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Revisiting the conventional wisdom regarding asset location

- Asset location is the strategic placement of assets into investment accounts to maximize total after-tax returns. For individual investors, it means locating assets based on their relative tax-efficiency among tax-advantaged and taxable accounts.
- Our research finds that a thoughtful asset location strategy can add significantly more value for clients than an equal-location strategy (defined here as allocating the same amounts among three types of account—traditional IRA, Roth IRA, and taxable). The value added typically ranges from 5 to 30 basis points (bps) of after-tax return, depending on client characteristics.
- In general, placing bonds first in traditional IRA, then Roth IRA, and then taxable accounts (TRX) is the optimal asset location strategy for most clients.[1] However, the preferred strategy for some investors with conservative asset allocations may differ if no step-up in basis is assumed and active equity is incorporated into the portfolio.[2]

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1 The allocation of assets to international holdings and associated foreign tax credit is not considered. We consider an alternate asset location strategy as optimal only if it is better than conventional by more than 5 bps.

2 Step-up in basis is a provision of U.S. tax law that allows an asset's cost basis to be reset when passed to a beneficiary upon the death of the asset owner.

Introduction

Asset *location* is the strategic placement of assets into investment accounts to maximize total after-tax returns. It focuses on tax-efficient implementation of asset *allocation*, which is primarily concerned with allocating asset types in a portfolio to balance risk and return. For individual investors, asset location involves distributing assets based on their relative tax-efficiency among tax-advantaged and taxable accounts.

The conventional asset location strategy has been to locate bonds in tax-advantaged accounts and relatively tax-efficient passive equities in taxable accounts (Garlappi and Huang, 2006) because bonds have traditionally been considered less tax-efficient than equities.

However, in recent decades, the fall in bond yields and change in tax rates have encouraged a revisiting of conventional asset location strategy. Also, because Roth IRAs and Roth 401(k)s were not available or widely used during the earlier studies, asset location has not been thoroughly studied in a three-account (Roth, traditional, and taxable) setup.

Our research tests whether the conventional asset location heuristic is still appropriate for most investors and, if not, what method could better support wealth accumulation. To do this, we examine how asset location strategy may differ based on a variety of investor dimensions such as tax rate and asset allocation. In addition, we incorporate uncertainty by using the distribution of various asset class returns generated by the proprietary Vanguard Capital Markets Model® (VCMM).

Methodology and assumptions

To study asset location, we use a proprietary cash flow model that incorporates granular tax accounting and various tax-advantaged and taxable accounts. It also enables us to model variations such as static and glide-path allocations. To simulate dynamic asset return forecasts, the model uses 10,000 asset-class return paths generated by the VCMM.

We study six different strategies based on the priority of placement of bonds in three different account types—traditional IRA (T), Roth IRA (R), and taxable (X)—as well as a seventh strategy in which the allocation is identical for all three accounts. This equal-location strategy serves as our benchmark. Using this notation, TRX represents the conventional asset location strategy.

We evaluate all the asset location strategies over a 20-year horizon. For the baseline scenario, we simulate investors who begin with their wealth equally distributed among all three accounts. At termination, we compare each strategy to the benchmark by calculating the strategy's annualized return implied by median terminal wealth and comparing it to that of the benchmark. This allows us to relay the quantitative significance of each strategy beyond our simulation.

Our model uses two broad asset classes: equities and bonds. We model two equity subclasses—active and passive—and two bond subclasses—taxable and tax-exempt—to estimate how differences in relative tax-efficiency and return can influence optimal asset location.

IMPORTANT: The projections and other information generated by the VCMM regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Distribution of return outcomes from VCMM are derived from 10,000 simulations for each modeled asset class. Simulations are as of December 31, 2020. Results from the model may vary with each use and over time. For more information, please see Appendix 1.

The baseline scenario assumes only the passive equity and passive fixed income assets are available for investment.

Investors in our simulation have a glide-path allocation over their investment horizon. Rebalancing is triggered when the weight of an asset falls outside of the set thresholds around their targeted allocation or when the allocation dictated by the glide path changes.

The median wealth for a portfolio is calculated after the entire balance in the traditional account is taxed at the ordinary income rate and the unrealized gains in the taxable account are taxed at the long-term capital gains rate. When investors have a full step-up in basis, none of the unrealized gains in their taxable account are taxed at the end of the simulation.

Aliaga-Díaz et al. (2019) estimated a U.S. equity active fund to have 81 basis points of alpha and 400 basis points of tracking error over 30 years (an information ratio of about 0.2). Wallick, Wimmer, and Balsamo (2015) found that over the period July 1, 1984, through June 30, 2014, annualized excess return ranged from 17 to 54 basis points, depending on weighting methodology. Based on these estimates, we simulate this asset class in our model by adding to the VCMM equity price returns a shock with 50 bps of net alpha and 250 bps of tracking error.

Tax-exempt fixed income is modeled by haircutting the VCMM bond income return by 24% and then allowing this income to be distributed tax-free. The deduction is based on the yield spread between the Barclays U.S. Aggregate Bond Index and the Barclays Municipal Bond Index. Bennyhoff and Kinniry (2017) found that the average yield spread between these indexes was 130 bps from 1980 through December 2015.

We found the average yield spread to be 32 bps from January 2016 to April 2022, about a 13% reduction.

Because this latter period contained the COVID-19 recession, we factored in a 24% reduction (about 40 basis points), about the regular amount from January 2016 to January 2020.

We study the impact of various asset location strategies on terminal after-tax wealth by varying investor dimensions including:

Investor dimension	Variations studied
Asset allocation	• Glide paths based on different risk preferences
Asset types	• Two broad assets classes: equities and bonds • Two equity sub-asset classes: passive and active • Two bond sub-asset classes: taxable and tax exempt
Bequest consideration	• Entire taxable amount subject to bequest with 100% step-up in basis • No bequest and zero step-up in basis
Taxes	• Different combinations of income and preferred tax rates
Account balances	• Three different variations of account balances: – Equal amount of initial wealth in all three accounts – 10% of wealth in Roth account – 95% of wealth in tax-advantaged account

First, we analyze our baseline scenario across a variety of glide paths and tax brackets. Our baseline scenario includes only passive equity and fixed income, assumes equal starting wealth in each account, and tests the value of each strategy against the benchmark equal-location strategy. Second, we rerun this scenario but vary the initial account mix to analyze how the advantages of asset location may change based on account proportions. Third, we retest our baseline scenario but include active equity to determine how changes in asset-class characteristics may influence asset location. Finally, we discuss the mechanisms at work in the model to provide insight into the best practices for asset location.

Detailed results

Only passive and taxable fixed income investments

We first look at the results of asset location using only passive equity and taxable fixed income classes. We examine three dimensions of these results: 1) tax rates, 2) the stock and bond allocation as determined by the glide path, and 3) the fraction of the taxable account that is used for bequests, which changes the amount of unrealized gains in the account subject to capital gains tax at the end of the horizon. Our analysis demonstrates that a thoughtful asset location strategy can add significant value in increasing clients' after-tax wealth compared to an equal-location approach.

The advantage is greater when investors:

- Are in higher tax brackets.
- Bequeath a greater proportion of their taxable account.
- Have more balanced asset allocations (more of their portfolio allocated toward bonds).

Figure 1 plots the annualized after-tax basis-point improvement of the optimal asset location strategy against the equal-location strategy. Each box identifies the optimal rebalance strategy. The number shown in each box represents the annualized after-tax basis-point improvement over the equal-location strategy. The rows label five glide paths, and the columns label the marginal (first number) and preferred (second number) tax rates used in the simulation. The figure also indicates whether the taxable balance gets a step-up or no step-up at termination.

FIGURE 1.

Annualized median after-tax basis-point improvement through asset location

a. Improvement without step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**8.3** TRX	**7.2** TRX	**9.5** TRX	**8.5** TRX	**5.5** TRX	**4.7** TRX
Aggressive	**13** TRX	**12** TRX	**15** TRX	**13** TRX	**8.5** TRX	**7.3** TRX
Moderate	**19** TRX	**17** TRX	**23** TRX	**20** TRX	**12** TRX	**9.8** TRX
Conservative	**19** TRX	**16** TRX	**24** TRX	**20** TRX	**12** TRX	**10** TRX
Very conservative	**16** TRX	**14** TRX	**23** TRX	**19** TRX	**10** TRX	**8** TRX

b. Improvement with step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**14** TRX	**13** TRX	**13** TRX	**12** TRX	**8.5** TRX	**7.7** TRX
Aggressive	**21** TRX	**19** TRX	**19** TRX	**18** TRX	**13** TRX	**12** TRX
Moderate	**30** TRX	**29** TRX	**29** TRX	**26** TRX	**19** TRX	**17** TRX
Conservative	**34** TRX	**31** TRX	**33** TRX	**29** TRX	**20** TRX	**18** TRX
Very conservative	**31** TRX	**28** TRX	**32** TRX	**28** TRX	**19** TRX	**17** TRX

Source: Vanguard, as of September 2021.

Recent discussions have considered using TXR instead of TRX as the alternative wealth-maximizing asset location strategy since it places high-growth stocks in a Roth account. Both strategies preferentially locate bonds in the traditional account. The trade-off, then, is primarily between the relative tax-inefficiency of locating bonds in the taxable account and the protection of the highest-returning asset, equity. With bequests, the taxable account converges on behaving like a Roth account because only the relatively smaller dividend and occasional capital gains are taxed under TRX. Furthermore, with glide-path allocations, TXR incurs a high rebalancing cost since most of the rebalancing is done in taxable accounts.

Varying the initial account mix

For the baseline scenario, we assume that each account has an equal amount of initial wealth. This is not far off from the average three-account portfolio in the 2019 Survey of Consumer Finance. However, three-account portfolios show some variation in proportion.

Figure 2 displays the distribution of account proportions, conditional on a household holding a positive amount in all three accounts.

Variation in an investor's account mix may show that the advantage of different strategies is dependent upon this mix. To test this, we rerun our baseline scenario with two alternative account mixes:

- **Investor 1.** 10/50/40 Roth/traditional/brokerage.
- **Investor 2.** 47.5/47.5/5 Roth/traditional/brokerage.

Investor 1 can be regarded as focused on saving on taxes now. They have little in their Roth account, and 90% of their savings is distributed between traditional and brokerage accounts. Investor 2 is more focused on retirement and saves little in their brokerage account. A balanced mix of Roth and traditional accounts could be expected from an investor who has Roth-converted some of their retirement savings.

FIGURE 2.

Distribution of household account balances among three accounts

	25th percentile	50th percentile	Average	75th percentile
Brokerage	3.5%	24.1%	31.9%	59.2%
Traditional	11%	23.2%	36.9%	67%
Roth	6%	23.1%	31.2%	51%

Source: 2019 Survey of Consumer Finance.

Overall, as shown in **Figures 3** and **4**, we find that the optimal asset location strategy does not change dramatically from the baseline scenario of an equal distribution of account wealth.

FIGURE 3.

Advantage of asset location when 10% of wealth is in Roth account

a. No step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**6.6** TRX	**5.9** TRX	**9.1** TRX	**7.8** TRX	**4.3** TRX	**3.6** TRX
Aggressive	**9.9** TRX	**8.9** TRX	**13** TRX	**11** TRX	**6.3** TRX	**5.1** TRX
Moderate	**17** TRX	**15** TRX	**22** TRX	**18** TRX	**10** TRX	**8.5** TRX
Conservative	**20** TRX	**18** TRX	**27** TRX	**23** TRX	**12** TRX	**9.8** TRX
Very conservative	**20** TRX	**16** TRX	**27** TRX	**23** TRX	**12** TRX	**8.9** TRX

b. Step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**15** TRX	**14** TRX	**14** TRX	**12** TRX	**8.3** TRX	**7.5** TRX
Aggressive	**21** TRX	**19** TRX	**19** TRX	**17** TRX	**12** TRX	**11** TRX
Moderate	**31** TRX	**29** TRX	**30** TRX	**26** TRX	**18** TRX	**16** TRX
Conservative	**37** TRX	**34** TRX	**37** TRX	**33** TRX	**22** TRX	**19** TRX
Very conservative	**35** TRX	**32** TRX	**37** TRX	**32** TRX	**21** TRX	**18** TRX

Source: Vanguard, as of September 2021.

FIGURE 4.

Advantage of asset location when 95% of wealth is in Roth and traditional accounts

a. No step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**7.8** TRX	**7.2** TRX	**7.8** TRX	**6.9** TRX	**4.8** TRX	**4.4** TRX
Aggressive	**11** TRX	**10** TRX	**11** TRX	**9.8** TRX	**7.5** TRX	**6.8** TRX
Moderate	**21** TRX	**20** TRX	**20** TRX	**18** TRX	**13** TRX	**12** TRX
Conservative	**28** TRX	**26** TRX	**27** TRX	**24** TRX	**17** TRX	**15** TRX
Very conservative	**29** TRX	**27** TRX	**28** TRX	**25** TRX	**18** TRX	**16** TRX

b. Step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**9.2** TRX	**8.6** TRX	**8.5** TRX	**7.5** TRX	**5.2** TRX	**4.6** TRX
Aggressive	**13** TRX	**12** TRX	**12** TRX	**11** TRX	**8** TRX	**7.5** TRX
Moderate	**23** TRX	**21** TRX	**22** TRX	**19** TRX	**14** TRX	**13** TRX
Conservative	**29** TRX	**28** TRX	**28** TRX	**26** TRX	**19** TRX	**17** TRX
Very conservative	**31** TRX	**29** TRX	**29** TRX	**27** TRX	**19** TRX	**17** TRX

Source: Vanguard, as of September 2021.

Could differences in asset classes influence asset location strategy more than differences in account mixes?

In the next section, we test this by setting the initial account mix to be equal for all accounts while including active equities and tax-exempt bonds in the portfolio.

Active equity and tax-exempt investments

When active equity and tax-exempt fixed income are added to the portfolio, the result varies modestly from the baseline case. Asset location still adds value over an equal-location strategy by from 3 to 23 bps depending on tax rates, allocation, and bequests (see **Figure 5**). The most notable distinction from the baseline case is that for certain glide-path and tax combinations, XTR is the median wealth-maximizing strategy. This results from the synergy of tax-exempt bonds and active equity. The replacement of taxable bonds with tax-exempt municipal bonds helps blunt the cost of placing bonds in the taxable account by improving the asset's relative tax-efficiency. This allows the investor to place the faster-growing active equity in the Roth account and minimize the downside of placing fixed income in the taxable account.

Mechanisms at work

Strategic asset location must overcome multiple tax frictions in order to maximize after-tax wealth. Asset location strategy has frequently emphasized the different taxation of bond and equity income and the ability of equities to defer capital gains realizations and realize capital gains at the long-term rate. However, our analysis also finds that the taxes paid on traditional accounts, the taxes paid on unrealized gains accumulated in taxable accounts, and the varying rebalancing costs of different asset location strategies all contribute to after-tax wealth accumulation.

FIGURE 5.

Optimal asset location strategies for active equity and tax-exempt assets

a. No step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**3.2** TRX	**2.7** TRX	**5.7** TRX	**4.8** TRX	**2.5** TRX	**1.8** TRX
Aggressive	**5.3** TRX	**4.3** TRX	**8.4** TRX	**7.1** TRX	**3.5** TRX	**2.4** TRX
Moderate	**8.8** TRX	**13** XTR	**13** TRX	**11** TRX	**6** TRX	**4.9** TRX
Conservative	**17** XTR	**17** XTR	**14** TRX	**12** TRX	**5.5** TRX	**11** XTR
Very conservative	**19** XTR	**19** XTR	**19** TXR	**16** TXR	**12** XTR	**12** XTR

b. Step-up in basis

	Tax brackets (marginal, preferred)					
Glide path	**(37%, 24%)**	**(35%, 24%)**	**(35%, 15%)**	**(32%, 15%)**	**(24%, 15%)**	**(22%, 15%)**
Very aggressive	**9.8** TRX	**9.3** TRX	**9.5** TRX	**8.8** TRX	**6.5** TRX	**6** TRX
Aggressive	**14** TRX	**13** TRX	**14** TRX	**13** TRX	**9** TRX	**8.1** TRX
Moderate	**22** TRX	**20** TRX	**21** TRX	**19** TRX	**13** TRX	**12** TRX
Conservative	**22** TRX	**21** TRX	**23** TRX	**20** TRX	**14** TRX	**13** TRX
Very conservative	**20** TRX	**18** TRX	**22** TRX	**19** TRX	**13** TRX	**11** TRX

Source: Vanguard, as of September 2021.

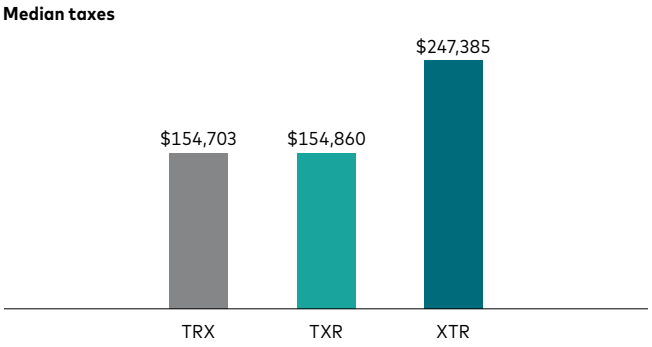
To demonstrate how the various factors work, we assume an investor has an asset allocation based on a very conservative risk tolerance, an income rate of 37%, and a long-term capital gains tax rate of 24%. There is no allocation to tax-exempt bonds, but active equity is incorporated assuming an alpha of 50 bps and 250 bps of tracking error. We start with equal wealth in all three simulated accounts.

Impact of traditional account balance growth and terminal taxation on wealth

Figure 6 shows the taxes paid on the traditional account balance at termination under three different asset location strategies. The tax on the traditional balance is significantly higher under the XTR strategy than under either TRX or TXR because XTR places equities in the traditional account before the taxable account. The higher return from this asset increases the final period's tax burden.

FIGURE 6.

Differences in taxes for various asset location strategies



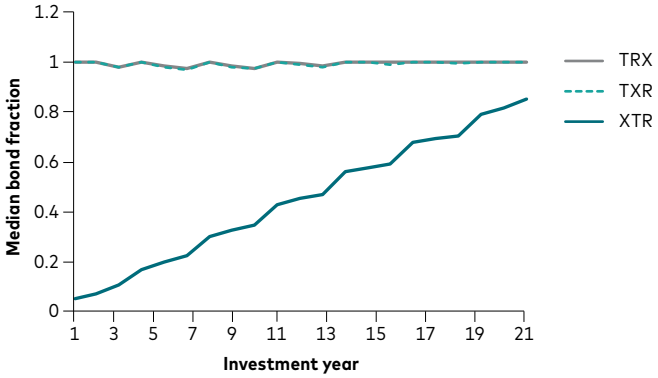
Source: Vanguard, as of September 2021.

The higher tax burden in XTR is further corroborated in **Figure 7**. In the TRX and TXR strategies, almost the entire balance in the traditional account is composed of bonds, while in XTR, the traditional account initially has no bonds. The growth of the traditional account is slower in TRX and TXR, leaving the investor with a smaller tax burden at termination than in the XTR case.

FIGURE 7.

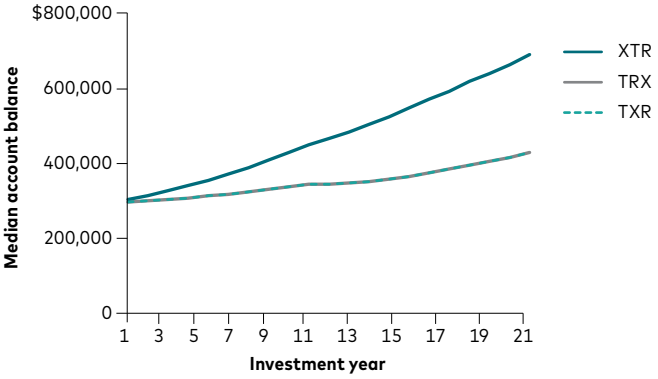
Impact on traditional balances of asset location strategies with various bond allocations

a. Bond allocation in traditional account



Source: Vanguard, as of September 2021.

b. Growth of account balance over time



Source: Vanguard, as of September 2021.

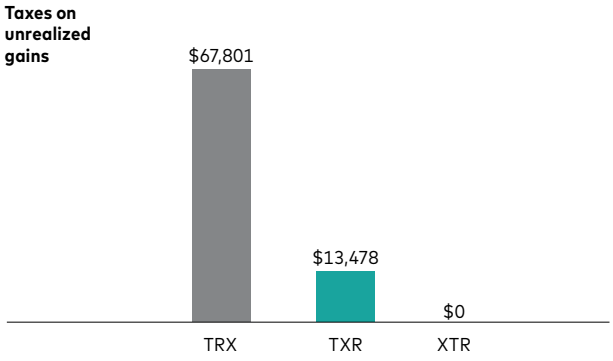
The impact of unrealized gains and associated taxes on terminal wealth

The second factor that influences optimal asset location strategy is the taxation on the unrealized gains in the taxable account. The primary driver of this tax burden is the availability of a step-up in basis. Different asset location strategies lead to different final levels of accumulated unrealized gains, as shown in **Figures 8** and **9**.

As seen in both figures, unrealized gains in the taxable account are larger under the TRX strategy than under TXR or XTR. TRX preferentially places equities, which usually grow faster than bonds, in the taxable account. Consequently, the tax burden in that account is greater than it is for the other two strategies, which locate equities first in the Roth account. One advantage of placing equities in the taxable account rather than in the traditional account is that terminal capital gains can be liquidated at the long-term rate; taxation in the traditional account is at the marginal rate. As seen in the baseline scenario, this is a hurdle the step-up in basis helps overcome.

FIGURE 8.

Difference in unrealized gains at termination for various asset location strategies

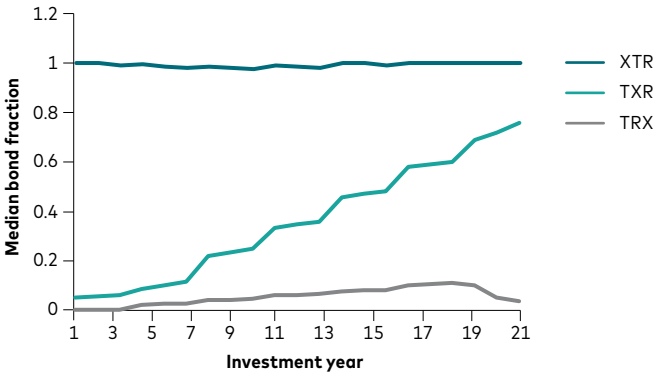


Source: Vanguard, as of September 2021.

FIGURE 9.

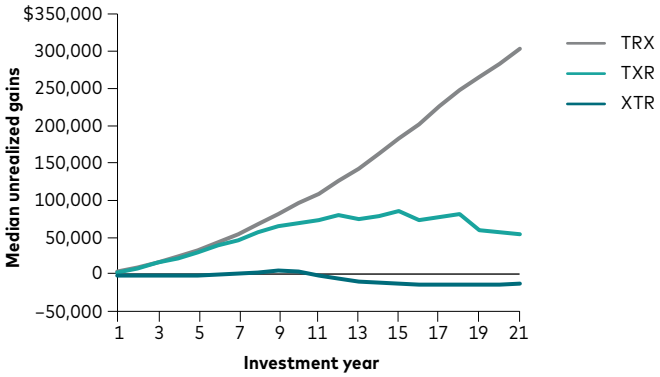
Difference in unrealized gains over time for various asset location strategies

a. Bond allocation in taxable account



Source: Vanguard, as of September 2021.

b. Unrealized gains in taxable account



Source: Vanguard, as of September 2021.

Rebalancing costs, differences in ordinary and preferred income taxes

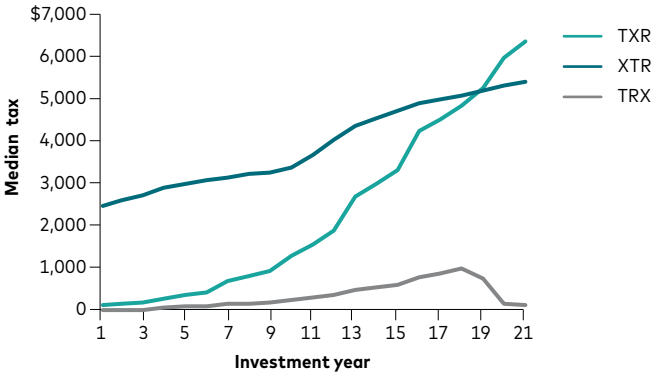
Rebalancing costs vary significantly depending on asset location strategy, especially for clients with glide-path allocations. As the glide path becomes more conservative over time, bonds must be bought and equities sold to meet the glide-path target. Most of this activity occurs in the Roth account under TRX and in the traditional account under XTR. However, in TXR, this rebalancing occurs in the taxable account and incurs taxes along the way. This can be seen by the spike in preferred taxes every three years shown in **Figure 10**.

In addition to rebalancing costs, the overall tax burden is also affected by the difference in taxation of bond and equity income. As seen in Figure 10, XTR pays more income tax because it allocates bonds to the taxable account, while TXR and TRX pay greater preferred tax on dividend income because stocks are allocated to taxable accounts.

FIGURE 10.

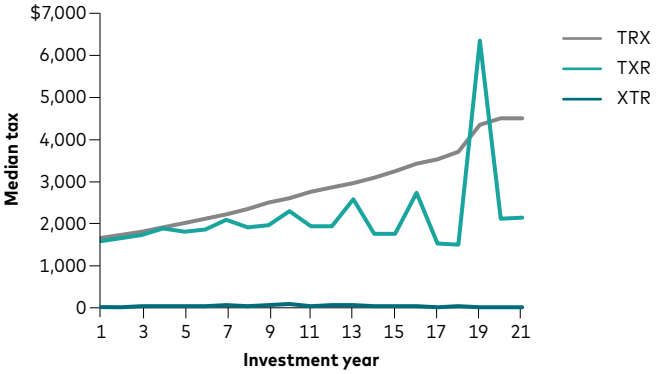
Difference in taxes under various asset location strategies

a. Difference in income taxes



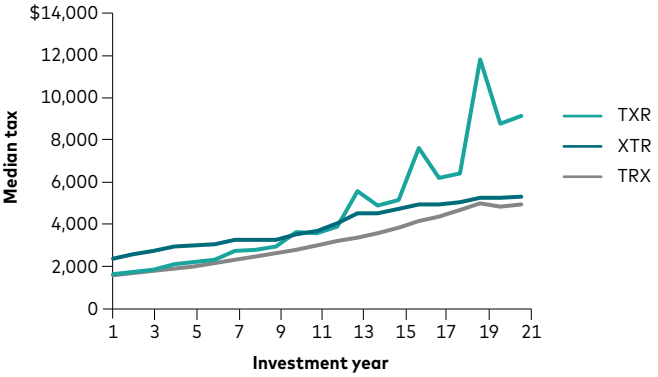
Source: Vanguard, as of September 2021.

b. Difference in preferred taxes



Source: Vanguard, as of September 2021.

c. Difference in overall tax burden



Source: Vanguard, as of September 2021.

Conclusion

This paper revisits conventional asset location strategy, which preferentially places bonds first in tax-advantaged accounts and equity in taxable accounts, in light of the changes in bond yields and tax rates over the past decade. We find that for most investors, the conventional TRX rebalancing strategy is still wealth-maximizing. The exception occurs for investors who allocate to active equity and spend a significant portion of their assets in their lifetime. In that case, it may be preferable, based on an individual's tax rate and asset allocation, to preferentially locate equity in the Roth account and shift some of the bond allocation into the taxable account.

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Appendix 1

About the Vanguard Capital Markets Model

IMPORTANT: The projections and other information generated by the Vanguard Capital Markets Model regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. VCMM results will vary with each use and over time. VCMM results presented are as-of December 31, 2020.

The VCMM projections are based on a statistical analysis of historical data. Future returns may behave differently from the historical patterns captured in the VCMM. More important, the VCMM may be underestimating extreme negative scenarios unobserved in the historical period on which the model estimation is based.

The Vanguard Capital Markets Model® is a proprietary financial simulation tool developed and maintained by Vanguard's primary investment research and advice teams. The model forecasts distributions of future returns for a wide array of broad asset classes. Those asset classes include U.S. and international equity markets, several maturities of the U.S. Treasury and corporate fixed income markets, international fixed income markets, U.S. money markets, commodities, and certain alternative investment strategies. The theoretical and empirical foundation for the Vanguard Capital Markets Model is that the returns of various asset classes reflect the compensation investors require for bearing different types of systematic risk (beta). At the core of the model are estimates of the dynamic statistical relationship between risk factors and asset returns, obtained from statistical analysis based on available monthly financial and economic data from as early as 1960.

Using a system of estimated equations, the model then applies a Monte Carlo simulation method to project the estimated interrelationships among risk factors and asset classes as well as uncertainty and randomness over time. The model generates a large set of simulated outcomes for each asset class over several time horizons. Forecasts are obtained by computing measures of central tendency in these simulations. Results produced by the tool will vary with each use and over time.

Appendix 2

The active-passive horse race in the taxable account

Figure A-2 shows the results of a horse race between a portfolio that is 100% active equity and one that is 100% passive equity in the taxable account only. For our target active alpha and tracking error assumptions, the difference between the active and passive portfolios is under 5 basis points for both tax brackets. In light of these results, we incorporate active equity only in tax-advantaged accounts when shelf space is available, according to the portfolio allocation. Similarly, when the tax-exempt asset class is modeled, it is held only in taxable accounts and is limited only by the shelf space in those accounts.

We justify our assumption of a 5% realization rate for active funds based on the academic literature. Arnott, Kalesnik, and Schuesler (2018) note that since 1993, mutual fund managers have more regularly timed capital gains to improve the tax-efficiency of alpha return. This is born out empirically. From 1993 through 1998, active funds realized about 8.3% of their net asset value (NAV) on average (Bergstresser and Poterba, 2002). From 1997 through 2006, actively funds realized about 4% of their NAV annually (Sialm and Starks, 2012). We believe 5% of the NAV is a fair, conservative estimate of the trend in the reduction of the active fund realization rate.

FIGURE A-2.

100% active equity account versus 100% passive equity account

a. Taxable account in 32% tax bracket

- Passive beats active by >5 bps (P>5)
- Passive beats active by ≤5 bps (P≤5)
- Active beats passive by >5 bps (A>5)
- Active beats passive by ≤5 bp (A≤5)

Tracking error (%) \ Alpha (%)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0
1.0	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
1.5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
2.0	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
2.5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
3.0	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
3.5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
4.0	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
4.5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
5.0	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
5.5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
6.0	P>5	P>5	P>5	P>5	P>5	P>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
6.5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
7.0	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
7.5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
8.0	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
8.5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
9.0	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
9.5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
10.0	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5

b. Taxable account in 24% tax bracket

Tracking error (%) \ Alpha (%)	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0
1.0	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
1.5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
2.0	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
2.5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
3.0	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
3.5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
4.0	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
4.5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
5.0	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
5.5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
6.0	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
6.5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
7.0	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
7.5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
8.0	P>5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
8.5	P>5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
9.0	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
9.5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P≤5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5
10.0	P>5	P>5	P>5	P>5	P>5	P>5	P>5	P>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5	A>5

Source: Vanguard, as of September 2021.

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