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TAX-RATE ARBITRAGE: REALIZATION OF LONG-TERM GAINS TO ENABLE SHORT-TERM LOSS HARVESTING

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We look at an enhanced loss-harvesting strategy, tax-rate arbitrage, which exploits the differential between short- and long-term tax rates. In our study, we examine tax-managed strategies over numerous historical periods. For the ideal tax-rate arbitrage investor, one who is subject to the highest federal-only 2020 tax rates, who has a long horizon and a planned liquidation date, and who launches the strategy from all cash, tax-rate arbitrage generated an average of 0.78% in excess after-tax active return at a 10-year horizon relative to a standard loss-harvesting strategy. Other investors with different profiles may benefit from tax-rate arbitrage but typically to a lesser extent.

US law generally requires that capital gains tax be paid only when securities are sold. This mandate has made the delaying of gains realization and methodical harvesting of losses into mainstays of tax-managed investing.[1] The benefits of the former are self-evident, since the realization of gains amounts to an unwanted tax bill. In contrast, loss harvesting is a nuanced practice that may require some discipline, since individual investors tend to be averse to realizing losses.[2] For an investor who has already realized capital gains or expects to have them, loss harvesting may add value by offsetting the tax liability, thereby increasing the after-tax value of those gains. While it may be substantial in some cases, this benefit must be considered against the potential for loss harvesting to increase risk and the complexity of tax law. Consider that losses in a portfolio held within a 401(k) can never be used to offset taxable capital gains.[3] Furthermore, an investor with a stake in a mutual fund or ETF cannot use capital losses from within the fund to offset capital gains arising from a stake in a hedge fund. For this reason, many taxable investors hold separate accounts for the purpose of harvesting losses.[4]

Diverse studies corroborate the potential for loss harvesting in public equity portfolios to be

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beneficial for certain taxable investors.[5] These studies highlight characteristics of loss harvesting that are intuitive and also familiar to the community of investors who practice tax management. For example, the benefits of loss harvesting tend to increase with the size of a portfolio and the volatilities of its constituents. In the same direction, loss harvesting tends to be more valuable in volatile regimes than in calm regimes. Studies that focus on investment horizon, however, such as Goldberg *et al.* (2019b), document a phenomenon that is not often discussed in print, even though it is well known to experienced advisors. Tax-managed equity portfolios have a life cycle, in the sense that opportunities to harvest losses tend to diminish over time. To understand why this is, consider that the ratio of *cost basis*, the purchase price of a security, to market price is an indicator of the potential to harvest losses. Specifically, higher cost basis to market price indicates greater loss-harvesting opportunity. However, rising equity markets and the action of loss harvesting, itself, tend to diminish cost basis relative to purchase price. This *ossification* of a tax-managed portfolio has prompted the development of life-extending enhancements to standard loss harvesting.

In this article, we look at a particular enhanced loss-harvesting strategy, *tax-rate arbitrage*, which exploits the fact that gains on securities held for more than a year are taxed at a lower rate than securities held for a year or less.[6] Tax-rate arbitrage selectively raises cost basis through targeted realization of long-term gains, which potentially increases opportunities to realize short-term losses.[7] Properly calibrated, this strategy may increase tax alpha relative to what is offered in a standard loss-harvesting strategy for specific types of investors.

We carry out an empirical study of the incremental rewards and risks of tax-rate arbitrage benchmarked against a standard loss-harvesting strategy, in which we do not deliberately realize gains. In our study, we measure performance over many different historical periods. By fixing investment horizon and staggering start date, we obtain a range of outcomes for tax-rate arbitrage and standard loss-harvesting strategies, thereby providing investors with a broad understanding of the different strategies' attributes as well as insight into strategy performance in specific historical periods.[8]

To illustrate the importance of customization in tax-managed investing, we examine return and risk profiles of tax-rate arbitrage tailored to investor types varied along three dimensions. We consider the nature of the initial funding by launching portfolios with cash or with ossified securities, where cost basis is (often substantially) below market price. We examine the impact of tax rate by applying federal-only rates, which apply in states with no income tax such as Texas, and California rates, which are higher. Finally, we look at outcomes in the estate/donation disposition, in which taxes are never paid, and the liquidation disposition, in which taxes are paid at horizon end. As emphasized throughout this article, the benefits and risks of tax-rate arbitrage vary across investor types. This variation underscores the importance of investor-specific information, including attributes outside the scope of this article, in determining the appropriate strategy for a taxable investor.[9]

The variation in tax rates from state to state affects the potential benefits of tax management. Specifically, the value of tax-rate arbitrage increases with the Tax-Rate Differential, which is the ratio of short-term to long-term tax rates minus one. Using 2020 tax rates, this means that the strategy tends to be more valuable in Texas, where the ratio is $(40.8/23.8)-1 = 0.71$, than in California, where the ratio is $(54.1/37.1) - 1 = 0.46$, even though standard loss harvesting is more valuable in California due to the higher absolute rates. Furthermore, while applying the tax-rate arbitrage strategy to an ossified portfolio has often been beneficial, the incremental value of the strategy appears to be greater when we apply it at inception to a cash-funded portfolio. It follows that an investor who anticipates short-term gains may want to apply tax arbitrage as early as possible.[10]

The viability of tax-rate arbitrage depends on an ample supply of realized short-term gains that require offsetting. For example, losses harvested from a tax-rate arbitrage strategy might be used to offset short-term capital gains from an investment in a hedge fund. The gains that require offsetting are almost always outside the tax-rate arbitrage strategy, since short-term gains are almost never realized in a tax-managed portfolio.[11] Also important is a horizon of at least three years, and likely longer for many types of investors, since the up-front cost of realizing long-term gains precedes the benefits that may accrue from the opportunity to harvest associated short-term losses. The strategy tends to work best for an investor who plans to liquidate, rather than donate or bequeath the securities in the portfolio. This advantage stems from the relatively high cost basis exhibited by tax arbitrage strategies at the investment horizon's end.[12]

Tax-rate arbitrage contains a particular downside risk that a candidate investor should note. Consider a scenario where a tax-rate arbitrage investor realizes a long-term gain on a stock and reinvests the proceeds in the same stock in the hope of realizing a short-term loss. If the price of the stock stays flat or rises over the subsequent year, there is no payoff to the up-front cost, even if the investor has ample short-term gains that require offsetting. In practice, we realize long-term gains on multiple stocks at multiple times in a tax-rate arbitrage strategy. Some of these realizations may lead to short-term loss-harvesting opportunities while others may not. A market move, however, can lead to correlated returns to tax-rate arbitrage across stocks at a point in time. While the up-front cost of tax arbitrage has typically been rewarded in the past, this outcome is not guaranteed, and tax arbitrage investors need to be aware of the possibility of less favorable outcomes. This downside risk is not present in standard loss-harvesting strategies.[13]

1 Evaluating Tax-Managed Equity Strategies

We describe a framework for evaluating historical performance of tax-managed equity strategies at different time horizons and over different periods. To elucidate the life cycle of these strategies, we consider outcomes at horizons of 3, 5, and 10 years. To mitigate the effect of period dependence on results, we launch each strategy on a quarterly basis within the long horizon of data that runs from June 1995 through March 2020. This yields multiple outcomes for each strategy/horizon combination in different market regimes. For example, we obtain 60 outcomes of a cash-funded strategy at a 10-year horizon by launching at three-month intervals beginning in June 1995 and ending in March 2010.

Unlike a cash-launched strategy, the initial state of a strategy launched from securities can vary with consequences for loss-harvesting potential.[14] In this study, we manufacture ossified portfolios by harvesting losses in a cash-launched portfolio, as detailed in Appendix A, and the output is used to launch an ossified strategy.[15] Since the ossification process consumes five years of data, we have 20 fewer outcomes for ossified portfolios than for portfolios launched with all cash, as summarized in Table 1.

Of course, an investor's tax rates materially affect the value of loss harvesting. In this article, we consider two tax regimes. We look at the highest

Table 1 Numbers of outcomes for each strategy at each horizon.

Count/horizon	3 Years	5 Years	10 Years
Cash-launched	88	80	60
Ossified	68	60	40

Table 2 Tax-rate scenarios.

	Short-term rate	Long-term rate
Federal only	40.8%	23.8%
California	54.1%	37.1%

federal-only and California rates that were set in 2018 and still hold in 2020. The values are specified in Table 2.

Throughout this article, we measure strategy performance for a taxable investor with after-tax active return (ATAR), which is the return difference between a portfolio and its benchmark after tax.

$$\text{ATAR} = \text{P(after tax)} - \text{B(after tax)}.$$

2 The Loss-Harvesting Life Cycle and Path Dependency

Before we explore tax-rate arbitrage, we review the return and risk profile of a standard tax-managed equity strategy: a cash-funded loss-harvesting portfolio that tracks a diversified index. Losses in a portfolio of this type are generally abundant at first, even in rising markets,[16] and tracking error (TE) has typically been low. Over time, however, losses become scarcer and tracking error drifts upward as loss-harvesting drives cost basis down. Rising prices amplify these effects.

2.1 Figure 1 summarizing results of all available outcomes for given horizons

Figure 1 shows outcomes at 3-, 5-, and 10-year horizons. We display the distributions of outcomes in box plots, which show the full range of outcomes at each horizon obtained by staggering start date. The white line in each box is the median outcome, and the dot marks the average. The top and bottom of each box correspond to the 75th and 25th percentiles, respectively, and horizontal black lines mark the maximum and minimum outcomes.

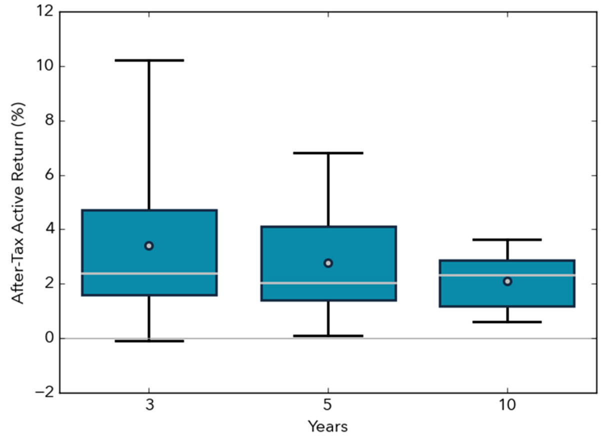
The results show that annualized after-tax active return tended to decline as horizon length increased.[17] At the same time, outcomes became more compressed and also less skewed. This outcome is consistent with numerous studies that we have performed, varying strategy, benchmark, time frame, and horizon.[18] One of the main sources of the decline in after-tax active return with horizon is the tendency for cost basis on a typical tax lot to be considerably lower than market price in mature, tax-managed strategies. As we demonstrate below, tax-rate arbitrage mitigates this decline by strategically elevating cost basis (of selected tax lots).

3 Implementing Tax-Rate Arbitrage

We sketch our implementation of a tax-rate arbitrage strategy, which proceeds in two steps. In the first step, we select suitable tax lots with unrealized long-term gains and sell them, thereby realizing long-term gains. In order to qualify as a long-term gain, a lot must be older than 365 days. In addition, we ask that a gain be shallow, meaning that the market price is not too high relative to cost basis. In what follows, we make this notion precise with an investor-specific formula that determines exactly which tax lots to realize. The qualitative characteristics that make a lot suitable for realization are summarized in Table 3.

The lot selection process is specified in terms of:

$$\text{Lot Appreciation} = \text{P/C} - 1,$$



	3 Years	5 Years	10 Years
Maximum	10.21	6.81	3.64
75th percentile	4.71	4.10	2.86
Median	2.40	2.04	2.33
Average	3.41	2.78	2.10
25th percentile	1.61	1.40	1.19
Minimum	−0.10	0.11	0.61

Figure 1 Distributions of estate/donation annualized after-tax active return for hypothetical standard loss-harvesting portfolios launched from cash using federal-only tax rates. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 3 Characteristics of tax lots that are suitable for long-term-gain realization.

Lot characteristic	Benefit
Shallow	Minimizes up-front tax cost
High volatility	Elevates the likelihood that replacement securities will be volatile, which is favorable for future loss harvesting

where P is price and C is cost basis. We harvest a long-term gain for every lot that satisfies:

$$\text{Lot Appreciation} < \text{Security Scalar},$$

where the Security Scalar is a dynamic threshold that depends on market regime, lot volatility, investor type, and in some cases, age of strategy. The Security Scalar is central to effective tax-rate arbitrage, and it is specified in Appendix B.

We set Security Scalar to be higher in more turbulent periods, when the value of aggregate short-term losses is likely to be higher than usual. With the same sort of reasoning, we set the Security Scalar to be higher for tax lots of more volatile securities. When there is a definite plan to liquidate the portfolio, we set the Security Scalar to be higher, since the elevated cost basis that results from tax arbitrage lowers liquidation impact. For an ossified portfolio, it is beneficial to begin with a lower Security Scalar and then increase, in order to avoid extensive gain realization at strategy inception. Finally, we set the Security Scalar to be higher when the Tax-Rate Differential is higher.

In the second step, we deposit the cash generated by selling the selected tax lots into the portfolio, which we then run through a standard factor-based, loss-harvesting optimization.[19] Further details are in Appendix C.

Figure 2 provides a first look into the difference in results between hypothetical tax-rate arbitrage and standard loss-harvesting portfolios. In the top panel, we show average net short-term losses harvested each year in the two strategies for cash-launched portfolios in the estate/donation disposition and the federal-only tax regime. In the bottom panel, we do the same for long-term losses. In the standard strategy (blue bars), average net short- and long-term losses were uniformly positive, there were many more short-term losses than long-term losses, and both types of losses declined consistently as the portfolio aged. In the tax-rate arbitrage strategy (orange bars), the more valuable short-term losses were positive and declined relatively slowly, on average, and even though long-term losses were negative, the effect was more than offset by the more copious and more valuable short-term losses. Figure 2 rightly suggests that tax-rate arbitrage can be viewed as levered loss harvesting.

4 Assessing the Effect of Tax-Rate Arbitrage

We measure excess return of a tax-rate arbitrage strategy relative to a standard loss-harvesting

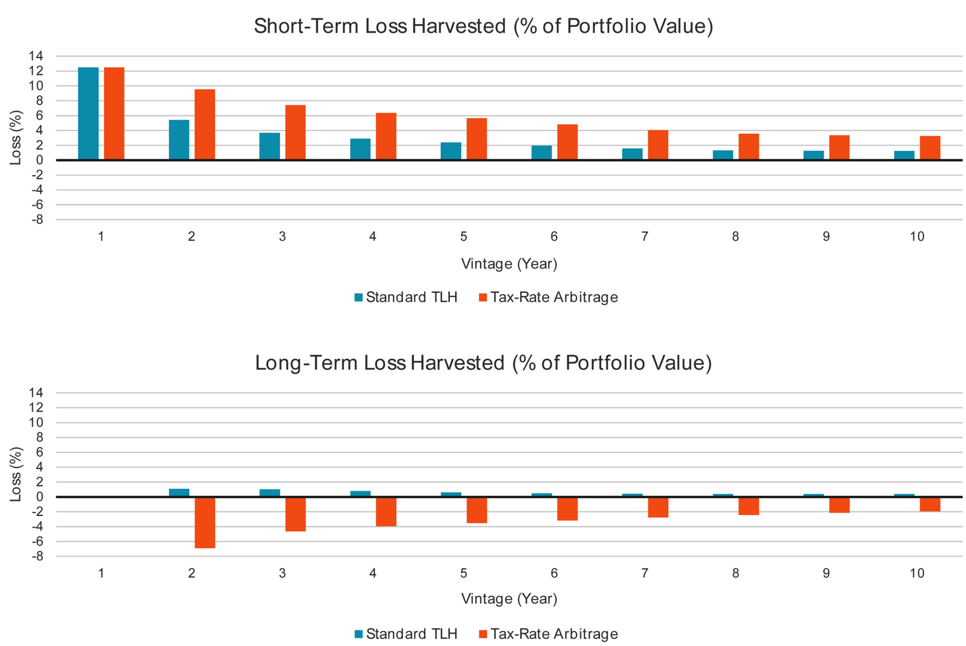


Figure 2 Hypothetical standard loss-harvesting and tax-rate arbitrage portfolios in the estate/donation disposition and the federal-only tax regime launched from cash. Top panel: Average net short-term loss as a percentage of portfolio value. Bottom panel: Average net long-term loss as a percentage of portfolio value. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 1995–March 2020.

strategy by:

$$\text{Tax Arbitrage Value Added} = \text{Return}_{\text{Tax Rate Arbitrage}} - \text{Return}_{\text{Standard Loss Harvesting}}.$$

We calculate tax arbitrage value added (TAVA) for after-tax active return. We also calculate TAVA for tax alpha, which is the component of after-tax active return that comes from harvesting losses.

We report realized tracking error for both standard and tax-rate arbitrage strategies, as well as Incremental Risk due to tax-rate arbitrage:

$$\text{Incremental Risk} = \text{TE\_tax-rate-arbitrage} - \text{TE\_standard-loss-harvesting}.$$

The risk profiles of standard loss-harvesting and tax arbitrage strategies tend to diverge over time. In this study, we calibrate our strategies so that the median 10-year forecast tracking error of the tax-rate arbitrage enhanced strategy and the standard strategy match. Because of differences in turnover in the two strategies, our calibration virtually guarantees that median forecast tracking errors will not match at horizons that are shorter (or longer) than 10 years.

5 Empirical Study

As in the analysis of the loss-harvesting life cycle, we quantify the impact of tax-rate arbitrage on loss harvesting at 3-, 5-, and 10-year horizons.

All of our strategies are constructed by minimizing forecast tracking error to the Russell 1000 benchmark while harvesting losses. The mathematical details are in Appendix C. In a tax-rate arbitrage strategy, the minimization step is preceded by gain realization, as described above.

6 Results

Below, we separately review the benefits of tax-rate arbitrage to after-tax active return outcomes for portfolios launched from cash and for ossified portfolios. We evaluate results across various time frames, tax regimes, and dispositions.

6.1 After-tax active return: portfolios launched from cash

We look first at the value that tax-rate arbitrage added to after-tax active return for portfolios launched from cash. At a 10-year horizon, tax arbitrage value added was positive, on average, in both the estate/donation and liquidation dispositions, and under both fed-only and California scenarios.

Relative to a standard loss-harvesting strategy, additional basis resetting from tax-rate arbitrage elevated cost basis and thus lowered liquidation impact, leading to a higher average TAVA in the liquidation disposition than in the estate/donation disposition. This effect is present in both tax-rate scenarios.

For both the estate/donation and liquidation dispositions, average TAVA was higher in the federal-only scenarios than in the California scenarios. This is because tax-rate arbitrage return depends on the Tax-Rate Differential, which is 0.71 in the fed-only scenario and 0.46 in the California scenario. An option-theoretic perspective on this point is in Appendix D.

We expand on the results in Table 4 in two ways. First, we look at the time evolution of after-tax active return by adding TAVA averages at the 3- and 5-year horizons to the 10-year horizon results. Table 5 shows that average TAVA tended to increase with term. This makes sense, in light of the up-front costs associated with tax arbitrage. The most extreme manifestation of term dependence of TAVA was at the three-year horizon for

Table 4 Average TAVA, tax arbitrage value added to annualized after-tax active return for hypothetical portfolios launched from cash at a 10-year horizon. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Disposition	Tax regime	Standard after-tax active return	Average TAVA
Estate/ donation	Fed	+2.10%	+0.24%
Estate/ donation	CA	+2.88%	+0.18%
Liquidation	Fed	+1.21%	+0.78%
Liquidation	CA	+1.41%	+0.52%

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 5 Term structure of TAVA, average tax arbitrage value added to annualized after-tax active return for hypothetical portfolios launched from cash. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Disposition	Tax rate	3 Years	5 Years	10 Years
Estate/ donation	Fed	−0.12%	+0.07%	+0.24%
Estate/ donation	CA	0.00%	+0.10%	+0.18%
Liquidation	Fed	+0.15%	+0.50%	+0.78%
Liquidation	CA	+0.19%	+0.42%	+0.52%

Benchmark: Russell 1000 Index. June 1995–March 2020.

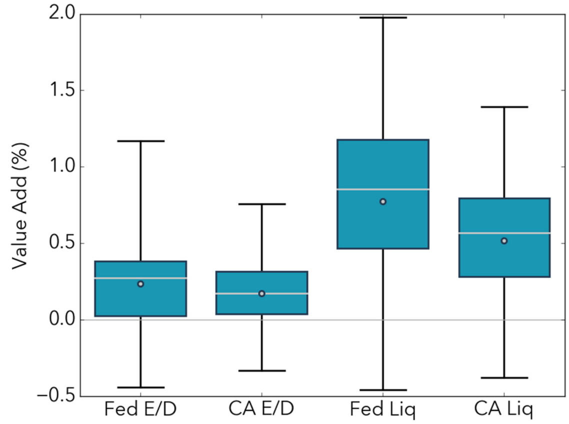
estate/donation fed-only after-tax active return, which was negative. More generally, tax-rate arbitrage appears to be suitable only for a long-term investor, as the benefits of tax-rate arbitrage are less pronounced in the earlier years of the strategy.

Next, in Figure 3, we look at the distributions of 10-year TAVA in the estate/donation and liquidation dispositions for the fed-only and California tax regimes. TAVA was positive at the 25th percentile in all four cases. The negative values of TAVA at the bottoms of the distributions shown in Figure 3 reflect the downside risk mentioned in the Introduction. There are scenarios in which the up-front cost of realizing long-term gains is not rewarded with the opportunity to harvest short-term losses. Scenarios launched just after the 2008–2009 global financial crisis had the lowest TAVA, as a result of calm, upward-trending markets following that event. The highest-TAVA scenarios were launched just prior to the bursting of the dot-com bubble in 2000. The calm, upward trend of the market between the dot-com crisis and the global financial crisis facilitated abundant long-term gain realization, which elevated cost basis. The market turbulence in the summer of 2007 and in 2008 allowed loss-harvesting algorithms to transform the elevated cost basis into short-term losses.

6.2 *After-tax active return: ossified portfolios*

Some investors fund a tax-rate arbitrage strategy with legacy securities. Others may embark on a standard loss-harvesting strategy and then switch to tax arbitrage. In either case, we use an ossified portfolio, for which cost basis is less than market price, to launch tax arbitrage. Ossified portfolios can be very different from one another, so a single analysis cannot give a complete picture of long-term performance. Still, we can begin to gauge the impact of legacy positions on tax-rate arbitrage strategies by considering some examples. In the analysis described below, with results shown in Table 6, we generate hypothetical ossified portfolios to launch our strategies with the process described in Appendix A. We describe the metrics we use to quantify ossification in Appendix E.

Average after-tax active return TAVA for ossified portfolios at a 10-year horizon was positive in all four cases we considered. As we can see, however, by comparing Tables 4 and 6, ossification cut average TAVA for after-tax active return at a



	Tax arbitrage value added			
	Estate/donation		Liquidation	
	Fed	CA	Fed	CA
Maximum	+1.17%	+0.76%	+1.98%	+1.39%
75th percentile	+0.39%	+0.32%	+1.18%	+0.80%
Median	+0.27%	+0.17%	+0.86%	+0.57%
Average	+0.24%	+0.18%	+0.78%	+0.52%
25th percentile	+0.02%	+0.04%	+0.47%	+0.28%
Minimum	−0.44%	−0.33%	−0.46%	−0.38%

Figure 3 Distributions of TAVA, tax arbitrage value added to annualized after-tax active return at a 10-year horizon for hypothetical portfolios launched from cash. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 6 Average TAVA, tax arbitrage value added to annualized after-tax active return for hypothetical ossified portfolios at a 10-year horizon. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Disposition	Tax regime	Standard after-tax active return	Average TAVA
Estate/donation	Fed	0.93%	+0.08%
Estate/donation	CA	1.27%	+0.09%
Liquidation	Fed	0.15%	+0.48%
Liquidation	CA	−0.06%	+0.24%

Benchmark: Russell 1000 Index. June 2000–March 2020.

10-year horizon by at least 38% in the four cases considered.

At shorter horizons of three and five years, average TAVA for after-tax active returns was inconsequential in the estate/donation disposition but substantial in the liquidation disposition. The impact of ossification on after-tax active return TAVA was less pronounced at shorter horizons, as shown by comparing Tables 5 and 7.

The box plots shown in Figure 4 indicate that at a 10-year horizon, roughly three-quarters of our outcomes showed positive TAVA for after-tax active return when strategies were launched

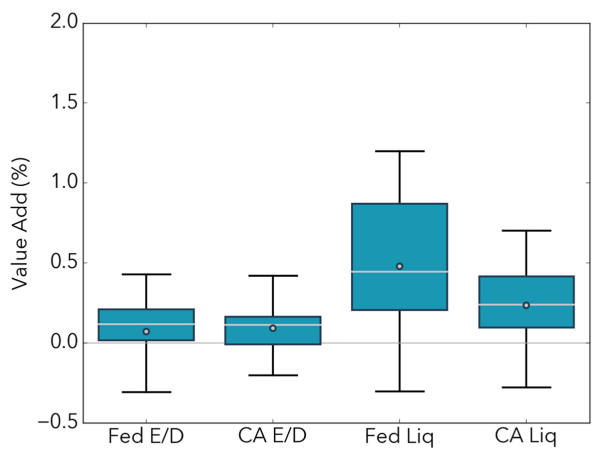
Table 7 Term structure of TAVA, average tax arbitrage value added to annualized after-tax active return for hypothetical ossified portfolios. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Disposition	Tax rate	3 Years	5 Years	10 Years
Estate/ donation	Fed	−0.08%	–0.01%	+0.08%
Estate/ donation	CA	−0.03%	+0.04%	+0.09%
Liquidation	Fed	+0.22%	+0.32%	+0.48%
Liquidation	CA	+0.19%	+0.22%	+0.24%

Benchmark: Russell 1000 Index. June 2000–March 2020.

from ossified portfolios. As in the cash-launched case shown in Figure 3, the negative values of TAVA at the bottoms of the distributions shown in Figure 4 reflect downside risk of tax-rate arbitrage for ossified portfolios.

The results in this section show that tax-rate arbitrage tended to offer superior returns relative to standard loss harvesting in 10-year ossified strategies, although the benefits were lower than in cash-only strategies. This suggests that an all-cash investor interested in the extra loss-harvesting capacity that tax arbitrage can provide may want to begin the process at inception.



	Tax arbitrage value added			
	Estate/donation		Liquidation	
	Fed	CA	Fed	CA
Maximum	+0.43%	+0.42%	+1.20%	+0.71%
75th percentile	+0.21%	+0.17%	+0.87%	+0.42%
Median	+0.12%	+0.12%	+0.45%	+0.24%
Average	+0.08%	+0.09%	+0.48%	+0.24%
25th percentile	+0.02%	−0.01%	+0.21%	+0.10%
Minimum	−0.30%	−0.20%	−0.30%	−0.28%

Figure 4 Distributions of TAVA, tax arbitrage value added to annualized after-tax active return at a 10-year horizon return for hypothetical ossified portfolios. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 2000–March 2020.

6.3 Decomposing after-tax active return

We can express after-tax active return (ATAR) as a sum of pre-tax active return (PTAR) and tax alpha (TA):

$$\text{ATAR} = \text{PTAR} + \text{TA}.$$

We look at the impact of tax arbitrage on these components of tax alpha in both the estate/donation and liquidation dispositions for a cash-launched portfolio in the fed-only tax regime.

Table 8 suggests that tax-rate arbitrage created a pre-tax drag, on average. In the estate/donation disposition, roughly one-third of the additional 0.11% in pre-tax drag in the tax-rate arbitrage strategy was due to trading costs.

At the same time, tax-rate arbitrage added value in our hypothetical strategy, on average, to tax alpha by making it easier to harvest short-term losses. A measure of the enhancement is *short-term basis*, which is the dollar value of the basis of short-term positions divided by the market value of the portfolio.[20]

Table 8 Decomposition of average annualized after-tax active return of hypothetical cash-launched portfolios in the estate/donation and liquidation dispositions and federal-only tax regime at a 10-year horizon. Results are gross of fees and assume a round-trip trading cost of 0.08%.

	After-tax active return	Pre-tax active return	Tax alpha
Estate/donation			
Standard TLH	2.10%	−0.12%	2.22%
Tax-rate arbitrage	2.34%	−0.23%	2.57%
TAVA	+0.24%	−0.11%	+0.35%
Liquidation			
Standard TLH	1.21%	−0.12%	1.33%
Tax-rate arbitrage	1.99%	−0.36%	2.35%
TAVA	+0.78%	−0.24%	+1.02%

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 9 Average short-term basis for hypothetical cash-launched portfolios in the estate/donation disposition and fed-only tax regime at 3-, 5-, and 10-year horizons. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Short-term basis (%)	3 Years	5 Years	10 Years
Standard TLH	16.5	10.4	5.7
Tax-rate arbitrage: estate/donation	45.8	34.5	18.9
Tax-rate arbitrage: liquidation	74.3	69.5	59.1

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 9 shows the increase in short-term basis due to tax-rate arbitrage at 3-, 5-, and 10-year horizons. Relative to the estate/donation disposition, the higher Security Scalar in the liquidation disposition appears to lead to more trading and a higher short-term basis.

To conclude this section, we look year by year at the average value of harvested losses in the hypothetical standard loss-harvesting and tax-rate arbitrage strategies in Figure 5. By construction, the values are the same in the first year. In the second year, the standard strategy outperformed, on average, since long-term gains were deliberately realized in the tax-rate arbitrage strategy. Also in year 2, the estate/donation version of tax-rate arbitrage outperformed the liquidation version, in which a higher Security Scalar allowed for greater gain realization. The trend reversed over time, with the liquidation version of tax-rate arbitrage delivering the highest tax alpha in year 10, as the up-front investment in long-term gain realization paid off, on average. This underscores the preference need for a tax-rate arbitrage investor to have a relatively long horizon in order to potentially benefit from the strategy.

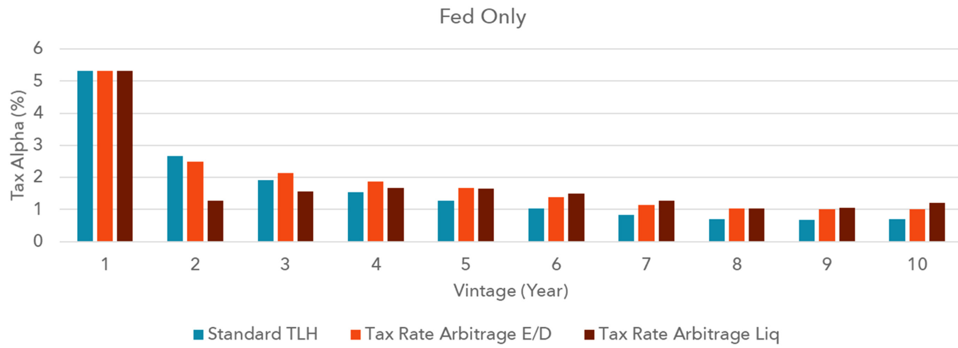


Figure 5 Average value of harvested losses per year in hypothetical standard loss-harvesting and tax-rate arbitrage strategies. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 1995–March 2020.

Table 10 Average liquidation impact at the end of the 10-year horizon in hypothetical standard loss-harvesting and tax-rate arbitrage strategies. Results are gross of fees and assume a round-trip trading cost of 0.08%.

Liquidation impact (%)	10 Years
Standard TLH	−14.7
Tax-rate arbitrage: liquidation	−8.8

Benchmark: Russell 1000 Index. June 1995–March 2020.

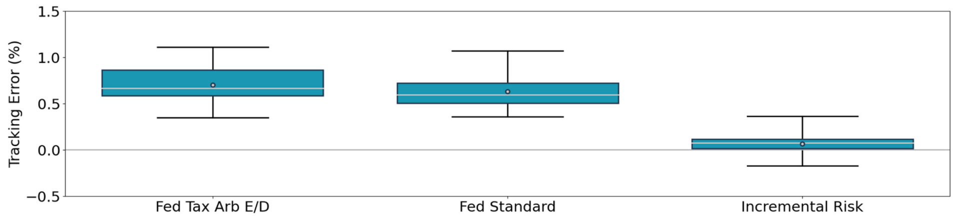
As shown in Table 10, the tax liability at the end of the 10-year horizon was greater, on average, in the standard strategy than in the liquidation version of the tax-rate arbitrage strategy, as a result of the cost basis elevation that arises from realization of capital gains.[21]

6.4 Risk

In the previous sections, we looked at how tax-rate arbitrage affects after-tax return in a loss-harvesting strategy. Here, we focus on risk, as measured by realized tracking error between our strategies and their benchmarks. The downside risk associated with the realization of long-term gains that are not converted to short-term losses is quantified as negative TAVA, and shown in Figures 3 and 4.

To begin, we mention two observations that affect strategy calibration. All else equal, tax-rate arbitrage tends to increase turnover, which leads to lower tracking error. Consequently, calibrating a standard loss-harvesting strategy and a tax-rate arbitrage strategy to have the same average forecast tracking error at one horizon necessarily means that the average forecast tracking errors of the two strategies must differ at other horizons. Our second consideration is that the forecast tracking error of an optimized portfolio tends to be biased downward.[22] This means that over many periods, realized tracking error tends to be higher than forecast tracking error. In this study, we calibrate our cash-launched tax-rate arbitrage strategy to have an average forecast tracking error at a 10-year horizon of 0.65%, which matches the average forecast tracking error at a 10-year horizon for our standard strategy. We use the same calibration for our ossified strategies.

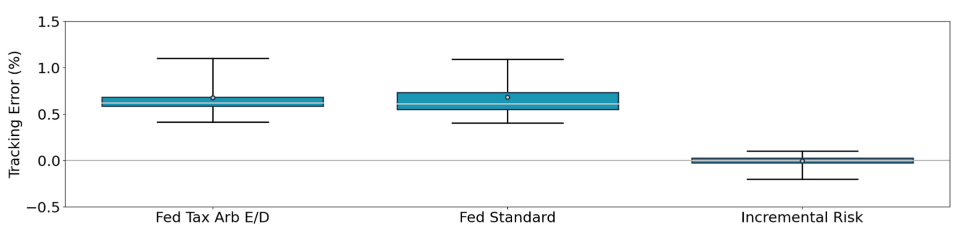
Distributions of realized tracking errors of our cash-launched strategies for the estate/donation fed-only strategies at a 10-year horizon are shown in Figure 6. Tax arbitrage tended to slightly



	Fed tax arbitrage	Fed standard	Incremental Risk
Maximum	1.11	1.07	0.36
75th percentile	0.86	0.73	0.12
Median	0.67	0.60	0.08
Average	0.70	0.64	0.07
25th percentile	0.59	0.51	0.02
Minimum	0.35	0.36	–0.17

Figure 6 Distributions of annualized realized tracking error and Incremental Risk for hypothetical standard estate/donation fed-only loss-harvesting and tax-rate arbitrage strategies at a 10-year horizon for cash-launched portfolios. Results are gross of fees and assume a round-trip trading cost of trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 1995–March 2020.



	Fed tax arbitrage	Fed standard	Incremental Risk
Maximum	1.10	1.09	0.10
75th percentile	0.68	0.73	0.03
Median	0.62	0.61	0.00
Average	0.68	0.68	–0.00
25th percentile	0.59	0.55	–0.02
Minimum	0.41	0.41	–0.20

Figure 7 Distributions of annualized realized tracking error and Incremental Risk for hypothetical standard estate/donation fed-only loss-harvesting and tax arbitrage strategies at a 10-year horizon for ossified portfolios. Results are gross of fees and assume a round-trip trading cost of trading cost of 0.08%.

Benchmark: Russell 1000 Index. June 2000–March 2020.

increase both the level and dispersion of realized tracking error of loss-harvesting strategies, which can be explained by our calibration scheme.[23] Results are qualitatively similar for California and liquidation strategies. The results presented in Figure 7 are for ossified strategies, where tax-rate arbitrage lowered both the level and dispersion of realized tracking error. As for the comparison in the cash-launched study, this outcome is a result of our calibration.[24] Again, the results are qualitatively similar for California and liquidation strategies. Note that the final columns in Figures 6 and 7 show the distributions of scenario Incremental Risk, so we do not expect the values at different quantiles to be differences of the previous two columns.

7 Conclusion

We have explored the incremental rewards and risks of tax-rate arbitrage, the targeted realization of long-term gains in a loss-harvesting strategy. In our study, we generate historical outcomes over numerous periods, thereby providing a broad perspective on how tax-managed strategies have performed, and allowing us to tailor our analysis to different types of investors.

We found that while many long-horizon investors with an ample supply of short-term gains may benefit from tax-rate arbitrage, the ideal candidate for this strategy is an investor who plans to liquidate at horizon end, has a high Tax-Rate Differential, and implements the strategy at inception in a cash-funded portfolio. At the same time, it is important to keep in mind that the up-front cost of tax-rate arbitrage leads to risks that are not present in standard loss-harvesting strategies. The impact of tax-rate arbitrage depends crucially on both market forces and the way in which the strategy is calibrated. For tax-rate arbitrage, as for virtually every other tax-management tool, one size does not fit all.

Appendix A: Generating hypothetical ossified portfolios

In this study, we construct an ossified portfolio to launch a strategy turning the clock back five years from our target start date. We launch a standard, loss-harvesting strategy on this earlier date, and the result after five years is the starting portfolio for an ossified portfolio run. Because we dedicate some of our data to generating ossified portfolios, the time period for the empirical study of ossified portfolios begins later, in June 2000, than for the study of our cash-launched portfolios, which begins in June 1995.

Appendix B: Security Scalar

In any period, the selection of tax lots for long-term gains for realization is defined in terms of the Security Scalar, a dynamic threshold that depends on market regime, lot volatility, investor type, and in some cases, age of strategy. An important component of the Security Scalar is the Tax-Rate Differential (TRD), defined:

$$\text{TRD} = \frac{\text{ST Rate}}{\text{LT Rate}} - 1.$$

In mathematical terms,

$$\begin{aligned}&\text{Security Scalar}\\ &\quad = \text{disposition constant}\\ &\quad\quad \times \frac{\text{tax rate differential}}{\text{default differential}}\\ &\quad\quad \times \frac{\text{security vol}}{\text{long-term market vol}}\end{aligned}$$

where:

$$\begin{aligned}&\text{default differential}\\ &\quad = \text{fed-only tax rate differential}\end{aligned}$$

In our empirical study, we set the disposition constant to be 0.25 for estate/donation portfolios and 0.50 for liquidation investors. This choice leads to a higher Security Scalar, and hence greater gain realization, for liquidation investors, for whom the impact of cost basis at the end of the investment horizon is salient. These values can be tuned to individual investor needs. A higher Tax-Rate Differential also leads to a higher Security Scalar. The positive relationship between the value of tax arbitrage and Tax-Rate Differential is derived in Appendix D. It makes sense, therefore, to allow more gain harvesting (by raising the Security Scalar) when the Tax-Rate Differential is higher. Finally, its positive dependence on individual security volatility elevates the Security Scalar in more volatile markets and for more volatile securities. We set the long-term market volatility to be 22% per year, which was the average month-end forecast volatility of the S&P 500 Index of the past 10 years.

We illustrate the effect of the Security Scalar with a hypothetical example based on California tax rates. We set the disposition constant to 0.25 and the long-term market volatility to 22%. Our example focuses on six long-term tax lots with unrealized gains in a hypothetical estate/donation portfolio. Tax lots 1 and 2 belong to low-volatility security ABC. We set ABC's volatility close to long-term market volatility, as is typical in financial markets.[25] Tax lots 3 and 4 correspond to medium-volatility security DEF. Tax lots 5 and 6 correspond to security XYZ, which is highly volatile.

The Security Scalar for ABC lots 1 and 2 is relatively low, primarily due to ABC's low volatility. A lower Security Scalar discourages gain realization, and that is desirable for lower-volatility lots since they are less likely to generate short-term losses. For DEF Tax lots 3 and 4, the Security Scalar is lower than the disposition constant, despite DEF's volatility being higher than long-term market volatility. This is because California rates are less favorable than federal only for tax-rate arbitrage. The reason for this dynamic is discussed in Appendix D. The Security Scalar for XYZ Tax lots 5 and 6 is large due to XYZ's high volatility, encouraging the realization of long-term gains.

Table 11 Top panel: Settings for our hypothetical example. Bottom panel: Security Scalars, Lot Appreciations, and their components for tax lots 1–6.

Disposition constant	0.25		
Long-term market vol.	22%		
Example ST rate	54.1%	Fed ST rate	40.8%
Example LT rate	37.1%	Fed LT rate	23.8%

Lot number	Security	Age of lot (days)	Long-term market vol.	Security volatility	Security Scalar	Basis	Price	Lot Appreciation	Liquidate lot to take gains?
1	ABC	400	22%	21%	15%	$10	$15	50%	No
2	ABC	500	22%	21%	15%	$14	$15	7%	Yes
3	DEF	400	22%	31%	23%	$39	$50	28%	No
4	DEF	500	22%	31%	23%	$45	$50	11%	Yes
5	XYZ	400	22%	75%	55%	$105	$180	71%	No
6	XYZ	500	22%	75%	55%	$125	$180	44%	Yes

As shown in Table 11, the long-term gains in Tax lots 1, 3, and 5 were too large to be realized in a tax-rate arbitrage strategy, since their Lot Appreciations exceeded their Security Scalars. In contrast, long-term gains for Tax lots 2, 4, and 6 were realized in the hope of harvesting short-term losses.

Appendix C: Objective for standard loss harvesting

Our standard loss-harvesting strategy minimizes a weighted sum of squared tracking error and transactions costs while seeking capital losses. Mathematically, the objective function is given by:

$$\begin{aligned} f(h) = (h - h_B)^T (\lambda_D D \\ + \lambda_F X F X^T)(h - h_B) \\ + \lambda_{TC} TC(h, h_0) \\ + \lambda_T T(h, h_0, r_{ST}, r_{LT}) \end{aligned}$$

where,

λ_F	Common factor risk aversion
λ_D	Specific risk aversion
λ_{TC}	Transaction cost multiplier
λ_T	Tax multiplier
h	Portfolio holding weights
h_0	Initial portfolio weights
h_B	Benchmark holding weights
D	Specific covariance matrix
F	Factor covariance matrix
r_{ST}	Short-term tax rate
r_{LT}	Long-term tax rate
$TC(h, h_0)$	Transaction cost function
$T(h, h_0, r_{ST}, r_{LT})$	Tax liability function

Appendix D: Valuing tax-rate arbitrage and its relationship with the Tax-Rate Differential

Suppose an investor realizes a long-term capital gain at tax rate L and immediately reinvests the proceeds of the sale in a stock with the hope of realizing a short-term capital loss at tax rate S. If P denotes stock price, then the transaction is effectively an American put option with payoff $S(P - P_0)+$. A lower bound for the value of the transaction is the Black−Scholes value V of a European put option with a term of one year times the S. Since the cost of the transaction is the difference between today's price and cost basis times the long-term rate, a lower bound for the return on the transaction is:

$$\begin{aligned} SV/(L(P_0 - C)) - 1 \\ = (TRD + 1) * V/(P_0 - C), \end{aligned}$$

where the Tax-Rate Differential (TRD) is defined above.

Appendix E: Portfolio value decomposition and measurement of ossification

The market value of a portfolio can be decomposed into two components: basis and unrealized net gains. Basis represents the capital used to establish all the positions in a portfolio, and unrealized net gains represents the total profit or loss in the event of full liquidation.

Unrealized net gains can be further decomposed into unrealized gains and unrealized losses, with the former tallying gains from all profitable positions and the latter tallying losses from all losing positions.

Finally, basis, unrealized gains, and unrealized losses can each be broken down into short-term and long-term components. A lot is a short-term position if it has been held in a portfolio for, at most, 365 days; otherwise, the lot is a long-term position. This leads to the tax-aware decomposition of portfolio market value:

- Short-term basis
- Long-term basis
- Unrealized short-term gain
- Unrealized long-term gain
- Unrealized short-term loss
- Unrealized long-term loss

These six components sum to portfolio market value, as illustrated in the numerical example in Table 12.

The tax-aware decomposition of portfolio market value leads to two measurements of portfolio ossification.

Short-term basis percentage (featured in Table 9) is a portfolio's short-term basis divided by its current value. A larger short-term basis percentage indicates a higher potential for short-term loss realization, and thus a lower ossification level.

Total basis percentage is a portfolio's (short plus long) basis divided by its current value. As an alternative to short-term basis percentage for measuring ossification, total basis percentage gauges the likelihood that tax lots in a portfolio will become losses. A lower total basis percentage indicates a lower likelihood of loss harvesting. This metric is commonly used to set tax alpha expectations. For the hypothetical ossified portfolios used to launch strategies in our empirical

Portfolio value					
Basis		Unrealized net gain			
		Unrealized gain		Unrealized loss	
ST basis	LT basis	Unrealized ST gain	Unrealized LT gain	Unrealized ST Loss	Unrealized LT loss

Table 12 Tax-aware decomposition of the market value of a hypothetical portfolio into six components.

Lot number	Age (days)	Short or long term	Number of shares	Current price	Basis	Unrealized net gain per share	Current market value	Total basis	Unrealized loss	Unrealized Gain
1	1	ST	10	\$10	\$25	−\$15	\$100	\$250	−\$150	
2	10	ST	10	\$20	\$10	\$10	\$200	\$100		\$100
3	400	LT	10	\$50	\$75	−\$25	\$500	\$750	−\$250	
4	500	LT	10	\$250	\$100	\$150	\$2,500	\$1,000		\$1,500
Portfolio level							\$3,300	\$2,100	−\$400	\$1,600

Portfolio level	Basis	Unrealized loss	Unrealized gain
Short term	\$350	−\$150	\$100
Long term	\$1,750	−\$250	\$1,500
Total	\$2,100	−\$400	\$1,600

study, average total basis percentage was approximately 55%, on average, at strategy inception.

Appendix F: Glossary

ATAR: after-tax active return

PTAR: pre-tax active return

TA: tax alpha

TAVA: tax arbitrage value added

TE: tracking error

TLH: tax-loss harvesting

TRD: Tax-Rate Differential

Notes

1 Constantinides (1983) uses an option theoretic framework to quantify the value of timing loss and gain realization in tax-managed investing. A more recent and more comprehensive exposition of tax-managed investing is in Wilcox *et al.* (2006). Geddes *et al.* (2015) illustrate the value of an indexed loss-harvesting portfolio as part of an asset allocation that regularly generates capital gains.

2 Odean (1998) demonstrates that investors exhibit disposition effects, in that they are more likely to realize profitable stocks than unprofitable stocks, except in December.

3 There is a vast literature on the subject of how to optimally locate different types of holdings within a taxable asset allocation. See, for example, Wilcox *et al.* (2006).

4 The tax benefits of separately managed accounts are discussed in Geddes (2011).

5 Jeffrey and Arnott (1993), Arnott *et al.* (2000) and Arnott *et al.* (2011) document the importance of tax management in equity portfolios of taxable investors. Berkin and Ye (2003) use a Monte Carlo simulation to quantify the benefits of highest in, first out (HIFO) accounting, as well as the incremental benefits of loss harvesting in a market with relatively high stock-specific risk, low average return and high dividend yield. Berkin and Luck (2010) use a Monte Carlo simulation to demonstrate the benefits of tax management in an extended equity strategy. Using empirical data, Bergstresser and Pontiff (2013) document the impact of taxes on value, growth, and size of portfolios, and show that taxes exacerbate the equity premium puzzle. Israel and Moskowitz (2012) explore the impact of tax management on size, value, growth, and momentum. Geddes (2011) and Geddes and Tymoczko (2019) use Monte Carlo simulations to demonstrate the after-tax benefits of loss harvesting in a separately managed account relative to holding an exchange-traded fund (ETF). Sialm and Sosner (2018) quantify after-tax returns in tax-managed 130−30 and long−short market-neutral strategies. Using historical back-tests, Santodomingo *et al.* (2016) and Goldberg *et al.* (2019a) examine after-tax return and risk profiles of popular factor tilts. Analogous profiles of index-tracking and carbon-free strategies are described in Goldberg *et al.* (2019b).

6 Joe Biden has proposed raising the long-term capital gains rate to the same level as the short-term rate, ultimately rendering tax-rate arbitrage ineffective for affected investors.

7 Constantinides (1984), Dammon *et al.* (1989), and Stein *et al.* (2008) use Monte Carlo simulations to evaluate a tax-rate arbitrage strategy.

8 The high path dependency of taxable strategies means that overlapping scenarios do not materially diminish independence of outcomes.

9 Consider, for example, an investor whose marginal tax rate changes over time. It may be possible to realize gains in a lower income year and book losses in a higher income year, thereby increasing the benefit of tax-rate arbitrage.

10 Investors with more complicated schedules of anticipated short-term gains may have some limited ability to time the gains-realization trades of tax-rate arbitrage accordingly.

11 In a back-test of a monthly rebalanced, standard loss-harvesting strategy at a 10-year horizon, we never realized short-term capital gains greater than 0.10%. We realized long-term capital gains in excess of the same threshold in 0.3% of the 15,183 rebalances in the study. There are exceptional cases where short-term capital gains are realized in a tax-managed portfolio. For example, an investor may choose to withdraw funds from a tax-managed account in an amount that necessitates the realization of short-term capital gains.

12 Timing gives another perspective on the differential impact of tax-rate arbitrage on loss harvesting in the estate/donation and liquidation dispositions. In the estate/donation disposition, tax-rate arbitrage forced long-term gain realization that would not have otherwise

occurred. In the liquidation disposition, tax-rate arbitrage accelerated long-term gain realization. Accordingly, the cost of tax-rate arbitrage was effectively lower in the liquidation disposition than in the estate/donation disposition.

13 Market moves do affect standard loss-harvesting strategies, even though these moves do not lead to up-front costs as in tax-rate arbitrage.

14 Loss-harvesting potential in ossified portfolios is explored in Ulucam (2021).

15 Since ossified portfolios come in a wide range of forms, our method for exploring the impact of ossification on tax-rate arbitrage is exploratory and not comprehensive.

16 Historically, growth in the US market has been driven by a relatively small number of stocks, leading to median stock performance that has been well below index performance. More information is in Cembalest (2014) and Bessembinder (2018). At the same time, underperforming stocks have been abundant and substitutable, facilitating loss harvesting and tracking error minimization.

17 The decline in annualized after-tax return is typically accompanied by growth in the active dollar value of the portfolio.

18 More information is found in Goldberg *et al.* (2019a, 2019b).

19 Since there is no wash sale rule for the realization of gains, the optimizer may choose to buy back a security that was sold in the first step of tax-rate arbitrage.

20 The formula for short-term basis is precisely specified in Appendix E.

21 In the liquidation disposition, we estimate liquidation impact on both the portfolio and the benchmark, which is modeled as an ETF. The liquidation impact in the estate/donation version of tax-rate arbitrage was zero.

22 The downward bias in risk forecasts for optimized portfolios is discussed in Bianchi *et al.* (2017) and Goldberg *et al.* (2020), Goldberg, Papanicolaou *et al.* (2020).

23 In order to match average forecast tracking error at a 10-year horizon, we need to set forecast tracking error higher for the tax-rate arbitrage strategy in the early years. Doing so amounts to lowering risk aversion.

24 The strategy parameters for the ossified study were taken from the calibration for cash-launched strategies. A dedicated calibration for ossified portfolios would likely lead to raising the forecast tracking error for tax arbitrage, or equivalent, to lowering risk aversion.

25 As a result of diversification, the volatility of the lowest-risk security of an index is close to (and often higher than) index volatility.

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