The Cross-Section of Municipal Bond Returns

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This paper studies the cross-section of expected municipal bond returns. We show that municipal bond yields contain reliable information about differences in expected municipal bond returns across states of issuance, duration range, and credit quality. Hence, using information embedded in those yields, we can target higher expected returns by focusing on tax clientele effects, term premiums, and credit premiums. Indeed, a well-diversified, low-turnover systematic strategy that emphasizes all three drivers of expected municipal bond returns would have outperformed the municipal bond market by 48 basis points per year, on average, between November 2006 and December 2021.

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1. Introduction

Systematic or factor-based investing is the focus of many recent academic and industry studies. Most research on systematic bond investing has examined government and corporate bonds (Cochrane and Piazzesi 2005, Houweling and van Zundert 2017, Israel et al. 2018, Bektić et al. 2019 & 2020, Henke at al. 2020). There has been limited research on systematic municipal bond investing. The municipal bond market, however, is an important part of the US bond market. According to the Municipal Securities Rulemaking Board (MSRB), the total market size (par value) of municipal bonds was $4 trillion in 2020, about half of the size of the US corporate bond market, $10.6 trillion (MSRB, 2021).

To study the cross-section of expected municipal bond returns, it is useful to review the basic framework for expected bond returns. Holding a risk-free bond to maturity, an investor will earn an annualized return equal to the bond yield at purchase, assuming the coupons are reinvested at the same yield. For a bond that has default risk or is not held to maturity, the return is not certain. It can be broken down into an expected return and an unexpected return. The unexpected return of a bond is random and unpredictable. The expected return of a bond, however, can be decomposed into 1) a forward rate (yield and expected capital appreciation), 2) expected future changes in bond yields, 3) probability of default, and 4) expected recovery rate given default (Lee et al. 2020). Ample research shows that forward rates contain information about the cross-section of expected government and corporate bond returns. For example, there is a reliable relation between current term spreads and future term premiums (Fama 1984, Fama and Bliss 1987), and between current credit spreads and future credit premiums (Giesecke et al. 2011, Nozawa 2017, Lee et al. 2020). Therefore, it is natural to expect that current municipal bond yields and forward rates contain reliable information about the cross-section of municipal bond returns as well.

In this paper, we focus on the explanatory power of municipal bond yields. Yields can be used to approximate forward rates in the municipal bond market as many investors buy and hold municipal bonds to maturity to minimize the impact of taxes and trading costs. Using a comprehensive panel of municipal bonds from 2006 to 2021, we study how cross-sectional differences in yields across municipal bonds relate to differences in their subsequent average returns. On average, a one basis point yield difference is associated with a reliable 1.54 basis points (bps) return difference in the following month. Because municipal bond yields tend to differ by state of issuance, duration range, and credit quality, we identify three main drivers of differences in expected municipal bond returns. First, there are tax clientele effects related to state income tax levels and policies. Municipal bonds issued in the states with higher state income taxes are likely in high demand by in-state investors, resulting in higher prices and lower yields for those municipal bonds relative to equivalent bonds from other states. Consistent with this intuition, within the sample, municipal bonds issued in states with weak or no clientele effects have outperformed those issued in other states by 13 bps per year on average, while exhibiting similar key characteristics such as duration and credit rating. Second, there is a reliable relation between current term spreads and future term premiums for municipal bonds. The average term premium is 19 bps per month. Moreover, on average the term premium is larger in months that start with wider term spreads. Third, there is also a reliable relation between current credit spreads and future credit premiums. The average credit premium is 6 bps per month. Similar to the term premium, the credit premium is on average larger in months starting with larger credit spreads.

To highlight the benefits of incorporating these drivers of higher expected returns into systematic municipal bond investing, we form a hypothetical systematic municipal bond strategy that is well-diversified and targets all three sources of higher expected returns subject to various constraints related to state of issuance, duration, credit quality, and turnover. The strategy emphasizes states with weak or no clientele effects. It also overweights or underweights bonds in different duration ranges and credit qualities depending on the prevailing term and credit spreads. This systematic strategy outperformed the municipal bond market by 48 bps per year on average between November 2006 and December 2021.

The remainder of this paper is organized as follows. Section 2 explains the rationale for using yields to approximate expected municipal bond returns. Section 3 describes the municipal bond data. In Section 4, we conduct cross-sectional regression analysis to study the relation between current yields and returns of municipal bonds in the subsequent month. In Section 5, we use portfolio analysis to identify the main sources of higher expected returns for municipal bonds: tax clientele effects, term premiums, and credit premiums. Section 6 discusses a framework for systematic municipal bond investing and studies the performance of a hypothetical systematic strategy that targets all three drivers of municipal bond returns. The last section concludes the paper.

2. Using Yields to Approximate Expected Municipal Bond Returns

In the section, we explain the rationale for using yields to approximate expected municipal bond returns.

Lee et al. (2020) show that the expected return on a bond can be decomposed into 1) a forward rate (yield and expected capital appreciation), 2) expected future changes in bond yields, 3) probability of default, and 4) expected recovery rate given default.

Historically, municipal bonds have had very low default rates. For example, the average 10-year cumulative default rate for investment-grade municipal bonds is 0.1% over the period 1970–2020 (Moody's 2021). This suggests that the probability of default and the expected recovery rate have a small impact in estimating expected municipal bond returns. There is also ample academic research showing that changes in bond yields cannot be systematically predicted and that the best forecast of future yield curves is the current yield curve (Fama 1984, Fama and Bliss 1987, Campbell and Shiller 1991, and Duffee 2002). Hence, we can treat expected future changes in bond yields as zero. As a result, we would ideally focus on forward rates as proxies for expected municipal bond returns. Since the forward rate is the sum of yield and capital appreciation (roll-down), we need to construct municipal yield curves for different credit quality groups and estimate the roll-down for each municipal bond. However, unique features of the municipal bond market suggest that yields are an appropriate approximation of expected returns for municipal bonds.

First, the municipal bond market is quite fragmented and less liquid. According to MSRB, there are approximately one million outstanding municipal bonds, compared to 43,000 US corporate bonds (MSRB, 2021). The municipal bond market is also less liquid than the corporate and Treasury markets. Many municipal bonds trade infrequently. The daily average trading volume of municipal bonds is $12.4 billion, in contrast to $38.9 billion for US corporate bonds (MSRB, 2021). The large number of bonds and relatively low liquidity would add substantial noise to the construction of municipal yield curves and the estimation of roll-downs.

Second, transaction costs are meaningful for municipal bonds. Wu (2018) estimates that, in early 2018, the average effective bid-ask spread was about 70 bps for all dealer-to-customer municipal bond trades, and about 20 bps for institutional-size trades (par greater than $1 million). To reduce the negative impact of transaction costs on municipal bond returns, many investors in that market tend to hold bonds over a longer period, often to maturity. Investors also tend to hold municipal bonds longer due to tax considerations. The exemption of municipal bonds' coupons from federal (and often state) income taxes attracts many tax-sensitive investors to the municipal bond market. While all the coupons from a municipal bond are tax-free, the capital gains from trading a municipal bond are not. Hence, in addition to reducing transaction costs, holding municipal bonds over a longer period can help reduce capital gains taxes.

Lastly, as the holding period becomes longer, the forward rate converges to the yield at purchase. Consider a non-defaultable zero-coupon bond with maturity T (years) and yield $y(t,T)$, where $y(t,T)$ represents the zero-coupon spot curve at time t for all maturities T. Assume that we hold the bond for s years and sell it when its time-to-maturity becomes $(T-s)$. The forward rate at time t, s-year forward, is the following:

$$F_{t,s} = \frac{y(t,T) \cdot T - y(t,T-s) \cdot (T-s)}{T-(T-s)} = y(t,T) + \frac{y(t,T) - y(t,T-s)}{s} \cdot (T-s). \tag{1}$$

As the holding period s becomes closer to T years, or equivalently as the bond is held closer to its maturity, the forward rate $F_{t,s}$ converges to the yield of the bond, $y(t,T)$. This suggests that for many municipal bond investors the yield is a good (albeit not perfect) approximation of the expected bond return.

3. Municipal Bond Data

We use a comprehensive panel of municipal bonds from the Bloomberg Municipal Bond Index constituents. The monthly data contain maturity, yield-to-worst (YTW),[1] option-adjusted duration (OAD), return, market value, state of issuance, credit rating, and optionality from October 2006 to December 2021. We include municipal bonds issued by all 50 states and the District of Columbia. For credit rating and liquidity considerations, those issued by US territories (Guam, Puerto Rico and US Virgin Islands) are excluded. We exclude taxable municipal bonds and those subject to the alternative minimum tax (AMT). We restrict the maturity range to 1–20 years, consistent with the eligible maturity range of the S&P Intermediate Term National AMT-Free Municipal Bond Index. In terms of credit ratings, we restrict the sample to investment grade only (AAA–BAA) based on index ratings provided by Bloomberg. As in other studies, putable or sinkable bonds are excluded from the sample, since they form a small portion of the index universe[2] and their optionality may confound the analysis. We include, however, callable bonds, since they represent a large portion of the index universe.

On average, our sample contains 38,154 municipal bonds and 1,390 unique issuers per month. The total market value of our sample is on average $864 billion and $1.01 trillion as of December 2021.[3] **Table 1** summarizes the distribution of our sample by credit rating, duration range, and call type. On average about 76% of bonds in the sample by market value are AAA/AA rated, and the remaining 24% are A/BBB rated. On the other hand, most of the bonds in the sample are below 10 years in duration by market value, with 48% in the 0–5 Year bucket and 48% in the 5–10 Year bucket. On average, 63% of the sample by market value are callable bonds with some type of call option embedded, and the remaining 37% are non-callable. While breakdowns by duration range and call type are relatively stable over time, there are significant changes in the market composition by credit rating. **Figure 1** shows that the number of issues, number of issuers, and market weight of bonds rated A/BBB have all increased during the sample period. In particular, the market weight for bonds rated A has grown from 9% to 18% and for bonds rated BBB, from 2% to 7%.

1. Throughout the empirical analyses in the paper, we use yield-to-worst instead of yield-to-maturity and option-adjusted-duration instead of duration to take bond optionality into consideration.
2. From October 2006 to December 2021, within the 1–20 year maturity range, on average 0.2% and 4.8% of the Bloomberg Municipal Bond Index are putable and sinkable by issue count, respectively, while on average 65% are callable.
3. The numbers are smaller than the $4 trillion total market size reported in MSRB 2021, since the Bloomberg Municipal Bond Index applies inclusion rules to eligible bonds, including credit quality (AAA–BAA), minimum amount outstanding, security type (for example, no private placement).

4. The Cross-Section of Expected Municipal Bond Returns

To examine the informational content in municipal bond yields, we start with monthly Fama-MacBeth regressions (Fama and MacBeth 1973) of future municipal bond returns on current yields. For municipal bonds described in Section 3, we run the following cross-sectional regression each month to test whether current month-end yields have reliable information about differences in next-month returns:

$$R_{i,t+1} = \alpha + \beta \cdot y_{i,t} + \epsilon_{i,t+1}. \quad (2)$$

$R_{i,t+1}$ is the return of municipal bond i in month $t+1$, $y_{i,t}$ is yield-to-worst of bond i at the end of month t, and $\epsilon_{i,t+1}$ is the error term.

Panel A of **Table 2** summarizes the results of the Fama-MacBeth regressions for all municipal bonds in the sample. We observe a positive relation between current yields and subsequent month returns. On average, a one basis point yield difference is associated with a reliable 1.54 bps return difference in the following month, with a t-statistic above two.

Since many municipal bonds don't trade frequently, their (month-end) prices might be estimated from other traded bonds with similar characteristics, including issuer, maturities, coupon rates, credit rating, etc. This is commonly known as matrix pricing. To examine if our analysis is robust to the impact of matrix pricing, we combine our municipal bond sample data with trade data from MSRB's EMMA[4] and split the bonds into two groups: "More Liquid Bonds" for those bonds with at least one trade in the last 10 business days of a month and "Less Liquid Bonds" otherwise. On average, about 34% of municipal bonds by issue count trade at least once in the last 10 business days of a month, while the remaining 66% of the bonds do not. Despite differences in trading behavior, the average yield, duration, and credit exposures of the two groups are similar.[5]

We run the same Fama-MacBeth regression analysis based on Equation (2) for both groups from May 2009 to December 2021—the available period for our municipal bond trading data. Panel B of Table 2 shows that the regression results are similar: There is a reliably positive relation between current yields and subsequent average returns for both More Liquid Bonds and Less Liquid Bonds.

4. EMMA is a service of the MSRB and provides market transparency data, which includes real-time prices and yields at which bonds and notes are bought and sold, for most trades occurring on or after January 31, 2005.

5. Between May 2009 and December 2021, each month, there are on average 13,200 bonds in the group "More Liquid Bonds", compared to 25,811 bonds in the group "Less Liquid Bonds". For "More Liquid Bonds", the monthly average (market-value weighted) yield is 1.94%, OAD is 5.11 years. The average credit breakdown is as follows: 71.5%(AAA/AA), 23.4%(A), and 5.1%(BAA). For "Less Liquid Bonds", the average yield is 1.98%, OAD is 5.36 years. The credit breakdown is as follows: 75.5%(AAA/AA), 19.9%(A), and 4.6%(BAA).

5. Sources of Higher Expected Returns

Having documented a reliably positive cross-sectional relation between current municipal bond yields and future municipal bond returns, we now examine the major drivers of systematic yield differences across municipal bonds and use them to identify systematic future return differences. Municipal bond yields differ by state of issuance, duration range, and credit quality. Thus, we form portfolios based on municipal bonds issued by states with different tax treatments, duration ranges, and credit qualities. Using these portfolios, we identify three main sources of higher expected returns for municipal bonds: tax clientele effects, term premium, and credit premium.

5.1 Tax Clientele Effects

Typically, states do not tax income from municipal bonds issued in-state but charge tax on income from municipal bonds issued out-of-state. This can lead to strong preferences by residents of states with high state income tax rates to hold municipal bonds issued in-state. For example, investors residing in California, a state with relatively high state income tax rates, may have high demand for California municipal bonds. For them, these are the only municipal bonds whose income is not subject to the high state income tax rate. The strong demand by California investors for California municipal bonds can push the prices of these bonds up and their yields down relative to similar bonds from other states. For investors residing in other states, the California municipal bonds will not be as attractive as other municipal bonds with similar characteristics. As a result, differences in tax treatment of bonds issued by different states can lead to tax clientele effects. Babina et al. (2020) show that different tax policies create incentives for concentrated local ownership, which in turn can affect municipal bond prices. The magnitude of this price impact could be meaningful. Ang et al. (2008) estimate that municipal bonds carrying income tax liabilities trade at yields around 25 bps higher than comparable municipal bonds that are not subject to any taxes.

To study the tax clientele effects empirically, we form two municipal bond portfolios that are market value weighted and rebalanced monthly. The first consists of bonds issued in states with potentially weak or no clientele effects ("Weak-clientele-effects States") and the other consists of bonds issued in other states ("Other States"). As shown in **Figure 2**, the Weak-clientele-effects States include states with no personal state income tax (Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming),[6] states that in general tax both in-state and out-of-state municipal bonds (Illinois, Iowa, Oklahoma, and Wisconsin), and states that have reciprocal tax provision or no income taxes in municipal bonds (Utah, and the District of Columbia).[7] The selection of the states is based on the State Tax Guide, which reflects tax laws through January 1, 2010, and the 2020 state tax codes regarding municipal bond investing.[8]

6. Tennessee has a "Hall income tax," levied at a rate of 3% on income received from stocks and bonds not taxed ad valorem as of 2019. The tax is 2% as of 2020, 1% as of 2021, and fully repealed as of 2022. We don't include Tennessee in the Weak-clientele-effects States in this paper.

7. Utah does not tax its own bonds, but also does not tax bonds issued in states that do not tax Utah bonds. Utah Code §59-10-114(1)(e): *incometax.utah.gov/additions/municipal-bond-interest*. The District of Columbia has enacted legislation repealing the taxation of income from state and municipal bonds: *otr.cfo.dc.gov/release/tax-state-and-municipal-bond-income-individuals-repealed*.

8. Due to lack of references for state tax codes over time, the list of Weak-clientele-effects States may ignore relevant state tax code changes in the sample period.

Figure 3 illustrates the yield of the two portfolios over the sample period. The yield on the Weak-clientele-effects States portfolio is persistently higher than the yield of the Other States portfolio. The average yield difference is 13 bps and is reliably positive, with a t-statistic above two. **Table 3** reports the simulated performance and characteristics of the two portfolios. On average, the Weak-Clientele-Effects States muni portfolio outperforms the Other States muni portfolio by 13 bps per year, while the average OAD and credit exposures are similar.

5.2 Term Spreads and Term Premiums

Fama (1984) and Fama and Bliss (1987) show there is a reliable relation between current term spreads and future term premiums for Treasuries. To test whether this relation also holds for municipal bonds, we form two market value weighted, monthly rebalanced portfolios: short duration (0–5 years) and intermediate duration (5 years and longer). We define the term premium, R_t^{Term}, as the return difference between the intermediate duration portfolio and the short duration portfolio, and the term spread, S_t^{Term}, as the yield difference between the two portfolios.

Panel A in **Figure 4** shows that the average monthly term premium for investment grade (AAA–BAA) municipal bonds is 19 bps across all months in the sample. Moreover, the average term premium is greater when the term spread at the start of the month is wider. For example, when the current term spread is wider than 50 bps, the next month's term premium increases to 23 bps, on average. Furthermore, when the term spread is wider than 100 bps, the average term premium becomes 28 bps. All three average term premiums are reliably larger than zero, with t-statistics above two. The results remain similar when we control for credit quality by limiting the bonds in the two portfolios to AAA/AA or A/BBB rated municipal bonds, as illustrated in Panel B and C in Figure 4.

Furthermore, we test the relation between current term spreads and next month's term premiums using the following time-series regression:

$$R_{t+1}^{Term,CR} = \alpha + \beta \cdot S_t^{Term,CR} + \epsilon_{t+1}^{CR}, \quad \text{for } CR = \text{AAA–BAA, AAA/AA, or A/BAA}, \tag{3}$$

where, for bonds with letter rating CR, $R_{t+1}^{Term,CR}$ is the term premium in month t+1, $S_{t+1}^{Term,CR}$ is the term spread at the end of month t, and ϵ_{t+1}^{CR} is the error term.

Table 4 summarizes the regression results. There is a reliable relation between current term spreads and next month's term premiums, as the slope coefficients are reliably positive across the board. On average, the wider the current term spread is, the larger the term premium is next month. The results are similar across subsamples with different credit ratings. In summary, we find that differences in yields across municipal bonds of different duration reliably forecast differences in future average monthly returns.

5.3 Credit Spreads and Credit Premiums

Prior studies have also documented a reliable relation between current credit spreads and future credit premiums, e.g., Giesecke et al. (2011), Nozawa (2017) and Lee et al. (2020). To test for this effect in municipal bonds, we form monthly rebalanced portfolios of different credit qualities: AAA/AA and A/BAA. The credit premium, R_t^{Credit}, is defined as the return difference between the lower-tier credit quality (A/BAA) portfolio and the upper-tier credit quality (AAA/AA) portfolio, while the credit spread, S_t^{Credit}, is defined as the yield difference between them.

Panel A in **Figure 5** shows that, on average, there is a monthly credit premium of 6 bps between A/BAA and AAA/AA rated municipal bonds, and that the average credit premium is bigger in months when the credit spread is wider. The results remain similar when we control for duration, by restricting the durations to a short duration range (0–5 years) and an intermediate duration range (5 years or above) in Panel B and C in Figure 5.

Unlike in Figure 4, in Figure 5 the t-statistics are not all above two. The callable bonds in the sample may be confounding the results, since their yields also reflect information about optionality. In **Figure 6**, we repeat the analysis restricting the sample to non-callable bonds only. The credit premiums become more reliable, with most t-statistics bigger than two.

As in the prior section, we test the relation between current credit spreads and next month's credit premiums using the following time-series regression:

$$R_{t+1}^{Credit,D} = \alpha + \beta \cdot S_t^{Credit,D} + \epsilon_{t+1}^D, \quad \text{for } D = \text{All Duration, 0–5Y, or 5Y+}, \qquad (4)$$

where, for duration range D, $R_{t+1}^{Credit,D}$, is the credit premium in month t+1, $S_t^{Credit,\,D}$ is the credit spread at the end of month t, and ϵ_{t+1}^D is the error term.

The results in **Table 5** confirm a reliably positive relation between current credit spreads and next month's credit premiums, as the slope estimates are positive, with t-statistics above two. On average, the wider the current credit spread is, the larger the next month's credit premium is. The results are also similar for subsamples of bonds in different duration ranges.

6. A Framework for Systematic Municipal Bond Investing

What would be the joint effect of incorporating all three drivers of municipal bond returns in a systematic strategy? To study that, we form a municipal bond strategy that systematically overweights or underweights bonds in different states, duration ranges, and credit qualities based on differences in expected returns.

Since there are about 38,000 bonds on average in the sample and they don't all trade every month, we group bonds into subindexes for our strategy simulations. Using subindexes instead of individual bonds helps simplify the problem mathematically and address liquidity considerations. The latter is particularly important in practice. While many municipal bonds don't trade frequently, we can choose bonds with similar characteristics as substitutes.

We construct a total of 459 subindexes by state (51 in total, including the District of Columbia), duration range (0–3 years, 3–7 years, and 7+ years), and credit quality (AAA/AA, A, and BBB). For example, a subindex could consist of 0–3 year duration AAA/AA rated municipal bonds issued in Alabama. The subindexes are market value weighted and rebalanced monthly. Each month, we calculate the duration, market value, and return for each subindex.

We design the systematic municipal bond strategy as follows. At each rebalance, we solve for the optimal subindex weights that maximize the expected return of the portfolio while subject to various constraints listed in Table 6. For example, to target the expected return difference due to tax clientele effects, the total weight of the Weak-clientele-effects States (defined in Section 5.1) must be above 50%, a threshold higher than their historical market weight. We add a maximum overweight constraint that caps each subindex's weight at five times its market weight to avoid over-concentration in any subindex with a tiny market weight. To control portfolio turnover, we rebalance the strategy annually at the beginning of each year and apply a 0.1% initial turnover budget to each subindex at rebalance such that the maximum turnover for each subindex is 0.1%. When there is no feasible solution, we relax the turnover budget gradually in 0.1% increments until the optimization becomes feasible. Within this framework, the constraints are highly customizable based on investment goals or risk preferences, and they can be implemented as a system of linear equations and inequalities. For example, if an investor is benchmark sensitive in terms of duration, we can change the strategy duration constraint to be within a range of the benchmark duration.

Table 7 reports the simulated performance and characteristics of the systematic municipal bond strategy. The annualized compound return of the strategy is 4.19% between November 2006 and December 2021. It outperformed the market of municipal bonds within the 1–15 year maturity range by an average of 48 bps per year.

9. Since municipal bonds can shift from one subindex to another or be dropped from the sample, the market weight of each subindex may change significantly in rare cases. This could leave the optimization problem without an optimal or feasible solution, particularly with turnover constraints.

To highlight the value-add of varying credit exposure over time, we construct a static credit quality strategy that applies fixed weight in each credit quality (AAA/AA, A, and BAA). The fixed weights match the average credit weights in the systematic strategy. Within each credit quality group, the static strategy is market value weighted and rebalanced monthly. With the same credit exposure, on average, the systematic strategy that dynamically shifts across the credit spectrum based on variations in credit spreads outperformed the static credit quality strategy by 32 bps annualized.

Also, to highlight the value-add of varying duration exposure over time, we construct a static duration strategy that matches the average duration of the systematic strategy. Specifically, each month we combine the 1–3 year and 3–15 year municipal bond market portfolios so that the overall strategy has a constant 5-year duration. On average, the systematic strategy outperformed the static duration strategy by 37 bps annually.

Similarly, we also construct a custom strategy with fixed weights between two market portfolios that consist of Weak-clientele-effects States and Other States, respectively. The fixed weight allocated to the Weak-clientele-effects market portfolio equals the average monthly weight of the Weak-clientele-effects States within our systematic strategy. On average, the systematic strategy outperformed the strategy with fixed Weak-clientele-effects States weight by 45 bps annually.

These results confirm that incorporating all three drivers of expected municipal bond returns in a systematic strategy with varying exposure over time to those drivers can be beneficial for the pursuit of higher expected returns.

Lastly, transaction costs can have a big impact on implementing any systematic municipal bond strategy. We estimate the monthly two-way turnover as the sum of absolute weight changes of all the subindexes due to rebalancing, or equivalently the sum of buys and sells as a percentage of the portfolio value at the start of the month. The average monthly turnover of the systematic strategy is about 5.3%, compared to an average of 4.4% for the municipal bond 1–15 year market.[10] This implies an annual excess turnover of about 10–15% for the systematic strategy. As mentioned earlier, estimated bid-ask spreads in the municipal bond market range from 20 bps for institutional trades to 70 bps for retail trades. Hence, investors could face additional trading costs of 3–10 bps per year when implementing such a systematic strategy. Since the before-cost average outperformance is about 50 bps, our analysis suggests that the benefits of the systematic pursuit of higher expected returns are likely to outweigh the costs of real-world implementation. Institutional-size trading with lower bid-ask spreads and a flexible trading approach can also help for the successful implementation of a systematic municipal bond strategy.

10. The actual turnover would be different due to the subindex construction method and the limitations of our sample data. For example, a bond could be dropped out of a subindex or our sample when it is called or removed from the investment grade universe due to a downgrade.

Conclusion

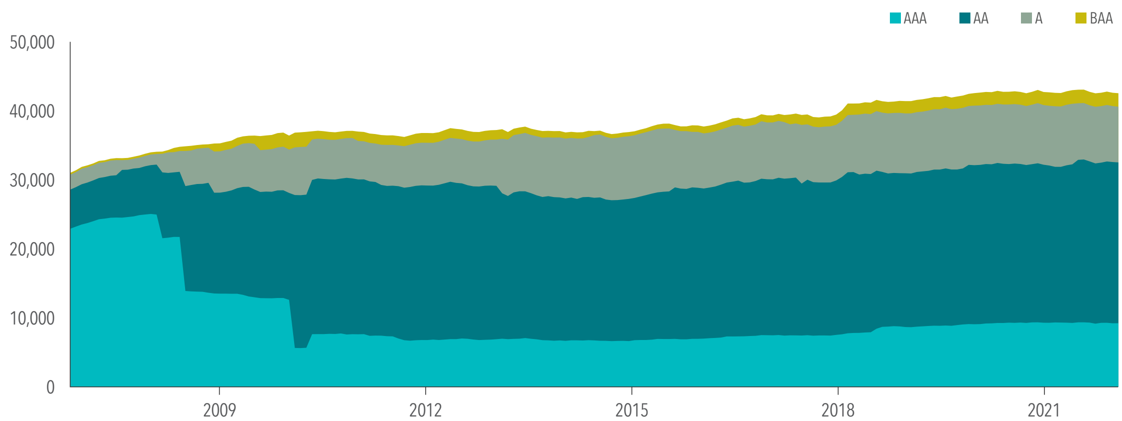
Market prices contain reliable information about future bond returns. In this paper, we study the cross-section of municipal bond returns and find a reliable and positive relation between current yields and future returns. We also identify three main drivers of higher expected returns for municipal bonds. Municipal bonds issued by states with weak or no tax clientele effects have higher yields and average returns than those issued by states with strong clientele effects. There is also a reliable relation between current term spreads and future term premiums, and between current credit spreads and future credit premiums. We propose a framework for systematic municipal bond investing that aims to add value by targeting all three drivers of higher expected returns while considering portfolio diversification and turnover.

Figures

FIGURE 1: Municipal Market Breakdown by Credit Rating, *October 2006–December 2021*

This figure shows the market breakdown by credit rating for all eligible municipal bonds in the sample from October 2006 to December 2021. We plot the number of issues, number of issuers, and market weight by credit rating over the sample period. The credit ratings are based on index ratings provided by Bloomberg.

NUMBER OF ISSUES



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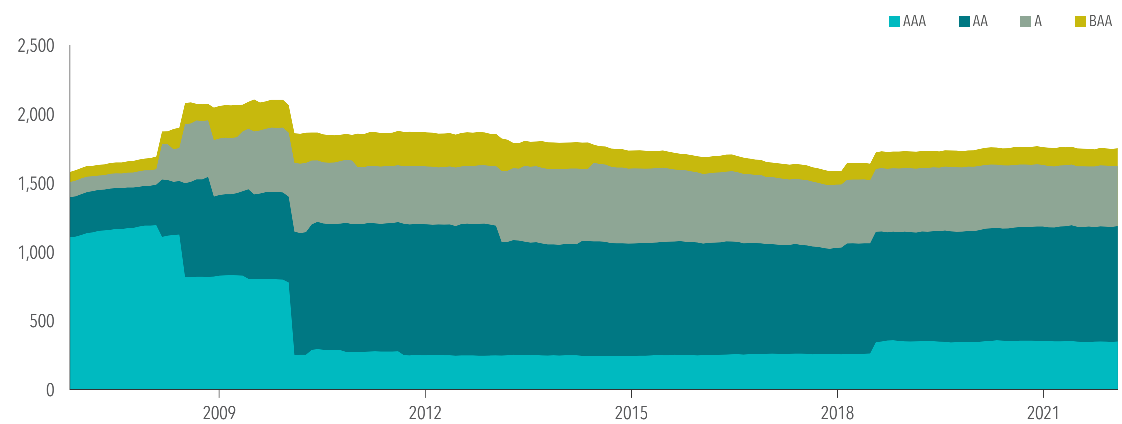

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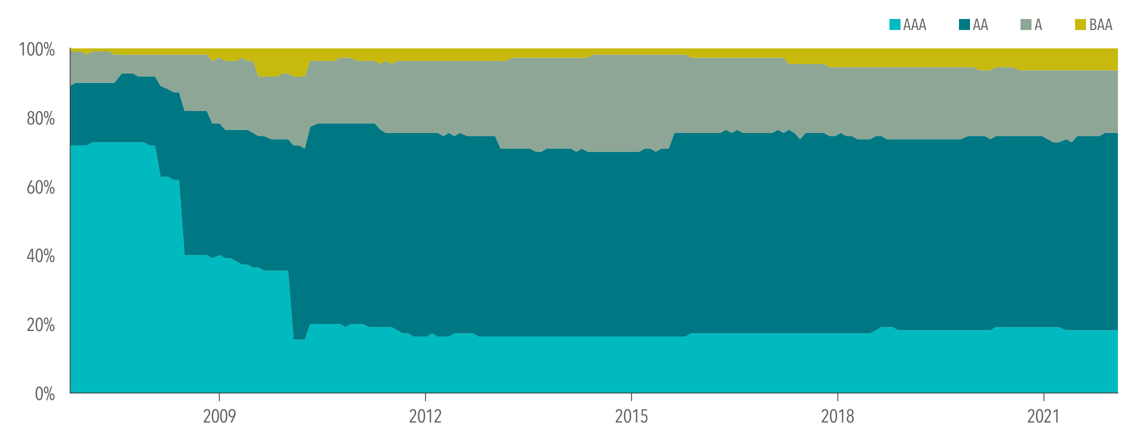
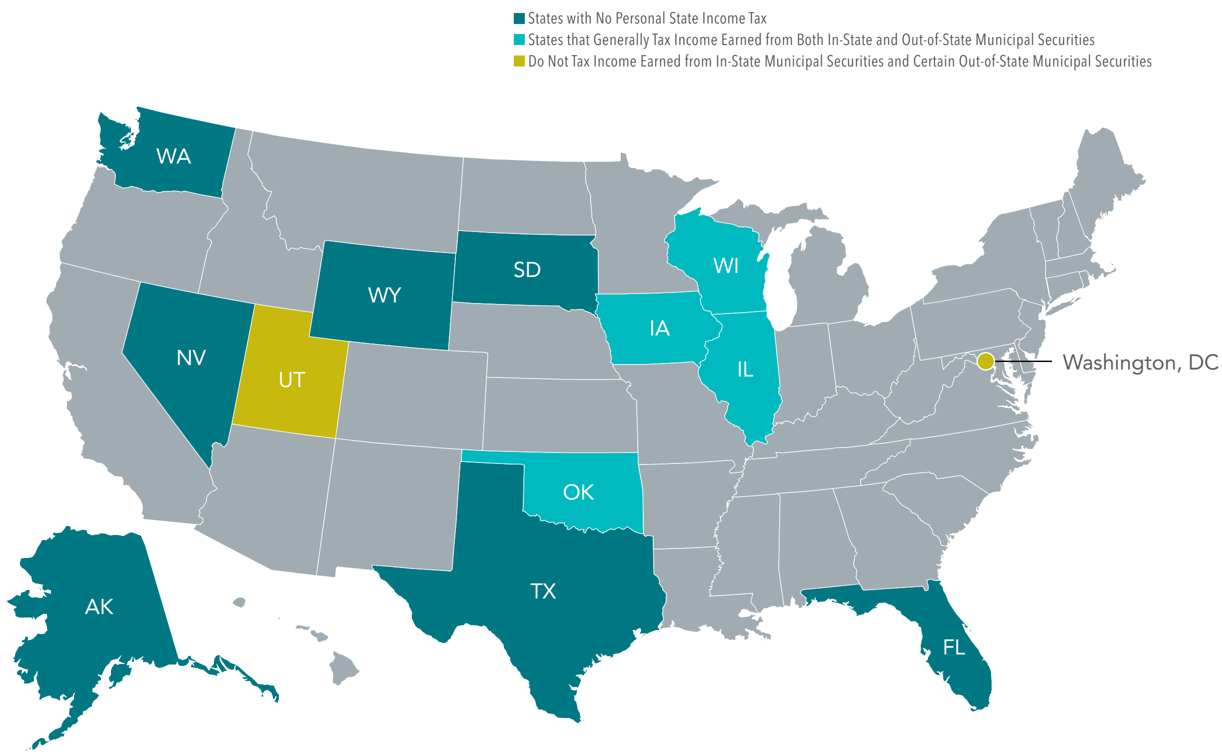


FIGURE 2: US States with Potentially Weak or No Tax Clientele Effects

This figure shows the US states with potentially weak or no clientele effects. The highlighted states include states with no personal state income tax (Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming), states that in general tax both in-state and out-of-state municipal bonds (Illinois, Iowa, Oklahoma, and Wisconsin), and states that have reciprocal tax provision or no income taxes in municipal bonds (Utah and Washington, DC).

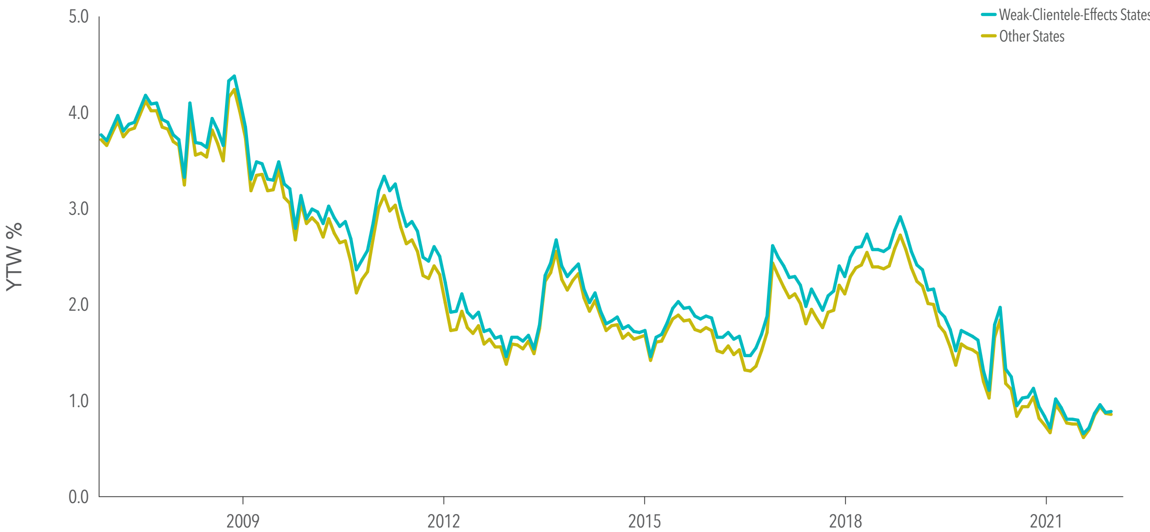


Source: Based on current state tax income laws and State Tax Guide, published and copyrighted by Commerce Clearing House, Inc.

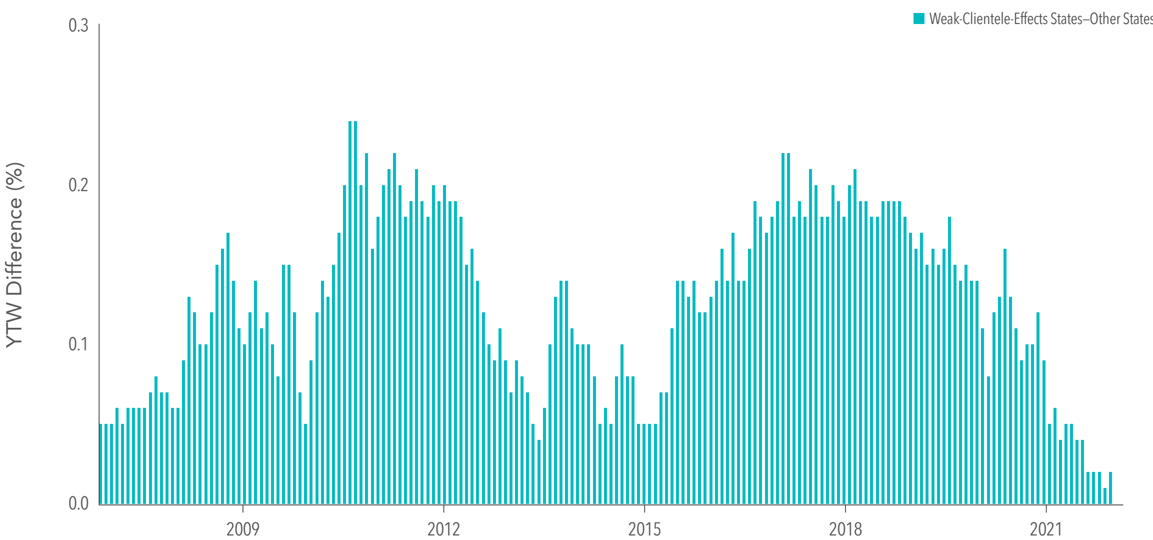
FIGURE 3: Weak-clientele-effects States Portfolio vs. Other States Portfolio, *October 2006–December 2021*

These figures show the yield movements over the sample period. The Weak-clientele-effects States portfolio consists of bonds issued in states with weak or no clientele effects, while the Other States portfolio consists of bonds issued in other states. Both are market value weighted and rebalanced monthly.

PANEL A: YIELD TO WORST (YTW)



PANEL B: YIELD TO WORST (YTW) DIFFERENCE



Past performance, including simulated performance, is no guarantee of future results.

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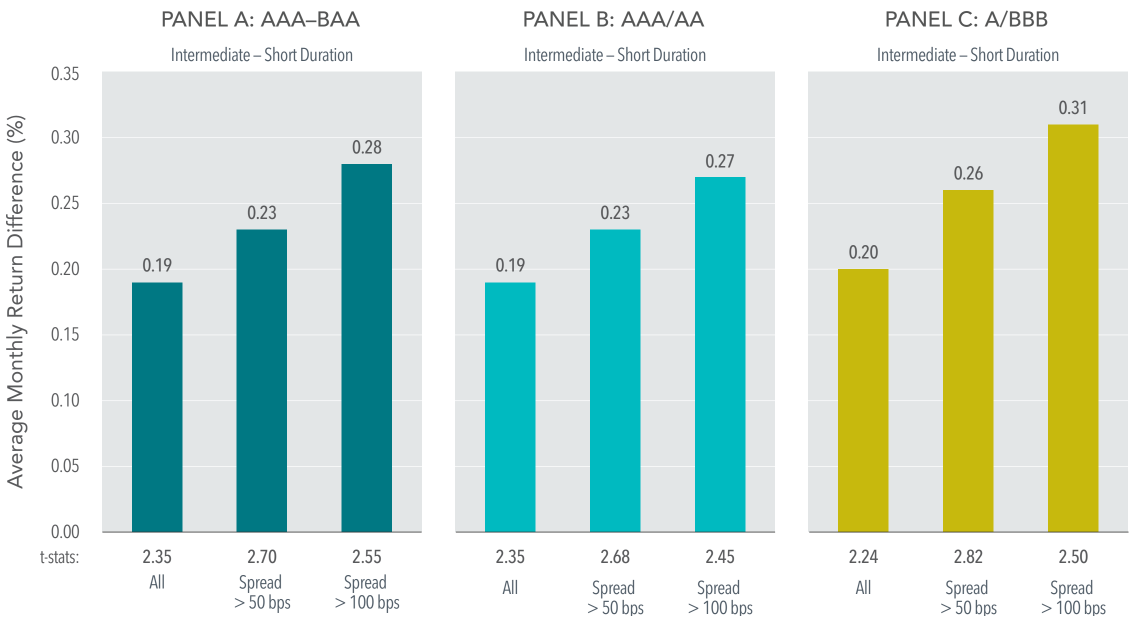
FIGURE 4: Term Spreads and Term Premiums, *November 2006–December 2021*

This figure reports the average monthly term premium between intermediate duration and short duration municipal bonds within our sample. Each bar illustrates the average term premium for all months in the sample period, for months when the beginning-of-month term spread is above 50 basis points, and for months when the beginning-of-month term spread is above 100 basis points, respectively. Panel A, Panel B, and Panel C are based on all AAA–BAA, AAA/AA, and A/BAA rated bonds in our sample, respectively.



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The simulated performance is "gross performance," which includes the reinvestment of dividends and other earnings but does not reflect the deduction of investment advisory fees and other expenses.

FIGURE 5: Credit Spreads and Credit Premiums, *November 2006–December 2021*

This figure reports average monthly credit premium between A/BAA and AAA/AA rated municipal bonds within our sample. Each bar illustrates the average credit premium for all months in the sample period, for months when the beginning-of-month credit spread is above 50 basis points, and for months when the beginning-of-month credit spread is above 100 basis points, respectively. Panel A, Panel B, and Panel C are based on all eligible bonds (All Duration), short duration (0–5 years), and intermediate duration (5 years and above) bonds, respectively.

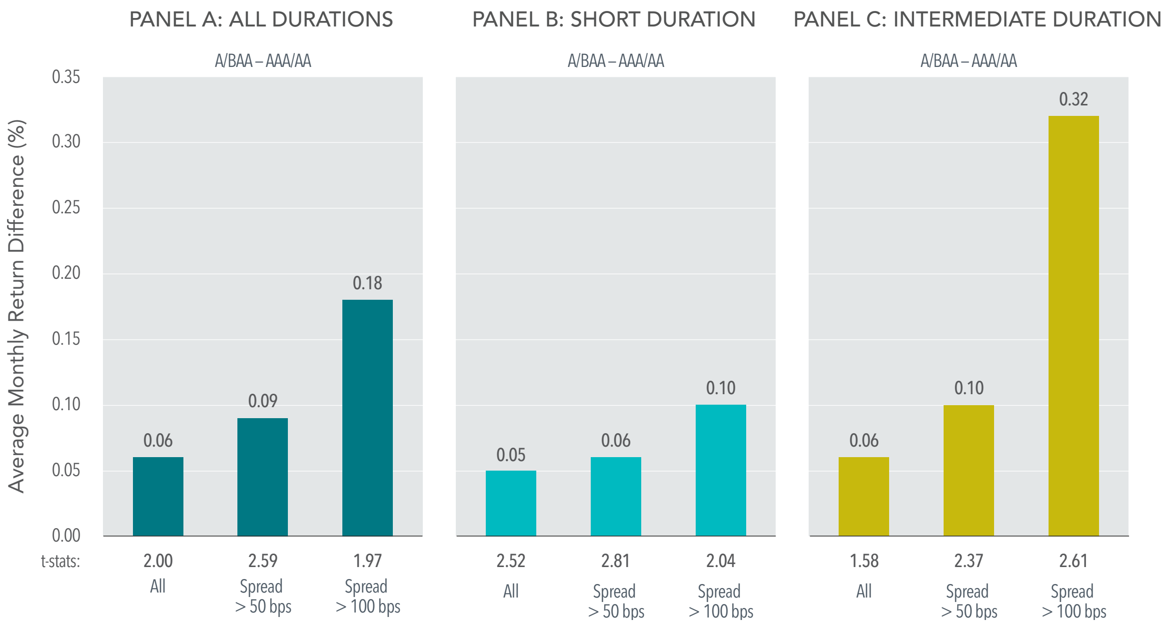

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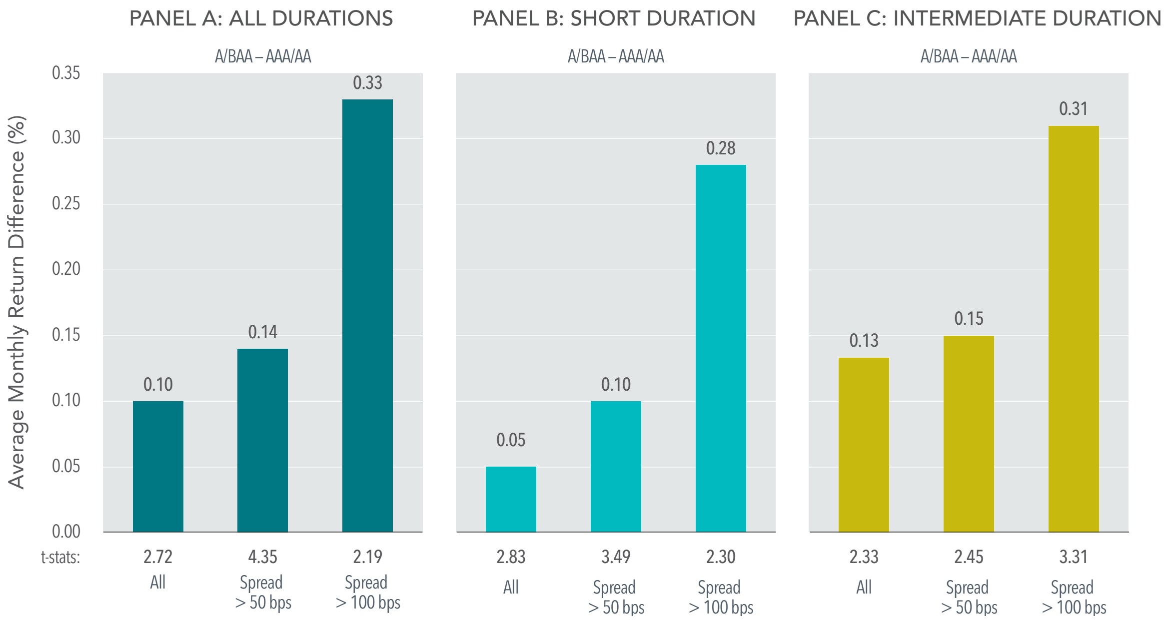
FIGURE 6: Credit Spreads and Credit Premiums, Non-callable Bonds Only, *November 2006–December 2021*

This figure reports average monthly credit premium between A/BAA and AAA/AA rated non-callable municipal bonds within our sample. Each bar illustrates the average credit premium for all months in the sample period, for months when the beginning-of-month credit spread is above 50 basis points, and months when the beginning-of-month credit spread is above 100 basis points, respectively. Panel A, Panel B, and Panel C are based on all eligible bonds (All Duration), short duration (0–5 year), and intermediate duration (5 year and above) bonds, respectively.



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Tables

TABLE 1: Municipal Bond Data Summary, *October 2006–December 2021*

This table reports summary statistics for all eligible bonds in our sample data from the Bloomberg Municipal Bond Index constituents between October 2006 and December 2021. We include municipal bonds issued by all 50 states and the District of Columbia. Taxable bonds and those subject to the alternative minimum tax (AMT) are excluded. Maturity of eligible bond is restricted to be less than 20 years. Bonds that are putable or sinkable are also excluded. Panel A, Panel B, and Panel C report the average number of issues, number of issuers, and market value by credit rating, duration range, and call type, respectively.

	PANEL A: BY CREDIT RATING					PANEL B: BY DURATION				PANEL C: BY CALL TYPE		
	AAA	AA	A	BAA	All	0–5Y	5–10Y	10Y+	All	Callable	Non-Callable	All
Average # of Issues	10,025	19,828	7,068	1,233	38,154	18,628	18,085	1,442	38,154	24,378	13,777	38,154
Average # of Issuers	434	763	434	153	1390	1,080	1,084	327	1,390	1,258	888	1,390
Average Market Value (in $billions)	207	444	173	39	864	419	410	34	864	543	321	864

TABLE 2: Monthly Fama-MacBeth Regressions

This table reports the results of monthly Fama-MacBeth regressions of subsequent month returns on current yields:

$$R_{i,t+1} = \alpha + \beta \cdot y_{i,t} + \epsilon_{i,t+1}.$$

$R_{i,t+1}$ is the return of municipal bond i between month t and month $t+1$. $y_{i,t}$ is the month-end yield-to-worst of bond i in month t. $\epsilon_{i,t+1}$ is the error term. We report the time-series average (β) of the monthly slope estimators, the t-statistics of the average slope (in parentheses), and the average adjusted R^2. Panel A reports the regression results for all the bonds in the sample from October 2006 to December 2021. Panel B reports the regression results for two subgroups: More Liquid Bonds with at least one trade in the last 10 business days of a month and those (Less Liquid Bonds) without. The analysis in Panel B starts in May 2009, when municipal bond trading data from MSRB EMMA become available.

PANEL A: ALL BONDS, *OCTOBER 2006–DECEMBER 2021*

Eligible Bonds	β	R^2
All Bonds	1.54	0.25
	(2.41)	

PANEL B: MORE LIQUID BONDS VS. LESS LIQUID BONDS, *MAY 2009–DECEMBER 2021*

Eligible Bonds	β	R^2
More Liquid Bonds	2.11	0.25
	(3.49)	
Less Liquid Bonds	1.58	0.25
	(2.46)	

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TABLE 3: Performance and Characteristics: Weak-clientele-effects States Portfolio vs. Other States Portfolio

This table reports simulated performance and characteristics of the Weak-clientele-effects States Portfolio and the Other States Portfolio between November 2006 and December 2021. Both portfolios are market value weighted and rebalanced monthly. The Weak-clientele-effects States portfolio consists of bonds issued in states with weak or no clientele effects, while the Other States portfolio consists of bonds issued in other states.

November 2006–December 2021	Weak-clientele-effects States	Other States
Annualized Compound Return (%)	4.03	3.90
Annualized Standard Deviation (%)	3.56	3.53
Annualized Premium (vs. Other States, %)	0.13	–
T-stats of Monthly Return Differences (vs. Other States, %)	1.62	–
Average YTW (%)	2.36	2.24
Average YTW Difference (vs. Other States, %)	0.13	–
T-stats of YTW Differences (vs. Other States, %)	31.02	–
Average OAD (in years)	5.36	5.26
Average AAA/AA Weight	76%	76%
Average A Weight	19%	20%
Average BAA Weight	5%	4%
Average # of Issues	11,057	27,098

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TABLE 4: Regression of Next Month's Term Premiums on Current Term Spreads, *October 2006–December 2021*

This table reports the results from time series regressions of next month's term premiums on current term spreads.

$$R_{t+1}^{Term,CR} = \alpha + \beta \cdot S_t^{Term,CR} + \epsilon_{t+1}^{CR}, \quad \text{for } CR = \text{AAA–BAA, AAA/AA, or A/BAA.}$$

For bonds with credit rating CR, $R_{t+1}^{Term,CR}$ is the term premium between month t and month $t+1$ and $S_t^{Term,CR}$ is the term spread at month t. ϵ_{t+1}^{CR} is the error term. The results include the estimators of the slope coefficient β, t-statistics for the slope coefficient (in parentheses), and the adjusted R^2.

CR	β	R^2
AAA–BAA	0.35	0.03
	(2.45)	
AAA/AA	0.33	0.03
	(2.39)	
A/BAA	0.46	0.03
	(2.54)	

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TABLE 5: Regression of Next Month's Credit Premiums on Current Credit Spreads, *October 2006–December 2021*

This table reports the results from time series regressions of next month's credit premiums on current credit spreads.

$$R_{t+1}^{Credit,D} = \alpha + \beta \cdot S_t^{Credit,D} + \epsilon_{t+1}^{D}, \quad \text{for } D = \text{All Duration, 0–5Y, or 5Y+.}$$

For duration range D, $R_{t+1}^{Credit,D}$ is the term premium between month t and month $t+1$ and $S_t^{Credit,D}$ is the term spread at month t. ϵ_{t+1}^{D} is the error term. The results include the estimators of the slope coefficient β, t-statistics for the slope coefficient (in parentheses), and the adjusted R^2.

D	β	R^2
All Duration	0.24	0.03
	(2.51)	
0–5Y	0.12	0.03
	(2.26)	
5Y+	0.45	0.04
	(2.86)	

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TABLE 6: A Systematic Municipal Bond Strategy with State, Credit, Duration, and Turnover Constraints

This table reports the objective and constraints of the portfolio optimization problem that is formulated in the Systematic Municipal Bond Strategy design.

Portfolio Objective and Constraints	Details
Objective	Find the optimal subindex weights w_i^* that maximize the portfolio's expected return: $max \sum_i w_i \cdot y_i$
Long only Constraints	$w_i \geq 0$ and $\sum_i w_i = 1$
Credit Quality Constraints	Total weight of A/BBB rated bonds ≤ 50% Total weight of BBB rated bonds ≤ 25%
Duration Constrains	Portfolio duration ≤ 5 years
Maturity Constraints	Maturity < 15 years, for all bonds
State Constraints	State Weight ≤ 10%, for Alaska, Iowa, Nevada, Oklahoma, South Dakota, Utah, Wisconsin, Wyoming, and the District of Columbia; State Weight ≤ 25%, for Florida, Illinois, Texas, and Washington; Total weight of the Weak-clientele-effects States ≥ 50%; State Weight ≤ 10%, for states with strong tax clientele effects.
Maximum Overweight Constraints	Each subindex weight $w_i \leq 5\times$ its market weight w_i^{MKT}
Rebalancing and Turnover Constraints	Rebalanced annually at the beginning each year; At rebalance, maximum turnover for each subindex is 0.1%. The max turnover threshold could be relaxed when the optimal solution is not feasible.

TABLE 7: Performance Summary: A Systematic Municipal Bond Strategy, *November 2006–December 2021*

This table reports the simulated performance and characteristics of the municipal bond market within 1–15 year maturity range, the custom municipal bond strategy with static credit weight, and the Systematic Municipal Bond Strategy. The Systematic Muni Strategy is formulated in Table 6. The muni market is market value weighted and rebalanced monthly. The static credit quality strategy also consists of bonds within the 1–15 year maturity range. It applies fixed weights in each credit quality (AAA/AA, A, and BAA), and these fixed weights match the average credit weights of the Systematic Strategy. Within each credit quality, the static strategy is market value weighted and rebalanced monthly.

November 2006–December 2021	Muni Market (1–15Y Maturity)	Static Credit Quality Strategy	Systematic Muni Strategy
Avg. Yield-to-Worst (YTW, %)	2.08	2.29	2.49
Avg. Option-Adjusted-Duration (OAD, in years)	4.73	4.77	5.02
Avg. AAA/AA Weight	77%	54%	54%
Avg. A Weight	19%	31%	31%
Avg. BAA Weight	4%	15%	15%
Annualized Compound Return (%)	3.71	3.87	4.19
Annualized Standard Deviation (%)	3.17	3.24	3.48
Maximum Drawdown (%)	4.25	4.38	5.75
Worst Rolling 1Y Return (%)	–1.57	–1.29	–1.41
Worst Rolling 3Y Return, Annualized (%)	1.31	1.59	1.81
Worst Rolling 5Y Return, Annualized (%)	1.80	2.04	2.26

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