Market Segmentation and the Cost of Capital in a Domestic Market: Evidence from Municipal Bonds [*]

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Abstract

We study the implications of market segmentation in a domestic setting, the US municipal bond market. A (state-level) segmentation of this market emerges from asymmetric tax-exemption -- municipal bond investors are exempt from state and local taxes on bonds issued by their own state but not on bonds issued by other states. We find that market segmentation limits the risk-sharing opportunities for investors, creates impediments to arbitrage, and increases the need for financial intermediation. Our results provide a unified explanation for a set of well-documented artifacts of the municipal bond market, such as its high yields, high transaction costs, and popularity of insurance. Our overall conclusion is that segmentation imposes significant costs in capital markets and these costs could materialize through different venues, only one of which is yields.

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Economic theory predicts that, by promoting better risk-sharing, integrated capital markets can lower the cost of capital and improve the allocative efficiency in capital markets. However, evaluating the real effects of capital market integration has been a challenging task, given that most markets exhibit substantial differences in their legal, institutional, and cultural environment, which creates difficulties in quantifying both the degree of integration and its impact. While some empirical studies have shown that market integration decreases the cost of capital, the documented effects are lower than theory predicts and many have even contended that the benefits of integration are too small to offset some of its harmful side effects, such as increased speculation and likelihood for financial crises.[1]

In this paper, we study the implications of market segmentation within a domestic setting, the U.S. municipal bond market. The income from most municipal bonds is exempt from state and local taxes for in-state investors but not for out-of state investors. This asymmetric tax-exemption creates an exogenous friction that segments the municipal bond market, thus offering a unique venue to evaluate the effects of market segmentation on issuers and investors. By restricting our study to the U.S. domestic market, we can easily control for differences in institutional settings that are present in international markets.

Studying the municipal bond market has several important advantages for understanding the effects of segmentation in financial markets. First, the rich data on municipal bonds allows us to examine the impact of market segmentation on a wide range of costs, such as floatation costs and other fees to financial intermediaries, which are generally not reflected in yields and, as a result, have been overlooked in existing research. Second, the municipal bond market consists of a large number of issues with similar structure and risk characteristics, which enables us to design

[1] See Stulz (1999, 2005) for a review of the literature. Recent attempts to evaluate the impact of market integration on the cost of capital include Domowitz, Glen and Madhavan (1997), Foerster and Karolyi (1999), Bekaert and Harvey (2000), and Henry (2000), among others.

more powerful tests. Next, focusing on initial bond offerings (instead of realized returns to investors) allows for a more precise estimate of the actual cost of capital for the issuer. Lastly, our analysis could provide insight into a series of puzzling characteristics of the municipal bond market, namely its high yields (the *Muni-puzzle*), popularity of insurance, limits to arbitrage, and high transaction costs.

Our major results could be summarized as follows. First, we present strong evidence for state-level segmentation of the municipal bond market and show that this segmentation results in a significant valuation discount of municipal bonds. Second, we find that by limiting investor ability to diversify across state borders, tax-induced segmentation creates an incentive for insurance in the market, a cost borne largely by the issuer. Third, we show that segmented markets are characterized with higher costs of financial intermediation, as measured by underwriting fees and mutual fund expense ratios. Our overall conclusion is that segmentation imposes significant costs in capital market and these costs could take many forms, only one of which is yields.

We start our analysis by exploring theoretically how asymmetric tax exemption affects the demands and valuations in the municipal bond market based on a standard model of portfolio choice. In the model, tax-exemption of interest income creates an incentive for investors to invest in-state, while the risk of the bonds creates an incentive to invest out-of-state. We show that in equilibrium investors would be biased towards local bonds (from the state of the issuer) but they would always allocate funds to out-of-state bonds.

In this economy differential taxation adversely affects investors in two ways – directly, through the taxes paid on out-of-state interest income, and indirectly, by creating excessive exposure to local risks. This results 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. The model provides testable hypotheses for the existence of segmentation in the municipal bond market and its impact.

Using a full sample of municipal bond new issues between 2001 and 2007, we provide empirical evidence for both state-level segmentation of the market and the associated costs of this segmentation. First, we find that the yields of municipal bonds are negatively related to local demand and positively related to local supply of bonds from the state of the issuer. Next, we examine the relationship between municipal bond yields and state-level demand and supply for the subsample of states with no income tax and for a control sample of taxable municipal bonds. Consistent with the idea of stronger integration of these two markets, we confirm that municipal yields are less sensitive to local demand and supply in the two markets.

The sample of taxable municipal bonds provides a clean benchmark for estimating the costs of tax-induced segmentation in the market. Comparing the yields between taxable and non-taxable municipal bonds allows us to assess the impact of market segmentation on bond yields while effectively controlling for risk and various bond characteristics. We show that tax-exempt municipal bonds are consistently priced at higher (after-tax) yields than taxable municipal bonds – the average yield of tax-exempt bonds exceeds the average yield of similar taxable bonds by 62 basis points. As expected, the yield differential is stronger for bonds with lower credit rating and longer maturity.

Tax-induced market segmentation can also explain another puzzling characteristic of the municipal bond market – the popularity of municipal bond insurance.[2] The tax-induced local bias of municipal bond investors results in an allocation which is sub-optimal from a risk-sharing perspective. Insurance companies, on the other hand, can effectively pool risks of municipal bonds across states and diversify large part of their regional risks, while allowing investors to maintain

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

the tax benefit. Consistent with this hypothesis, we show that the probability for insurance of a 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.

To investigate further the impact of market segmentation on the cost of capital for issuers and the expected returns for investors, we examine how market segmentation affects the costs of bond issuance and bond investment, respectively. In line with the idea that segmented capital markets exhibit higher issuing costs than integrated capital markets, we show that tax-exempt municipal bonds have higher underwriting spreads than similar taxable municipal bonds.

We next study the investment choices of municipal bond investors and the structure and fees of municipal bond mutual funds. Consistent with our model prediction that investors would always allocate part of their municipal bond portfolio to out-of-state bonds, we observe that investors direct substantial wealth towards *national* municipal bond mutual funds, thus foregoing their tax exemption at the state level. More importantly, single-state municipal bond mutual funds (funds that invest in municipal bonds from the same state and, as a result, offer state and local tax exemption benefits) charge higher fees than national funds and the level of the state fund fees is positively correlated with the level of the state income tax rate. The latter suggests that large part of the tax-benefits of municipal bonds for investors is actually offset by costs associated with investing in these bonds.

By studying a segmented market in a domestic setting, we show that segmentation imposes substantial costs in capital market. Segmentation affects the cost of capital not only directly, by increasing the yields of financial securities, but also indirectly by increasing the costs of financial intermediation in these markets associated with security issuance, insurance, and investor participation. We argue that the benefits of financial market integration documented in existing

studies are very likely understated as a result of an incomplete measurement of the actual cost of capital in these studies.

Our results provide insights on some puzzling characteristics the municipal bond market, such as its high yields (*the Muni-puzzle*) and relatively low liquidity.[3] The discount of municipal bonds relative to the prices of other similar bonds could be, at least partially, attributed to tax-induced regional segmentation of the municipal bond market. However, by restricting trading across state borders, market segmentation reduces not only the risk-sharing opportunities in the market but also its liquidity. Recent studies show that the municipal bond market has a surprisingly low liquidity given its size (see Green, Hollifield, and Schürhoff (2007) and Harris and Piwowar (2006)). We note that municipal bond illiquidity is an endogenous artifact of the market and it could be, to some extent, attributed to the regional segmentation of the market.

We also contribute to the analysis of tax-exemption policies. Most studies in this area focus on the tradeoff between lost revenues (from tax-exemption) and additional savings (due to lower yields), without explicitly consider the distortion effects of asymmetric tax-exemption associated with market segmentation (see Poterba and Verdugo (2008) for a review). Because market segmentation introduces significant deadweight loss to the market, both issuers and investors would be better off if the segmentation barriers are lifted. One possible policy solution 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. 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

[3] Arak and Guentner (1983), 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), and 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.

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 only agreed that overturning the exemption would upset the market.[4]

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 evidence on the regional segmentation of the municipal bond market; while Section V explores the costs of market segmentation. We conclude in Section VI.

I. The Municipal Bond Markets

In this section we outline facts about the municipal bond market that provide the basis for our analysis. We also discuss some well-documented facts 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.[5]

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,

[4] See DEPARTMENT OF REVENUE OF KENTUCKY et al. v. DAVIS et ux. No. 06-666. May 19, 2008
[5] 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/.

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 bond interest from state income tax provided that the bonds were issued within the state of the bondholder's residence.[6] 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).[7] 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

[6] In these five states, interest income from some of in-state municipal bonds is tax exempt.
[7] 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.

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.

I.B. Municipal Bond Yield (the 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 increase the yields ant transaction costs of municipal bonds relative to otherwise similar securities. Consistent with our conjecture, recent studies have shown that the municipal bond market has relatively low liquidity (see Green, Hollifield, and Schürhoff (2007) and Harris and Piwowar (2006)). Some authors have also argued that the low liquidity of municipal bonds can explain part of the valuation discount of municipal bonds (Wang, Wu and Zhang (2008)). We note, however, that municipal bond illiquidity is an endogenous artifact of the market and it could be related to the regional segmentation of the market.

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. Other proposed explanations for the popularity of municipal bond insurance are improved diversification and liquidity. For example, bond insurers might be able 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 demand for municipal bond insurance. Asymmetric tax exemption limits the incentive of investors to diversify regional risk. 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 while maintaining their full tax advantage.

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

Given the higher yields of municipal bonds relative to taxable bonds with similar characteristics and the yield differentials across states, arbitrageurs may be able to take advantage of such opportunities and drive down municipal bond yields. 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 suggest that there are some hidden costs associated with this arbitrage strategy. Some of these costs are regulatory. For example, the Tax Reform Act of 1986 reduced banks' ability to engage in municipal bond arbitrage in most municipal bonds.[8] Indeed, 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 arbitrage activities and among those engaged in arbitrage, many firms

[8] 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.

employ less than the safe-harbor amount allowed by the tax authorities. The authors 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 additional impediment to arbitrage in the market. 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. Since arbitrageurs are concerned about their after-tax returns, 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. Theoretical Justification

In this section, we develop a simple equilibrium model of asset pricing under asymmetric tax-exemption based on the municipal bond market. The model illustrates how asymmetric tax-exemption of municipal bonds could create investor clienteles in the municipal bond market. It also provides testable hypothesis for both the existence of market segmentation and its impact on bond yields.

In the model investors trade-off the tax-benefits of in-state bonds with the diversification benefits of out-of-state bonds.[9] There are at least two different ways to think about risk in the municipal bond market – default and liquidity. Most municipal bonds are long-term instruments

[9] There is plenty of anecdotal evidence suggesting that risk is an important consideration for municipal bond investors. For example, in a recent article in the New York Times, a money manager at Envision Capital comments that “many investors buy state-specific funds because they offer exemption from state taxes, as well as from federal taxes. But in some cases, it can make sense to "give up the state exemption"” (see “Municipal Bond Funds, in Starring Roles” by Jan Rosen in the April 12 issue of the New York Times). Our communications with several municipal bond investment managers also reveal that these municipal bond investors allocate fifteen to twenty percent of their portfolio in out-of-state bonds.

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 default risk and liquidity risk separately, we expect shocks to local fundamentals and local demands to be highly correlated.

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); with M_i the total number of municipal bond investors from the state (local demand); and with 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 price of these bonds at the beginning of the period is denoted with P_i. We assume that the coupon payment is certain 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. For simplicity, we also assume that coupon payments are equal 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's 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 the maximization of a CARA utility function is equivalent to the following optimization problem

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

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

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 we consider the portfolio allocation decision of 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 local state tax rate T_1.

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 result in the following equilibrium price of State 1 municipal bonds (more detailed derivation is presented in the Appendix):

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

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

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

From here we can make a series of observations. First, tax-induced segmentation results in dispersion of yields across states. As equation (2) shows, higher local demand, M_1, increases local bond prices, while higher local supply, Y_1, decreases local bond price. Riskier bonds tend to be affected more by market segmentation. The second term of equation (2) indicates that the price of State 1 bonds would also depend on the demand-weighted average tax rate in the market – the

higher the average tax rate the lower bond prices would be. The contribution of each state's own tax to the municipal bond discount is weighted with the local demand in the state. We note, however, that the second term in equation (2) is the same across bonds from all states and, as a result, it doesn't have direct cross-sectional implications.

Next, equation (2) shows that asymmetric tax exemption increases the average yields in the market ($P_1 < P_1^F$). In this economy differential taxation adversely affects investors in two ways – directly, through the taxes paid on out-of-state interest income, and indirectly, by distorting their optimal allocation towards excessive bearing of local risk. The direct effect could be described as follows. In equilibrium, investors would always allocate part of their portfolio out-of-sate. 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.

The magnitude of the valuation discount of municipal bonds, however, would generally exceed the tax amount. Even if we ignore all tax effects, the investor allocation in equilibrium (2) would be always suboptimal relative to the allocation in equilibrium (3), which achieves the first-best outcome.

In essence, asymmetric tax exemption increases the average yields of municipal bonds by generating outflows on out-of-state positions and by restricting the opportunities of investors to share risks across regions. 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 even when the volatilities in the pricing equations (2) and (3) converge to zero, the bond prices under asymmetric tax exemption would be still 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 academic literature has identified several limits to arbitrage in capital markets (Shleifer and Vishny (1997)). Both the differential taxations on municipal bonds across states and the asymmetric tax exemption of municipal bonds and government bonds with respect to federal taxes could restrict these arbitrage opportunities even further.

Because municipal bonds are exempt from federal income taxes while treasury securities are not, even if municipal bond yields are 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.[10] For example, even if 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. Arbitrage trading in municipal bonds from various states could be even more difficult due to strong short sale constraints – note that lenders of municipal bonds generally do not receive tax exemptions on interest income. As a result, the yields of bonds from two different states could diverge significantly even if the bonds have similar characteristics.

[10] 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. One major variable of interest 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.

Our model predicts that the variation of bond yields across states is related to the local demand and supply of bonds in the state. In order to assess the 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 the 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. Investment income and investment income per capita for each state are derived from the Regional Economic Information System (REIS) provided by the Bureau of Economic Analysis.

We also use a set of control variables quantifying bond callable features, insurance, preferential treatments by banks, type of the initial sale (competitive bid vs. negotiated offer), 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 introduce a bias towards 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 .

Table II reports the highest marginal state tax rates and the rank of the relative demand and supply of municipal bonds in each state. As discussed above, municipal bond demand is measured with the investment income per capita in the state, while municipal bond supply is measured with the value of new debt per capita in the state. Rank 1 (rank 51) corresponds to the state with the lowest (highest) value of the corresponding variable.

The state with the highest marginal tax rate is Montana (11%), followed by California (10.3%) and Rhode Island (9.9%). The average marginal state tax rate is 5.71%, including the zero-tax states, and 6.63%, excluding zero-tax states. These statistics indicate that the magnitude of state and local taxes is very substantial (note that all local tax rates are not even reported). The state with the highest demand for municipal bonds relative to the population of the state is Montana, while the

state with the lowest demand is Louisiana. On the supply side, Illinois has the largest relative supply of municipal bonds, while California has the lowest. The correlation coefficient between the demand and supply ranks is 0.57 across states, suggesting that the municipal bond market is largely segmented (note that under perfect segmentation, demand and supply would be equal across states and as a result perfectly correlated). We explore in more detail the geographic segmentation of the municipal bond market in the next section.

IV. Geographic Segmentation of the Municipal Bond Market

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.

We start our analysis by estimating pooled 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 *investment income per capita*, defined as the aggregate income of local residents in the form of dividends, interest, and rent. This variable measures 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. 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 state; and *No-tax State* is an indicator variable set to 1 if the corresponding state does not tax either in-state or out-of-state municipal bonds.

Table III regresses municipal bond yields on the state-level demand and supply measures and control variables for the whole sample of tax-exempt municipal bonds (first panel) and the subsample of tax-exempting states (second panel). 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 yields on new municipal bonds are negatively related to in-state demand and positively related to in-state supply of municipal bonds.[11] Bonds from the group of states that do not tax the interest income from out-of-state municipal bonds tend to have higher yields. This finding is also consistent with tax-induced segmentation of the municipal bond market – since states that exempt both local and out-of-state bonds would lose some of their local demand to states with asymmetric tax exemption, such states would have higher yields in equilibrium.

All control variables have the expected signs – municipal yields are higher for callable issues, bonds with lower credit ratings, and bonds with longer maturities. Bonds offered through a

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

competitive bids have lower yields than bonds offered through negotiated sales.[12] 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 as bank 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 measure of local demand. Consistent with the case of segmentation, greater demand by banks is also associated with lower municipal bond yields.

Interestingly, 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 ratings of the latter largely reflect the credit ratings of their insurance company. Furthermore, the insurance decision is endogenously determined and it depends on various state and bond characteristics. We analyze in more detail the insurance decision in Section V.

In the second panel of Table III, 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,

[12] 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.

Washington, and Wyoming.[13] The second group includes sates with income tax but exempt all municipal bond investments in the market – District of Columbia, Indiana and Utah.[14] As expected, neither local demand nor local supply are significantly related to municipal bond yields in the cross-section.

Table IV explores 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. Consistent with the

[13] 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.

[14] 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.

geographic integration of the market for taxable municipal bonds, we observe that sate demand and supply measures in this market have no significant impact on the yields of municipal bonds.

V. The Costs of Segmentation

So far we have presented empirical evidence consistent with the idea that the differential tax-treatment of in-state and out-of-state municipal bonds induces segmentation in the municipal bond market. In this section we study the associated costs of this segmentation. In Subsection V.A., we focus on yields; while in Subsections V.B., V.C. and V.D., we focus on the indirect costs of market segmentation – underwriting gross-spreads, insurance, and mutual fund fees.

V.A. Segmentation and Bond Yields

Existing studies on market segmentation have predominantly worked with realized stock returns in international markets, which is a very noisy setting for estimation of the cost of capital (see Foerster and Karolyi (1999) and Domowitz, Glen and Madhavan (1997) for a discussion). Focusing on the yields of initial bond offerings in a single country, on the other hand, provides a direct estimate of the cost of capital for the issuer.

To evaluate the impact of tax-induced segmentation on tax-exempt municipal bond yields we use as a benchmark the sample of taxable municipal bonds. In the previous section, we showed that the market of taxable municipal bonds is less segmented than the market of tax-exempt municipal bonds. Given that both tax-exempt and taxable bonds originate from the same states and exhibit similar characteristics (Table 1), the difference in the yields of these bonds could be a reasonably good proxy for the cost of segmentation in the municipal bond market.

To control more rigorously for bond and state-level characteristics we pool the two samples and estimate OLS regressions of after-tax bond-yields on a tax-status dummy (TS, equal to

1 for taxable bonds, and to 0 for tax-exempt bonds) and control variables. The coefficient on the tax-status variable captures the valuation premium of taxable municipal bonds relative to similar tax-exempt municipal bonds. Estimated coefficients and their T-statistics are reported in Table V. In the first panel of the table we estimate the basic model, while in the second and the third panels, we interact the tax-status variable with major bond and state characteristics.

We observe that tax-exempt municipal bonds are systematically priced at higher yields than taxable municipal bonds. The "segmentation" premium is around 62 basis points across the whole sample (Model 1). The interactions of the local demand and supply measures with the tax-status variable show that the segmentation discount increases with the aggregate supply and decreases with aggregate demand in the state of the issuer.

The risk-sharing view on market segmentation suggests that the yields of bonds with low credit rating and long maturity would be more strongly affected by segmentation, since local residents who already bear substantial amount of un-diversifiable regional risk, would be even more reluctant to add these bonds to their portfolios. As predicted, we show that these bonds have greater segmentation discount (last two interactions of Model 3).

V.B. Segmentation and Gross-Spreads

In this subsection, we focus on another component of the cost of capital of municipal bonds – floatation costs. We expect segmented capital markets to have greater floatation costs than integrated capital markets for at least two reasons. First, issues in segmented capital markets could be more difficult to place as a result of the smaller number of potential investors in these markets. Second, segmented capital markets could naturally have a smaller and less competitive underwriting business which would give more bargaining power to underwriters.

In Table VI, we estimate OLS regressions of municipal bond gross spreads (underwriting fee, relative to the size of the issue) of tax-exempt and taxable municipal bonds on the same set of independent variables as in Table V. The variable of interest again is the tax-status dummy for individual bonds. We observe that issuers of taxable municipal bonds pay substantially lower fees than the issuers of tax-exempt municipal bonds. Also issuers of bonds that exhibit greater degree of complexity, such as callable bonds, insured bonds, and bonds with longer maturity and lower credit rating tend to pay larger fees.

Consistent with the case of tax-induced segmentation, we also observe that the gross spreads of taxable and tax-exempt bonds are not significantly different from each other within the subsample of exempting states.

V.C. Segmentation and Bond Insurance

In recent years, nearly 50 percent of new municipal bond issues were insured against loss of principal and interest (see Table I). This practice seems puzzling, given that insurance is relatively unpopular in other bond markets. One justification for insurance could be that it can mitigate information asymmetries by certifying quality.[15] 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).

In Section II, we argue that the geographic segmentation of the municipal bond market could offer another rationale for municipal bond insurance. When investors construct their

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

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. Insurance can reduce the risk exposure of investors, while allowing them to maintain the tax benefit.[16]

Insurance companies can diversify efficiently across geographic regions. By pooling risks across states, insurance companies can generate surplus that could be shared between them and municipalities. 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). We note that at this stage our results are also consistent with Nanda and Singh (2004), who argue that 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 differentiate the two explanations by examining the impact of local demand and supply on the bond insurance decision.

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

We estimate the Logit-model the tax-exempt and taxable bond samples separately. We observe that in 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

[16] 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.

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 these local bonds.

V.D. Segmentation and the Costs to Investors

Here we evaluate the cost of market segmentation from the perspective of investors. One advantage of studying the municipal bond market is that here we can obtain information about the asset allocation decisions of investors. Under asymmetric tax exemption, municipal bond investors would allocate disproportionately more wealth towards local bonds, which would expose them excessively to local risks. In equilibrium, the tax-benefit on local positions is the compensation for these risks. An interesting empirical question is how investors allocate funds across bonds with different tax-exemption status and can investors effectively cash the whole tax benefit?

To examine the impact of market segmentation on investors' welfare we use data on municipal bond mutual funds. On average, half of individual investors' investment in municipal bonds is through mutual funds, and as a whole, holdings of municipal bond mutual funds represent one third of all municipal bonds outstanding. So, the mutual fund sample represents a substantial portion of municipal bond investment in the U.S.

Our sample of municipal bond mutual funds comes from the CRSP Survivor-Bias Free US open-end Mutual Fund Database. The sample includes all mutual funds classified by Strategic Insight and Lipper as tax-exempt municipal bond funds. Both Strategic Insight and Lipper classify municipal bond funds into *national bond funds* and *single-state bond funds*. For a fund that is classified as "other" by Lipper, we manually check the fund name and assign the fund into its corresponding state. Because of the tax exemption at state level, a single-state municipal bond fund

invests only in municipal bonds issued by that state and is marketed to investors from that state only. In contrast, national municipal bond funds invest in municipal bonds from different states, and are typically offered to investors nationally. Interest income from national municipal bond mutual funds is not exempted from local and state income taxes.

Table VIII reports several summary characteristics of state and national municipal bond mutual funds. The table reveals a series of interesting facts. First, the large number of national mutual funds (631 at the end of 2007) indicates that the out-of-state investment of municipal bond investors is not trivial. Given that by investing in national mutual funds investors completely forgo their state tax-benefit, this, indeed, suggests that risk is an important consideration for municipal bond investors. Next, we observe that the expense ratios of state mutual funds (average of 82 percent) exceed substantially the expense ratios of national mutual funds (average of 64 basis points). This is consistent with the idea that state mutual funds "capture" part of the tax-benefits of local municipal bond investments.

The high expense ratios of single-state funds suggest an additional cost associated with market segmentation. It is possible that the higher fees of state-level funds are related to the smaller size of these funds (as measured by TAV) or to the relatively smaller number of funds per state which could result a less competitive environment (relative to national municipal bond mutual funds). It is also possible, however, that when mutual fund companies are setting their management fees, they take into account the preferential tax-status of their investor clientele and intentionally inflate the fund fees. To test this hypothesis more rigorously, we estimate a pooled state-year regression of mutual fund expense ratios on state tax rates and state-level control variables.

The estimated coefficients are reported in Table IX. We observe that the fees of state-mutual funds are significantly positively related to the state-tax rates in their corresponding states – one percent increase of state tax rate results in 1.1 percent increase in state mutual fund expense

ratios. Because the benefit of tax exemption is greater in high income tax states, investors here are more likely to participate in single-state funds. This gives mutual fund companies bargaining power and allows them to charge higher fees. The positive link between fund fees and state tax rates is robust with respect to various measures of fund size and market share.

VI. Conclusion

We study the costs of financial market segmentation in a domestic setting. Most municipal bonds are exempt from state taxes for in-state investors but not for out-of-state investors. We present theoretical arguments and empirical evidence that the asymmetric tax exemption of municipal bonds induces segmentation of the market and increases the cost of capital of municipal bonds. By focusing on the municipal bond market we effectively control for differences in legal and institutional settings that are present in international markets and hinder the assessments of the impact of market segmentation.

The main contribution of this paper is that it documents substantial costs associated with market segmentation. First, segmentation increases the yields of newly issued municipal bonds. Second, the diversification constraints in segmented market create an incentive for municipal bond insurance. Next, bonds in segmented capital market have higher underwriting fees than bonds in less-segmented capital markets. Finally, using data on municipal bond mutual funds, we show that investors pay higher fees when investing in segmented vs. integrated markets. Our conclusion is that segmentation affects adversely both issuers and investors through many channels. This suggests that most existing studies very likely under-estimate the benefits of market integration.

Another contribution of the paper is that it identifies a single cause for a wide range of puzzling characteristics of the municipal bond market – asymmetric tax exemption with respect to state and local taxes. This asymmetric tax exemption creates segmentation of the market, which

contributes to the increase in bond yields (the muni puzzle), the propensity for bond insurance (the muni insurance puzzle), and the relatively low liquidity of the municipal bond market.

Our paper has implications for the estimation of the marginal tax rates incorporated in tax-exempt debt securities. The yield differential in these markets would reflect the implied marginal tax rate only if investors hold tax-exempted securities in isolation, i.e. the market is perfectly segmented.[17] This, however, is not the case. We show that in reality the tax consideration of investors always interacts with the diversification consideration. The latter creates an incentive for investor to give-up part of the tax-benefits, thus resulting in a marginal tax rate that is substantially lower.

The segmentation costs in the municipal bond market suggest that states would be better off if they either exempted both in-state and out-of state municipal bonds from taxation or imposed 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. Such changes, however, could be difficult to carry out. If the changes are introduced simultaneously, all issuers and investors in the market would be better off, but if the changes are introduced state by state, the states that move first would be in a disadvantage relative to all other states since they would lose local demand to other states without gaining anything in return. As a result, the change towards symmetric tax-exemption is not a game-theoretical equilibrium.

It seems that many municipalities and investors have become increasingly aware of the potential benefits of symmetric tax exemption and have attempted steps in this direction. A recent court case, Davis vs. Department of Revenue of Kentucky, declared state statutes limiting the state income tax exemptions to in-state-issues unconstitutional. On May 19, 2008, however, the

[17] For notable exceptions, see Green (1993) for a model that takes into account the taxation of capital gains and losses, and the tax exemptions of interest income in a portfolio approach.

Supreme Court ruled in favor of Kentucky allowing states to continue the practice of exempting interest on bonds issued within their borders while imposing income taxes on out-of-state issues. Another example is from the state of Utah who passed a legislation stating that interest earned on non-Utah municipal bonds after January 1, 2003 will not be subject to Utah income tax if the state issuing the bonds does not impose an income tax on bonds issued by Utah.

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. Given that in equilibrium $M = Y$, we conclude that

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

Q.E.D.

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Table I
Summary Statistics by Issue

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
Summary Statistics by State

The table reports the highest marginal state tax rate and the rank of relative demand and relative supply of municipal bonds in each state (and the District of Columbia). Municipal bond demand is measured with the investment income per capita in the state, where investment income is defined as the aggregate income of state residents in the form of dividends, interest, and rent. Municipal bond supply is measured with the value of new debt issues per capita in the state. Rank 1 (rank 51) corresponds to the state with the lowest (highest) value of the corresponding variable.

State	State Tax	Demand Rank	Supply Rank	State	State Tax	Demand Rank	Supply Rank
Montana	11.00	51	10	Kentucky	6.00	22	24
California	10.30	3	1	Georgia	6.00	43	39
Rhode Island	9.90	28	27	Delaware	5.95	18	22
Vermont	9.50	40	40	Virginia	5.75	16	9
D.C.	9.30	30	31	North Dakota	5.54	42	17
Oregon	9.00	31	19	Massachusetts	5.30	2	12
Iowa	8.98	11	18	New Mexico	5.30	46	47
New Jersey	8.97	8	38	Arizona	5.04	6	13
Maine	8.50	4	21	Alabama	5.00	19	2
North Carolina	8.25	44	20	New Hampshire	5.00	26	23
Hawaii	8.25	7	35	Mississippi	5.00	14	28
Minnesota	7.85	33	42	Connecticut	5.00	37	36
Idaho	7.80	24	34	Maryland	4.75	25	16
New York	7.70	34	33	Colorado	4.63	23	37
Utah	7.00	13	4	Michigan	3.90	12	7
South Carolina	7.00	15	14	Indiana	3.40	50	25
Arkansas	7.00	41	48	Pennsylvania	3.07	36	49
Ohio	6.87	48	44	Illinois	3.00	47	51
Nebraska	6.84	10	26	Nevada	0.00	5	3
Wisconsin	6.75	45	43	Florida	0.00	9	11
West Virginia	6.50	29	30	South Dakota	0.00	20	32
Kansas	6.25	27	15	Texas	0.00	39	41
Oklahoma	6.25	35	29	Wyoming	0.00	49	45
Louisiana	6.00	1	5	Wirginia	0.00	38	46
Missouri	6.00	32	6	Alaska	0.00	21	50
Tennessee	6.00	17	8	*Avergage*	*5.71*	*26*	*26*

Table III
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 rate* 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; *State Aggregate Income* is the logarithm of the aggregate income in the state; *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 first panel estimates the model on the sample of all tax-exempt municipal bonds, while the second panel estimates the model for the sub-sample states that exempt both in-state and out-of-state municipal bonds. The T-statistics are computed based on clustered standard errors at the state-year 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.

	Full Sample		Exempting States	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	0.221	0.94	0.663	1.32
T-Bond Yield	0.625**	28.81	0.624**	15.1
Callable	0.297**	13.97	0.338**	6.34
Insured	0.058**	3.98	0.013	0.62
Bank-qualified	-0.125**	-9.94	-0.098**	-3.6
Competitive bid	-0.340**	-8.63	-0.086**	-1.32
Medium maturity	0.464**	9.28	0.560**	3.79
Long maturity	1.036**	15.56	1.171**	6.93
Issue amount	-0.005	-0.90	-0.010	-0.72
Medium-grade	-0.016	-1.07	-0.107**	-3.06
Low-grade	0.260**	13.75	0.341**	10.73
Tax rate	0.006	1.18	-0.032**	-2.74
No-tax State	0.110**	2.97		
State Aggregate Income	0.012	0.27	0.151	1.25
Investment Income Pca.	-0.039**	-5.10	-0.046	-1.73
New Debt Pca.	0.061**	3.83	-0.016	-1.62
adj_R2	0.63		0.67	
Observations	18,279		2,213	

Table IV

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 rate* is the highest marginal income tax rate for the state; *State Aggregate Income* is the logarithm of the aggregate income in the state; *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 T-statistics are computed based on clustered standard errors at the state-year 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.

	Estimate	T-Stat
Intercept	-1.927	-2.10
T-Bond Yield	1.078**	18.82
Callable	0.209**	3.57
Insured	0.097	1.24
Competitive bid	-0.429*	-2.82
Medium maturity	0.627**	6.42
Long maturity	1.283**	9.19
Issue amount	-0.046*	-2.29
Medium-grade	0.101	1.15
Low-grade	0.334**	3.49
Tax rate	0.010	0.84
No-tax State	0.172	1.43
State Aggregate Income	0.409*	2.37
Investment Income Pca.	0.008	0.27
New Debt Pca.	-0.040	-0.68
adj_R2	0.62	
Observations	778	

Table V
Determinants of Municipal Bond Yields for the Pooled Sample of Tax-exempt and Taxable Municipal Bonds

The table estimates OLS regressions of the (after-tax) yields of tax-exempt and taxable municipal bonds on the following set of independent variables: *TS* is a tax-status dummy set to 1 for taxable bonds, and to 0 for tax-exempt bonds; 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 rate* is the highest marginal income tax rate for the state; *State Aggregate Income* is the logarithm of the aggregate income in the state; *Invest. 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. We further interact the supply-, demand-, long-maturity, and low-grade- variables with the tax-status dummy and report the estimated coefficients in models 2 and 3. The T-statistics are computed based on clustered standard errors at the state-year 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		MODEL 3	
	Estimate	T-Stat	Estimate	T-Stat	Estimate	T-Stat
Intercept	0.072	0.35	0.187	0.81	0.186	0.81
TS	-0.622	-30.26	-0.314	-1.51	-0.247	-1.19
T-Bond Yield	0.611	26.38	0.625	29.62	0.624	29.64
Callable	0.290	14.51	0.287	14.18	0.289	14.22
Insured	0.051	3.62	0.058	4.06	0.058	4.09
Bank-qualified	-0.128	-9.68	-0.124	-9.92	-0.124	-9.90
Competitive bid	-0.340	-8.63	-0.336	-8.74	-0.336	-8.78
Medium maturity	0.452	9.70	0.449	9.59	0.454	9.69
Long maturity	1.018	15.91	1.016	15.87	1.030	15.99
Issue amount	-0.009	-1.73	-0.005	-0.96	-0.006	-1.07
Medium-grade	-0.016	-1.13	-0.011	-0.77	-0.012	-0.82
Low-grade	0.254	13.43	0.256	13.71	0.259	13.82
Tax rate	0.641	1.23	0.658	1.35	0.645	1.32
No-tax State	0.146	3.69	0.118	3.27	0.116	3.23
State Aggregate Income	0.039	2.64	0.024	0.55	0.023	0.54
Invest. Income Pca.			-0.040	-5.32	-0.040	-5.32
New Debt Pca.			0.025	3.61	0.025	3.60
Invest. Inc Pca.***TS**			0.082	3.99	0.073	3.66
New Debt Pca.***TS**			-0.086	-3.68	-0.074	-3.20
Long maturity***TS**					-0.246	-5.69
Low-grade***TS**					-0.088	-2.09
adj_R2	0.64		0.65		0.65	
Observations	19057		19057		19057	

Table VI
Determinants of Municipal Bond Gross Spreads for the Pooled Sample of Tax-exempt and Taxable Municipal Bonds

The table estimates OLS regressions of the gross spread (The difference between the price of a bond paid by the underwriter and the offering price, relative to the size of the issue) of tax-exempt and taxable municipal bonds on the following set of independent variables: *TS* is a tax-status dummy set to 1 for taxable bonds, and to 0 for tax-exempt bonds; 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 rate* is the highest marginal income tax rate for the state; *State Aggregate Income* is the logarithm of the aggregate income in the state; *Invest. 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 T-statistics are computed based on clustered standard errors at the state-year 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.

	Full Sample		Exempting States	
	Estimate	T-Stat	Estimate	T-Stat
Intercept	9.79	4.42	8.00	1.80
TS	**-1.19**	**-4.01**	**-1.01**	**-0.79**
T-Bond Yield	-0.34	-1.66	0.10	0.39
Callable	0.58	2.52	1.25	3.48
Insured	1.53	8.64	1.71	2.74
Bank-qualified	-1.11	-4.41	-1.59	-2.71
Competitive bid	-1.43	-4.4	0.48	1.36
Medium maturity	2.85	9.47	2.30	2.91
Long maturity	5.59	14.09	3.90	5.23
Issue amount	-1.82	-21.66	-1.80	-10.56
Medium-grade	0.14	0.61	-0.02	-0.03
Low-grade	3.27	10.56	2.63	2.76
Tax rate	0.21	5.79	-0.30	-3.07
No-tax State	1.06	2.66		
State Aggregate Income	-0.24	-2.1	-0.13	-0.44
Invest. Income Pca.	0.07	0.77	-0.05	-0.36
New Debt Pca.	0.15	0.45	0.19	0.58
adj_R2	0.35		0.30	
Observations	5664		672	

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 rate* is the highest marginal income tax rate for the state; *State Aggregate Income* is the logarithm of the aggregate income in the state; *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 P-values are computed based on clustered standard errors at the state-year 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.

	Tax-exempt bonds		**Taxable Bonds**	
	estimate	P-value	estimate	P-value
Intercept	-8.684	<.0001	-8.548	0.00
T-Bond Yield	-0.004	0.96	-0.070	0.76
Callable	0.433	<.0001	0.498	0.03
Bank-qualified	0.226	0.01		
Competitive bid	0.434	0.01	-0.539	0.19
Medium maturity	1.869	<.0001	0.569	0.05
Long maturity	2.390	<.0001	1.590	<.0001
Issue amount	0.642	<.0001	-0.047	0.63
Tax rate	-0.093	0.00	-0.102	0.10
No-tax State	-0.008	0.97	-0.325	0.58
State Aggregate Income	0.353	<.0001	0.598	0.00
Investment Income Pca.	0.002	0.96	0.195	0.09
New Debt Pca.	0.781	<.0001	-0.130	0.77
adj_R2	0.32		0.17	
Observations	17,035		742	

Table VIII
State-level Distribution of State and National Municipal Bond Mutual Funds

The table reports summary characteristics of municipal bond mutual funds. The funds are classified as a state fund if it only invests in municipal bonds from the particular state. The fund is classified as a national fund if it invests in municipal bonds from different states. The number of funds and total asset value under management are for the last quarter of 2007. The expense ratio for the funds in each state is first calculated as the asset value weighted expense ratio in each state for each year. The table then reports the average expense ratio for year 2001-2007.

State	Num. of Funds	TAV	Expense Ratio	State	Num. of Funds	TAV	Expense Ratio
California	213	51,272	0.64	Tennessee	12	786	0.85
New York	150	37,987	0.78	Hawaii	11	1,157	0.78
Pennsylvania	73	9,702	0.66	Rhode Island	11	249	0.92
Massachusetts	68	6,906	0.70	West Virginia	10	398	0.87
Ohio	64	4,915	0.76	Delaware	9	210	1.11
New Jersey	60	7,268	0.68	Wisconsin	9	301	0.94
Maryland	57	6,424	0.56	New Mexico	7	262	1.01
Florida	50	11,590	0.77	Mississippi	6	120	0.81
Minnesota	50	3,351	0.84	Nebraska	6	162	0.79
Michigan	48	3,460	0.76	Arkansas	5	199	0.86
Virginia	46	3,944	0.75	Idaho	4	97	1.10
North Carolina	39	2,737	0.78	Montana	3	30	1.08
Arizona	37	2,412	0.78	Utah	3	223	0.62
Georgia	32	1,415	0.80	North Dakota	2	7	0.99
Colorado	29	1,921	0.79	Washington	2	42	0.73
Connecticut	29	2,067	0.83	Maine	1	16	0.94
Kentucky	24	1,855	0.75	New Hampshire	1	4	0.94
Oregon	22	2,027	0.75	Oklahoma	1	53	0.79
Missouri	19	1,544	0.81	Texas	1	68	0.74
South Carolina	18	795	0.78	Vermont	1	49	0.82
Louisiana	16	564	0.87	*State Total*	*1274*	*169,549*	*0.82*
Alabama	13	487	0.85	*National*	*631*	*206,545*	*0.64*

Table IX

Determinants of the Expense Ratios of State Municipal Bond Mutual Funds

The table estimates OLS regressions of the average expense ratio of municipal bond mutual fund for each state on the following variables: *Tax rate* is the highest marginal income tax rate for the state; *Num. of funds* is the number of state specific municipal bonds; *Fund size* is the average total asset value of each fund with a state. All three variables are measured at the state level and for each year from 2001 to 2007 annually. The expense ratio for the funds in each state is calculated as the asset value weighted expense ratio. The T-statistics are computed based on clustered standard errors at the state-year 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		MODEL 3	
	Estimate	T-Stat	Estimate	T-Stat	Estimate	T-Stat
Intercept	0.745	44.47	0.890	34.43	1.122	23.5
Tax Rate	1.193	4.33	1.111	4.46	1.231	5.19
Num. of Funds			-0.050	-8.09	-0.007	-0.75
Fund size					-0.092	-5.86
Adj_R2	0.04		0.25		0.34	
Observations	301		301		301	