Generating Tax Alpha with Optimized Index Tracking

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I. Introduction

Background

Despite the significant impact of taxes on the growth of wealth held in taxable accounts, much of the research and discussion about portfolio management is based on pre-tax returns. The last two decades have seen increasing interest in tax-aware portfolio construction and performance measurement.¹ This paper presents our empirical investigation into how tax-aware portfolio optimization can systematically improve the post-tax returns of equity investment strategies tracking a broad market index. Our focus is on individual investors subject to the United States tax code as of January 2021, but similar results do also hold true in other countries with analogous tax regulations.

Equity investors face taxes on two sources of investment income: capital gains and dividends. Capital gains taxes are based on the gains realized when a security in the portfolio is sold for more than its original cost basis. Investors can time the realization of their capital gains and losses to manage these taxes. Tax loss harvesting strategies (Constantinides, 1983) reduce investors' tax burden by accelerating the realization of capital losses and deferring the realization of capital gains. Recognizing capital losses is advantageous because these losses can be used to offset capital gains realized in the same tax year or thereafter. On the other hand, deferring the realization of capital gains delays potential tax obligations. Under the current tax code, it can also enable an investor to avoid capital gains taxes altogether if the assets are donated to a charity or transferred through an estate at the end of the investment horizon. Loss harvesting strategies also take advantage of the lower tax rates applied to long-term capital gains as these strategies hold their capital gains and realize short-term losses.

Harvesting capital losses comes with certain trade-offs. In a world without transaction costs, selling a security that has a loss and claiming tax benefits would always be advantageous if the same security could be purchased again immediately. However, the recognition of capital losses from such sales are prevented by tax regulations governing wash sales.² Therefore, harvesting losses can necessitate deviating from a model portfolio and expose the investor to active risk.

The simplest approach to improve a portfolio's post-tax expected return is to use a tax accounting method which generates low capital gains taxes (for instance, assigning trades to tax lots with higher cost bases first).³ In this approach, the tax consequences of executing a trade list are optimized after the portfolio weights have been determined. This provides an advantage of enhanced post-tax return without requiring the portfolio to deviate from its original mandate targeting pre-tax return. It is also straightforward to implement: the lot-level decisions can be optimized separately for each asset to realize the maximum losses. A more comprehensive loss harvesting strategy is to target reduced capital gains taxes when deciding the portfolio weights. This



¹ One of the earliest papers to point out the inadequacy of tax-agnostic portfolio management for taxable investors was Jeffrey and Arnott's "Is Your Alpha Big Enough to Cover Its Taxes?" (1993). The authors showed that most actively managed mutual funds underperformed the market after taxes because their excess pre-tax returns were outweighed by their tax bills. Since then, tax-aware portfolio construction has been studied from various angles. Stein and Narasimhan (1999) and Arnott, Berkin, and Ye (2001) argued based on controlled simulations that tax loss harvesting can improve the post-tax return of index-tracking equity investment strategies. Chaudhuri, Burnham, and Lo (2020) evaluated the excess return from loss harvesting in the context of index tracking using historical data. Bergstresser and Pontiff (2013) estimated the historical impact of taxes on the returns of certain tax-agnostic index and factor strategies. Israel and Moskowitz (2012), Santodomingo, Nemtchinov, and Li (2016), and Goldberg, Hand, and Cai (2019) demonstrated the benefits of active tax management for factor strategies with simulations using historical market returns.

² More generally, a wash sale occurs when an investor sells securities at a loss and purchases substantially similar securities within 30 days of the sale. IRC § 1091 prohibits the recognition of capital losses from wash sales.

³ The tax efficiency of highest-in-first-out (HIFO) tax accounting has been studied by several authors; see (Berkin and Ye, 2003) for example.

provides significantly more opportunities to increase the portfolio's post-tax return, but it also leads to more complex portfolio rebalancing problems. The loss harvesting objective must now be balanced with the portfolio's original goal of tracking the model portfolio, and sold securities must be replaced with other securities that have similar risk and return characteristics to maintain low tracking error.

Purpose of This Study

This study investigates the benefits of tax-loss harvesting for strategies tracking a broad cap-weighted equity market index.⁴ We compare the post-tax return and risk performance of tax-agnostic and tax-managed strategies tracking the Russell 1000 or Russell 2000 over the period from March 1990 through June 2020. The tax-agnostic strategies match the composition of the index every quarter, whereas the tax-managed strategies harvest capital losses while controlling tracking error to the index. Each portfolio is rebalanced quarterly. We assume that the current tax code prevails throughout the simulation period for simplicity. The value added by tax-loss harvesting is measured through tax alpha, which we define precisely in Section II.

Figure 1 shows the trade-off between tax alpha and realized active risk for some tax-managed strategies launched in different periods. It can be seen that tax-managed strategies can generate substantial tax alphas via loss harvesting at moderate tracking error levels, and the portfolio funding time can be an important factor affecting how much tax alpha can be generated. For instance, a portfolio funded in March 1990 can capture up to 75 basis points (bps) of tax alpha while targeting 25 bps of ex-ante active risk with respect to the Russell 1000 (both the tax alpha and active risk values are annualized). On the other hand, a portfolio launched in June 2008 can capture up to 161 bps of tax alpha while maintaining the same level of tracking error. The benchmark choice also has a noticeable impact on tax alpha. In contrast with our results for the Russell 1000 portfolios, a portfolio tracking the Russell 2000 starting in March 1990 can achieve up to 207 bps of tax alpha while keeping its ex-ante active risk below 25 bps. In addition to portfolio funding time and benchmark choice, we also examine how tax alpha is affected by the presence of external capital gains, higher tax rates, and investor cash contributions and withdrawals.

⁴ Tax optimization and loss harvesting can also be incorporated into factor strategies. A companion paper by Sivaramakrishnan and Liu (2021) studies active tax management in the context of smart-beta portfolios based on the STOXX equity factor indexes.



Figure 1. Tax Alphas and Realized Active Risks of Selected Tax-Managed Portfolios

Potential tax alphas achievable by taxmanaged strategies tracking the Russell 1000 and Russell 2000 over the periods from March 1990 through June 2020 and from June 2008 through June 2020. The horizontal axis measures average realized active risk. All return and active risk values are annualized.

Source: Qontigo, FTSE Russell

Our results in this paper also underscore the value of direct indexing for tax-aware investors. Direct indexing is an investment paradigm whereby investors replicate the performance of an index by holding the individual underlying securities instead of owning a mutual fund or exchange-traded fund (ETF). It has become more popular recently with the advent of digital investment platforms and fractional share trading. Direct indexing allows investors to customize their portfolios according to their personal preferences and reduce their tax liabilities through granular control over their holdings in individual stocks (Lieber, 2020). The tax benefits of direct indexing are especially relevant for high-net-worth investors facing high tax rates and holding complex investment portfolios. In contrast, an ETF investor can only trade at the fund level, which is far less volatile than the underlying stocks and therefore presents fewer opportunities for harvesting capital losses. We revisit this comparison between direct indexing and ETF portfolios in Section IV.

II. Methodology

In this section, we describe our methodology for constructing tax-agnostic and tax-managed indexing portfolios and measuring the value added by tax-loss harvesting. In the remainder of the paper, indexing and indextracking refer to strategies which target pre-tax returns similar to a market index such as the Russell 1000.

Tax Code Assumptions

Asset managers must specialize their tax management strategies to the applicable tax code to make the best investment decisions with respect to their tax consequences. While the tax codes of most countries have some common overarching elements, they can differ in their particulars. In this study, we assume the United States tax code as of January 2021 when constructing tax-managed portfolios and evaluating their post-tax return performance.

The capital gains tax resulting from a trade depends on the difference between the current price and cost basis of the traded shares as well as the duration for which the shares have been in the portfolio. Under the current tax code, gains realized on shares which have been in the portfolio for less than a year are considered short-term capital gains and taxed at the ordinary income tax rate, while long-term capital gains are taxed at a



preferential tax rate. We assume that short-term gains and long-term gains are taxed at the highest applicable federal marginal tax rates, which are 40.8% and 23.8% respectively.⁵ Dividends received from equity holdings are also subject to taxation. Qualified dividends are taxed at the long-term capital gains tax rate, whereas ordinary dividends are taxed at the ordinary income tax rate.⁶ We assume that all dividend income is qualified. This is a suitable assumption because portfolios are rebalanced quarterly in our backtests.

The current United States tax code requires that short-term and long-term capital losses realized within a tax period are first used to offset capital gains of the same character.⁷ If the resulting short-term net gains (STNG) and long-term net gains (LTNG) are both negative, the net losses are carried forward to the following period and retain their respective characters. If the short-term and long-term net gains are both positive, the corresponding tax liability is the sum of the short-term and long-term net gains weighted with the applicable tax rates. If the short-term net gains have opposite signs, they are netted, and the character of the larger side applies to the total. When the total net gains (LTNG+STNG) are positive, these computations can be summarized with the formula

Capital Gains Tax Liability = $\begin{cases} r_l \text{ LTNG} + r_s \text{ STNG} & \text{if LTNG}, \text{STNG} > 0, \\ r_l (\text{LTNG} + \text{STNG}) & \text{if LTNG} + \text{STNG} > 0, \text{STNG} < 0, \\ r_s (\text{LTNG} + \text{STNG}) & \text{if LTNG} + \text{STNG} > 0, \text{LTNG} < 0. \end{cases}$ (1)

In this equation, r_l and r_s stand for the long-term and short-term capital gains tax rates, respectively. Based on our assumption that all received dividends are qualified, the dividends tax liability in each tax period is computed as

Dividends Tax Liability = r_l Dividends (2)

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<sup>5</sup> These rates include the 3.8% Net Investment Income Tax which is applied to investment income if an investor's investment income and modified adjusted gross income are above certain thresholds.
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⁶ Under IRC § 1(h)(11), qualified dividends are defined as dividends which are received from shares in United States corporations or qualifying foreign corporations and satisfy certain minimum holding period requirements. Shares of common stocks must have been held unhedged for at least 61 days out of the 121-day period beginning 60 days before the ex-dividend date for their dividends to be considered qualified.

⁷ The netting and carry-forward of capital gains are governed by IRC §§ 1222 and 1212(b), respectively.

Investment Strategies

Tax-managed indexing requires tracking a model portfolio while harvesting as many losses as possible. Such portfolio construction problems are best addressed using optimization. In this section, we describe our optimization-based methodology for constructing tax-managed index-tracking portfolios.

The tax-managed investment strategies studied in this paper minimize a weighted sum of the long-term and short-term net capital gains realized while maintaining a specified ex-ante annualized tracking error to the market index (Russell 1000 or Russell 2000) and enforcing that no cash or short positions are held. More precisely, the rebalancing strategy is

minimize	Weighted Net Capital Gains	
subject to		(3)
	Fully-invested long-only portfolio	
	Tracking error $\leq R$	

The strategy objective Weighted Net Capital Gains is a linear combination of the long-term and short-term net capital gains weighted with the corresponding tax rates r_l and r_s :

Weighted Net Capital Gains =
$$r_l \text{ LTNG} + r_s \text{ STNG}$$
 (4)

This objective takes both capital gains and losses into consideration as well as the tax rate differential. All else being equal, losses are preferred over gains, short-term losses are preferred over long-term losses, and long-term gains are preferred over short-term gains. The tax-managed strategies are parameterized by how much tracking error is allowed; we simulate five strategies with the tracking error bound *R* set to 10 bps, 25 bps, 50 bps, 75 bps, and 100 bps. We use the Axioma US Medium-Horizon Equity Factor Risk Model (AXUS4) to estimate tracking error.⁸ The investment universe consists of the index constituents.

We use the Axioma Portfolio OptimizerTM (APO) to rebalance tax-managed portfolios according to the strategy in Equation 3. APO also streamlines backtesting tax-managed strategies by automating the optimization modeling for tax constraints and objectives, managing tax lots, and maintaining records of the capital gains and losses realized over time. Besides the weighted net capital gains objective in Equation 4, APO allows asset managers to incorporate additional tax considerations into their investment strategy including targets on the amount of capital gains and losses realized, constraints regarding wash sales, and lot-level trade restrictions. ⁹

The tax-agnostic strategy which forms the baseline for our comparisons matches the composition of the market index exactly every time the portfolio is rebalanced. The resulting trades are assigned to tax lots minimizing Weighted Net Capital Gains.

⁸ Detailed information about the Axioma US4 Equity Risk Models can be found in the Axioma Risk Model Handbook.

⁹ For detailed information about the tax-aware optimization capabilities of the Axioma Portfolio Optimizer, please refer to the product documentation. Some of its features are illustrated in the Qontigo case study by Bandar (2020).

Post-Tax Return and Tax Alpha

We define the post-tax return of a portfolio in each period as

$$Post-tax return = Pre-tax return - \frac{Capital Gains Tax Effect + Dividends Tax Liability}{Start-of-Period Portfolio Size}$$
(5)

In our backtests, the portfolios are rebalanced at the end of each quarter, and their quarterly post-tax returns are computed according to Equation 5. The capital gains realized and dividends received during a quarter are incorporated into the portfolio's post-tax return in the same quarter. This is a reasonable assumption because tax obligations and savings result in an almost immediate cash flow through quarterly estimated tax payments. We assume that taxes are paid from holdings outside the portfolio and do not require further liquidation of assets.

Because the tax-managed strategies are allowed to deviate from the index to harvest losses, they can underperform or overperform the tax-agnostic strategy on a pre-tax basis. To isolate the benefit of active tax management, we adopt the following performance attribution scheme (see, e.g., Santodomingo, Nemtchinov, and Li (2016) and Goldberg, Hand, and Cai (2019)):

Post-tax active return = Tax alpha + Pre-tax active return (6)

In this equation, the pre- and post-tax active returns are both computed with respect to the tax-agnostic strategy. Therefore, tax alpha quantifies the reduction in the tax burden (or increase in the tax benefits) of a tax-managed strategy over its tax-agnostic counterpart. For strategies which maintain a small tracking error to the index, the pre-tax active return should be small, and the tax alpha should explain most of post-tax active return. When reporting the performance of tax-managed strategies in the next section, we state both the tax alpha and pre-tax active return of each strategy.

Many investors own multiple separately managed accounts with distinct investment goals, trading histories, and capital gains realization characteristics. The United States tax code allows capital gains and losses to be offset across different accounts.¹⁰ To allow for interactions between the indexing portfolio and other accounts owned by the same investor, we compute the post-tax return of a strategy in each simulation from two perspectives.

In the first perspective, we assume that any capital losses realized in the indexing portfolio can be applied immediately to offset capital gains of the same character. This will, for example, be true if the investor has other investments (such as a hedge fund account or real estate holdings) which realize sufficiently large short-term and long-term gains. The losses harvested in the indexing portfolio can then be used to reduce the investor's tax liabilities associated with the capital gains realized in the external accounts, and the resulting tax savings can be reinvested.¹¹ We evaluate a strategy's period post-tax return in this perspective by equating Capital Gains Tax Effect with Weighted Net Capital Gains in Equation 5. Note that this allows the post-tax return of a strategy to exceed its pre-tax return if the strategy realizes more losses than gains.

In the second perspective, the indexing portfolio is viewed in isolation. Any capital losses realized in the indexing portfolio are used to offset only the gains realized in the same portfolio, and if enough gains are not available, the unused losses are carried forward according to the tax code. This will be the case for an investor who realizes no capital gains outside the indexing portfolio. We compute period post-tax return in this perspective by equating Capital Gains Tax Effect with Capital Gains Tax Liability in Equation 5. Note that

¹⁰ Capital losses can also be used to offset other taxable income (including dividends) up to \$3,000 per year. To keep the effects of capital gains and dividends taxes separate, we do not apply capital losses to offset dividends in our analysis.

¹¹ Tax-managed strategies have been studied under similar assumptions in a number of papers; see (Berkin and Ye, 2003), (Israel and Moskowitz, 2012), (Goldberg, Hand, and Cai, 2019), and (Chaudhuri, Burnham, and Lo, 2020) for example.

Capital Gains Tax Liability is never negative; therefore, post-tax return is always less than or equal to pre-tax return in this perspective.

The unlimited external gains perspective allows optimal use of the harvested losses and therefore provides a best-case estimate on the tax alpha of tax-managed strategies. In contrast, the no external gains perspective yields a worst-case estimate on tax alpha because the harvested losses cannot be monetized until the indexing strategy realizes some gains. In some cases, the realized losses are carried forward until the end of the investment horizon. Furthermore, the realized short-term losses must often be used to offset long-term gains because no short-term gains are available. For most investors, the actual benefit of loss harvesting will be somewhere between our results in these two extreme perspectives.

The current United States tax code also allows investors to avoid taxes on unrealized capital gains accumulated in their portfolios through cost basis "step-up" provisions at death (IRC § 1014(a)) or charitable donations (IRC § 170). In cases where these options are not applicable, an investor may need to liquidate her portfolio at the end of the investment horizon and incur a lump-sum tax liability. To cover both disposition scenarios, we report the tax alpha of tax-managed strategies both before and after the final liquidation.

Backtesting Setup

All portfolios start from a cash investment at the start of the simulation period and are rebalanced on the last trading day of each quarter. In our base case, the simulation period is from March 1990 through June 2020, and the portfolios track the Russell 1000 index. We assume that short-term gains and long-term gains are taxed at the highest applicable federal marginal tax rates, which are 40.8% and 23.8% respectively.

Our results in the base case provide a good indication of how much loss harvesting can benefit strategies tracking a large-cap cap-weighted market index.¹² However, it is not clear that these results would directly extend to strategies tracking a small-cap index. In particular, small-cap indices have distinct reconstitution rules and cover securities which possess different risk and return characteristics. To explore how the benchmark choice affects tax alpha, we report on simulations comparing strategies tracking the Russell 2000.

The tax alpha from active tax management can depend strongly on when a portfolio is launched. To understand the relationship between tax alpha and portfolio funding time better, we conducted additional simulations starting on different dates. To highlight an extreme case, we present results on simulations which start in June 2008 and in March 2009 (shortly before and after the Russell 1000 index hit its lowest level during the Global Financial Crisis).

Another question we examine is the relationship between tax alpha and investor cash contributions (or withdrawals). Cash withdrawals from a portfolio force the sale of securities and increase the realization of capital gains, whereas cash contributions create opportunities for adjusting a portfolio's cost basis without tax consequences. Such transactions have little effect on the pre-tax return of our strategies but can impact their capital gains taxes. We investigate how the post-tax performance of tax-managed and tax-agnostic strategies change when the investor contributes or withdraws a fixed percentage of the portfolio size every quarter.

Assuming that capital gains are taxed at the highest federal marginal rates can underestimate the tax impact for an investor subject to high state and local income taxes.¹³ To explore the sensitivity of our results to tax



¹² In experiments not reported in this paper, we have found that similar results can be obtained for strategies tracking other large-cap cap-weighted market indexes.

¹³ Most US federal states tax capital gains as ordinary income. The top state marginal tax rate on capital gains is 13.30% in California and 8.82% in New York. Other states such as Florida and Texas do not tax capital gains.

rates and estimate tax alpha more accurately in exacting tax regimes, we provide simulation results where long-term and short-term capital tax rates are 10% higher (33.8% and 50.8% respectively).

We assume that transaction costs are zero in our backtests. We discuss the consequences of this assumption and report turnover statistics for tax-managed and tax-agnostic strategies in Section IV.

III. Results

General Remarks

We start with some general observations about the loss harvesting behavior of tax-managed index-tracking strategies. The left panel of Figure 2 shows the capital losses realized over the simulation horizon as a percentage of the total losses available for strategies tracking the Russell 1000. We note that the tax-agnostic strategy realizes less than 10% of the portfolio losses in most quarters. In contrast, the tax-managed strategy limiting the predicted tracking error to 50 bps already realizes more than 80% of the available losses most of the time; the two intervals during which this strategy leaves a significant amount of losses unrealized correspond to market downturns at which the portfolio depreciates considerably. Overall, the tax-managed strategies harvest substantially more losses than their tax-agnostic counterpart. Besides realizing more losses, the tax-managed strategies also avoid unnecessary capital gains realizations. This can be observed in the right panel of Figure 2, which shows the unrealized gains as a percentage of the portfolio size for the same strategies. These plots confirm that our tax-managed strategies exhibit the expected loss harvesting behavior.

Figure 2. Time Series of Realized Losses / Total Losses (Left) and Unrealized Gains / Portfolio Size (Right)

Time series of the realized losses as a percentage of the total losses (left) and unrealized gains as a percentage of the portfolio size (right) for strategies tracking the Russell 1000 from March 1990 through June 2020. The label TA indicates the tax-agnostic indexing strategy, while the label TM X bps denotes the tax-managed strategy tracking the Russell 1000 within X bps of ex-ante active risk.





Source: Qontigo, FTSE Russell



In the remainder of this section, we compare the post-tax performance of tax-agnostic and tax-managed indexing strategies in the unlimited external gains and no external gains perspectives. Table 1 reports the annualized pre-tax and post-tax returns of the tax-agnostic strategy under the various simulation settings that will be considered. These results serve as a reference point for the performance of tax-managed strategies. All return and risk values reported in the following discussion are annualized.

Table 1. Annualized Return of the Tax-Agnostic Strategy

Annualized pre-tax and post-tax returns of the tax-agnostic strategy under various simulation settings. Negative cash contributions correspond to withdrawals.

		Unlimited external gains		No external gains	
			Liquidated		Liquidated
	Pre-tax return	Post-tax return	post-tax return	Post-tax return	post-tax return
Base case	9.90%	9.41%	8.82%	9.29%	8.72%
Higher tax rates	ligher tax rates				
r _l =33.8%, r _s =50.8%	9.90%	9.20%	8.33%	9.04%	8.20%
Funding time					
June 2008	9.89%	9.45%	8.28%	9.32%	8.18%
March 2009	1arch 2009 15.19%		12.96%	14.47%	12.95%
Cash contributions					
-1.50% per quarter	9.90%	8.85%	8.14%	8.81%	8.11%
-1.25%	9.90%	8.97%	8.27%	8.93%	8.24%
-1.00%	9.90%	9.08%	8.40%	9.04%	8.36%
-0.75%	9.90%	9.19%	8.52%	9.14%	8.47%
-0.50%	9.90%	9.28%	8.63%	9.22%	8.57%
-0.25%	9.90%	9.35%	8.73%	9.27%	8.65%
0.25%	9.90%	9.46%	8.89%	9.31%	8.77%
0.50%	9.90%	9.49%	8.96%	9.32%	8.82%
0.75%	9.90%	9.51%	9.01%	9.32%	8.85%
Benchmark choice					
Russell 2000	8.70%	7.56%	7.42%	7.46%	7.33%

Source: Qontigo, FTSE Russell

Tax Alpha with Unlimited External Gains

In this section, we compare the post-tax performance of tax-agnostic and tax-managed indexing strategies in the unlimited external gains perspective. Recall that this perspective allows the harvested capital losses to be used immediately each quarter to offset gains of the same character. This provides best-case estimates of tax alpha because the value of the realized losses is not limited by the availability of realized gains. In particular, harvesting more losses improves a strategy's post-tax return even when the strategy does not realize gains itself.

Base Case

We first compare the post-tax performance of tax-agnostic and tax-managed strategies tracking the Russell 1000 from March 1990 through June 2020. Table 1 shows that in this case the tax-agnostic strategy loses 49 bps of its pre-tax return to taxes before liquidation. Its post-tax return drops another 59 bps when the portfolio is liquidated at the end of the simulation. Figure 3.a presents the post-tax active return of tax-managed strategies as a combination of their tax alpha and pre-tax active return according to Equation 6. The horizontal axis of the plot indicates the average realized active risk of these strategies. Loss harvesting generates 58 bps of tax alpha before liquidation for the strategy targeting 10 bps of ex-ante tracking error. As the tax-managed strategies take more active risk, their tax alphas increase, but only up to a point. The strategies limiting the predicted active risk to 25 bps and 50 bps produce 75 bps and 85 bps of tax alpha before liquidation, respectively. Assuming more active risk does not bring any additional tax alpha. This is in line with our observation in the previous section that the tax-managed strategy targeting at most 50 bps of tracking error already harvests most of the available losses (as seen in the left panel of Figure 2).

Liquidation brings a reduction in tax alpha because the tax-managed strategies have more unrealized gains in the portfolio at the end of the simulation (recall the right panel of Figure 2). The tax alphas of the aforementioned strategies limiting the tracking error to 10 bps, 25 bps, and 50 bps drop to 49 bps, 63 bps, and 73 bps after liquidation, respectively.

In general, we do not have any expectation that the tax-managed strategies overperform or underperform the tax-agnostic strategy before taxes. We only expect that their pre-tax active returns are small because the strategies maintain low tracking error to the index. In this setup (and also in others), we observe that the tax-managed strategies yield somewhat higher pre-tax returns than the tax-agnostic strategy as well as positive tax alphas. We discuss the effect of loss harvesting on pre-tax returns in Section IV.

Higher Tax Rates

Our results in the previous subsection assumed capital gains are taxed at the highest federal marginal rates. We now compare the performance of tax-managed and tax-agnostic strategies subject to higher capital gains tax rates (33.8% for long-term and 50.8% for short-term gains). Figure 3.b details the tax alphas achieved by tax-managed strategies in this setting. The tax alphas increase for all active risk levels compared with the base case, indicating that active tax management provides greater value in more exacting tax regimes. The tax-managed strategy targeting at most 25 bps of active risk generates 93 bps of tax alpha before liquidation and 76 bps after liquidation. When the active risk limit is increased to 50 bps, the pre- and post-liquidation tax alphas increase to 105 and 86 bps, respectively.



Figure 3. Tax Alphas of Tax-Managed Russell 1000 Strategies with Unlimited External Gains

Tax alphas and pre-tax active returns of tax-managed strategies tracking the Russell 1000 with unlimited external gains. The horizontal axis measures average realized active risk and is shared in all subplots. All return and active risk values are annualized.











e. Frontier results for the simulation period from March 1990 through June 2020 with 75 bps of cash deposited into the portfolio every quarter.



b. Frontier results for the simulation period from March 1990 through June 2020 with higher tax rates.



d. Frontier results for the simulation period from March 2009 through June 2020.



f. Frontier results for the simulation period from March 1990 through June 2020 with 75 bps of cash withdrawn from the portfolio every quarter.

Source: Qontigo, FTSE Russell



Portfolio Funding Time

For a portfolio starting from cash and experiencing low turnover after its initial constitution, the time that the portfolio is created determines to a large extent the age and cost bases of its tax lots. This can cause significant differences in the capital gains taxes incurred, even between portfolios which perform similar trades at the same time. For instance, two portfolios matching an index exactly can experience different tax liabilities over the same period if they are funded at different times. Furthermore, market downturns are usually good opportunities for harvesting losses, and more often than not, the earlier a market slump occurs in the life of a portfolio, the greater the losses available for harvesting are. A portfolio started shortly before a market downturn can realize substantial short-term losses and boost its post-tax return by offsetting costly short-term gains. Therefore, how much loss harvesting improves a strategy's post-tax return is sensitive to when the portfolio is funded.

To study the effect of portfolio funding time, we consider strategies tracking the Russell 1000 starting from June 2008 and March 2009. As before, the simulations run through June 2020. Figures 3.c and 3.d present the tax alphas of tax-managed strategies launched in June 2008 and March 2009, respectively. We can observe that loss harvesting generates significantly higher tax alphas for a portfolio funded in June 2008 (shortly before the Russell 1000 hit its lowest level in 2008). The tax-managed strategy targeting at most 25 bps of active risk achieves 161 bps of tax alpha, which decreases to 123 bps after the portfolio is liquidated. When the active risk limit is increased to 50 bps, the tax alpha generated goes up to 198 bps before liquidation and 155 bps after. For the largest active risk limit of 100 bps, tax optimization generates an impressive 231 bps of tax alpha. In contrast, the benefit of active tax management is smaller when the portfolio is funded in March 2009, not only in comparison to launching the portfolio in June 2008 but also in comparison to the base case. The tax-managed strategy limiting the active risk to 25 bps produces 51 bps of tax alpha before liquidation and 26 bps after liquidation. This illustrates that the opportunities for loss harvesting in an indexing portfolio are limited when the portfolio is funded at a market nadir.

Cash Contributions and Withdrawals

We now examine the effect of cash flows on tax alpha. Figure 3.e details the tax alphas of the tax-managed Russell 1000 strategies over the period from March 1990 through June 2020 when 75 bps of cash is contributed into the portfolio each quarter. Compared with the base case, the tax-managed strategies generate higher tax alphas. The strategy targeting at most 10 bps of predicted active risk obtains 72 bps of tax alpha, which drops to 62 bps after the portfolio is liquidated. The tax alphas before and after liquidation rise to 90 and 78 bps respectively when the active risk limit is relaxed to 25 bps. Conversely, Figure 3.f shows that the tax alphas decrease from their base-case levels when quarterly cash withdrawals of 75 bps are assumed instead. The strategy limiting the ex-ante active risk to 10 bps generates 44 bps of tax alpha before liquidation and 36 bps after. With a looser active risk limit of 25 bps, the pre- and post-liquidation tax alphas increase to 60 and 49 bps, respectively.

Figure 4 provides a complementary view of the effect of cash contributions by focusing on the tax-managed strategy targeting at most 50 bps of active risk (negative cash contributions correspond to withdrawals). The results show an approximately linear relationship between tax alpha and cash contributions; for every 25 bps of cash contributed to the portfolio quarterly, the tax alpha increases roughly by 5 bps. This is a consequence of the "refreshing" effect of cash contributions on the portfolio composition. Cash contributions increase the flow of new securities into the portfolio, which raises the portfolio's cost basis and proportion of short-term holdings. This facilitates loss harvesting in later periods. In contrast, cash withdrawals require the sale of portfolio holdings and prevent tax-managed strategies from timing the realization of capital gains and losses. Furthermore, the holdings which are sold to meet a withdrawal request are not replaced, which makes it harder to harvest losses in later periods.





Figure 4. Tax Alphas and Cash Contributions with Unlimited External Gains

Tax alphas achieved with various quarterly cash contribution rates and unlimited external gains. The results shown belong to the taxmanaged strategy tracking the Russell 1000 within 50 bps of predicted active risk over the period from March 1990 through 2020.

Source: Qontigo, FTSE Russell

Benchmark Choice

Next, we consider strategies tracking the Russell 2000 from March 1990 through June 2020. Table 1 shows that the tax-agnostic strategy tracking the Russell 2000 loses more of its return to taxes than its counterpart tracking the Russell 1000. The main reason for this difference is the Russell 2000 reconstitution rule: companies whose market cap become too large are removed from the index at periodic reconstitutions. These companies are often the ones whose stock has appreciated in the recent past. Hence, tracking the Russell 2000 closely requires more capital gains realizations than tracking a large-cap index such as the Russell 1000.

Figure 5 plots the tax alphas of tax-managed strategies tracking the Russell 2000. We see that loss harvesting delivers higher tax alphas for strategies tracking the Russell 2000 than for those tracking the Russell 1000 over the same period. The tax-managed strategy targeting less than 50 bps of predicted tracking error with respect to the Russell 2000 generates 232 bps of tax alpha before liquidation. In contrast, the tax alpha for the strategy targeting the same level of tracking error with respect to the Russell 1000 is 85 bps, as we noted earlier. The difference is primarily due to the fact that strategies tracking the Russell 2000 have had greater opportunities to harvest losses in the last 30 years. Indeed, the Russell 2000 has underperformed the Russell 1000 on the basis of annualized average price return over this period, and its cross-sectional price return dispersion has been consistently higher.

Figure 5. Tax Alphas of Tax-Managed Russell 2000 Strategies with Unlimited External Gains

Tax alphas and pre-tax active returns of tax-managed strategies tracking the Russell 2000 from March 1990 through June 2020 with unlimited external gains. The horizontal axis measures average realized active risk with respect to the Russell 2000.



Source: Qontigo, FTSE Russell

Tax Alpha with No External Gains

In this section, we compare the post-tax performance of tax-agnostic and tax-managed indexing strategies with no external gains. Recall that in this perspective the capital losses harvested from a portfolio can be used to offset only the gains realized within the same portfolio and any remaining losses are carried forward. This provides worst-case estimates of tax alpha because the realized losses may need to be carried forward indefinitely or used below their potential value. It also puts a natural bound on the achievable tax alpha because unused losses have no economic value and hence post-tax portfolio return cannot be greater than pre-tax return. In fact, the tax alpha is roughly bounded by the return lost to capital gains taxes by the tax-agnostic strategy because tax-agnostic and tax-managed strategies incur similar liabilities for taxes on dividends received.

Accordingly, in our results below, the main factor driving tax alpha is often the capital gains realized by the taxagnostic strategy rather than the capital losses harvested by tax-managed strategies. Replicating the Russell 1000 exactly is already a tax-efficient strategy in this perspective because the composition of the Russell 1000 changes slowly over time and the companies which are removed from the index at a reconstitution are usually the ones whose stock has depreciated. Therefore, the tax-managed strategies tracking the Russell 1000 can only achieve modest tax alphas with respect to the tax-agnostic strategy. On the other hand, the tax-agnostic Russell 2000 strategy realizes more capital gains and experiences a larger tax drag. This allows the tax-managed strategies tracking the Russell 2000 to capture sizable tax alphas even in the no external gains perspective.



Base Case

We again start with a comparison of the post-tax performance of tax-agnostic and tax-managed strategies tracking the Russell 1000 from March 1990 through June 2020. Figure 6.a presents the tax alphas and pre-tax active returns of tax-managed strategies under the no external gains assumption. Active tax management adds 5 bps of tax alpha before liquidation for the strategy targeting less than 10 bps of active risk. Allowing more tracking error does not increase the tax alpha much. In contrast with our results in the unlimited external gains perspective, the tax alphas go up slightly after liquidation because the tax-managed strategies finish the simulation with more unused realized losses than the tax-agnostic strategy; these losses are used to offset the gains realized when the portfolio is liquidated and reduce the final tax bill.

Higher Tax Rates

Using higher tax rates of 33.8% and 50.8% for long-term and short-term capital gains increases the tax drag on all strategies. Figure 6.b shows how the tax alpha changes as the tracking error to Russell 1000 is increased. The tax alphas are somewhat higher than their base-case levels but still limited. For instance, the tax-managed strategy restricting the predicted active risk to 10 bps obtains 6 bps of tax alpha before liquidation.

Portfolio Funding Time

Launching a strategy shortly before a market downturn creates an opportunity to realize substantial losses early on. When the portfolio is regarded in isolation, these losses are carried forward, allowing even the taxagnostic strategy to keep its capital gains taxes low for many years. Lower tax liabilities for the tax-agnostic strategy mean smaller tax alphas for tax-managed strategies. On the flip side, starting a portfolio during the recovery after a market downturn means that opportunities for harvesting losses are initially limited, resulting in greater tax liabilities for the tax-agnostic strategy and higher tax alphas for tax-managed strategies.

To study the effect of portfolio funding time, we consider strategies tracking the Russell 1000 starting from June 2008 and March 2009 as in our earlier analysis. Figures 6.c and 6.d describe the tax alphas of tax-managed strategies launched in June 2008 and March 2009, respectively. Confirming our observations above, loss harvesting generates lower tax alphas than in the base case for portfolios starting from cash in June 2008. In contrast, tax-managed strategies launched in March 2009 capture higher tax alphas. For example, the strategy targeting at most 10 bps of active risk obtains 13 bps of tax alpha before liquidation. The tax alphas decrease after liquidation because in this case, the tax-managed strategies do not have enough unused realized losses to cover their substantially higher unrealized gains at the end of the simulation.



Figure 6. Tax Alphas of Tax-Managed Russell 1000 Strategies with No External Gains

Tax alphas and pre-tax active returns of tax-managed strategies tracking the Russell 1000 with no external gains. The horizontal axis measures average realized active risk and is shared in all subplots. All return and active risk values are annualized.





c. Frontier results for the simulation period from June 2008 through June 2020.



e. Frontier results for the simulation period from March 1990 through June 2020 with 25 bps of cash withdrawn from the portfolio every quarter.



b. Frontier results for the simulation period from March 1990 through June 2020 with higher tax rates.



d. Frontier results for the simulation period from March 2009 through June 2020.



f. Frontier results for the simulation period from March 1990 through June 2020 with 75 bps of cash withdrawn from the portfolio every quarter.



Cash Contributions and Withdrawals

In the unlimited external gains perspective, cash flows influenced tax alpha primarily through their effect on the losses available for harvesting by tax-managed strategies. When each portfolio is regarded in isolation, the determining factor becomes the effect of cash flows on the tax-agnostic strategy's capital gains realizations. Cash withdrawals require the sale of portfolio holdings and lead to higher capital gains taxes for the tax-agnostic strategy (see Table 1). In contrast, cash contributions reduce its tax burden because fewer capital gains realizations are needed to replicate the Russell 1000 exactly.





Tax alphas achieved with various quarterly cash contribution rates and no external gains. The results shown belong to the tax-managed strategy tracking the Russell 1000 within 50 bps of predicted active risk over the period from March 1990 through 2020.

Source: Qontigo, FTSE Russell

The results of our simulations support these observations. Here we highlight our results for strategies tracking the Russell 1000 from March 1990 through June 2020 while 75 bps of cash is withdrawn from the portfolio every quarter. Figure 6.f demonstrates that the tax alphas of tax-managed strategies are higher than in the base case at all tracking error levels. The strategy targeting less than 10 bps of predicted active risk achieves 17 bps of tax alpha. To complete the picture, Figure 7 shows how the tax alpha of the tax-managed strategy requiring a 50-bp tracking error bound changes as the quarterly cash flow rate is varied. Note that the highest tax alpha of 23 bps is achieved when 1% of the portfolio value is withdrawn from the portfolio every quarter. For larger withdrawal rates, although the tax burden on the tax-agnostic strategy continues to increase, the tax-managed strategy cannot take advantage of this because it is also forced to realize more gains. Hence, the difference between the tax-agnostic and tax-managed strategies starts to diminish. On the other hand, the tax alpha also goes down when cash contributions are considered because regular cash deposits reduce the capital gains taxes paid by the tax-agnostic strategy.

Benchmark Choice

We now turn to strategies tracking the Russell 2000 from March 1990 through June 2020. Figure 8 shows the tax alphas of the tax-managed Russell 2000 strategies. The strategies allowing 10 bps and 25 bps of predicted active risk generate 55 bps and 65 bps of tax alpha before liquidation, respectively. As in our earlier analysis in the unlimited external gains perspective, loss harvesting provides higher tax alphas for strategies tracking the Russell 2000 than for those tracking the Russell 1000. There are two reasons for this. First, strategies tracking the Russell 2000 can harvest more losses. Second, unlike the tax-agnostic Russell 1000 strategy faces a significant tax burden due to capital gains. This allows active tax management to make a meaningful difference because the harvested losses can be used to reduce the taxes associated with tracking the Russell 2000.

Figure 8. Tax Alphas of Tax-Managed Russell 2000 Strategies with No External Gains

Tax alphas and pre-tax active returns of tax-managed strategies tracking the Russell 2000 from March 1990 through June 2020 with no external gains. The horizontal axis measures average realized active risk with respect to the Russell 2000.



Source: Qontigo, FTSE Russell

IV. Discussion

Our results in the previous section demonstrate that active tax management can significantly improve the posttax returns of strategies tracking a broad equity market index when there are sufficient capital gains to offset. This will be the case for an investor who owns multiple taxable investment accounts, some of which realize large amounts of capital gains. Such an investor can reduce her tax burden substantially by harvesting losses as a part of her index-tracking strategy. Furthermore, this tax alpha can be captured while still maintaining low tracking error to the target index; allowing 50 bps of active risk is enough to reap most of the potential benefit. On the other hand, for an investor who does not realize capital gains outside the indexing portfolio, the size of the tax alpha obtained from loss harvesting depends on the capital gains realization characteristics of the benchmark index. The tax alpha is limited for strategies indexed with a broad large-cap index such as the Russell 1000 because the index can be usually matched without realizing significant gains. Loss harvesting can add meaningful tax alpha to a strategy tracking the Russell 2000 even when the investor does not realize capital gains elsewhere.

In the remainder of this section, we highlight some interesting aspects of tax-managed index-tracking strategies and discuss extensions of our results.

Pre-Tax Returns

The tax-managed index-tracking strategies often have small but positive pre-tax active returns in our experiments (see Figure 3). For example, in the base case, the tax-managed strategy tracking the Russell 1000 with less than 50 bps of predicted active risk obtains 15 bps of active return before taxes. The pre-tax active returns of the tax-managed strategies tracking the Russell 2000 are somewhat larger but still within a range consistent with their tracking errors.

Return attribution with the Axioma US Medium-Horizon Equity Factor Risk Model shows that these deviations are primarily due to small active exposures to specific style factors. In particular, the tax-managed portfolios tend to have slightly higher exposures to the Medium-Term Momentum and Profitability factors and lower exposure to Volatility when compared with their benchmark index.14 The increased Medium-Term Momentum exposure is due to the preference of loss harvesting strategies to realize losses on underperforming securities and retain positions which have appreciated. This relationship has been noted previously by Israel and Moskowitz (2012). Similarly, tax-managed strategies tend to overweight Profitability and underweight Volatility because the portfolio positions with the largest gains are often those with high Profitability scores and those with the largest losses usually belong to high Volatility names.

¹⁴ Medium-Term Momentum measures a stock's past performance over the last 250 trading days, with the last 20 trading days progressively down-weighted. Profitability is a composite measure that combines the return-on-equity, return-on-assets, cashflow-to-assets, cashflow-to-income, gross margins, and sales-to-assets descriptors. Volatility measures an asset's relative volatility over the last 125 trading days. For detailed information about these factors, please refer to the Axioma US4 Style Factor Handbook.

Transaction Costs

Despite the fact that transaction costs are not modeled in Equation 3, the tax-managed strategies have low or moderate turnover for most of the simulation period. Table 2 reports the average annualized two-way turnover of strategies tracking the Russell 1000 and Russell 2000 from March 1990 through June 2020. The tax-managed Russell 1000 strategies generate 23-35% annualized two-way turnover on average. The strategies tracking the Russell 2000 trade more because the composition of the index undergoes greater changes. In either case, the transaction costs associated with active tax management would typically be small compared to the tax alphas achievable.

Table 2. Annualized Two-Way Turnover

Average annualized two-way turnover of strategies tracking the Russell 1000 and Russell 2000 from March 1990 through June 2020. The label TA indicates the tax-agnostic indexing strategy, while the label TM X bps denotes the tax-managed strategy using a X-bp tracking error limit.

Index	ТА	TM 10 bps	TM 25 bps	TM 50 bps	TM 75 bps	TM 100 bps
Russell 1000	13.54%	23.31%	28.92%	33.09%	34.50%	34.48%
Russell 2000	47.25%	67.68%	88.20%	102.09%	105.16%	104.54%

Source: Qontigo, FTSE Russell

Ignoring transaction costs in the tax-managed strategies means that selling tax lots at a slight loss can seem preferable to holding the same position. Transaction costs can be easily incorporated into the strategy objective function in Equation 3.¹⁵ This would make the realization of small capital losses less attractive and reduce the turnover of tax-managed strategies.

Dividends

The tax burden of strategies tracking the Russell 1000 is largely due to stock dividends. This suggests reducing dividend income as a potential approach for lowering the tax bill. The effectiveness of this approach has been investigated by Israel and Moskowitz (2012). The authors show that targeting low dividend yield exposure accelerates the realization of capital gains, with the resulting increase in capital gains taxes outweighing the savings from lower dividends. Therefore, managing capital gains is considered a more viable approach for improving post-tax return.

A related question is how loss harvesting affects the dividend income of indexing strategies. We have found in our experiments that the dividends received by tax-agnostic and tax-managed strategies are very similar and the corresponding tax liabilities are approximately equal.



¹⁵ The Axioma Portfolio Optimizer supports linear, convex piecewise linear, and fixed-charge transaction costs as well as some nonlinear market impact functions.

Direct Indexing and ETFs

ETF sponsors are legally obligated to pass through their fund's capital gains and dividends to their shareholders. Even when a shareholder does not trade any ETF shares herself, she can be responsible for capital gains taxes resulting from the fund's transactions. If the fund realizes more capital gains than losses during a tax year, the net long-term and short-term capital gains are distributed to ETF shareholders. On the other hand, the legal structure of ETFs prevents them from distributing capital losses when the realized losses are greater than the gains. This limits the usefulness of ETFs for tax loss harvesting. While most ETF sponsors reduce their capital gains distributions through turnover controls and in-kind transactions, the fact that excess losses cannot be passed through means that at best ETFs do not add to their shareholders' capital gains tax liabilities. In contrast, tax-managed direct indexing strategies provide more opportunities for loss harvesting, and the harvested losses are available for immediate use to reduce the investor's capital gains taxes. This is especially valuable for high-net-worth investors who are subject to high tax rates and hold broad investment portfolios with substantial capital gains realizations. These observations are consistent with the analyses of Geddes and Tymoczko (2019) and Santodomingo and Subkoviak (2020).

Our results in the unlimited external gains perspective can be adapted to illustrate this difference between taxmanaged direct indexing strategies and buy-and-hold ETF strategies. To this end, we use the tax-agnostic indextracking strategy as a proxy for holding an ETF which replicates the same index. In the base case, the taxagnostic Russell 1000 strategy realizes slightly more capital losses than gains before liquidation, and capital gains taxes have a net positive effect on this strategy's pre-liquidation post-tax return. We would expect that holding a Russell 1000 ETF yields a similar pre-liquidation post-tax return over the same period, even if we assumed that the ETF does not distribute any capital gains to its shareholders. Therefore, the tax-managed Russell 1000 strategies would produce pre-liquidation tax alphas that are similar to those in Figure 3.a over holding a Russell 1000 ETF under the conditions of our base case.

V. Conclusion

In this study, we investigated the benefits of active tax management for strategies tracking a broad equity market index. We backtested tax-agnostic and tax-managed indexing strategies tracking the Russell 1000 or Russell 2000 under the current United States tax code. Our results show that an optimization-based approach for tax loss harvesting can provide significant tax alpha while controlling tracking error to the index. For example, using a target tracking error of 25 bps with respect to the Russell 1000, loss harvesting can generate up to 75 bps of annualized tax alpha over a tax-agnostic investment strategy during the period from March 1990 through June 2020. This tax alpha can be fully realized within a broader investment mandate in which the investor realizes sufficiently large capital gains and the losses harvested in the indexing portfolio can be used immediately. We have also examined the robustness of our findings to changes in tax rates, portfolio funding time, and investor cash contributions and withdrawals.

Our analysis demonstrates the value of active tax management as a systematic approach for boosting post-tax returns in taxable accounts. However, tax-managed investing also presents new challenges for asset managers. First, active tax management adds significant mathematical complexity to portfolio construction. To produce the highest returns after taxes, asset managers must strike a careful balance between their pre-tax investment goals and tax goals such as loss harvesting. They must also make more granular decisions regarding trades from individual tax lots. Second, active tax management requires high levels of customization to meet each investor's unique investment and tax circumstances. Tax-aware portfolio optimization enables asset managers to navigate these challenges and deliver the best results for tax-sensitive investors.

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