Market Segmentation and the Cost of Capital: Evidence from the Municipal Bond Market [*]

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Abstract

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Financial economists generally agree that taxes have profound effect on capital markets, but the nature of this effect remains largely unclear. This is partly due to the fact that the tax code is complex and investors are heterogeneous with respect to their tax-status, which creates difficulties in both developing general intuitions and designing empirical tests on the effects of taxation in financial market. Dybvig and Ross (1986) comment that "in the study of investments, taxes are largely a source of embarrassment to financial economists. We know that taxes are significant, but we do not know the equilibrium effect of taxes on asset pricing and the consequent effect on portfolio choice."[1]

In this paper we study one aspect of taxation that has direct asset pricing implications – the formation of investor clienteles. In the municipal bond market clienteles emerge as a result of asymmetric tax exemption – the income from most municipal bonds is exempt from state and local taxes for in-state investors but not for out-of state investors.[2] This asymmetric tax-exemption creates a robust segmentation of the market by attracting predominantly in-state investors in relatively high tax brackets. Our analysis provides insight into several long standing puzzles in the municipal bond market, such as its high yields (*the Muni-puzzle*), popularity of insurance, and unusually high transaction costs.[3]

We start the paper by exploring theoretically how taxes affect the demands and valuations in the municipal bond market. In the model investors allocate wealth among in-state municipal bonds, out-of state municipal bonds, and a risk-free bond. At the end of the period, investors

[1] See Dybvig and Ross (1986). Recent papers that examine various impacts of taxes on financial market include[Cite the papers that have advanced our understanding on this issue since Dybvig and Ross]

[2] Unlike treasury bonds municipal bonds are usually exempt from federal taxes for U.S. investors. This asymmetric tax treatment of municipal bonds with respect to federal taxes imposes additional frictions in the market, most notably limits to arbitrage. We elaborate more on them in Section II.

[3] Arak and Guentner (1983) and Poterba (1986), and Green (1993), among many others, show that *long-term* municipal bond yields tend to be much higher than predicted by theory. Hempel (1972), Zimmerman (1977), Fama (1977) argue that municipalities are more opaque than other issuers. In a recent article, Baber and Gore (2007) show that GAAP standards have become increasingly popular for municipalities and that GAAP requirements reduce municipal borrowing costs.

receive income in the form of interest payments and capital gains. The income from the municipal bonds is at risk as a result of possible default or liquidity shock in the future demand for the bond. The tax-exemption of interest income creates an incentive for investors to invest in-state, while the risk of the bond creates incentive to invest out-of-state. The equilibrium allocation under asymmetric tax-exemption would always be biased toward local bonds relative to the allocation under symmetric tax exemption.

We show that the formation of local clienteles in the municipal bond market creates cross-sectional dispersion in bond yields across states which wouldn't be present in a market with symmetric tax exemption. Such dispersion increases the average yields in the market, given that in equilibrium, investors would always allocate part of their portfolio out-of-sate.[4] As a result, although investors are exempt from state taxes on their local positions, their effective tax rate would always be positive. This will result in a discount of municipal bond prices relative to the prices of otherwise similar bonds that are not subject to differential taxation. The discount could be significant even for bonds with low level of risk if the average tax rate in the market is high and the state has relatively low demand for municipal bonds.

We also note that the current tax treatment of municipal bonds creates impediments to arbitrage in the market which would allow for the divergence in municipal bond yields across states to persist over time. On the one hand, since arbitrageurs are concerned about after-tax returns, the asymmetric tax exemption with respect to state taxes increases the cost of arbitrage by limiting the capital flows across states. A more important limit to arbitrage, however, concerns the link between the municipal bond market and the treasury market. Municipal bonds are exempt from federal income taxes while treasury securities are not. As a result, even if municipal bond yields are higher

[4] Our communications with several municipal bonds investment managers reveal that municipal bond investors generally allocate fifteen percent to twenty percent of municipal bond portfolio to out-of-state bonds.

than after-tax treasury yields, arbitrageurs would never be able to lock in the difference since the borrowing cost against treasuries is not tax exempt.

Using a full sample of municipal bond new issues between 2001 and 2007, we next provide empirical evidence on the effects of asymmetric tax-exemption in the municipal market. Consistent with the case of segmentation, we find that the yields of municipal bonds are negatively related to local demand and positively related to local supply of bonds in the state of the issuer. We measure local demand with the average income per capita in the state and the average income from dividends, interest, and rent, which could characterize better the representative investor in the market – wealthy individual investors with capital market participation. We measure local supply with the value of new bond issues per capita in the state. As predicted by the segmentation hypothesis, we also show that the sensitivity of yields to local demands is stronger for bonds with lower credit rating and longer maturity.

To assess the importance of local tax exemption for segmentation, we next examine the relationship between municipal bond yields and state-level demand and supply for the subsample of states with no income tax. Because investors within this group can invest across states at no additional cost, we predict that municipal bond yields in these states will be less sensitive to local demand and supply of municipal bonds. We confirm this conjecture.

To shed additional light on the tax-argument, we also analyze a sample of taxable municipal bonds. We expect that the market of taxable municipal bonds would be generally less segmented than the market of tax-exempt municipal bonds, since these bonds attract investors in relatively low tax-brackets and tax-exempt institutional investors. Given their tax-status, such investors would be less constrained by tax-considerations when constructing their portfolios. Consistent with a stronger geographic integration of this market, we observe that both state taxes and state demands have no significant impact on the yields of taxable municipal bonds.

At the end of our empirical analysis, we provide an estimate of the actual cost of tax-induced segmentation of the municipal bond market. We use as a benchmark case the market for taxable municipal bonds. Given that taxable municipal bonds are otherwise similar to tax-exempt municipal bonds, the difference in the yields of these bonds could be interpreted as a segmentation premium. We show that tax-exempt municipal bonds are consistently priced at higher yields than taxable municipal bonds – the average yield of tax-exempt bonds exceeds the average yield of similar taxable bonds by 55 basis points. The valuation premium of taxable bonds is robust across bond-ratings and maturity.

Tax-induced market segmentation also helps explain the increasingly popular practice of municipal bond insurance.[5] The tax-induced local bias of municipal bond investors would result in allocation which is sub-optimal from a risk-sharing perspective. Insurance companies, on the other hand, can diversify effectively across geographic regions. By pooling the regional risk of municipal bonds and placing it in portfolios that are well diversified across geographic regions, insurance companies can generate surplus that could be shared between them and municipalities. Consistent with the hypothesis that municipal bond investors are under-diversified on the state level, we show that the probability for insurance of a new tax-exempt municipal bond increases with the local supply of bonds in the market and the size of the offering. The probability for insurance of taxable municipal bonds, on the other hand, is not significantly related to the local supply of bonds in the state.

Our results have direct policy implications. We argue that the tax-induced segmentation of the U.S. municipal bond market increases the borrowing costs of municipalities in several ways. First, by restricting investor participation across regions, market segmentation increases the yields of states with small local demand. Second, by limiting risk sharing among investors from different

[5] In recent years, nearly 50 percent of new municipal bond issues were insured (American Banker Incorporated, The Bond Buyer Yearbook, 2002).

states, market segmentation increases the cost of capital even for states with greater local demand. Although bond issuers attempt to reduce the adverse impact of risk sharing on yields by purchasing insurance from financial intermediaries, such an approach could be more costly and less effective than direct risk sharing by investors. Third, market segmentation reduces the overall liquidity of municipal bonds, which could also increase the yields across the whole market. Finally, the status-quo of numerous localized markets could present a serious impediment for financial development of the market. This could be largely the reason while we still lack good trading environment for municipal bonds despite the large size of the market.

One possible policy solution to the asymmetric tax exemption problem is to eliminate the asymmetric tax treatment – by either exempting both in-state and out-of state municipal bonds from taxation or taxing both in-state and out-of state municipal bonds equally. Symmetric taxation of in-state and out-of-state bonds could improve the efficiency of the market and lower the cost of capital for municipalities, but such changes could be difficult to carry out. In a widely followed Supreme Court ruling in 2008 regarding tax exemption of in-state bonds, the Supreme Court upheld the long-standing state tax exemptions for municipal bonds and ruled that such exemption does not violate the Constitution's commerce clause. Neither the court majority opinion nor briefs submitted by all fifty states and the Securities Industry and Financial Markets Association, however, have questioned the merits of such tax exemption policies and have agreed that overturning the exemption would upset the market.[6]

The paper is organized as follows. Section I describes the municipal bond market and the associated tax policies. Section II presents a theoretical justification of the analysis. Section III describes the municipal bond data. Section IV presents the basic empirical results; Section V

[6] See DEPARTMENT OF REVENUE OF KENTUCKY et al. v. DAVIS et ux. No. 06-666. May 19, 2008

explores the issue of municipal bond insurance; and Section VI estimates the cost of segmentation. We conclude in Section VII.

I. The Municipal Bond Markets

In this section we outline basic facts about the municipal bond market and particularly the asymmetric tax exemption of municipal bonds interest income. We also discuss some well-documented facts about the municipal bond market that could be related to the tax-induced segmentation of the market – the muni-puzzle, bond insurance, and limits to arbitrage.

I.A. Institutional Details

Municipal bonds are issued by local governments such as states, cities, and counties, or their agencies to raise funds. In recent years, the municipal bond market has grown significantly in size. At the end of 2007, there were $2.6 trillion municipal securities outstanding, as compared to $4.9 trillion Treasuries.[7]

One of the most important features of municipal bonds is the tax treatment of interest income. Interest income of most municipal bonds is exempt from federal income tax. In contrast, interest income from treasury securities is subject to federal taxation. The principle reason behind the federal tax exemption of municipal debt was that the Supreme Court originally interpreted the U.S. constitution to not allow the Federal government to tax states. Such tax exemption of municipal debt has remained largely unchanged from the inception of the current federal income tax.

Another important tax exemption for municipal bonds is at the state and local level. In 2006 all but five states (Illinois, Iowa, Kansas, Oklahoma, and Wisconsin) exempted municipal

[7] Federal Reserve, Flow of Funds Accounts of the United States, tbl.L.211, at 89 (March 6, 2008) available at http://www.federalreserve.gov/releases/Z1/.

bond interest from state income tax provided that the bonds were issued within the state of the bondholder's residence.[8] But not all interest earned on municipal bonds is excluded from state income taxes. In 36 states, interest from out-of-state municipal bonds is taxed as income. In 9 states and the District of Columbia, there is no income tax on interest income from municipal bond issued by any authority, either because the state does not have state income tax or chooses to exempt interest income for all municipal bonds (DC, Indiana and Utah).[9] Interest from U.S. treasury bonds is excluded from income for state tax purposes in every state of the United States.

Because of the benefit of tax exemption, and particularly after the Tax Reform Act of 1986 that restricted tax-exempt investments by commercial banks and corporations, municipal bonds are attractive to high net worth individuals. At the end of 2007, individuals held 70% of all outstanding municipal bonds – 36% directly, and 34% through mutual funds, closed-end funds, and other taxable pass-through intermediaries.

An increasingly important subset of the municipal bond market is the market of taxable municipal bonds. Taxable municipal bonds are issued by the same municipal entities that issue tax-exempt bonds. The taxable municipal bonds are created when 10% or more of a newly issued bond is used to finance private business activities. As a result of its taxable status, a taxable municipal bond produces interest income that is subject to federal income tax. However, a taxable municipal's interest income is often exempt from state and local income taxes. The taxable municipal market has grown significantly in recent years and now represents approximately 6% of the total municipal market. The clientele of taxable municipal bonds differ from that of the tax-exempt municipal bonds. The buyers of taxable municipal bonds tend to be investors in a low tax bracket, such as retirees, and investors who invest in the bonds for their retirement accounts.

[8] In these five states, interest income from some of in-state municipal bonds is tax exempt.
[9] Starting from January 1, 2003, Utah exempts interest earned on non-Utah municipal bonds if the state issuing the bonds does not impose an income tax on bonds issued by Utah, changing its policy of exempting all municipal bonds.

I.B. Municipal Bond Yield (Muni-puzzle)

In equilibrium, the after-tax yields of similar taxable and tax-exempt bonds should be equal, or at least "very close". However, empirical evidence has consistently shown that municipal bond yields are higher than the yields of treasury or corporate bonds with similar characteristics. The yield differential is particularly high for long term bonds. Stated differently, the muni-puzzle indicates that municipal bond yields imply a tax rate much lower than the marginal tax rates of high-income individuals.

Different explanations have been proposed for the muni-puzzle. Trzcinka (1982), Yawitz, Maloney and Ederington (1985), and Stock (1994) argue that municipal default risk is an important factor in determining the relative yields, even when yields from high-quality municipal bonds are analyzed. However, Chalmers (1998) analyses U.S. government secured municipal bonds that are effectively default-free and shows that they also trade at a discount relative to treasury securities. He concludes that differential default risk is not the only explanation of the municipal bond puzzle. Other explanations such as less valuable tax-timing options in municipal bonds (Constantinides and Ingersoll (1984)) and the importance of portfolio tax-avoidance strategies (Green (1993)) were also unable to resolve completely the puzzle.

In our theoretical discussion, developed in the next section, we show that the asymmetric tax exemption at state level creates barriers to capital flows across state borders. Such barriers limit the market participation and risk sharing opportunities for municipal bond investors, which could result in a valuation discount of municipal bonds relative to otherwise similar securities. Tax-induced segmentation of the municipal bond market could also reduce the overall liquidity of the market and impose limits of arbitrage.

I.C. Municipal Bond Insurance

A salient feature of the municipal bond market is the popularity of insurance for municipal bonds. In municipal bond insurance, bond issuers purchase insurance at the time of issuance from a third-party insurer. The insurer promises to step in and make timely payments to the bondholder in the event of default. Currently, about 50% of municipal bonds are prepackaged with insurance at the time of the issue.

Nanda and Singh (2004) show that the demand for municipal bond insurance can be attributed in part to the tax exemption feature of municipal bonds. Insurance maintains the timing of payments in the event of default, and thus preserves the tax status of the payments received by the investors. In comparison, maintaining the tax status of a taxable bond is unimportant. Insurance can also provide improved diversification and liquidity. For example, bond insurers can diversify default risk better than individual investors. Similarly, insurance can increase liquidity for insured bonds by reducing information risk faced by investors.

Segmentation in the municipal bond market could help explain the popularity of municipal bond insurance. Asymmetric tax exemption limits the incentive of investors to diversify regional risk, which creates demand for insurance. Unlike most individual investors, insurance companies can diversify effectively across geographic regions at no additional cost. This would allow insurance companies to reduce the risk exposure of individual investors at a lower cost than they can do on their own.

I.D. Tax-arbitrage in the Municipal Bond Market

Given the higher yields of municipal bonds relative to taxable bonds with similar characteristics and yield differentials across states, arbitrageurs may be able to take advantage of such opportunities and drive down municipal bond yields both across states and the overall level.

For example, corporations can employ a simple arbitrage strategy to take advantage of such yield differentials by borrowing money to invest in tax-exempt municipal bonds. Such strategy is profitable whenever the tax exempt return exceeds the after-tax cost of borrowing.

The persistently higher yields of municipal bonds imply that there is some hidden cost associated with this arbitrage strategy. Part of this cost is regulatory. For example, the Tax Reform Act of 1986 reduced banks' ability to engage in municipal bond arbitrage in most municipal bonds.[10] Erickson, Goolsbee and Maydew (2003) show that there is little evidence of municipal bond tax arbitrage by non-financial corporations. They find that firms generally do not engage in the arbitrage activities and among those engaged in arbitrage, many firms do less than the safe-harbor amount allowed by the tax authorities. They conclude that some underlying costs of such arbitrage activity, though difficult to identify, prevent tax arbitrage in the municipal bond market.

We argue that the asymmetric tax exemption of municipal bonds with respect to both state and federal taxes constitutes an impediment to arbitrage. Arbitrageurs are concerned about their after-tax returns. Tax-exempt securities have lower yields than similar taxable securities. The tax-shields on tax-exempt securities, however, can be realized only on long positions. As a result the yields of municipal bonds from different states and the yields of treasury securities could diverge substantially even if these bonds have similar characteristics.

II. Model

To study the impact of taxation in the municipal bond market, we develop a simple equilibrium model under asymmetric tax-exemption. The model illustrates how asymmetric tax-

[10] The Tax Equity and Fiscal Responsibility Act of 1982 limited banks' interest deduction in to their investment in municipal bonds and the Tax Reform Act of 1986 repealed the interest deduction. The 1986 Act retained a class of "bank qualified" municipal bonds that such interest deductions can still be applied. The "bank qualified" bonds are issued by municipalities that do not plan to sell more than $10 million of bonds in each given year.

exemption of municipal bonds could increase the average yields in the market by restricting the opportunities of investors to share risks across regions. There are at least two different ways to think about risk in the municipal bond market. The first one is default risk, while the second one is liquidity risk. Most municipal bonds are long-term instruments and the marginal investor in the market is very likely to sell prior to maturity, in which case he would face uncertain future demand. Although we don't model these risks explicitly, we note that in segmented capital markets they would be highly correlated given that the idiosyncratic shocks in local fundamentals and local demands are expected to be correlated.

In the model investors trade-off the tax-benefits of in-state bonds with the diversification benefits of out-of-state bonds. In equilibrium, the marginal diversification benefit of investing out-of-state would be always equal to the marginal local tax-rate. In this equilibrium, investors would always allocate part of their portfolio out-of-sate, and as a result, their effective tax rate would be always positive. This will result in a discount of municipal bond prices relative to the prices of otherwise similar securities that are not subject to differential taxation.[11]

Consider N states which have issued municipal bonds. For each state *i*, we denote with – Y_i the total number of municipal bonds offered (local supply); M_i the total number of municipal bond investors from the state (local demand); T_i the local state tax. All bonds within each state are identical. At the end of the period, the bonds from State i pay a coupon C_i and a principal $\tilde{F}_i$; the

[11] The risk-sharing cost of segmentation has been addressed in the literature within other settings. For example, Merton (1987) analyses capital market equilibrium in which investors invest only in a subset of available securities, the ones they are familiar with. He shows that in such a market the cost of capital of a security would be inversely related to breadth of its ownership. Within an international context, Stulz (1999) shows that the cost of capital of a country can be affected by the degree of home bias of its domestic and foreign investors. Stulz shows that the cost of capital always falls as the home bias decreases. There is also extensive empirical evidence from international finance showing that segmented capital markets have a higher cost of capital (see Errunza and Losq, 1985; Foerster and Karolyi (1999); Bekaert and Harvey (2000); and Stulz (1999), among others).

price of these bonds at the beginning of the period is denoted with P_i. We assume that the coupon payment is certain [mention this is for ease of exposition], while the principal payment is at risk and it is modeled as a random variable with expected value equal to 1 and a variance equal to σ_i^2. We also assume that these random variables are independent across bonds and identically distributed across states.

There is also a risk-free security in the market with a principal amount equal to 1. The cash-flows generated by a municipal bond are exempt from federal taxes for all investors and from state taxes for all investors from the state of the issuer. For simplicity, we assume that the federal tax rate is equal to zero.

Assume that all investors are risk-averse with a CARA utility function of expected wealth and a constant risk-aversion coefficient equal to ρ. Let's consider the investment decision of an investor from State 1. If we denote this investor demands for the municipal bonds and the risk-free security with $(x_{1,1}, x_{1,2}, ..., x_{1,N}; z_1)$, it is well known that maximization of a CARA utility function is equivalent to maximizing

$$\underset{\{x_{1,1}, x_{1,2}, ..., x_{1,N}; z_1\}}{Max} \mathrm{E}(\pi_1 \mid P) - \frac{\rho}{2} Var(\pi_1 \mid P) \qquad (1)$$

$$\text{S.t. } x_{1,1} P_1 + \sum_{j=2}^{N} x_{1,j} P_j + z_1 \frac{1}{1+r} = W_1,$$

$$\text{where } \pi_1 = \sum_{j=1}^{N} x_{1,j} (c_j + \tilde{F}_j) - \sum_{j=2}^{N} x_{1,j} c_j T_1 + z_1 1.$$

The second summation term in the terminal wealth expression captures the differential tax treatment of municipal bonds. Since this is a Sate 1 investor, the interest income generated by the

State 1 bond is not subject to taxation, while the income generated by other states bonds is taxed at the state tax rate T_1. For simplicity, we assume coupon payments are equal across states.

After substituting investor terminal wealth into the objective function in (1), we derive the optimal in-state and out-of-state investor demands, which combined with the market-clearing conditions of all states results in the following equilibrium price of State 1 municipal bonds (more detailed derivation is presented in the Appendix):

$$P_1 = \frac{1}{1+r}\left\{(1+c) - c\sum_{j=1}^{N} T_j \frac{M_j}{M} + cT_1 \frac{M_1}{M} - \rho\sigma_1^2\left(\frac{Y_1}{M}\right)\right\} \tag{2}$$

Note that if we have full tax exemption, the pricing equation in (2) collapses to

$$P_1^F = \frac{1}{1+r}\left\{(1+c) - \rho\sigma_1^2\left(\frac{Y_1}{M}\right)\right\} \tag{3}$$

From here we can make a series of observations. First, asymmetric tax exemption increases the dispersion of yields across states. Second, asymmetric tax exemption also increases the average yields in the market ($P_1 < P_1^F$). Since the equilibrium portfolio of any municipal bond investor would always contain out-of-state bonds, the effective state tax of municipal bond investors is always greater than zero. This will result in a discount of municipal bond prices relative to the prices of otherwise similar securities that are not subject to differential taxation. The discount could be significant even for bonds with low level of risk and the magnitude of the discount increases with the level of the state tax rate. Note that, when the volatilities in the pricing equations (2) and (3) converge to zero, the bond prices under asymmetric tax exemption would be always higher than the bond prices under symmetric tax exemption.

The high yields of municipal bonds relative to taxable government bonds raise naturally the question about arbitrage in this market. In particular, a firm could borrow money against the risk-free rate to invest in tax-exempt municipal bonds from the states with the highest yields. Such

a strategy is profitable whenever the tax exempt return exceeds the after-tax cost of borrowing. There are, however, several limits to this arbitrage opportunity. On the one hand, such arbitrage would be risky. On the other hand, the asymmetric tax exemption of municipal bonds and government bonds with respect to federal taxes would restrict this arbitrage even further.

Because municipal bonds are exempt from federal income taxes while treasury securities are not, even if municipal bond yield is higher than after-tax treasury yields, arbitrageurs may not be able to take advantage of such arbitrage opportunities because borrowing costs associated with such arbitrage activities are not tax exempt.[12] For example, even if municipal yields are higher than treasury yields after adjusting for federal taxes (say, municipal bonds offer 4%, while treasury bonds offer 4.2% before taxes and 3.5% after taxes), the actual borrowing cost for an arbitrageur would be the before-tax treasury yield (in the example, 4.2%). As a result, an arbitrage with the treasury market would not work unless the yield differential between municipal bonds and treasury securities is unusually high.

An arbitrage opportunity between municipal bonds from various states could be even more expensive than an arbitrage between municipal securities and treasuries. First of all, similarly to government bonds shorting tax-exempt municipal bonds would be also against after-tax yields. Second, shorting municipal bonds even without tax exemption is difficult. As a result the yields of bonds from two different states could diverge significantly even if the bonds have similar characteristics. In sum, asymmetric tax exemption imposes a significant impediment to arbitrage in the municipal bond market, in addition to other well documented constraints in the literature (Shleifer and Vishny (1997)).

[12] As explained in Erickson, Goolsbee and Maydew (2003), there is little evidence of municipal bond tax arbitrage by corporations that can deduct taxes in borrowing costs associated with municipal bond investment.

III. Data on Municipal Bond Issuance

To test the theoretical predictions outlined in the previous section, we use a comprehensive sample of municipal bond offerings from the Thomson Financial SDC Platinum database (SDC). We include in our sample bonds that are issued between 2001 and 2007 and bonds that are with maturity longer than one year. Because the yield of municipal bonds is the main variable of interest in our empirical analysis, we restrict our basic sample to bonds with non-missing yield information (Total Interest Cost or TIC). As indicated in Table I, yield coverage reduces sample size significantly but doesn't introduce a strong bias with respect to all major variables except the type of the offering – bonds sold through a competitive bid tend to have better yield coverage than bonds sold through negotiation.

The objective of our study is to assess the economic impact of tax-induced segmentation of the municipal bond market on the borrowing cost of municipalities. Our major cost variable is the municipal bond *yield*. Municipal bond issues are generally structured with serial maturities (i.e. principal maturing in each year). This convention allows the issuer to structure the financing so that the pattern of total principal and interest payments are optimized relative to the issuer's budget planning. Coupon rates often vary by maturity. The overall yield on the entire issue is calculated as the interest rate that equates the present value of payments on the bond issue with the net proceeds derived from the issue.

In order to assess the importance of geographic segmentation for the municipal bond market, we construct measures of local demand and supply of municipal bonds. We measure local demand with state *income per capita* and *investment income per capita*, where the latter is defined as the aggregate income of local residents in the form of dividends, interest, and rent. Investment income could represent better the demand of the representative investor in the market than total income, given that typical municipal bond investors are wealthy individual investors with active

capital market participation. We measure local supply with the value of new debt issues per capita in the state. Personal income, investment income, personal income per capita, and investment income per capita for each state are derived from the Regional Economic Information System (REIS) provided by the Bureau of Economic Analysis. Investment income and investment income per capita is defined as income derived from dividends, interest, and rent.

We also use additional control variables that are related to bond yields, such as callable features, insurance, preferential treatments by banks, type of the initial sale (competitive bid vs. negotiated offer), bond maturity and credit rating. With respect to bond maturity, we regard the bond as a short-term bond if it has a maturity of less than 5 years, as a medium-term bond if it has a maturity between 5 and 15 years, and as a long-term bond if it has a maturity of more than 15 years. We classify a bond as a high-grade bond if it is rated as "Aaa", as a medium-grade bond if it is rated as "Aa1", "Aa2", or "Aa3", and as a low-grade bond in all other cases (including the case of no-rating), according to Moody's ratings.

Table I presents the basic summary statistics. The initial sample covers around 100,000 new bond issues from 2001 to 2007. Form the initial sample we exclude bonds without yield information and other bond characteristics information. We further exclude auction rate bonds from the sample. The final sample contains 19,057 bonds that have non-missing yield information, of which 18,297 are tax-exempt bonds. The tax-exempt bonds comprise our basic sample.

The first two panels of the table present average bond characteristics across the two samples. The basic sample is slightly biased towards medium- and long-maturity bonds and bonds with higher credit rating. The most notable difference between the two samples is the type of the offering – only around one-third of the bonds in the initial sample were offered through a competitive bid, while for the basic sample this number is close to 90 percent. However, we don't think that these differences are biased towards establishing a segmentation of the municipal bond

market. On the contrary, the basic sample has better quality offerings, in terms of investment grade and allocation method, which are more likely to attract out-of-state investors.

The second panel of Table I indicates that the average size of the offering has increased from 20 million in 2001 to more than 25 million in 2006. We can also see that the basic sample exhibits comprehensive variation along major bond characteristics, such as maturity, default risk, insurance provision, etc. Around 60 percent of the bonds issued were long-term (with maturity greater than 15 years). High-grade bonds accounted for 58 percent of the sample and low-grade bonds – for 27 percent. Approximately 50 percent of the bonds were insured.

The last panel of Table I covers a subsample of 779 taxable municipal bonds. Taxable municipal bonds are issued by municipal entities when 10% or more of the proceeds is used to finance private business activities. The interest income of taxable municipal bonds is always subject to federal income tax and is often exempt from state and local income taxes. Table I reveals that when compared to tax-exempt municipal bonds, taxable bonds tend to have shorter maturity and lower credit ratings; they are also less likely to be insured .

IV. Market Segmentation and Municipal Bond Yields

In this section we present evidence on the geographic segmentation of the municipal bond market. To assess the segmentation of the market, we examine the relationship between measures of local demand and supply of municipal bonds and bond yields. If the municipal bond market is perfectly integrated, local demand and supply would have no impact on the yield of municipal bonds. If the market is segmented, local demand (supply) measures would affect negatively (positively) the yields of local bonds. In Subsection IV.A, we analyze the sample of tax-exempt bonds; in Subsection IV.B, we condition on the credit rating and maturity of the bonds; in

Subsection IV.C, we analyze the subsample of states which exempt both in-state and out-of-state bonds; and in Subsection IV.D, we study a sample of taxable municipal bonds.

IV.A. The Base Case

We start our analysis by estimating cross-sectional regressions of municipal bond yields on proxies of local demand and supply of municipal bonds and additional control variables. We measure local demand with state *income per capita* and *investment income per capita*, where the latter is defined as the aggregate income of local residents in the form of dividends, interest, and rent. Both variables measure the level of investable income in the state. Capital market participation is more common for wealthier and more financially sophisticated residents. This is particularly true for municipal bonds which are usually targeted to wealthy individual investors in relatively high tax brackets.[13] We measure local supply of municipal bonds with the ratio of new debt issued over the particular year normalized with the population of the state.

We include a set of issue and bond characteristics in the regression as additional control variables. We designate a dummy for callable municipal bonds because these bonds tend to have higher yields than comparable non-callable bonds. Bank-qualified bonds are issues that qualify for preferential tax treatment by banks. We also include dummy variables for bonds with different maturities and credit ratings and bonds sold by a competitive bid (vs. negotiated sale). We include the yield of 10-year Treasury bonds at the time of the municipal bond issue in the regression to control for the time variation in interest rates over the sample period. Finally, we include two tax related variables in the regression. *Tax rate* is the highest marginal state income tax rate for the

[13] Until the mid-80s, commercial banks were the major purchasers of tax-exempt bonds. The Tax Reform Act of 1986 eliminated the tax exemption of the interest from most municipal bonds for banks and effectively took banks out of the market.

state; and *No-tax State* is an indicator variable set to 1 if the state does not tax in-state and out-of-state municipal bonds.

Table II reports the estimated coefficients from two different regression specifications, for each one of the two demand measures. The T-statistics are computed based on clustered standard errors at the state level. Consistent with the case of market segmentation, we observe that the yield on new municipal bonds is negatively related to the in-state demand and positively related to the in-state supply of municipal bonds.[14]

All control variables have the expected signs – municipal yields are higher for callable issues, bonds with lower credit ratings, and bonds with longer maturities. We also find that bank-qualified issues have lower yields. An exception in the Tax Reform Act of 1986 allows banks to deduct 80% of the interest on qualified tax-exempt obligations. In order for bonds to be qualified tax-exempt obligations, they must be issued for public purposes only and must have a principal of no more than $10 million. As such, the bank-qualified feature of municipal bonds could be viewed as an additional demand measure in the market. Consistent with the segmentation argument, greater demand is associated with lower yields in the market.

Next, we find that bonds that are insured tend to have higher yields than similar un-insured bonds. This result is not as surprising as it seems. Since we already control for credit risk in the regression, the result indicates that insured bonds (typically with *Aaa* ratings) offer higher yields than uninsured bonds with *Aaa* rating. It is possible that investors perceive uninsured *Aaa*-rated bonds as having a higher quality than insured *Aaa*-rated bonds because the *Aaa* ratings are derived from the credit ratings of the insurance companies. Furthermore, the insurance decision is endogenously determined and it depends on various state and bond characteristics. We analyze in

[14] We have also estimated the regression over subsamples of issues with different size and the results are qualitatively similar.

more detail the insurance decision in Section V. We also find that bonds offered through a competitive bids have lower yields than bonds offered through negotiated sales.[15]

We don't establish a direct link between state tax rates and yields because in equilibrium yields will settle down in such a way that the marginal tax-cost of investing out-of-state would be equal to the marginal benefit of doing so. More informative is the fact that bonds from states that tax-exempt the interest income from out-of-state municipal bonds tend to have higher yields. This is consistent with the idea that sates with tax-exemption would lose some of their local demand to states without tax exemption, which would result in an additional premium of their bonds.

IV.B. States that do not Tax In-state and Out-of-State Bonds

In this section we explore the relationship between municipal bond yields and state-level demand and supply for the subsample of states that do not tax the municipal bond interest of both in-state and out-of-state municipal bonds. Since this sector of the market exhibits no tax-induced segmentation, we expect that municipal bond yields here will be less sensitive to local demand and supply. There are two groups of sates in this sample. The first group includes the sates with no income tax – Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming.[16] The second group includes sates with income tax but exempt all municipal bond investments in the market – District of Columbia, Indiana and Utah.[17]

[15] This result is consistent with Simonsen, Robbins, and Helgerson (2001) who find that that competitive sales result in significantly lower interest rates compared to negotiated sales for a sample of new municipal bond issues in the state of Oregon from 1994 to 1997.

[16] Even though Florida does not have state income tax, out-state municipal bonds were subject to Florida intangible tax (the tax rate is 0.1% of the fair market value of the assets for our sample period) before January 1, 2007. The tax was appealed for municipal bonds for 2007.

[17] More precisely, beginning from January 1, 2003, Utah exempts the interest earned on non-Utah municipal bonds if the state issuing the bonds does not impose an income tax on bonds issued by Utah. Before that, Utah exempted all municipal bonds.

Table III reports the estimated coefficients from regressions of municipal bond yields on local demand and supply measures and control variables for the subsample. As expected, neither local demand measures (state income per capita and state investment income per capita), nor the local supply measure are significantly related to municipal bond yields in the cross-section.

IV.C. Bonds with Low Credit Rating and Long Maturity

The risk-sharing view on market segmentation suggests that yields of bonds with low credit rating and long maturity would be particularly sensitive to local demand because such bonds are riskier. As a result, local residents who already bear large amount of un-diversifiable regional risk in the form of labor income, real estate investment, etc., would be even more reluctant to add these bonds to their portfolios.

In this subsection, we explore the relationship between municipal bond yields and state-level demand and supply for bonds with low credit ratings in Table IV. The table regresses yields on the same set of independent variables as in Table II plus interaction terms between local supply and demand and a dummy variable, equal to 1 if the bond has a Moody's credit rating of A or lower, and 0, otherwise. We find some evidence that the interactions of bond supply and the low credit rating dummy help to explain the impact of local supply on the yields. There is very little evidence that interactions of local demand measures with low credit rating affect the relation between local demand and bond yields. We should interpret the evidence with caution, however. As we examine in the next section, because the insurance decision is endogenously determined, bond issuers' decision not to insure (thus increase the credit rating of the bonds) is also endogenously determined. Such endogeneity could reduce the explanatory power of the interaction variables.

In Table V, we interact local demand and supply with a long-maturity dummy variable. The long-maturity dummy equals 1 if the time to maturity of the bond is greater than 15 years, and 0, otherwise. Similar to low credit quality bonds, long maturity bonds are also associated with higher risks. As predicted, the yields of long-maturity bonds are more sensitive to local demand measures. Similarly, the sensitivity of yields to local supply is also stronger for long maturity bonds.

More than half of the observations from the basic sample are long maturity bonds. The regression results indicate that the impact of local demand and supply on bond yield is largely driven by the long maturity bonds. Existing evidence of muni-puzzle also suggests that the higher yields of municipal bonds relative to treasury or corporate bonds with similar characteristics are also driven by the long maturity bonds.

IV.D. Taxable Bonds

In this section we explore the relationship between municipal bond yields and state-level demand and supply for a subsample of taxable municipal bonds. In 1986, the Federal Government banned the use of tax-exempt bonds to finance projects which do not benefit the public at large. Some common examples of these projects include bonds used for sports stadium construction, bonds used to fund state pension obligations, and some bonds used to cover the costs of issuing tax-exempt bonds. In order to finance these types of projects, many municipalities issue taxable municipal bonds.

Despite the fact that taxable municipal bonds represent a relatively small part of the market, they could make a particularly interesting case-study with respect to segmentation. We expect that the market for taxable municipal bonds is less geographically segmented than tax-exempt municipal bonds. As a result of its taxable status, a taxable municipal bond produces

interest income that is subject to federal income tax, and often exempt from state and local income tax. Because of the lack of tax exemption at the federal level, taxable municipal bonds would attract clienteles of investors in relatively low tax-brackets and tax-exempt institutional investors. Given their tax-status, such investors would be affected less by tax-considerations when constructing their municipal bond portfolios. The latter would lead to a much weaker segmentation of the taxable municipal bond market relative to the tax-exempt market.

Table VI estimates the determinants of the yields of taxable municipal bond. Consistent with the conjecture that taxes are not a consideration for investors in these bonds, we observe that all tax variables here are not significant. Consistent with the geographic integration of the market, we also observe that sate demand and supply measures in this market have no significant impact on the yields of municipal bonds.

V. Market Segmentation and Municipal Bond Insurance

In recent years, nearly 50 percent of new municipal bond issues were insured against loss of principal and interest. As confirmed in our basic tax-exempt bond sample in Table I, more than 50 percent of the bonds in the sample are insured. This practice seems puzzling, given that insurance is relatively unpopular in other bond markets. One justification for insurance could be that insurance can mitigate information asymmetries by certifying quality.[18] This, however, doesn't explain why the need is so strong for municipal bonds relative to other bonds. Nanda and Singh (2004) offer a tax arbitrage explanation, which builds on the specificity of the municipal bond market. They argue that insurance enables the capture of tax-exemption subsidies that would have been lost in the event of default. This increases the size of the pie available to market participants (at the expense of the taxing authority).

[18] The concept of a delegated monitor in the context of bank loan defaults is discussed by Diamond (1984).

In Section II, we show that the geographic segmentation of the municipal bond market could offer another rationale for municipal bond insurance. When investors construct their portfolios of municipal bonds they trade-off the tax benefit of investing locally with the diversification benefit of investing out-of-state. The tax consideration will lead to allocation which is sub-optimal from a risk-sharing perspective. In other words, the equilibrium portfolio allocation would be biased towards local bonds relative to the case of no differential tax treatment of in-state and out-of-state bonds. Reduction in the risks of bonds through insurance can reduce the negative impact of risks on investor demand, thus lowering the borrowing cost of bond issuers.[19] This provides a strong incentive for the issuers to purchase insurance.

Insurance companies, on the other hand, can diversify efficiently across geographic regions. By pooling risks across regions, insurance companies can generate surplus that could be shared between them and municipalities. Insurance makes both parties better off. Consistent with this prediction, we observe that the fraction of insured bonds is substantially higher in the tax-exempt municipal bond market than in the less segmented taxable municipal bond market – 54% versus 36%, respectively (Table I). To be sure, Nanda and Singh (2004) also argue that the taxable bonds are less likely to be insured because maintaining the tax status of a taxable bond is not valuable. In the following empirical analysis, we attempt to differentiate the two explanations by examining the impact of local demand and supply on bond insurance.

In Table VII we estimate a Logit model on the probability that a particular new issue is insured. We delete the bonds that are "Aaa" rated without insurance form the sample because for these bonds, insurance is not a variable of choice. Overall, most municipal bonds achieve the highest credit rating through insurance, so the reduction of sample size is minimal.

[19] There is considerable debate about the benefits and costs of municipal bond insurance to bond issuers. Studies (see Angel (1994) and Quigly and Rubinfeld (1991)) show that insurance reduces borrowing cost significantly.

We estimate the tax-exempt and taxable bond samples separately. For the tax-exempt sample, the probability for insurance of a municipal bond increases with the local supply in the market and the size of the offering. The probability for insurance of taxable municipal bonds, on the other hand, is not significantly related either to the local supply of bonds in the state or the size of the offering. The results are consistent with the idea that, when local supply of municipal bonds is high, bond issuers are more likely to purchase insurance to entice investors to hold the local bonds.

VI. Measuring the Cost of Segmentation

So far we have presented evidence that the differential tax-treatment of in-state and out-of-state municipal bonds induces geographic segmentation of the municipal bond market and, as a result, bond yields are affected by both local demand and supply. We also show that bond insurance is related to the supply of bonds in the local market.

One of the most puzzling aspects of the municipal bond market is the relatively high yields across states. In Section II, we show that tax-induced market segmentation can increase the overall the cost of capital for municipalities. In this section, we provide an estimate on the actual cost of tax-induced segmentation of the municipal bond market by comparing the yields of tax-exempt and taxable municipal bonds with the same credit ratings and maturity.

A major advantage of this approach is that by directly comparing two types of municipal bonds, we effectively control for all other municipal bond characteristics. Recent studies (see Green, Hollifield, and Schürhoff (2007) and Harris and Piwowar (2006)) show that the municipal bond market has low liquidity. While municipal bond illiquidity could explain part of the high yields of municipal bonds relative to treasuries, we note that municipal bond illiquidity is endogenous and it could be viewed as part of the puzzle.

In section III, we showed that the taxable bond market is less segmented than the market of tax-exempt municipal bonds. However, taxable and tax-exempt bonds are traded in the same market. Given that both the tax-exempt and taxable bonds originate from the same regions and exhibit similar characteristics (Table 1), the difference in the yields of these bonds could be a reasonably good proxy of the cost of segmentation in the municipal bond market.

In Table VIII, we calculate the difference of after-tax yields of tax-exempt and taxable municipal bonds across portfolios with similar credit rating and maturity for each year. When computing the after tax yield for the taxable bonds, we assume that the bonds are tax-exempt at the state and local level. We use the highest tax bracket for the federal income tax. So for the taxable bonds, we compute the after tax yield as $y(1-T_F)$, where y is the yield on taxable bonds, and T_F is the applicable federal income tax rate at the highest tax bracket.

We observe that tax-exempt municipal bonds are systematically priced at higher yields than taxable municipal bonds. The "segmentation" premium is around 55 basis points across the whole sample and is slightly higher among long maturity bonds (74 basis points for long-maturity bonds vs. 41 basis points for short-maturity bonds). We obtain weaker, but still consistent results when we use the second or third highest tax bracket for federal income tax.

VII. Conclusion

The yields of municipal bonds are substantially higher than the yields of bonds with similar default risk (*Muni-puzzle*). In this paper, we present theoretical arguments and empirical evidence, suggesting that the asymmetric tax exemption of municipal bonds induces segmentation in the market and increases the yields of municipal bonds. We further argue that differential taxation of municipal bonds creates additional limits of arbitrage in the market and an increased incentive for insurance.

Consistent with our theoretical predictions of market segmentation, we find that the yields of municipal bonds are negatively related to local demand and positively related to local supply of bonds in the state of the issuer. This sensitivity is stronger for bonds with longer maturity and lower credit rating and weaker among the subsample of states with no state income tax. In contrast, taxable bond yields are unrelated to local demand and local supply. We further show that, consistent with segmentation, the probability for bond insurance increases with the local supply of municipal bonds. Finally, using the sample of taxable bonds as the benchmark, we show that the yield of tax-exempt bonds significantly exceeds the (after-tax) yield of otherwise similar taxable municipal bonds, suggesting high cost of market segmentation.

One of the main contributions of the paper is that identifies a single cause for a wide range of frictions in the municipal bond market – asymmetric tax exemption with respect to federal, state, and local taxes. This asymmetric tax exemption creates segmentation of the market, which increases the cost of capital of municipal bonds. It could be argued that municipalities would be better off if they either exempt both in-state and out-of state municipal bonds from taxation or impose taxation on both. The symmetric tax treatment would enable better risk sharing of investors across geographic regions and enhance the liquidity of the market by attracting more individual and institutional investors.

Recognizing existing inefficiencies in the municipal bond market, U.S. regulators recently have implemented various plans for improving the information disclosure and trading transparency in the market. For example, SEC recently approved the electronic municipal market access system (or EMMA) as the central database for the municipal bond market. Our analysis indicates that while these steps could improve the quality of the market, the substantial costs associated with market segmentation would very likely remain unchanged.

Appendix

After substituting investor terminal wealth into the objective function in (1), we arrive at a constrained quadratic optimization with respect to demands. The first-order conditions of this maximization are:

$$\begin{cases} (1+c) - \rho\sigma_1^2 x_{1,1} = \lambda P_1 \\ (1+c) - cT_1 - \sum_{j=2}^{N} \rho\sigma_j^2 x_{1,j} = \lambda P_j, \text{ for } j = 2,...,N \\ 1 = \lambda/(1+r) \end{cases} \quad \text{(A1)}$$

From here we can express the demand for in-state municipal bonds of State 1 investors as

$$x_{1,1} = \frac{(1+c) - (1+r)P_1}{\rho\sigma_1^2} \quad \text{(A2)}$$

and the demand for State 1 municipal bonds of State j investors as follows:

$$x_{j,1} = \frac{(1+c) - cT_j - (1+r)P_1}{\rho\sigma_1^2} \quad \text{(A3)}$$

In equilibrium the market of State 1 municipal bonds clears, i.e. $\sum_{j=1}^{N} x_{j,1} M_j = Y_1$. From here it follows that:

$$(\rho\sigma_1^2)Y_1 = (1+c)M - c(\sum_{j=2}^{N} T_j M_j) - (1+r)MP_1, \quad \text{(A4)}$$

where M denotes the total number of investors in the market. And from here

$$P_1 = \frac{1}{1+r}\left\{(1+c) - c\sum_{j=1}^{N} T_j \frac{M_j}{M} + cT_1 \frac{M_1}{M} - \rho\sigma_1^2 (\frac{Y_1}{M})\right\} \quad \text{(A5)}$$

Q.E.D.

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Table I
Summary Statistics

The table reports the total number of municipal bonds issues per year; the average issue amount (in millions); the fraction of long-term bonds (maturity greater than 15 years); the fraction of short-term bonds (maturity less than 5 years); the fraction of high-grade bonds (Moody's rating of Aaa); the fraction of low-grade bonds (Moody's rating of A or lower and unrated bonds); the fraction of insured bonds, the fraction of issues offered through a competitive bid (instead of negotiated offer); and the average yield of the bonds offered that particular year. Panel A covers the sample of all new issues; Panel B restricts the sample to tax-exempt bond issues with non-missing yield information; while Panel C further identifies the subsample of taxable bonds.

Year	Num. of Issues	Issue Amnt.	Long-term	Short-term	High-grade	Low-grade	Insured	Comp.Bid	Yield
Panel A: Initial Sample									
2001	14,837	19.8	0.58	0.13	0.40	0.48	0.36	0.37	--
2002	15,490	23.8	0.55	0.13	0.43	0.46	0.40	0.36	--
2003	16,240	24.3	0.54	0.14	0.43	0.48	0.40	0.37	--
2004	14,536	25.5	0.57	0.13	0.47	0.44	0.43	0.33	--
2005	14,966	27.6	0.62	0.12	0.49	0.41	0.47	0.32	--
2006	13,793	28.7	0.66	0.13	0.43	0.47	0.41	0.33	--
2007	13,915	30.67	0.64	0.20	0.15	0.41	0.48	0.39	--
Panel B: Basic Sample with Non-missing Yields									
2001	2,674	20.0	0.62	0.04	0.53	0.26	0.49	0.89	4.61
2002	3,077	21.8	0.58	0.06	0.55	0.27	0.52	0.87	4.22
2003	3,138	20.5	0.57	0.03	0.56	0.30	0.52	0.91	3.77
2004	2,683	22.9	0.59	0.04	0.60	0.25	0.56	0.92	3.91
2005	2,737	24.5	0.64	0.04	0.62	0.23	0.58	0.94	4.02
2006	2,528	25.6	0.67	0.05	0.58	0.28	0.56	0.94	4.25
2007	2,368	25.4	0.66	0.04	0.58	0.28	0.55	0.94	4.17
Panel C: Subsample of Taxable Bonds									
2001	86	14.6	0.40	0.14	0.37	0.30	0.31	0.88	5.95
2002	105	10.6	0.30	0.13	0.31	0.39	0.30	0.88	5.11
2003	164	9.5	0.41	0.09	0.35	0.48	0.33	0.95	4.62
2004	115	15.8	0.46	0.15	0.34	0.32	0.33	0.97	4.70
2005	117	19.7	0.48	0.11	0.44	0.23	0.41	0.96	4.86
2006	100	17.3	0.37	0.15	0.53	0.23	0.46	0.95	5.52
2007	92	30.1	0.41	0.20	0.36	0.27	0.35	0.98	5.47

Table II
Municipal Bond Yields and Local Demand and Supply

The table reports the coefficient estimates from OLS regressions of municipal bond yields on the following set of independent variables: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Insured* is a dummy variable set to 1 if any part of the issue is insured; *Bank-qualified* is a dummy variable set to 1 if the issue qualifies for preferential tax treatment by bank lenders; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; Medium-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *No-tax State* is an indicator variable set to 1 if the state has no income tax; *Income Pca.* is the state income per capita; *Investment Income Pca.* is the state income derived from dividends, interest, and rent per capita; *New Debt Pca* is the ratio of aggregate municipal bond issuance during the year relative to population. All regressions include year dummies. The T-statistics are computed based on clustered standard errors at the state level. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	MODEL 1		MODEL 2	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	1.46	10.90	1.30	9.91
T-Bond Yield	0.52	46.50	0.52	46.39
Callable	0.30	12.18	0.30	12.44
Insured	0.07	4.06	0.07	4.14
Bank-qualified	-0.13	-8.64	-0.13	-8.87
Competitive bid	-0.32	-4.47	-0.33	-4.57
Medium maturity	0.46	10.99	0.46	11.03
Long maturity	1.05	17.37	1.04	17.25
Issue amount	0.00	-0.42	0.00	-0.27
Medium-grade	0.04	1.56	0.04	1.38
Low-grade	0.25	7.65	0.26	7.76
Tax rate	0.00	0.40	0.01	0.43
No-tax State	0.10	1.66	0.11	1.70
Income Pca.	-0.01	-4.27		
Investment Pca.			-0.03	-4.51
New Debt Pca.	0.06	3.16	0.08	3.13
adj_R2	0.64		0.64	
Observations	18279		18279	

Table III
Yields and Local Demand and Supply Measures for States with Tax Exemption of Both In-state and Out-of-state Municipal Bonds

The table reports the coefficient estimates from OLS regressions of municipal bond yields of bonds offered in states with no-income tax (Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming) on the following set of independent variables: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Insured* is a dummy variable set to 1 if any part of the issue is insured; *Bank-qualified* is a dummy variable set to 1 if the issue qualifies for preferential tax treatment by bank lenders; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; Medium-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *Income Pca.* is the state income per capita; *Investment Income Pca.* is the state income derived from dividends, interest, and rent per capita; *New Debt Pca* is the ratio of aggregate municipal bond issuance during the year relative to population. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	MODEL 1		MODEL 2	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	1.019	3.58	1.057	4.71
T-Bond Yield	0.494	12.24	0.494	12.37
Callable	0.334	4.00	0.335	4.03
Insured	0.036	1.85	0.033	1.74
Bank-qualified	-0.114	-6.21	-0.114	-6.18
Competitive bid	-0.056	-1.99	-0.054	-1.83
Medium maturity	0.564	2.94	0.567	2.99
Long maturity	1.166	5.23	1.172	5.33
Issue amount	-0.007	-0.28	-0.008	-0.35
Medium-grade	0.123	5.23	0.125	5.4
Low-grade	0.335	6.74	0.334	6.68
Tax rate	-0.006	-0.71	-0.006	-0.99
Income Pca.	0.003	0.27		
Investment Pca.			0.010	0.53
New Debt Pca.	-0.034	-0.46	-0.028	-0.59
adj_R2	0.71		0.71	
Observations	2213		2213	

Table IV
Municipal Bond Yields and Local Demand and Supply for Bonds with Low Credit Rating

The table reports the coefficient estimates from OLS regressions of municipal bond yields on the following set of independent variables: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Insured* is a dummy variable set to 1 if any part of the issue is insured; *Bank-qualified* is a dummy variable set to 1 if the issue qualifies for preferential tax treatment by bank lenders; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; Medium-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *No-tax State* is an indicator variable set to 1 if the state has no income tax; *Income Pca*. is the state income per capita; *Investment Income Pca*. is the state income derived from dividends, interest, and rent per capita; *New Debt Pca* is the ratio of total municipal bond issuance during the year relative to population. We further interact the supply and demand variables with the Low-grade-dummy variable (LG). All regressions include year dummies. The T-statistics are computed based on clustered standard errors at the state level. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	MODEL 1		MODEL 2	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	1.471	12.04	1.310	10.76
T-Bond Yield	0.516	46.47	0.517	46.49
Callable	0.298	12.35	0.300	12.57
Insured	0.066	3.93	0.074	4.03
Bank-qualified	-0.130	-8.83	-0.131	-9.17
Competitive bid	-0.323	-4.54	-0.330	-4.64
Medium maturity	0.458	10.96	0.457	11.13
Long maturity	1.048	17.27	1.040	17.32
Issue amount	-0.004	-0.48	-0.003	-0.33
Medium-grade	0.043	1.53	0.038	1.37
Low-grade	0.232	1.7	0.221	2.21
Tax rate	0.004	0.4	0.005	0.44
No-tax State	0.100	1.68	0.111	1.73
Income Pca.	-0.012	-4.53		
Income*LG	-0.003	-0.56		
Investment Pca.			-0.029	-2.57
Investment*LG			-0.005	-0.32
New Debt Pca.	0.046	2.12	0.005	0.10
NewDebt*LG	0.085	2.83	0.059	2.61
adj_R2	0.64		0.64	
Observations	18279		18279	

Table V
Municipal Bond Yields and Local Demand and Supply for Bonds with Long Maturity

The table reports the coefficient estimates from OLS regressions of municipal bond yields on the following set of independent variables: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Insured* is a dummy variable set to 1 if any part of the issue is insured; *Bank-qualified* is a dummy variable set to 1 if the issue qualifies for preferential tax treatment by bank lenders; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; Medium-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *No-tax State* is an indicator variable set to 1 if the state has no income tax; *Income Pca*. is the state income per capita; *Investment Income Pca*. is the state income derived from dividends, interest, and rent per capita; *New Debt Pca* is the ratio of total municipal bond issuance during the year relative to population. We further interact the supply and demand variables with the Long-maturity-dummy variable (LM). All regressions include year dummies. The T-statistics are computed based on clustered standard errors at the state level. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	MODEL 3		MODEL 4	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	0.826	4.57	0.972	6.77
T-Bond Yield	0.512	46.53	0.516	46.77
Callable	0.293	11.77	0.295	11.76
Insured	0.071	4.61	0.079	4.59
Bank-qualified	-0.134	-9.33	-0.135	-9.5
Competitive bid	-0.328	-4.61	-0.342	-4.75
Medium maturity	0.459	11.36	0.459	11.39
Long maturity	2.043	11.04	1.548	11.7
Issue amount	-0.005	-0.59	-0.002	-0.2
Medium-grade	0.040	1.76	0.036	1.5
Low-grade	0.248	7.82	0.262	7.76
Tax rate	0.004	0.34	0.003	0.28
No-tax State	0.080	1.44	0.081	1.33
Income Pca.	0.016	2.80		
Income*LM	-0.042	-5.98		
Investment Pca.			0.055	2.92
Investment*LM			-0.123	-4.07
New Debt Pca.	-0.157	-2.64	-0.098	-1.64
NewDebt*LM	0.323	3.6	0.154	2.71
adj_R2	0.66		0.65	
Observations	18279		18279	

Table VI

Municipal Yields and Local Demand and Supply Measures for a Sample of Taxable Bonds

The table reports the coefficient estimates from OLS regressions of taxable municipal bond yields on the following set of independent variables: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Insured* is a dummy variable set to 1 if any part of the issue is insured; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; High-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aaa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *Income Pca.* is the state income per capita; *Investment Income Pca.* is the state income derived from dividends, interest, and rent per capita; and *New Debt Pca* is the ratio of total municipal bond issuance during the year relative to population. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	MODEL 1		MODEL 2	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	1.106	1.93	1.123	2.01
T-Bond Yield	0.884	9.94	0.882	9.94
Callable	0.226	3.54	0.226	3.58
Insured	0.092	1.06	0.102	1.16
Competitive bid	-0.392	-2.67	-0.386	-2.69
Medium maturity	0.624	9.63	0.624	9.75
Long maturity	1.300	13	1.298	13.13
Issue amount	-0.053	-2.25	-0.056	-2.39
Medium-grade	0.129	1.28	0.133	1.32
Low-grade	0.345	3.21	0.346	3.19
Tax rate	-0.002	-0.14	-0.001	-0.07
Income Pca.	0.004	0.04	0.005	0.05
Investment Pca.	-0.007	-0.89		
New Debt Pca.			-0.043	-1.17
adj_R2	0.71		0.71	
Observations	778		778	

Table VII
Determinants of he Probability of Municipal Bond Insurance

The table reports coefficient estimates from a Logit-regression explaining the probability of insurance for a tax-exempt municipal bond. The sample consists of 18,279 different municipal bond issues after removing bonds that are Aaa rated without insurance. As explanatory variables we use: the *T-Bond Yield* is the yield of Treasury bonds a the time of the issue; *Callable* is a dummy variable set to 1 if any part of the issue is callable; *Bank-qualified* is a dummy variable set to 1 if the issue qualifies for preferential tax treatment by bank lenders; *Competitive bid* is a dummy variable set to 1 for sales through a competitive bidding process, and 0 for negotiated sales; *Medium Maturity* (*Long Maturity*) is a dummy variable set to 1 if the years to maturity are between 5 and 15 (exceed 15); *Issue amount* is the log of the face value of the issue*; High-grade* (*Low-grade*) is a dummy variable set to 1 if the Moody's rating of the bond is Aaa (A or lower or the bond is not rated); *Tax* is the highest marginal income tax rate for the state; *No-tax State* is an indicator variable set to 1 if the state has no income tax; *Income Pca.* is the state income per capita; *Investment Income Pca.* is the state income derived from dividends, interest, and rent per capita; and *New Debt Pca* is the ratio of total municipal bond issuance during the year relative to population. The last two rows report the R-squares and number of observations in each regression. (**) and (*) indicate statistical significance at the 0.01 and 0.05 level, respectively.

	Tax-exempt bonds				**Taxable Bonds**			
	estimate	P-value	estimate	P-value	estimate	P-value	estimate	P-value
Intercept	-5.19	<.0001	-5.02	<.0001	-1.51	0.35	-2.10	0.13
T-Bond Yield	0.05	0.49	0.05	0.49	-0.12	0.65	-0.09	0.70
Callable	0.43	0.00	0.43	0.00	0.36	0.15	0.38	0.13
Bank-qualified	0.22	0.18	0.22	0.18				
Competitive bid	0.35	0.30	0.35	0.30	-0.63	0.03	-0.67	0.03
Medium maturity	1.84	<.0001	1.85	<.0001	0.58	0.16	0.57	0.18
Long maturity	2.42	<.0001	2.43	<.0001	1.75	<.0001	1.73	<.0001
Issue amount	0.67	<.0001	0.67	<.0001	0.00	0.99	0.02	0.91
Tax rate	-0.11	0.15	-0.11	0.14	-0.13	0.34	-0.12	0.33
No-tax State	0.02	0.97	-0.01	0.99	-0.66	0.48	-0.56	0.50
Income Pca.	0.01	0.79			0.03	0.54		
Investment Pca.			0.00	1.00			0.26	0.09
New Debt pca.	1.12	0.00	1.19	<.0001	0.82	0.21	0.64	0.19
adj_R2	0.30		0.30		0.21		0.21	
Observations	17035		17035		742		742	

Table VIII
Difference in After-tax Yields of Taxable and Tax-exempt Municipal Bonds

The table reports the difference in yields between tax-exempt bonds and taxable bonds. We classify both tax-exempt and taxable bonds by maturity: long-term bonds (maturity greater than 15 years); medium-term bonds (maturity between 5 years and 15 years); short-term bonds (maturity less than 5 years); and by credit ratings: high-grade bonds (Moody's rating of Aaa); low-grade bonds (Moody's rating of A or lower and unrated bonds); and medium-grade bonds (Moody's rating higher than A and lower Aaa). For each year, we compute the average yields of newly issued bonds for the nine portfolios based on maturity and credit rating. For the taxable bonds, we compute the after-tax yields as $y*(1-T_F)$, where y is the pre-tax yield and T_F is the applicable federal income tax rate. The table reports the difference between the yields of tax-exempt bonds and the tax-adjusted yield of taxable bonds. We use the highest federal tax bracket in each year for the federal income tax.

		Credit Rating		
Maturity	Year	High	Medium	Low
Long	2001	1.211	0.571	1.057
	2002	0.857	0.815	1.073
	2003	0.756	0.545	0.714
	2004	0.797	0.71	0.775
	2005	0.851	0.706	0.934
	2006	0.538	0.489	0.558
	2007	0.547	0.444	0.554
Medium	2001	0.483	0.586	0.602
	2002	0.657	0.474	0.881
	2003	0.439	0.377	0.378
	2004	0.399	0.365	0.506
	2005	0.660	0.416	0.694
	2006	0.396	0.437	0.494
	2007	0.399	0.495	0.347
Short	2001	0.667	0.358	0.233
	2002	0.547	0.058	0.223
	2003	0.585	0.523	0.367
	2004	0.057	0.298	0.486
	2005	0.535	0.393	0.345
	2006	0.772	0.206	0.356
	2007	0.710	0.583	0.359