

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Andrew Kalotay

President, Andrew Kalotay Associates, Inc.

61 Broadway, New York NY 10006

212 482 0900

andy@kalotay.com

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Abstract

As currently practiced, tax-loss selling of municipal bonds is typically an ad hoc year-end exercise. Under dynamic tax management the right to execute a tax-beneficial trade is considered to be a valuable option. Selling a bond and reinvesting in another entails swapping the associated tax options. The generalized tax efficiency measure signals the optimum time to transact. Long-duration bonds trading at a premium are best poised to achieve superior performance; bonds purchased below par are unsuitable for tax management. The incremental return from dynamic management is significant, particularly when short-term gains are available to offset short-term losses.

Key Words

Tax-efficient trading, tax-efficient portfolio construction, tax-loss selling, municipal bonds.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Introduction

Tax-efficient investing is a widely covered topic in wealth management. Municipal bonds held in taxable accounts are generally thought of as tax-efficient because the interest is tax-free. It is also widely recognized that tax-loss selling can improve the performance of taxable accounts such as those containing municipal bonds (Constantinides and Ingersoll, [1984], Wilcox and Fabozzi, [2013]). However, as currently practiced, tax-loss selling of municipal bonds is typically an ad hoc year-end exercise, rather than a component of a dynamic tax management strategy. As we will show, some bonds are better candidates for tax management candidates than others. Our objective is to quantify how much dynamic tax management can improve the expected performance of various types of municipal bonds, and show how to identify bond structures best poised to achieve superior after-tax performance.

There is considerable academic literature on tax management, including the timing of tax-driven transactions. Applications range from typical portfolio-based investing to exercising employee stock options and converting a regular IRA to a Roth IRA. The opportunity to execute a tax-beneficial sale has long been recognized as an option. However, scant attention has been paid to the valuation of a tax option, and its potential contribution to after-tax performance.

We first review the fundamental concepts of after-tax analysis. Next we describe what is meant by dynamic tax management and how it differs from one-time tax-beneficial selling. Measuring after-tax performance requires a rigorous definition of after-tax portfolio value. We discuss alternative definitions, and select the one most suitable for municipal bonds. In the rest of the paper we quantify how much dynamic tax management can improve after-tax performance over a buy-and-hold strategy, and suggest an approach to identifying bonds suited for superior after-tax return.

This paper is restricted to tax-exempt municipal bonds, an asset class unique to the United States. A distinguishing feature of this asset class is that 'hold value' and market price may differ, as discussed below, and this increases the complexity of the sale decision. However, the dynamic tax management concept is applicable to a wide range of transactions, including ones in foreign markets under different tax regimes.

I. Fundamental Concepts of After-Tax Analysis

Investor's Tax Basis

The tax basis determines the gain or loss for tax purposes resulting from sale. It depends on the purchase date and purchase price. If a muni is purchased at a premium, its tax basis is amortized to par at maturity (or to the call price as of the call date) at the purchase yield. If purchased at a (market) discount, the basis is the purchase price. However, a gain on a discount purchase can have bifurcated tax treatment. It is taxed as ordinary income up to the accrued market discount, and at the capital gains rate for any remaining gain (Kalotay [2014], JPM). Depending on the holding period (less than or more than one year), gains and losses may

Optimal Municipal Bond Portfolios for Dynamic Tax Management

be taxed as short-term or long-term. Currently the applicable short-term and long-term capital gains rates are roughly 40% and 20%, respectively.

Liquidation Value

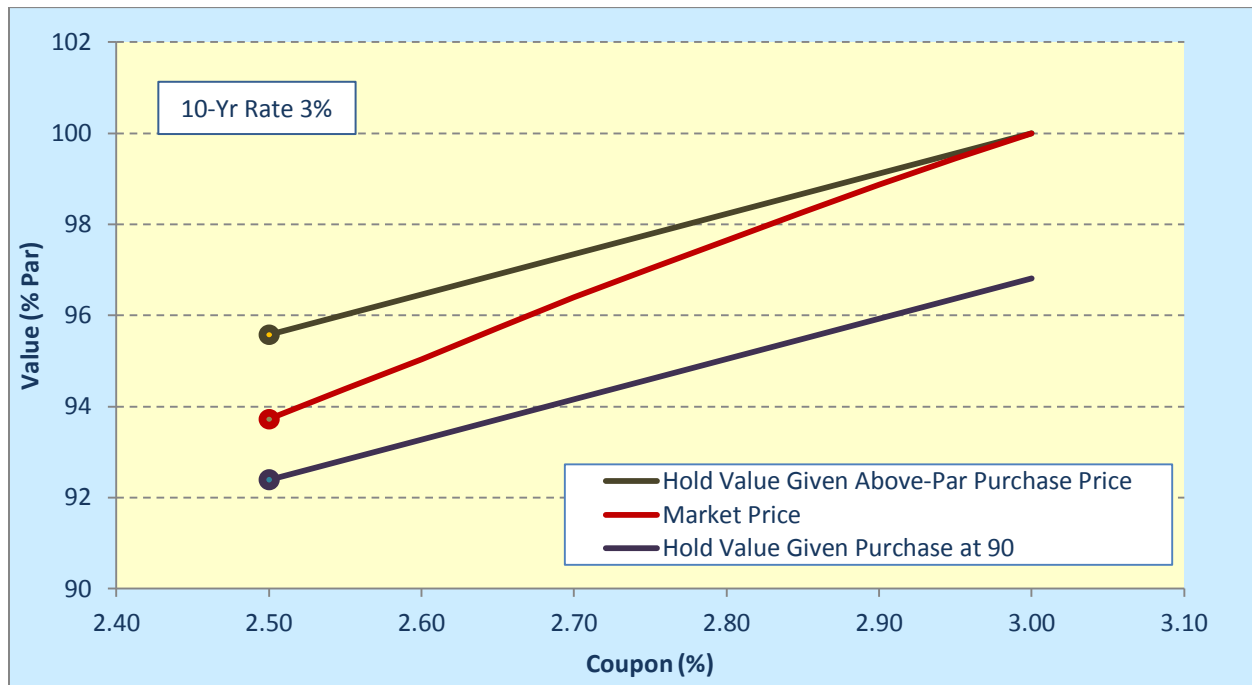
The liquidation value is the sum of the sale price (plus accrued interest) and the tax of the resulting gain or loss. The gain or loss is the difference between the sale price and the investor's tax basis. For example, when the tax basis is 110, selling at 105 would result in a 5-point loss. At a 40% short-term capital gains rate, the tax savings would be 2 points, and the liquidation value would be 107.

Hold Value

The hold value is the worth of the bond to the current investor. In the complete absence of taxes, the mid-market price is a reasonable indicator of the hold value. If a muni was purchased above par and is currently selling above par, the hold value is the mid-market price. However, if a muni was purchased at a discount or is currently selling at a discount, the calculation of the hold value can be complicated. A below-par market price incorporates the tax payable at maturity by the marginal investor (Kalotay, [2014] *JOIM*). But that tax would not be owed by earlier investors who paid par or above. Their hold value diverges from the market price, and while this value can be inferred from relevant market information (as described in Kalotay, [2014], *JPM*), it is not observable. Figure 1 illustrates for 10-year discount bonds how the hold value depends on the purchase price, and the relationship between market price and hold values.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Figure 1: Hold Value Can Differ Significantly From Market Price



Cashflow Benefit from Selling

The cashflow benefit is the excess of the liquidation value over the hold value. If the hold value equals the market price, the cashflow benefit is the resulting tax savings. However, as discussed above, in the case of a discount the hold value and the market price can differ, and the calculation of the cashflow benefit has to be adjusted accordingly.

Tax Option

The tax option is the opportunity to execute tax-beneficial trades. It is acquired automatically and without cost at the time an asset (here, a muni) is purchased in a taxable account. The valuation and optimal exercise of the tax option will be discussed below.

Intrinsic Value of Tax Option

The intrinsic (i.e. exercise) value of the tax option is the cashflow benefit from sale; by definition it is non-negative.

II. Valuation and Optimal Exercise of the Tax Option

On an after-tax basis, selling a bond may be preferable to holding onto it. Given that liquidating a security can increase the after-tax value of a portfolio, related questions arise. Instead of selling now, would it be preferable to wait for a possibly better opportunity? And if so, when is the right time to sell? These questions suggest that a potential tax-beneficial sale can be considered as an option, and the actual sale is an option exercise. Although this tax option is not contractual, not transferable, and not amenable to hedging, it nevertheless has value. This

Optimal Municipal Bond Portfolios for Dynamic Tax Management

value can be decomposed into intrinsic (exercise) value and time value, and even when the exercise value is negligible, the time value of could be significant. Formally incorporating tax optionality provides an analytical framework for the manager to maximize performance.

Three recent articles on the tax management of municipal bonds provide background to the current paper. The relevant insight is that the value of a tax option depends on the manager's contemplated strategy. We distinguish between 'one-time sale' (without consideration to reinvesting) (Kalotay [2014], *JPM*), and 'dynamic tax management' (Kalotay and Howard [2014], *JPM*) and (Kalotay, forthcoming in *FAJ*). The notion of dynamic tax management, without reference to municipal bonds, is also considered in Haugh et al. [2014] (*working paper*). Under dynamic management, the value of the option acquired upon reinvesting is explicitly incorporated into the sale decision. Although the cashflow benefit from sale does not depend on the reinvestment strategy, the timing of the sale, i.e. the option exercise, does so. Thus, under dynamic management, trades are executed much earlier, i.e. at a higher price/smaller loss, than under one-time sales.

Because the topic of this paper is long-term performance, the assumed framework is dynamic management, which takes into account the fact that reinvestment may give rise to future tax-beneficial opportunities. Under dynamic management the potential of recognizing losses within the first year of purchase at the short-term capital gains rate is an important consideration. Currently the short-term capital gains rate is roughly twice the long-term rate; reinvestment automatically restarts the short-term clock. This phenomenon has been long recognized; Constantinides [1984] makes an analogous observation for equities. At the same time it should be recognized that the short-term rate is relevant only if there is an offsetting short-term gain, which cannot be guaranteed. We will explore how performance depends on the availability of short-term gains, and distinguish between 'conservative' and 'aggressive' management styles. Under the conservative approach the tax rate applicable to short-term losses is assumed to be the long-term rate, while under the aggressive approach it is the short-term rate. The assumption affects the value of the tax option and the timing of the trade. Presumably the account manager can decide which approach is appropriate.

Details on the valuation and optimal exercise of the tax option under dynamic management are provided in Kalotay and Howard [2014] and Kalotay, Yang, and Fabozzi [2007]. The value depends on investor-specific information (purchase price, purchase date, applicable tax rates), and market data (price volatility of the bond, prevailing yield curve, transaction costs).

III. After-Tax Portfolio Value

Calculation of after-tax return requires a rigorous definition of after-tax portfolio value. Several definitions have been proposed, ranging from market value to after-tax liquidation value. Publications by the CFA Institute contain a rich source of ideas (for example, Tanzer [2015], and AIMR Performance Presentation Standards). Calculating an after-tax return requires an assumption about the after-tax value of the capital gains that accrue but remain unrealized in the portfolio (Bergstresser and Pontiff, [2013]).

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Market prices provide the starting point for any valuation, including pretax liquidation value, which is relevant for an estate upon the death of the owner (Poterba, [1997]). However there may be predictable tax payments prior to the demise of the owner (Horan, et al. [2008]). In the case of municipal bonds purchased at a discount, such tax payments are predictable, and they could be explicitly recognized. On the other extreme, a bond whose price has declined may be candidate for a tax-beneficial sale, and the resulting tax savings could also be reflected in the value of the portfolio. Of course, in this case extracting the tax benefit would require active management. The salient point is that pretax and after-tax values can be quite different, depending on potential taxes and tax savings.

Calculating pretax value from market prices is straightforward; calculating after-tax value can be intricate. The two components of the latter are hold value and tax option value. Hold value incorporates any tax payable at maturity or call. In the absence of tax-related flows the hold value equals the market value. This is the case if a bond was purchased above par and is currently selling above par. However, in the case of discounts, taxes may need to be explicitly incorporated (Kalotay, JPM, [2014]). In addition, current and potential tax-beneficial trading opportunities should also be recognized; their value is embodied in the tax option. As mentioned earlier, tax optionality can be divided into intrinsic (exercise) value and time value. Because the intrinsic value can be immediately 'monetized' by selling the bond, it could even be reported to the holder. The full option value is useful for the manager of the account, because it also encompasses potential future tax-beneficial transactions.

The discussion above suggests alternative definitions of the after-tax value. Each of these is a candidate for reporting after-tax performance to the investor, and for indicating the theoretical value to the manager. The initial challenge is to identify the one most suitable for our purposes.

Alternative definitions of after-tax value

Market Price

After-Tax Liquidation

Hold

Hold + Intrinsic

Hold + Tax Option (for the manager)

The *Market Price* of discount muni is affected by the tax payable on the gain at maturity by the marginal investor. But that tax is irrelevant to the current holder; what matters to him is his own tax liability, which is based on his purchase price. Note that the other four candidates are ordered according to their values, from smallest to largest. The flaw with *After-Tax Liquidation Value* is that it does not exclude cases with negative tax benefit. Because *Hold Value* incorporates the current holder's tax liability it is a reasonable and convenient representation of after-tax value, and it is the one we will use to measure performance. Of the remaining two alternatives, *Hold + Intrinsic* conveys the tax benefit of selling, while *Hold + Tax Option* is informative for the manager, because it also encompasses potential tax management opportunities in the future.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

For our purposes, hold value provides a suitable basis for measuring after-tax performance. As will be clear from the example in the next section, hold value is a value at a snapshot in time. The terminal hold value could include cash (e.g. after-tax proceeds) from having made a sale decision during the horizon period. The methodology could be adapted to accommodate any reasonable alternative of after-tax value, such as the sum of the hold value and the intrinsic value of the tax option.

IV. Methodology

Our goal is to quantify how much dynamic tax management increases after-tax return over buy-and-hold. Before presenting the results, we illustrate the calculation of after-tax return.

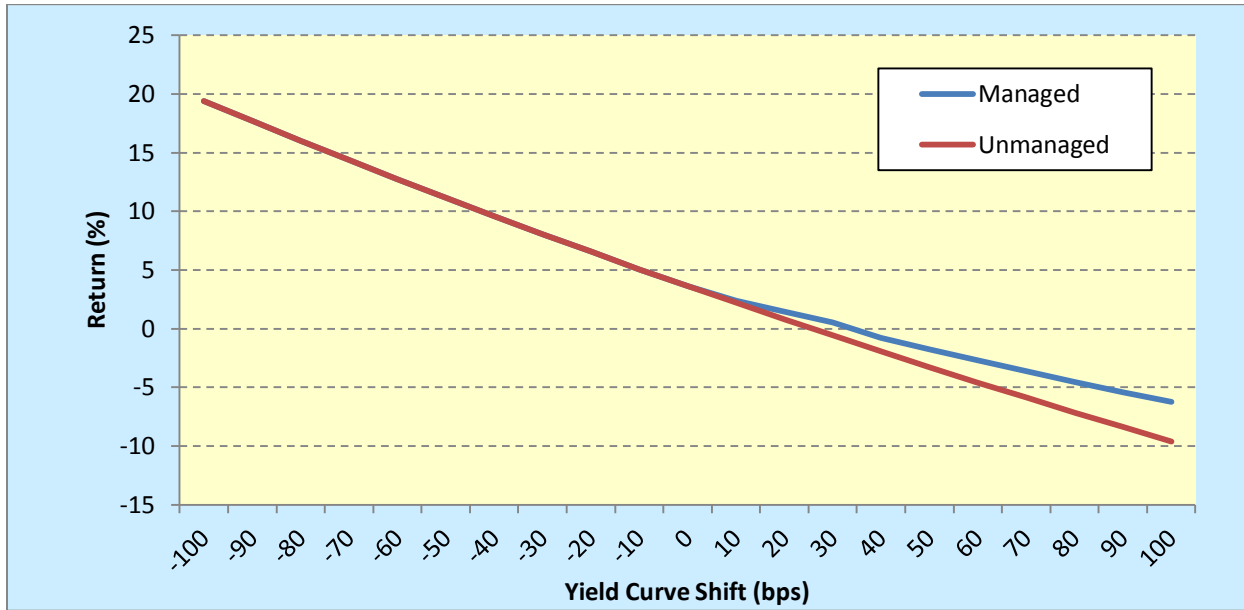
Suppose an investor buys a 20-year 3.25% bond at par. The yield curve rises 50 basis points, and one year minus one day later the mid-market price is 91.873 and the bid price is 91.623 (0.25 transaction cost). Selling the bond would result in an 8.377 point loss; at a 40% tax rate it would reduce the investor's taxes by 3.351 points. Thus the after-tax proceeds would amount to 94.974 (91.623 + 3.351). Because the proceeds exceed the hold value 93.455 (not quite the price of a 19-year 3.25% bond yielding 3.75%, because we shifted the yield *curve* not the yield), selling is preferable to holding. The sum of the proceeds, the 1.625% coupon, the 0.02% reinvestment income, and the 1.625% (ending) accrued interest results in a terminal 'hold' value of 98.244. The initial hold value is 100, thus the after-tax return is -1.76% (annual compounding).

Note that the same transaction one year and one day later would not be beneficial, because the applicable tax rate would be 20%, resulting in 1.675 points of tax savings and 93.298 after-tax proceeds, below the 93.455 hold value. As this example demonstrates, bonds purchased near par are unlikely to provide opportunities for long-term tax-beneficial sales.

Figure 2 shows the one-year minus one day managed and unmanaged returns of the same 20-year 3.25% bond under parallel shifts of the yield curve ranging from -100 to 100 basis points. Consistent with the return calculation example above, the managed return corresponding to a 50 basis points increase is -1.76%, which exceeds the unmanaged return of -3.27% by 151 basis points. The more rates increase the greater is the advantage of active tax management over buy-and-hold. On the other hand, if rates decline there is no opportunity for tax-beneficial selling, and therefore the managed and unmanaged performances are identical.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Figure 2: After-Tax Returns of 3.25% Par Bond After One Year Minus One Day



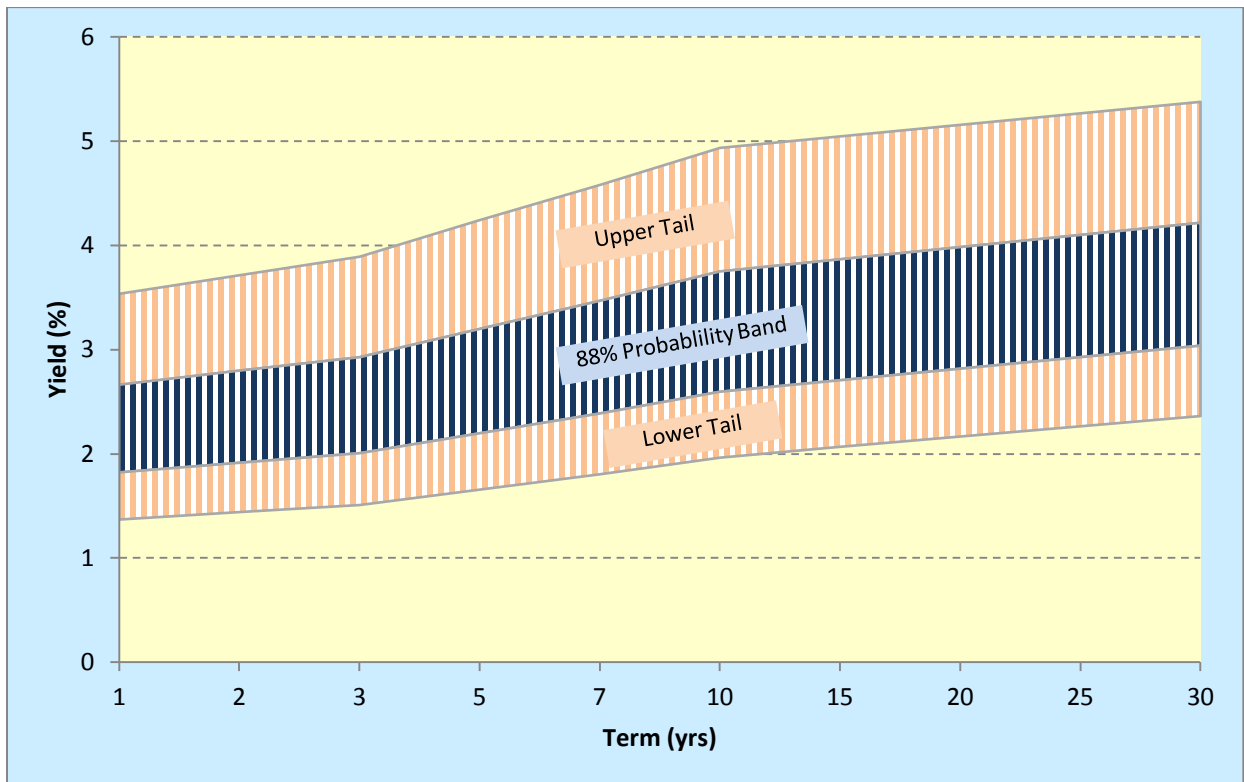
Next, we estimate after-tax performance by Monte Carlo simulation over a one-year horizon, using an industry-standard interest rate process (see details in Table 1). Because the mean reversion factor reduces the price volatility of longer bonds and, the results are more conservative. Starting with the initial yield curve, we sample terminal curves within probability bands (see distribution range in Figure 3). For illustrative purposes, we assume that the portfolio consists of a single security. The security is sold (i.e. the tax option is exercised) after 364 days if the tax efficiency (Kalotay *FAJ*, *forthcoming*) is 100%.

Table 1: Simulation Assumptions

Interest Rate Process	Black-Karasinski
Initial Optionless Yield Curve	1-yr 2.00%, 5-yr 2.44%, 10-yr 3.00%, 20-yr 3.25%, 30-yr 3.50%
Short Rate Volatility	15%
Mean Reversion	2
Tax Rate Assumptions	Income 40% Short-term gain/loss 40% Long-term gain/loss 20%
Transaction Cost	0.25% of par

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Figure 3: Distribution of Yield Curves One Year Forward



After-tax performance depends on several parameters. These include applicable short-term capital gains rate, transaction cost, and bond-specific attributes (maturity, premium, par or deep discount, bullet or callable). As we will see, being able to fully utilize short-term losses can make a major contribution to after-tax performance. At the same time, it may be desirable to be conservative and assume that short-term losses can only be written off at a lower long-term capital loss rate. This inhibits performance, particularly of bonds purchased close to or below par. In general, the tax-managed performance is enhanced by bonds purchased at higher prices and with longer maturities. We will see that premium bonds are far better suited for tax management than par bonds.

In the examples below, we first study non-callable par bonds, to provide intuition for expected return without the complexity of call options (that are almost always present for maturities beyond 10 years). We will refer to non-callable bonds as being optionless, because they lack embedded options. Of course, investors obtain a tax option on any investment and the term 'optionless' should not be interpreted as not having a tax option. We then compare the results to those of 5% premium bonds without call options. An added variable is the deductibility of short-term losses at the short-term capital gains rate (aggressive assumption) or at the long-term rate (conservative assumption). Finally, we show the expected incremental return from tax management for 5% callable bonds, 5% optionless bonds, and bonds selling at par under aggressive and conservative management styles.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

In the last section, we discuss the perspective of the manager and provide recommendations for selecting the most tax-efficient portfolio.

V. Tax Management of Optionless Bonds

Currently municipal bonds targeted for institutional investors tend to follow a standard structure. They carry an above-market coupon, usually 5%, and are callable at par after 10 years. Because of the high coupon, these bonds are usually sold at substantial premiums over par. There are relatively few optionless long-term municipal bonds outstanding. In this section we consider only optionless bonds; this allows us to compare the performances of premium and par bonds as 'apples to apples', without the possibility of call. Callable premium bonds will be considered later.

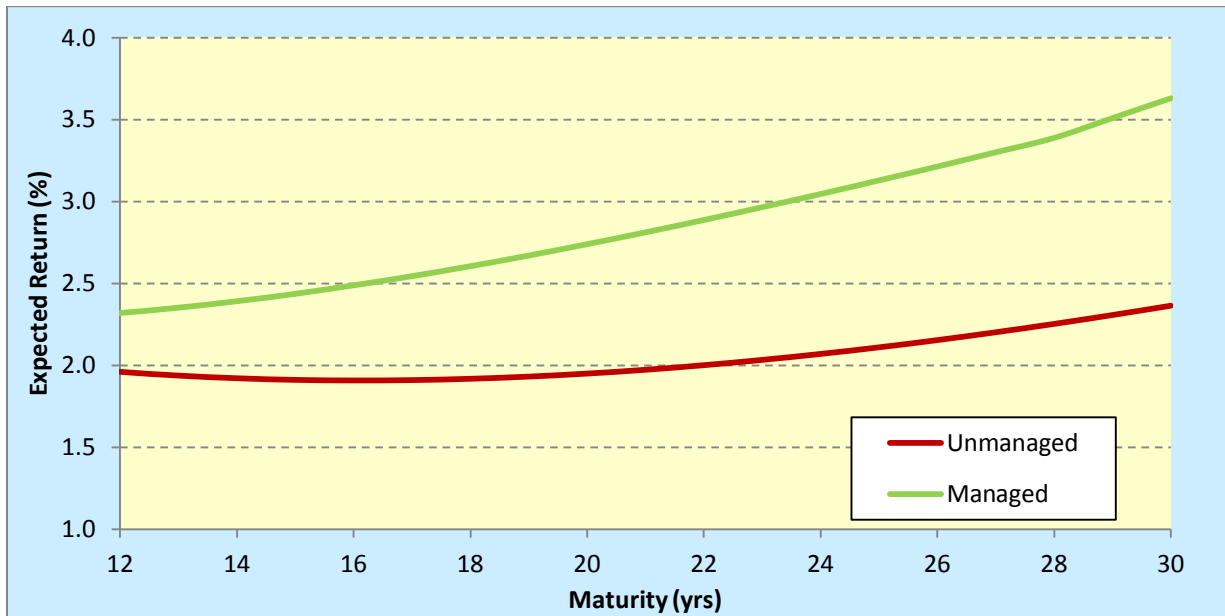
In the initial examples below, we compare the performances of 5% premium bonds and par bonds assuming that aggressive management is appropriate, and then perform similar comparisons under conservative management. In each case tax-managed premium bonds perform significantly better than par bonds. Also, as expected, under aggressive management the results are much better than under conservative management. Because the performance of discount bonds is similar to that of par bonds, discounts are not displayed.

We note that the results are expected performances, and keep in mind that the improvements depend on the individual scenario. Tax management is beneficial when prices decline, i.e. interest rates rise or credit spreads widen. When prices rise there may be no opportunities to execute tax-beneficial trades, and in that case the performances of managed and unmanaged strategies will be the same. Thus in addition to providing a higher expected return, tax management also reduces the standard deviation of the expected return by mitigating the loss under unfavorable price movements.

Figure 4 displays the effect of tax management relative to buy-and-hold for par bonds of various maturities over a one-year horizon. Under buy-and-hold the expected return is roughly the 1-year rate, which is assumed to be 2%. The improvement from tax management ranges from about 35 basis points for a 12-year par bond to about 125 basis points for a 30-year maturity.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

**Figure 4: After-Tax Expected Return of Optionless Par Bonds
Aggressive Management**



Next we compare directly the performance of premium and par optionless bonds under aggressive and conservative management.

Figure 5 shows the aggressively managed performances of premium and par bonds of various maturities. In order to provide points of reference, it also shows the unmanaged performance of par bonds, as in Figure 4. Premium bonds perform better at any maturity, the difference ranging from 35 basis points for intermediate-term bonds to about 10 basis points for long-term bonds. The reason the difference narrows as maturity increases is because the tax on the gain has a negligible effect on the price of a long-term discount, i.e. long-term par bonds are less punished when rates rise. In theory, perpetual bonds should perform virtually identically, independent of their current price. Note that managed long-term bonds outperform like unmanaged bonds by roughly 140 basis points.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Figure 5: Performance of Optionless Premium and Par Bonds
Aggressive Management

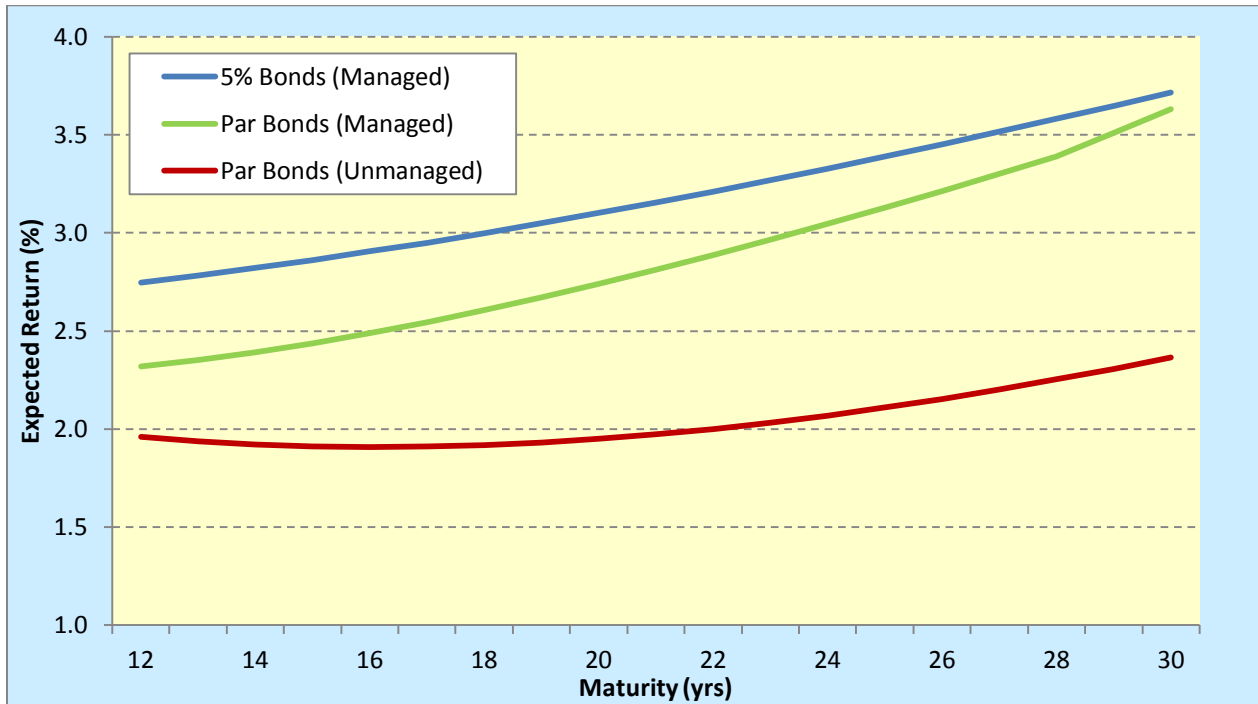
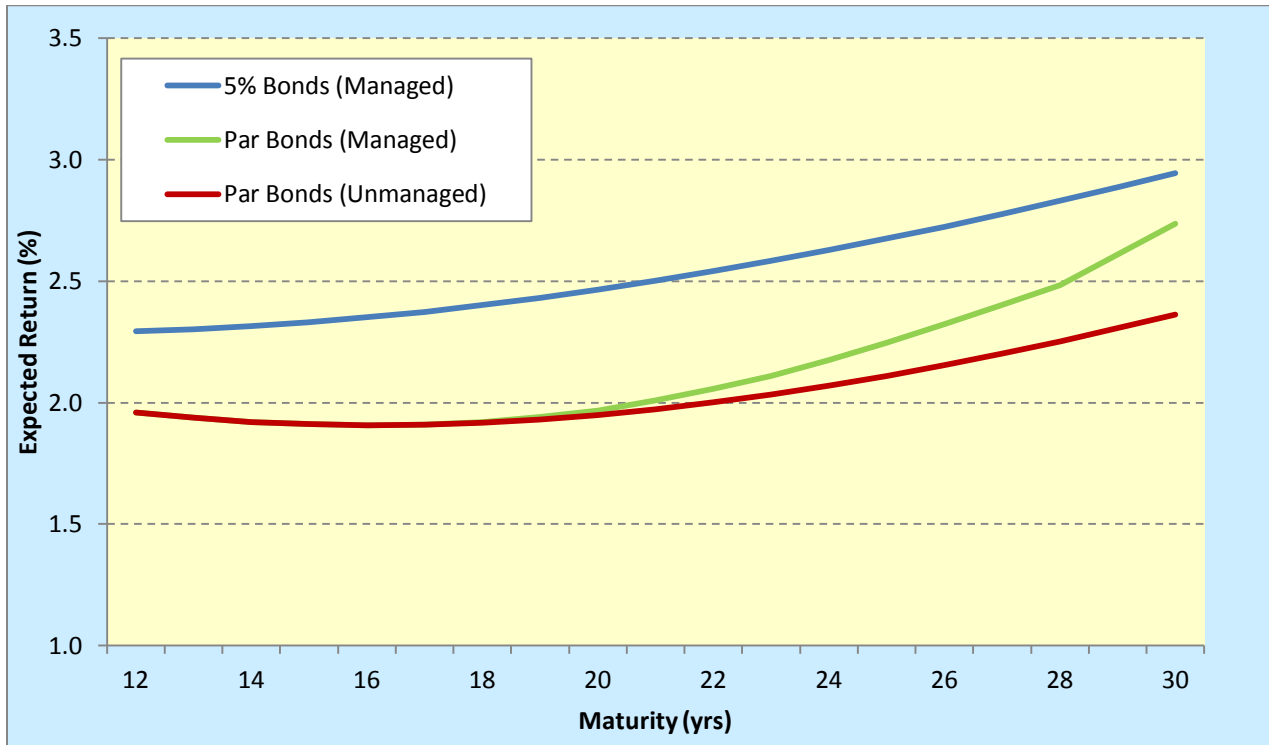


Figure 6 displays the performances of premium and par bonds under conservative management. Although the absolute performances are lower than under aggressive management, the patterns are quite similar. Note that intermediate-term par bonds are essentially not amenable to tax management — i.e. the managed and unmanaged performances are identical. The spread between the excess performance of premium and par bonds narrows with maturity, as discussed above. On the long end the excess performance from tax management is roughly 80 basis points.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

**Figure 6: Performance of Premium and Par Bonds
Conservative Management**



VI. Tax Management of Callable Bonds

In this section we investigate the effect of tax management on new 5% bonds callable after 10 years at par. Because the assumed low interest rates are much lower than 5%, these bonds would be priced well over par. The investor's tax basis depends on the premium, which in this case is accreted to par as of the call date, rather than as of final maturity. The steep decline of the tax basis reduces the taxable loss. This is particularly detrimental if the price of a callable bond falls below par, because the tax basis is not adjusted to reflect the extension of the expected life.

Figure 7 displays the incremental return of 5% callable premium bonds, along with those of optionless premium and par bonds discussed above, under aggressive management. Figure 8 shows similar information assuming conservative management. It is evident that optionless premium bonds are by far the best performers under either management style. We also observe that the spread between optionless and the callable premium bonds steadily widens with maturity, in contrast to the spread between optionless premium and par bonds.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Figure 7: Incremental Return from Aggressive Tax Management

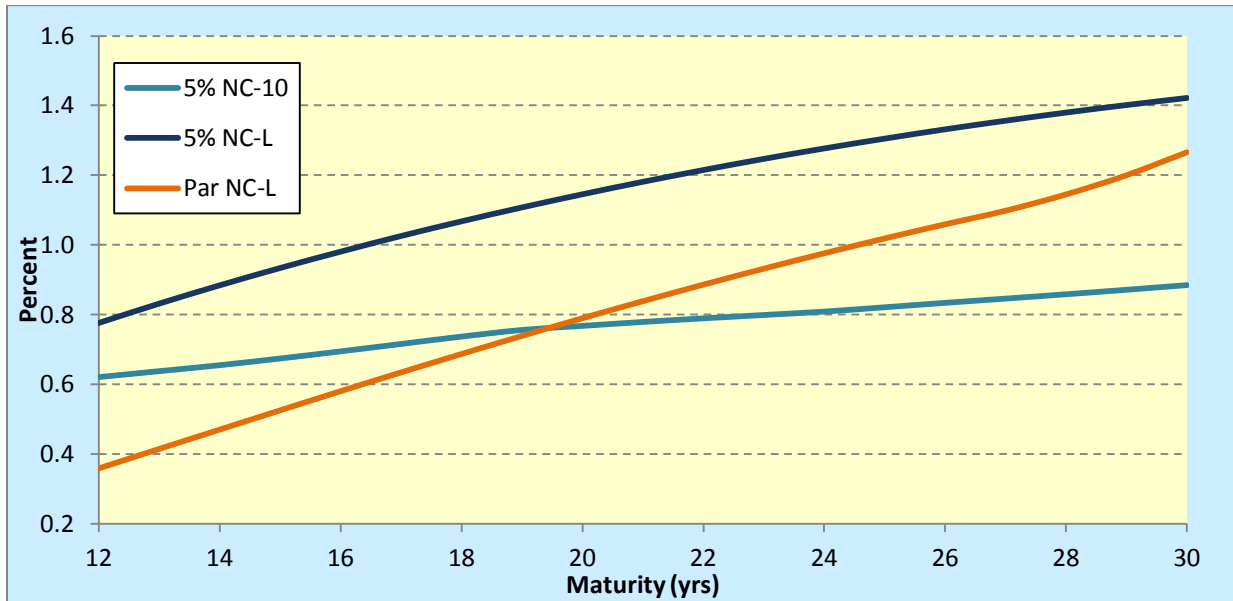
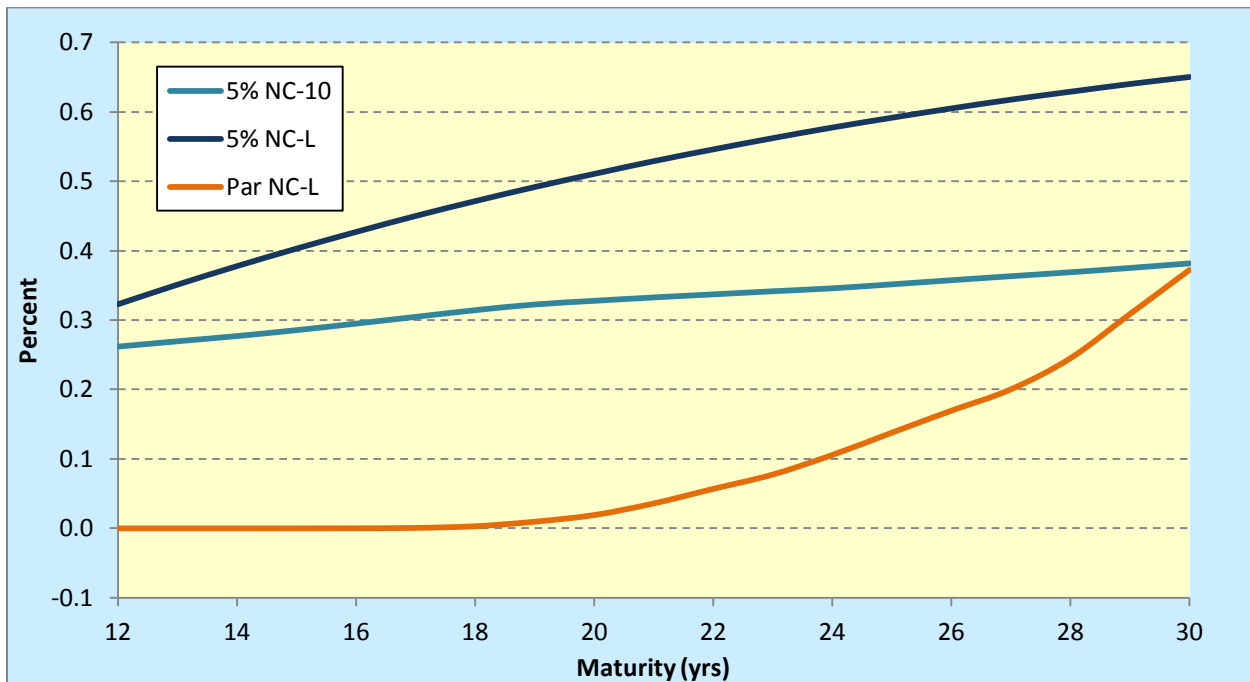


Figure 8: Incremental Return from Conservative Tax Management



Optimal Municipal Bond Portfolios for Dynamic Tax Management

VII. Maximizing After-Tax Return

In this section we consider the perspective of a portfolio manager who attempts to achieve a superior after-tax performance. We have seen that dynamic tax management can make a significant contribution to return. The underpinning of the improved performance is the tax option — an astute manager recognizes that the tax option is a valuable asset.

The intrinsic value of the tax option can be disclosed to the owner of the account; it could possibly be included in the reported value of the portfolio. As a practical matter, the benefit from a tax-driven trade would be manifested in reduced tax payment, and therefore it may not be reflected directly in the value of the portfolio.

Although the time value of the tax option is not meaningful to lay people, it is of importance to a manager. The manager should be cognizant of the value of the tax option, and structure the portfolio to maximize tax optionality, subject to the constraints on credit risk, market risk, diversification, etc. All other factors being the same, more option value is preferable to less. As will be shown below, some investments are much better poised than others to achieve a superior after-tax return.

Portfolio Optimization: Example

We want to construct a single-security portfolio with 10-year duration. Alternatives are premium optionless 5% bonds, optionless par bonds, and premium 5% bonds callable at par in 10 years.

As discussed earlier, first we need to specify whether duration should be based on market price or hold value. For premium bonds the two are identical. However for discounts the market price is more sensitive to interest rates than the hold value, and therefore the duration based on market price would be longer. Par bonds are between the extremes: if rates decline they behave like premiums, if rates rise they behave like discounts — their duration should reflect this asymmetry. Because our performances are based on hold values rather than market prices, in this example our selection criterion is 'hold' duration.

The maturities and prices of the three investment alternatives are shown in Table 2. Note that the 20-year maturity of the premium callable bond is much longer than those of the optionless bonds. Table 2 also shows the respective option values under aggressive and conservative management. The option values of the premium bonds, whether based on aggressive or conservative estimates, are much higher than those of the par bond. In particular, under conservative management the option value of the par bond is zero. Based on this information, premium bonds would be expected to perform better than the par bonds.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

Table 2: Investment Alternatives for Tax Management

Bond	Purchase Price	Hold Value Duration (Yrs)	Tax Option Value	
			Short-Term Losses Offset Short-Term Gains	Short-Term Losses Offset Long-Term Gains
5% 13-year NC-L	120.83	10.04	2.91	1.17
5% 20-year NC-10	116.18	10.04	2.90	1.32
3.05% 12-year NC-L	100.00	10.15	0.79	0.00

As shown in Table 3 and Table 4 below, premium bonds perform much better than par bonds. Under aggressive management the excess return of premium bonds is roughly 80 basis points, and that of par bonds is only 36 basis points. Even more striking is that while under conservative management the excess return of premium bonds is more than 30 basis points, that of par bonds is nil. Of course, the latter could have been anticipated: tax-beneficial trading opportunities are absent because if rates rise, the hold value far exceeds the bond's market value.

Table 3: Short-Term Losses Offset Short-Term Gains (Aggressive Management)

Bond	Purchase Price	Hold Value Duration (Yrs)	One-Year Expected Return		Performance Improvement from Tax Management (bps)
			Buy and Hold	Tax-Managed	
5% 13-year NC-L	120.83	10.04	1.95	2.78	83
5% 20-year NC-10	116.18	10.04	2.14	2.90	76
3.05% 12-year NC-L	100.00	10.15	1.96	2.32	36

Table 4: Short-Term Losses Offset Long-Term Gains (Conservative Management)

Bond	Purchase Price	Hold Value Duration (Yrs)	One-Year Expected Return		Performance Improvement from Tax Management (bps)
			Buy and Hold	Tax-Managed	
5% 13-year NC-L	120.83	10.04	1.95	2.30	35
5% 20-year NC-10	116.18	10.04	2.14	2.46	32
3.05% 12-year NC-L	100.00	10.15	1.96	1.96	0

As demonstrated by this example, the value of the tax option is an excellent indicator of expected excess return over buy-and-hold. It is also evident that premium bonds provide significantly more option value than par or discount bonds, and therefore premium bonds are the ideal candidates for tax management.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

In the examples above, we report expected returns based on simulated interest rate scenarios. Of course, if interest rates declined during the holding period there would be no benefit from tax management, because there would be no tax-loss harvesting opportunities. We also assume that the bonds in the examples were purchased at the beginning of the holding period. In practice, a manager might be looking at a portfolio of bonds purchased at various times in the past. If the current basis of a bond is below the market price, the tax option (and hence the potential boost from tax management) will have little value. Finally, the examples indicate the expected boost in performance for a one-year holding period. The expected return in the following period may be different depending on the after-tax value of the holdings at the end of the first period and the level of interest rates then.

VIII. Conclusion

We have examined the effect of dynamic tax management on the performance of municipal bonds. The result depends on several factors. In particular, being able to offset short-term losses against short-term gains ('aggressive management') can be a major contributor to incremental return. However the improvement is significant even under conservative management, when short-term losses are netted against long-term gains.

We recommend that the after-tax return should be based on hold values, because hold values incorporate potential tax payments. We have shown that dynamic tax management can increase the return of an intermediate-duration portfolio by roughly 35 to 80 basis points, depending on the availability of short-term capital gains. Longer-duration portfolios would be expected to perform even better.

Superior after-tax performance can be achieved only by constructing a 'tax-efficient' portfolio. The value of the tax option is derived from the price volatility of the bond. We have shown that a tax-efficient portfolio should consist of long-duration callable bonds that trade at premiums. Optionless premium bonds would be preferable, but at the present they are not available in volume. In spite of their relatively long duration, intermediate par and discount bonds provide very little tax option value, and thus they are not suitable for tax management.

Optimal Municipal Bond Portfolios for Dynamic Tax Management

References

- AIMR Performance Presentation Standards (2005).
http://www.cfainstitute.org/ethics/Documents/Codes%20Documents/aftertax_changes.pdf
- Bergstresser, D. and J. Pontiff. (2013). "Investment Taxation and Portfolio Performance," *Journal of Public Economics* 97, 245–257.
- Constantinides, G. (1984). "Optimal Stock Trading with Personal Taxes," *Journal of Financial Economics* 13, 65-89.
- Constantinides, G., and J. Ingersoll. (1984). "Optimal Bond Trading with Personal Taxes," *Journal of Financial Economics* 13, 299-335.
- Global Investment Performance Standards (CFA Institute).
- Haugh, M., G. Iyengar and Chun Wang. (2014). "Tax-Aware Dynamic Asset Allocation," *Working paper*.
- Horan, S., Philip Lawton and Robert R. Johnson. (2008). "After-Tax Performance Management," *Journal of Wealth Management* 11, 69–83.
- Kalotay, A. (2014). "The Interest Rate Sensitivity of Tax-Exempt Bonds Under Tax-Neutral Valuation," *Journal of Investment Management* 12, 62-68.
- Kalotay, A. (2014). "Optimal Tax Management of Municipal Bonds," *Journal of Portfolio Management*, 41, 85-94.
- Kalotay, A. "Tax-Efficient Trading of Municipal Bonds," *Financial Analysts Journal*, forthcoming
- Kalotay, A., and C. Howard. (2014). "The Tax Option in Municipal Bonds," *Journal of Portfolio Management* 40, 94-102.
- Kalotay, A., D. Yang, and F. Fabozzi. (2007). "Refunding Efficiency: A Generalized Approach," *Applied Financial Economic Letters* 3, 141-146.
- Porterba, J. (1997). "The Estate Tax and After-Tax Investment Returns," *NBER Working Paper No. 6337*.
- Tanzer, A. (2015). "Private Wealth: An Introduction to After-Tax Performance Measurement Principles," *Investment Risk and Performance (CFA Institute)*, 2015:1.
- Wilcox, J and F. Fabozzi. (2013.) "Financial Advice & Investment Decisions: A Manifesto for Change." *John Wiley & Sons*.