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The Tax-Loss Harvesting Life Cycle

A Historical Look at the Experiences of Taxable Equity Investors in the US

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Tax-loss harvesting index strategies uniformly outperformed their benchmarks at a 10-year horizon.
In an empirical study of tax-loss harvesting over the period January 1973–February 2016, all 408 historical simulations of an S&P 500-tracking portfolio generated positive alpha (gross of fees) at a 10-year horizon for both the estate/donation and liquidation dispositions.

Tax-loss harvesting index strategies performed best in bear markets.
For the estate/donation disposition, tax-loss harvesting generated the highest tax alpha during market declines, and the lowest tax alpha during bull markets. Tax alpha averaged 2.66% over the lowest quintile of index returns, and 1.32% over the highest quintile of index returns.

Tax-loss harvesting index strategies compared favorably to top-quintile actively managed strategies.
At a 10-year horizon, the median tax information ratio was 1.28 and the minimum was 0.60.

> "In an industry guilty of many crimes against investors, ignoring the tax consequences of portfolio transactions ranks among the most grievous."
>
> – David Swensen, *Unconventional Success: A Fundamental Approach to Personal Investing* (New York, Simon & Schuster, 2005), 93.

Tax-loss harvesting (TLH) aims to realize losses on individual stocks in conjunction with an investment objective such as index tracking. Realized losses are used to offset pending capital gains, enabling an investor to delay tax payment or to avoid it entirely. This makes TLH valuable to taxable investors, but how valuable? To date, the appraisal of the potential benefits, risks, and limitations of tax-loss harvesting has been largely based on anecdotes and Monte Carlo simulation. Both deliver useful, but incomplete, information: anecdotes are necessarily limited in scope, and Monte Carlo simulations rely on idealized assumptions about return and risk.[1] Here, we complement those perspectives with a detailed historical analysis, emphasizing the spectrum of potential investor experiences rather than simple averages.

The performance of a taxable strategy is sensitive to its age as well as market attributes such as turbulence. We address this by aggregating characteristics of TLH strategies over many historical periods and at different investment horizons. Our study provides insight into the life cycle of a TLH strategy, which has its youth, midlife, and golden years.

Rewards and Risks of Tax-Loss Harvesting Strategies

Like many quantitative investment strategies, tax-loss harvesting strives to generate return while controlling risk. In a standard TLH strategy, risk is measured as tracking error against a benchmark, and the desired return is tax dollars saved, compounded over time.[2] The relative importance of loss harvesting and risk control varies across investors, since more aggressive harvesting tends to widen tracking error, thereby increasing the chance of substantial pre-tax underperformance. In the portfolio construction process, the tradeoff between loss harvesting and risk control can be tailored to individual preferences.

The most tangible measure of the effectiveness of TLH index tracking is the spendable benefit to the investor: tax alpha, the difference between after-tax returns of a portfolio and its benchmark.

$$\mathrm{TA} = R_P^{at} - R_B^{at}$$

TA is tax alpha

R_P^{at} is after-tax portfolio return

R_B^{at} is after-tax benchmark return

Tax alpha comes in two varieties, depending on its disposition. In the estate/donation disposition, wealth is either bequeathed or donated to a charitable organization and taxes are never paid. In the liquidation disposition, payment of taxes is delayed, but not indefinitely.

Our portfolio construction process controls forecast tracking error, which indicates how effectively pre-tax portfolio returns are expected to mimic benchmark returns. In a TLH strategy, forecast tracking error tends to drift upward over time, and we quantify this drift as part of our study.

Return on a risk-adjusted basis is reported as the tax information ratio of the estate/donation tax alpha divided by its standard deviation.[3]

Study Outline

We launch long-horizon, tax-loss harvesting strategies in the S&P 500 monthly over the period from January 1973 to February 2016. To avoid risk associated with leverage, we disallow short positions, and we set tax rates to the highest US federal level as of February 2016.[4] Our portfolio construction process relies on factor-based mean-variance optimization, and we rebalance monthly.[5]

In the next section, we present ranges of tax alpha observed in our historical study. To highlight the aging process of TLH strategies, we show outcomes at horizons of 5, 10, and 20 years.[6] At each horizon, we generate a box-and-whiskers plot, which identifies the median outcome, the 25th and 75th percentiles delimiting the interquartile range, and the worst and best cases at the extremes. This gives a concise presentation of the ranges of historical outcomes at fixed horizons achieved by strategies in different periods. We provide further insight into the behavior of TLH strategies by examining the relationship between index return and tax alpha.

Subsequently, we focus on risk in the form of forecast tracking error, again using box-and-whiskers plots at 5-, 10-, and 20-year horizons to show how the spectrum of outcomes evolves as a TLH strategy ages.

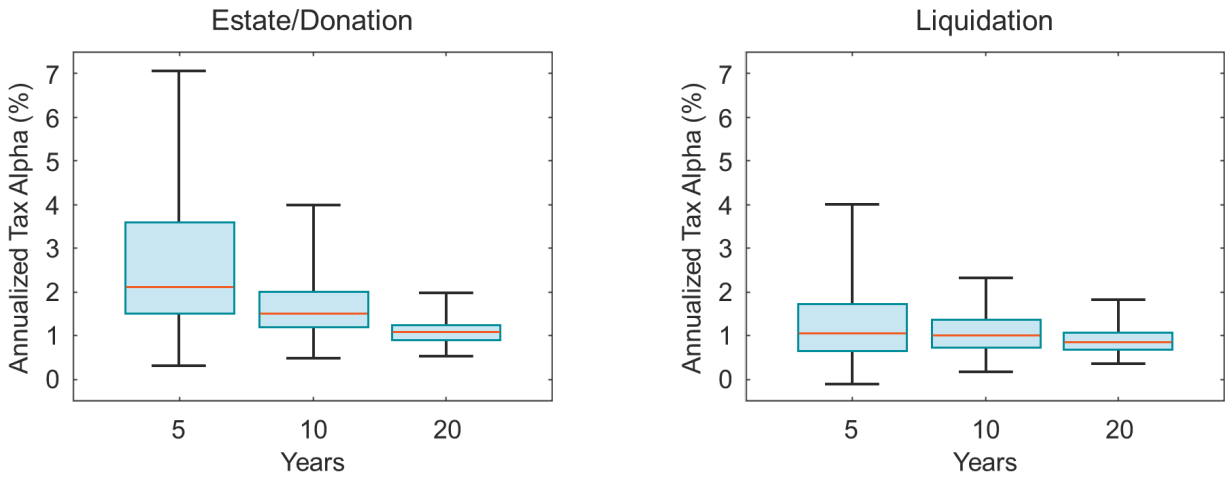
Finally, we look at the tax information ratio, the risk-adjusted return of TLH strategies at 5-, 10-, and 20-year horizons. The tax information ratio is average tax alpha divided by its standard deviation, and it is analogous to the information ratio used to evaluate active strategies.

Tax Alpha

Historically observed tax alpha generated in our empirical study is shown in Figure 1. The chart in the left panel shows that estate/donation tax alpha was uniformly positive over the 43-year study period at horizons of 5, 10, and 20 years. As the strategy aged, the median annualized return declined and the range of outcomes compressed.

Post-liquidation tax alpha is shown in the right panel of Figure 1. The results were uniformly positive at 10- and 20-year horizons. However, at a 5-year horizon, the TLH strategy underperformed its benchmark for strategies beginning September 1974, November 1995, August 1998, and July 2003. In three of the four cases, the tax alpha was relatively low prior to liquidation. For the strategy beginning August 1998, severe market losses in Year 5 led to a preponderance of short-term gains at liquidation.

In contrast to the estate/donation disposition, median liquidation after-tax returns show little horizon dependence, since liquidation costs tended to decline as the investment horizon grew. This can be explained, at least in part, by the prevalence of short-term gains in younger TLH strategies.



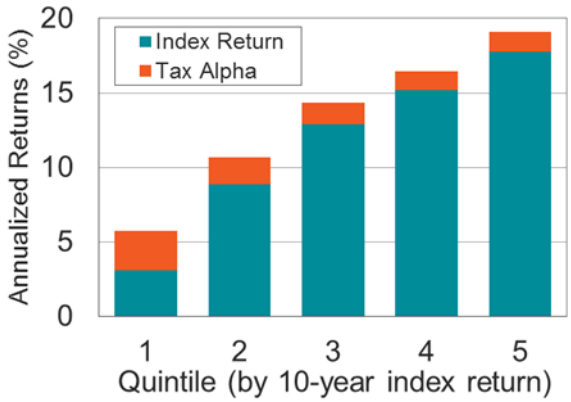
Years	5	10	20
Max	7.04	3.98	1.96
75th	3.57	1.98	1.22
Median	2.09	1.50	1.05
25th	1.50	1.19	0.89
Min	0.26	0.45	0.50

Years	5	10	20
Max	4.01	2.32	1.83
75th	1.71	1.37	1.07
Median	1.09	1.02	0.88
25th	0.68	0.76	0.71
Min	(0.10)	0.19	0.36

Figure 1: *Ranges of annualized tax alpha of a historically simulated S&P 500 tax-loss harvesting strategy at 5-, 10-, and 20-year horizons over the period from January 1973 to February 2016. The estate/donation disposition is shown in the left panel and the liquidation disposition is shown in the right panel. Simulated returns are gross of fees. Round-trip trading costs of 12 basis points are assumed.*

Source: Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer.

Next, we explore the relationship between tax alpha and index return. Like the purchase of bonds or put options, tax-loss harvesting performs best when markets are turbulent and in decline. The left panel of Figure 2 shows average tax alpha (orange bars) sorted by quintiles of index returns. As the index averages (teal bars) decline, the average tax alpha increases. Tax alpha averages stand alone in the right panel of Figure 2, highlighting the nature of the decline as a function of index return.



	Quintile				
	1	2	3	4	5
Average Index Return	3.07	8.86	12.91	15.18	17.75
Average Tax Alpha	2.66	1.80	1.46	1.25	1.32

	Quintile				
	1	2	3	4	5
Average Tax Alpha	2.66	1.80	1.46	1.25	1.32

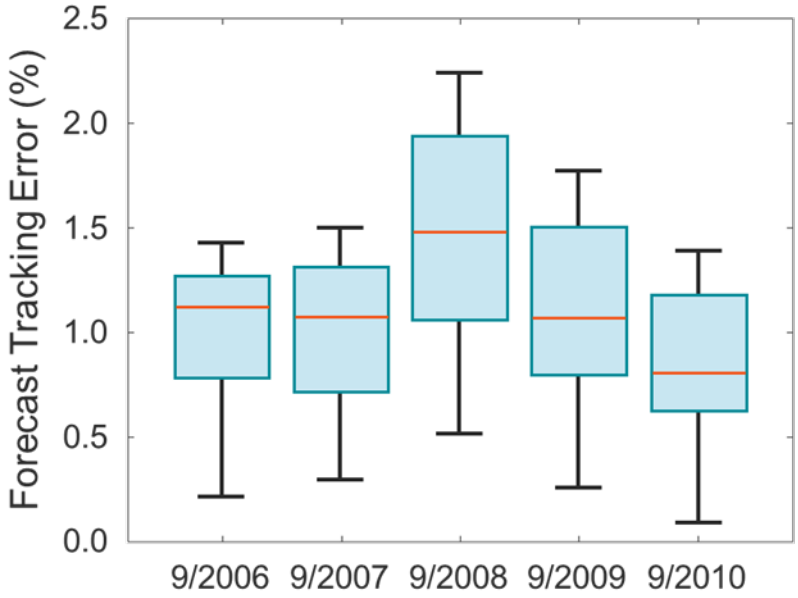
Figure 2: *Ranges of annualized estate/donation tax alpha (orange bars) of historically simulated S&P 500 tax-loss harvesting sorted by index returns (teal bars) over the period from January 1973 to February 2016. Simulated returns are gross of fees. Round-trip trading costs of 12 basis points are assumed.*

Source: Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer.

Tracking Error Drift

Turning from return to risk, we look at the characteristics of forecast tracking error of tax-loss harvesting strategies.[7]

Forecast tracking error is an essential input to the construction of a tax-loss harvesting portfolio, and it is sensitive to prevailing market volatility. For example, in the turbulence of 2008, tracking errors of TLH strategies of all horizons tended to increase. Then, as volatility levels normalized in 2009, tracking error of tax-loss harvesting strategies tended to diminish. This is illustrated in Figure 3, which shows ranges of tracking error by date (and not by horizon).



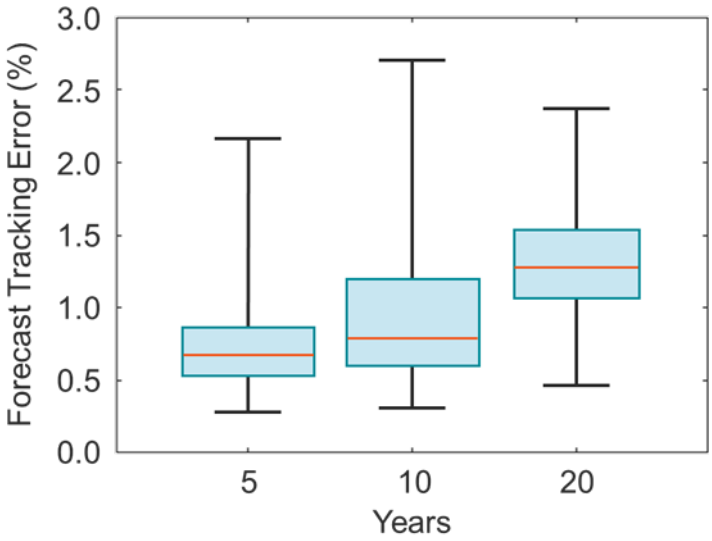
Years	2006	2007	2008	2009	2010
Max	1.42	1.50	2.23	1.76	1.39
75th	1.27	1.31	1.94	1.50	1.18
Median	1.12	1.07	1.48	1.07	0.81
25th	0.78	0.72	1.06	0.79	0.63
Min	0.22	0.30	0.52	0.26	0.10

Figure 3: *Ranges of forecast tracking error of a historically simulated S&P 500 tax-loss harvesting strategy before, during, and after the financial crisis. Strategy horizons at each date vary from two months to 20 years.*

Source: Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer.

Nevertheless, there is an identifiable drift in the tracking error of a TLH strategy as it ages. Using an analysis that controls for period-specific effects,[8] we find that tracking error of the S&P 500-tracking TLH strategy increased, on average, by 0.0028% per month.[9] That translates to an average of 0.67%, over an investment horizon of 20 years.

In Figure 4, we illustrate tracking error drift by reverting to a horizon-based presentation. The average upward drift of 0.67% for 20-year strategies in their golden years corresponds roughly to the change in median value from the youthful 5-year strategies. The largest tracking errors we observed were just over 2.5%,[10] and they correspond to dates just before the bursting of the Internet bubble. As a consequence of the run-up in equity prices that preceded that crisis, TLH strategies included substantial amounts of appreciated equity. In order to avoid a tax bill, optimized TLH strategies were forced to increase tracking error. When the bubble burst and equity values fell, tracking error decreased to more ordinary levels.



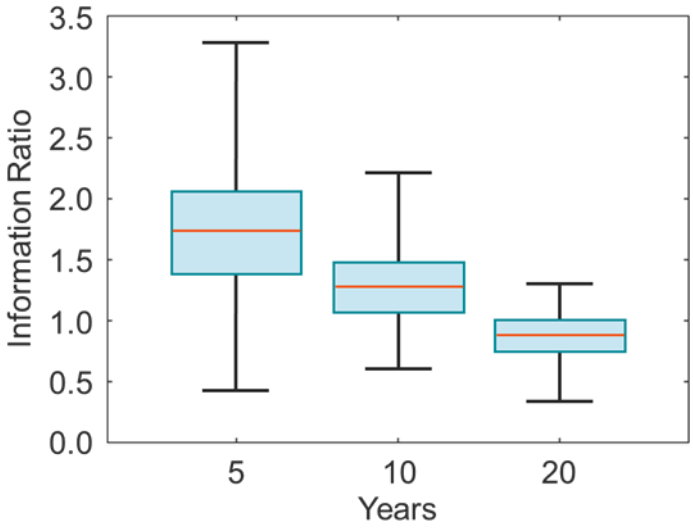
Years	5	10	20
Max	2.15	2.70	2.37
75th	0.85	1.20	1.53
Median	0.68	0.80	1.29
25th	0.54	0.60	1.07
Min	0.28	0.31	0.47

Figure 4: *Ranges of forecast tracking error of a historically simulated S&P 500 tax-loss harvesting strategy at 5-, 10-, and 20-year horizons over the period from January 1973 to February 2016.*

Source: Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer.

Tax Information Ratio

Finally, we turn to the tax information ratio, which is analogous to the risk-adjusted return measure used to evaluate active managers. The tax information ratio is average tax alpha per unit of realized tracking error. In Figure 5, we show ranges of historical tax alpha for the estate/donation disposition at horizons of 5, 10, and 20 years. The decline and compression that accompany the aging process reflect both the corresponding effects in tax alpha shown in the left panel of Figure 1.



Years	5	10	20
Max	3.27	2.21	1.30
75th	2.05	1.47	1.01
Median	1.73	1.28	0.88
25th	1.39	1.08	0.76
Min	0.43	0.60	0.34

Figure 5: *Ranges of annualized estate/donation tax information ratios of a historically simulated S&P 500 tax-loss harvesting strategy at 5-, 10-, and 20-year horizons over the period from January 1973 to February 2016. Simulated returns are gross of fees. Round-trip trading costs of 12 basis points are assumed.*

Source: Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer.

Summary

Tax-loss harvesting can generate value for taxable investors by facilitating delay, or even avoidance, of tax payments. The study described in this article quantifies the value that has been created historically through the simulation of TLH strategies that tracked the S&P 500 during the 43-year period from January 1973 to February 2016. We highlight the life cycle of a TLH strategy as well as path dependence and sensitivity to market conditions by presenting ranges of simulated tax alpha, tracking error, and tax information ratios at horizons of 5, 10, and 20 years.

Over the 43-year study period from January 1973 to February 2016, the strategy's tax alpha was uniformly positive, gross of fees, on an estate/donation basis at horizons up to 20 years.

With the exception of a 5-year horizon, the same was true post-liquidation. An important difference between the two dispositions is that the median estate/donation return declined as the strategy aged, while the median liquidation return was relatively insensitive to horizon. TLH delivered its strongest returns in turbulent periods when markets were in decline.

Our preferred measure of relative risk, tracking error, tended to drift upward as our strategy aged, by an average of 0.67% at a 20-year horizon. However, the extreme sensitivity of tracking error to market volatility could lead to a wide range of different experiences for different investors in different periods.

Financial markets are rife with uncertainty. We believe that tax-loss harvesting stands apart from other investment strategies by having a clearly defined profile of return and risk. We further believe that, based upon the simulated data described in this article, ultra-high-net-worth investors in the US who employed a disciplined loss-harvesting strategy that tracked the S&P 500 over the past half century may have been almost uniformly rewarded.

Appendix A: Strategy Construction Process

All portfolios were constructed from the universe of securities in the S&P 500 Index using the Barra USE3 Multi-Factor Model and the Barra After-Tax Mean-Variance Optimizer. Our objective was to harvest losses while effectively tracking the S&P 500 Index. We rebalanced portfolios monthly, and the optimization settings we used are included below.

Benchmark	S&P 500
Universe of securities	S&P 500
Short-term capital gains rate	43.4%
Long-term capital gains rate	23.8%
Transaction costs per side	6 bps
Risk Aversion	1.0
Tax Multiplier	1.0
Risk Aversion Ratio	0.1

Appendix B: Estimating Tracking Error Drift

In a TLH strategy, forecast tracking error tends to increase over time. Since forecast tracking error is sensitive to market attributes such as turbulence, we estimate tracking error using the fixed effects regression specified below.

$$\mathrm{TE} = \beta_{age}\ \mathrm{age} + \sum_{month} \gamma_{month}\ \mathrm{month} + \epsilon$$

TE is tracking error for a portfolio of a specified age forecast at the start of a specified calendar month

β_{age} is the sensitivity of tracking error to portfolio age

month is a dummy variable indicating calendar month

γ_{month} is the sensitivity of tracking error to the dummy variable month

ϵ is a random error

Regression Results		
	Value	T-statistic
Beta Age	0.0028	317.90
Adjusted R^2 = 0.85		

Endnotes

[1] For example, a Monte Carlo simulator may assume that equity returns follow a normal or a log-normal distribution, even though these assumptions are incompatible with the empirically observed rate of extreme events.

[2] Tax alpha, the after-tax return difference between a TLH strategy and its benchmark, includes the pre-tax difference between the TLH portfolio and its benchmark, which can be either positive or negative.

[3] The standard deviation of post-liquidation, after-tax returns is a poor measure of risk due to the lump sum payment at horizon. Consequently, we do not report tax information ratios for this disposition.

[4] We assume long-term and short-term capital gains are taxed at rates of 23.8% and 43.4%. We are effectively investigating the question, "How would a TLH strategy have performed had the federal tax rate as of December 2015 prevailed through history?" For comparison, the average long-term capital gains tax rate over our study period was 25.7%, according to www.taxpolicycenter.org/statistics/historical-capital-gains-and-taxes.

[5] Details are in Appendix A.

[6] Since we use as much data as possible, the number of observations depends on horizon as indicated in the table below.

Horizon (years)	# of Observations
5	468
10	408
20	288

[7] We focus on forecast pre-tax post-trade tracking error since it is an essential element of our portfolio construction process, and it avoids technical complications inherent in realized tracking error, after-tax tracking error, and pre-trade tracking error. Realized tracking error is averaged over disparate volatility regimes. After-tax tracking error intertwines tax alpha and pre-tax tracking return. Pre-trade tracking error can be artificially high due to unresolved corporate actions.

[8] Our analysis relies on a fixed effects regression. Details are in Appendix B.

[9] We control for sensitivity to prevailing market conditions with a fixed effects regression. More information is in Appendix B.

[10] To put this in perspective, a typical active strategy has a tracking error of 5% or more.

Disclosure

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With respect to the description of any investment strategies, simulations, or investment recommendations, we cannot provide any assurances that they will perform as expected and as described in our materials. Past performance is not indicative of future results. Every investment program has the potential for loss as well as gain.

Due to the complexity of tax law, not every single taxpayer will face the situations described herein exactly as calculated or stated, i.e., the examples and calculations are intended to be representative of some but not all taxpayers. Since each investor's situation may be different in terms of income tax, estate tax, and asset allocation, there may be situations in which the recommendations would not apply. Please discuss any individual situation with tax and investment advisors first before proceeding. Taxpayers paying lower tax rates than those assumed or without taxable income would earn smaller tax benefits from tax-advantaged indexing or even none at all compared to those described.

Back-testing involves simulation of a quantitative investment model by applying all rules, thresholds, and strategies to a hypothetical portfolio during a specific market period and measuring the changes in value of the hypothetical portfolio based on the actual market prices of portfolio securities. Investors should be aware of the following: 1) Back-tested performance does not represent actual trading in an account and should not be interpreted as such, 2) back-tested performance does not reflect the impact that material economic and market factors might have had on the manager's decision-making process if the manager were actually managing clients' assets, and 3) there is no indication that the back-tested performance would have been achieved by a manager had the program been activated during the periods presented above. For back-tested performance comparisons, the benchmark returns are simulated using historical constituents' weights and total returns.

The **S&P 500® Index** is an equity benchmark for US stock performance. It is a capitalization-weighted index covering 500 large US companies chosen by Standard & Poor's for market size, liquidity, and industry group representation.