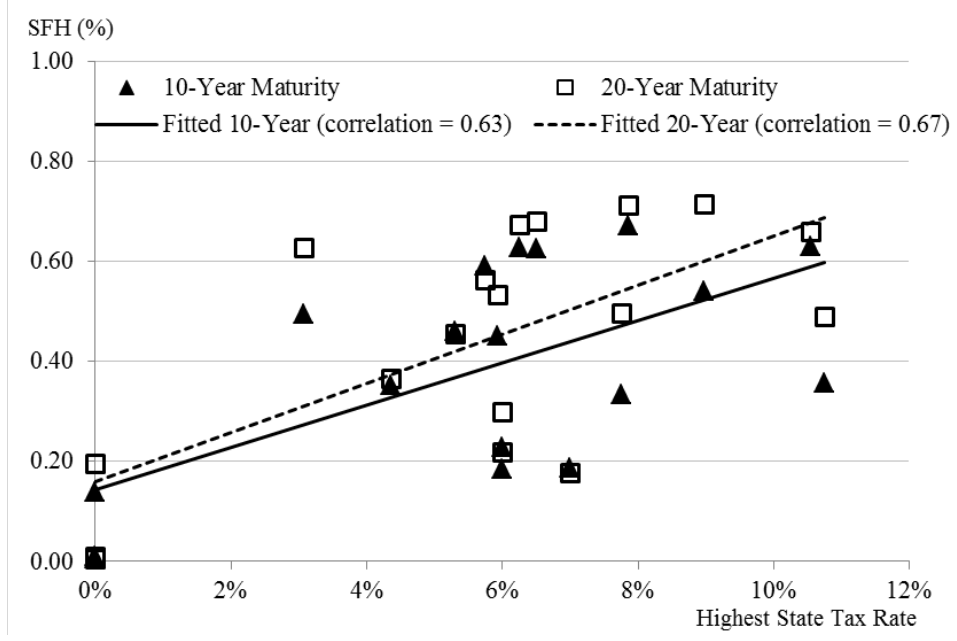
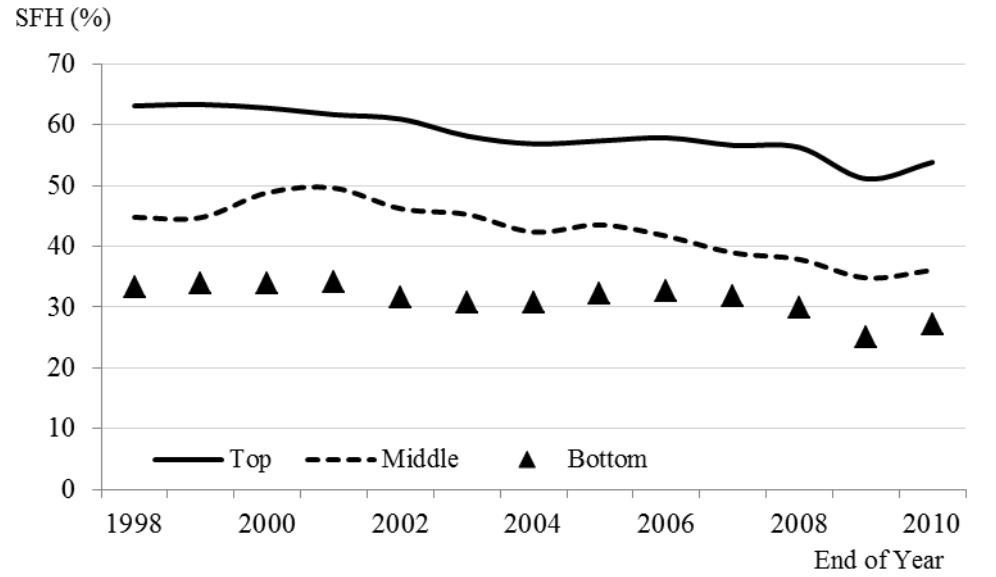


Figure 2. State tax rate and state fund holding. This figure plots state fund holding (SFH) of all municipal bonds issued by each state against the highest state income tax rate. For each state at each time point, SFH is the amount of state-issued municipal bonds held by state municipal bond funds, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. Panel A presents the data at the ends of 2000 (triangle) and 2009 (rectangle), and their best fitted linear lines. Panel B presents the data at the end of 2009 for bonds in the 10-year maturity bucket (triangle) and bonds in the 20-year maturity bucket (rectangle). The 10-year (20-year) maturity bucket includes maturities from 8 to 15 years (greater than 15 years). Unusual states, including DC, FL (prior to 2007), IL, and WI, are excluded.

Panel A: Average State Fund Holding by Tax Terciles



Panel A: Average State Fund Holding for Selected States

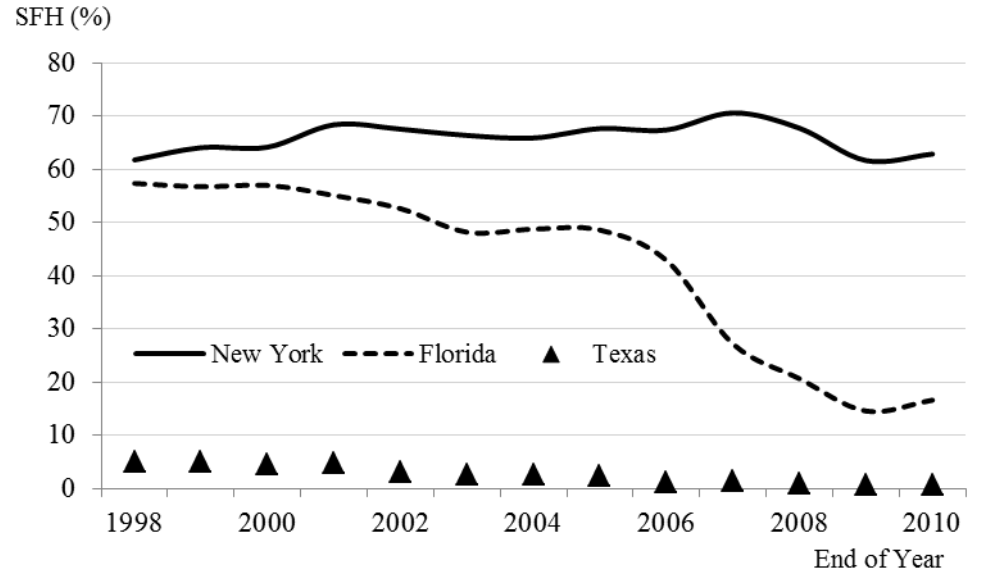


Figure 3. State fund holding for high- and low-tax states over time. This figure plots state fund holding (SFH) for different states over time. For each state at each time point, SFH is the amount of state-issued municipal bonds held by state municipal bond funds, presented as a percentage of the amount of state-issued municipal bonds held by all municipal bond funds. Panel A presents the average SFH for three state terciles, sorted by the time-series average of highest state tax rate. The top (bottom) terciles include states with the highest (lowest) state tax rates. Unusual states, including DC, FL (prior to 2007), IL, and WI, are excluded. Panel B presents the SFH for three selected states: NY, FL, and TX. Effective from 2007, FL abolished intangible property tax on financial assets, including investments in municipal bonds and bond funds.