Vanguard

Tax-loss harvesting: A portfolio and wealth planning perspective

Vanguard Research

October 2020

Kevin Khang, Ph.D.; Thomas Paradise; and Joel M. Dickson, Ph.D.

- In this paper, we demonstrate that investment outcomes resulting from equity-based tax-loss harvesting vary significantly across investor characteristics and market environments. The expected results range from no benefit, or even negative returns, to gains of more than 1% annually.

- Based on an examination of more than 80,000 distinct investor profile and equity market volatility environment combinations, we conclude that the volatility environment, capital gains available to offset, and investors' current and future tax rates are critical determinants of the benefit of tax-loss harvesting.

- Based on an evaluation of U.S. investor profiles from the Survey of Consumer Finances, tax-loss harvesting likely provides the greatest portfolio benefits for those in the top 2% of net worth distribution (approximately $5.3 million or higher in 2016). This group has higher shares of financial assets held outside of tax-advantaged accounts and significant taxable realized gains available to offset. While tax-loss harvesting generally provides benefits across the distribution, for households outside of the top 10% (approximately $1.2 million or less in 2016), the benefit to their entire portfolio is likely lower because of lower taxable account holdings and capital gains to offset.

Introduction

This paper investigates the merits of tax-loss harvesting (TLH) for an individual investor and provides guidance on how to incorporate it into an overall portfolio. Our objective is to identify the combination of investor characteristics and market conditions that would make TLH viable.

A wide range of TLH benefit—after-tax excess return—is documented in academic and practitioner literature (for example, see Stein and Narasimhan (1999), Arnott et al. (2003), Atwill et al. (2017), and Chaudhuri et al. (2020)). Its value ranges from 20 to well over 300 basis points (bps) per year; in order to realize a benefit of meaningful magnitude, a number of factors must be aligned when pursuing TLH.

Key factors driving TLH benefit include: the availability of capital gains[1] for the loss harvest to offset, the profile of recurring cash flows into the taxable account, the investment universe in which TLH takes place, the volatility environment, and applicable tax rates for the present and the future. These factors work, not in isolation, but together to create TLH benefit. The extant literature, however, generally lacks an understanding of how they interact to deliver TLH benefit.

We investigate the value of TLH from a holistic viewpoint, incorporating fact-based assumptions of the individual investor profile and various market environments. This is motivated by our view that TLH benefit does not take place in an isolated corner of an investor's taxable account. On the contrary, it is best thought of as a potentially integral element of an overall tax optimization and wealth planning strategy. To this end, we identify the optimal investor profiles and market environments and clarify what questions investors and their advisors should ask to determine the likely benefit *specific to them*.

We begin by reviewing the economics of TLH here and discuss how its benefit arises. We introduce our framework for quantifying TLH benefit, including its main drivers. Next, we identify the type of investors most likely to benefit from tax loss harvesting, highlighting that one size does not fit all. Finally, we show how TLH benefit varies along three key dimensions—investor profile, volatility environment, and granularity of the investment universe—and discuss the importance of each in forming an appropriate expectation.

The economics of tax-loss harvesting

TLH benefit stems from two main sources: minimizing taxes over the entire investment horizon, and deferring a current tax liability to the future and compounding this extra cash flow with a market return.[2]

The following equation is a simplified representation.

Equation 1.

$$Value_{TLH} = \min(G,L)\,(\tau_{t_1} - \tau_{t_2}) + \min(G,L)\tau_{t_1} R(1 - \tau_{t_2})$$

where G and L are the amount of capital gains and losses realized, τ_{t_1} and τ_{t_2} are the current and future marginal tax rates associated with gain and loss realizations, and R is the cumulative return over the investment horizon from the present (t_1) to the future (t_2).

This equation separates the two sources of benefit by positing that investors deciding to engage in TLH at time t_1 reduce their tax burden by offsetting taxable income or capital gains with realized losses in that period.[3] These tax savings are reinvested in the portfolio until liquidated at the end of the investment horizon.[4]

Notes on risk

Tax-loss harvesting involves certain risks, including, among others, the risk that the new investment could perform worse than the original investment and that transaction costs could offset the tax benefit. There may also be unintended tax implications. We recommend that you consult a tax advisor before taking action.

1 A capital gain is realized by selling an investment for a price greater than its cost basis, or the original price paid; see *Internal Revenue Code (IRC) Section 1001(a)*. Capital gains are considered short-term if the underlying investment has been held for one year or less and long term if held for more than one year; see *IRC Section 1222*. Short-term capital gains are taxed at the ordinary income tax rate, which is often higher than the rate on long-term capital gains.

2 See Constantinides (1984), who first introduced this framework to the literature.

3 More generally, tax savings from realizing losses may be generated by offsetting gains realized in the same tax year, offsetting up to $3,000 of ordinary income in that tax year, or carrying forward unused loss to offset realized gains and/or ordinary income in future tax years.

4 A large portion of the TLH benefit as expressed in the equation results from the reinvestment of tax savings as additional cash flows generating long-term returns from the investment portfolio. In practice, these tax savings may be partially or totally consumed rather than reinvested. In that case, the benefit from TLH would only reflect the difference in current and liquidation tax rates in the first term of the equation. Of course, the additional consumption would also be a benefit to the investor relative to his or her lower consumption without TLH.

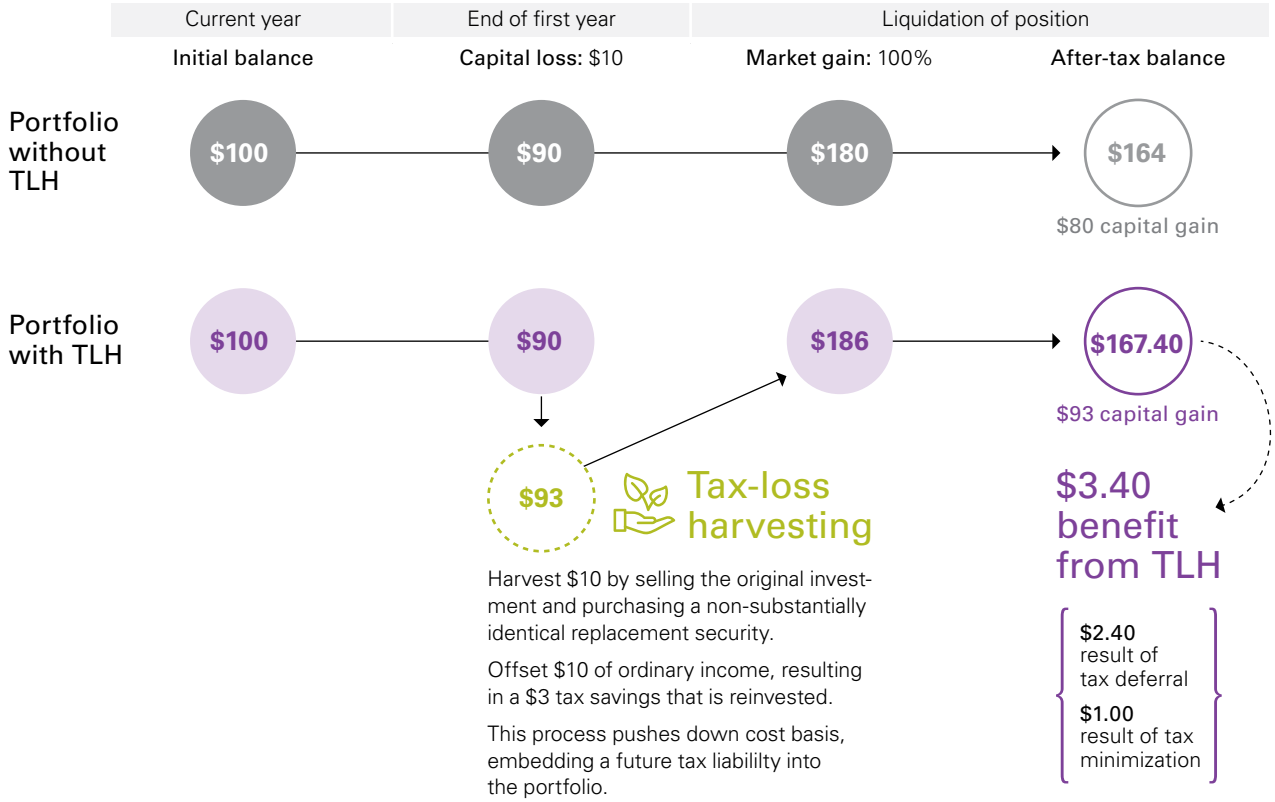
The first term represents the difference in tax liability over the investment horizon—this value is positive as long as the future tax rate at the time of liquidation is less than the present tax rate. The second term computes the benefit of deferring a current tax liability to the future and compounding it with a market return; this will be positive as long as the risky asset provides a positive long-term return.

A numerical example

Figure 1 shows a simple numerical example in which an investor has a realizable capital loss of $10 at the end of the first year, resulting from an initial investment of $100 declining to $90. If realized, this $10 loss will create a tax savings at an applicable tax rate of 30% by offsetting $10 of otherwise taxable income or realized capital gains. Between the end of the first year and the end of the investment horizon, the investment in the risky asset is assumed to double in value, at which point it is liquidated at an applicable tax rate of 20%.

If the investor engages in TLH, the benefit ends up being $3.40 over the investment horizon—$167.40 versus $164 without TLH. This includes $1 of overall tax minimization, the amount by which the $3 of tax savings on ordinary income at the end of first year outweighs the $2 of tax owed on the additional $10 long-term capital gain resulting from the reduced cost basis, and $2.40 of tax deferral benefit, representing the $3 gain from reinvesting deferred taxes less 20% capital gains tax owed upon liquidation.

Figure 1. Two sources of TLH benefit



Source: Vanguard.

Under what conditions is the value of TLH positive? Rearranging Equation 1 and solving for the conditions when $Value_{TLH}>0$ is true, we find that the following equation describes all such instances.[5]

Equation 2.

$$R > \frac{\tau_{t_2} - \tau_{t_1}}{\tau_{t_1}(1 - \tau_{t_2})}$$

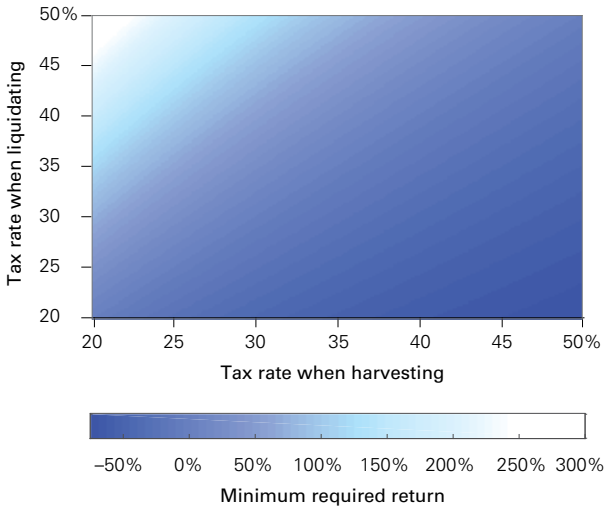
Equation 2 posits that for every pair of current and future tax rates, a minimum rate of return is required to benefit from TLH. This return varies whereby the greater the future tax rate in relation to the current tax rate, the greater the required return to break even on TLH (as shown in **Figure 2**). The flip side is that TLH can also result in a net negative outcome if the future tax rate turns out to be greater than the current rate and return on reinvestment is mediocre or negative, so that

$$R < \frac{\tau_{t_2} - \tau_{t_1}}{\tau_{t_1}(1 - \tau_{t_2})}.$$

Factors driving TLH benefit

The ultimate size of any TLH benefit depends on determinants such as tax rates and liquidation strategies. Many of these factors depend on the investor's profile, including present tax rate and its relation to future tax rate and recurring cash flow into the taxable account. Other determinants of potential capital gains and loss realizations, such as what type of volatility environment awaits and how this interacts with the cash flow profile, are largely beyond the investor's control. **Figure 3** lists six factors grouped under two main themes and the impact of each on TLH benefit. We detail the relative importance of each factor through empirical analysis later in this paper.

Figure 2. Minimum required return for TLH to add value under present and future tax rates



Source: Vanguard.

Figure 3. Main factors driving TLH benefit

Investor profile	Source of losses
Recurring cash flows More frequent and larger cash flows diversify cost bases and improve the ability to harvest, resulting in higher TLH benefit.	**Market volatility** Market volatility is the foremost source of losses. The greater and more frequent the volatile periods, especially shortly after investment, the more prevalent the opportunities to harvest losses, resulting in higher TLH benefit.
Capital gains availability More capital gains turn more loss harvests into additional re-investment, resulting in higher TLH benefit.	
Liquidation plan Less liquidation of taxable portfolio at the end lowers the tax base permanently, resulting in higher TLH benefit.	**Investment granularity** Holding individual securities instead of pooled investment funds allows the investor to harvest losses not only in market downturns but also in bull markets with low volatility, leading to more losses and higher TLH benefit.
Tax rates The greater the present tax rate relative to the future tax rate, the greater the benefit of overall tax minimization, resulting in higher TLH benefit.	

Source: Vanguard.

5 Equation 2 is not defined for instances where the current tax rate, τ_{t_1}, equals zero, a current long-term capital gains bracket for certain U.S. taxpayers. If realized losses were to offset gains that would otherwise be taxed at zero, TLH would be an inferior wealth management strategy. Instead, the investor may benefit from harvesting capital gains without offsetting losses. For additional perspectives on this topic, see Dammon and Spatt (1996) and Stein et al. (2008).

Of the six factors in Figure 3, we have already discussed the role of liquidation and tax rates above. Each of the other four factors—market volatility, investment granularity, recurring cash flows, and capital gains availability—drives TLH benefit in the following ways.

Market volatility

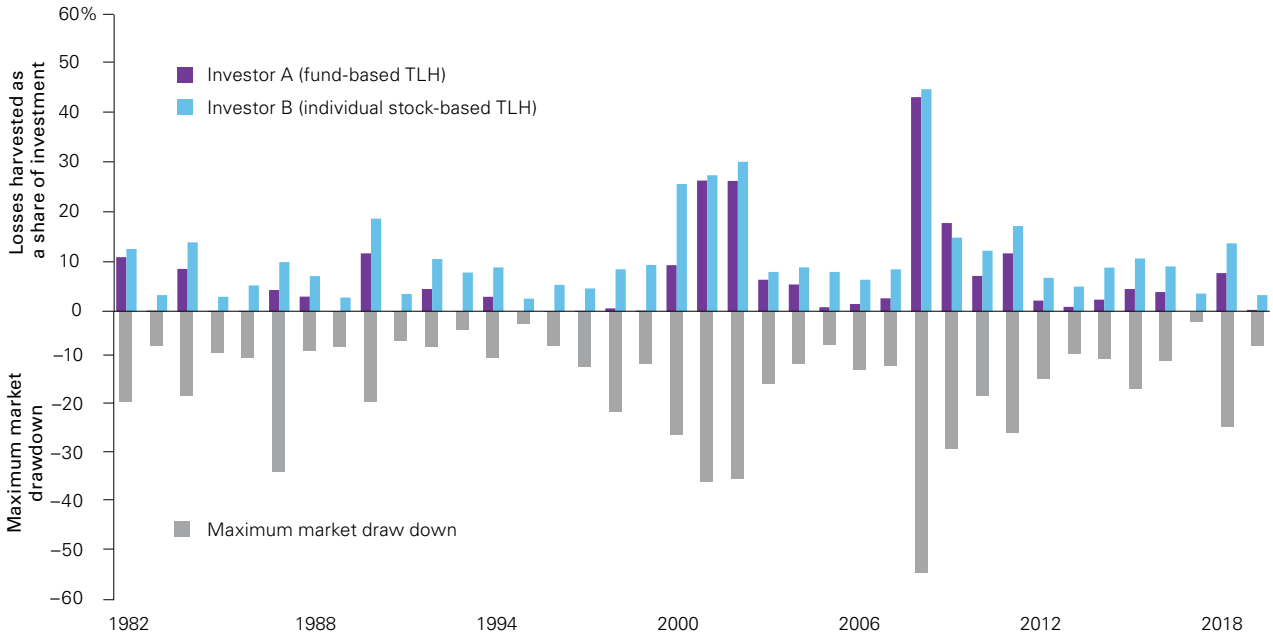
Generating losses in a taxable account is the first step in TLH that all others build on; without losses to harvest, there are no tax savings, additional cash flows to reinvest, or gains to reap from reinvestment. Generally speaking, opportunities to harvest losses arise in the presence of volatility. The greater the volatility, the greater the odds that a security acquired previously can be sold below its cost basis.

Equity market volatility manifests in two ways. First, it rises and falls over time, leading to high-volatility and low-volatility periods. Second, it affects individual securities in different ways: Some appreciate significantly (for example, many technology stocks post-COVID-19 in 2020), while others decline in value (for example, most financial and energy stocks during the same period). Market practitioners often refer to the first type as "time-series" or "market" volatility and the second type as "cross-sectional" volatility.

We can illustrate how both types of volatility may affect loss realizations through two hypothetical investors. In the beginning of every calendar year from 1982 to 2019, Investor A and Investor B make the same investment with one difference: Investor A invests in a fund that tracks a market-capitalization-weighted U.S. index, and Investor B holds individual U.S. securities in the exact same proportions as in the index.[6] To employ TLH, both investors harvest losses when the loss is greater than 10% of the cost basis established in the beginning of the calendar year and stop harvesting one year after their initial investment (see **Figure 4**).

Investor A's loss harvest depends solely on time-series volatility—how the pooled index fund performs post-investment each year. Her opportunities to generate losses tend to cluster around market downturns with high volatility. As shown in Figure 4, between 1982 and 2019, most losses were harvested during two periods of equity market turmoil: 2000–2002 (the dot-com bust) and 2008–2009 (the global financial crisis).

Figure 4. More granular portfolio construction often provides more harvesting opportunities



Source: Vanguard calculations, based on Axioma US4 data.

6 We create a hypothetical market-capitalization-weighted U.S. index consisting of the top 400 securities in the Axioma US4 risk model's estimation universe. See p. 10 for additional details.

This indicates that the very first step of TLH—generating losses—can be inconsistent over time. It also means that the start of the process in earnest—the timing of the next major downturn—is largely beyond the investor's control. If a downturn takes place around the time the investor starts practicing TLH (for example, at the beginning of 2000 on the eve of the dot-com bust), he or she has ample opportunity to harvest losses, eventually turn them into additional cash flows, and reinvest in the market.[7] On the other hand, the investor who starts deploying TLH at the beginning of a ten-year bull market with low volatility (for example, at the beginning of 1992) ends up with a decade-long period of few opportunities to generate losses.

Investment granularity (cross-sectional volatility)

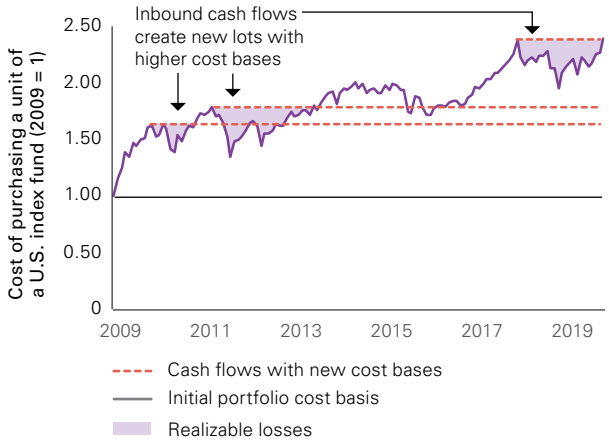
Investor B's losses also tend to be concentrated around major downturns. However, she is able to generate losses on some of the individual securities even when the index as a whole does not decline in value. This means Investor B can generate losses virtually every year, including those outside of the major downturns or market corrections that Investor A's losses are concentrated in. This is the main source of the additional value gained by pursuing TLH with more granularity—with individual securities rather than pooled investment funds. We will revisit this topic in greater detail later.

Recurring cash flows

Recurring cash flows into a portfolio create new, often higher, cost bases and diversify tax lots.[8] This creates greater harvesting opportunities, especially when a market correction falls short of a major downturn. Original investments, on the other hand, are less likely to provide opportunities in market corrections, because once they generate a large enough embedded gain, the type of volatility present is unlikely to push the market value back below cost basis (**Figure 5**).

Harvesting opportunities are generally diminished in a portfolio with no recurring cash flows after the initial investment. Figure 5 illustrates the importance of recurring cash flows using the example of the decade following the 2008–2009 crisis. The solid black line represents the initial cost basis of a hypothetical investment in a market-capitalization-weighted U.S. index fund. In the ten years after the initial investment in 2009, few loss harvesting opportunities existed for the initial cost basis, without further inbound portfolio cash flows. However, with additional cash flows establishing higher cost bases—orange dashed lines, the investor could have harvested losses in subsequent corrections—purple areas below the orange dashed lines—even after the market low of March 2009.

Figure 5. Ongoing cash flows increase TLH opportunities



Notes: The cash flow timing is hypothetical and assumed for illustrative purposes. Potential TLH opportunities from reinvested distributions are not considered. *Past performance is no guarantee of future returns.*

Source: Vanguard calculations, based on data from Axioma.

7 Unused capital losses can be carried forward indefinitely to offset future capital gains and $3,000 of ordinary income per year. Any losses carried forward to future years retain their status as short or long term and must be used to offset any capital gains of the same type before they can offset a different type, according to *IRC 1212(b), Section 1222*. State tax treatment may differ from federal tax treatment.

8 Tax lot is a record that is created when a security is purchased; it contains detailed information on the date of purchase and the purchase price (cost basis). A unique tax lot is created for each unique combination of security purchased, purchase price, and purchase date. When a security is sold, the tax lot defines the relevant cost basis and duration of the investment to determine the appropriate tax consequences.

Capital gains available to offset

A dollar of capital loss harvested is only as good as a dollar of capital gain and the ordinary income up to $3,000 per year that it is used to offset.[9] Absent sufficient capital gains, loss harvests will not translate into tax savings. And without tax savings, there will be no additional cash flows to reinvest and no TLH benefit from compounding tax deferral. In the most extreme case, an investor would be left with only $3,000 of ordinary income to offset each year.

In this situation, the benefit of TLH is small for many investors with a sizeable taxable account. It is important to right-size the strategy so that the loss harvests roughly equal the capital gains expected over the course of the investment.[10] This is centrally important to having realistic expectations and implementing TLH correctly.

Right-sizing TLH

We encourage investors and their advisors to identify where TLH belongs in their wealth planning priorities and then set a level of aggressiveness to match the expected capital gains profile. To identify the correct scope of the strategy, investors should gain as much clarity into the following questions as possible:

Q1. *Where are the sources of anticipated capital gains over the investment horizon?*
Q2. *Given the sources identified, what is the future profile of expected capital gains?*

The answers will depend on the investor's profile, including levels of income and wealth and whether he or she is in the accumulation or divestment stage, and the complexity of the balance sheet—the variety and types of assets held. For example, a young investor with a modest level of wealth and a simple balance sheet—all wealth held in the primary residence, retirement accounts, and brokerage accounts—will tend to realize capital gains less frequently, in instances of target allocation changes and/or transactions on the primary residence.[11] On the other end of the spectrum, an ultra-high-net-worth investor in his or her early 60s with ownership interests in private businesses and non-primary real estate holdings may realize a sizeable amount of capital gains on a regular basis.[12]

Capital gains profile by net worth

In this paper, we anchor the expected profile of capital gains to the investor's level of net worth. Our approach is grounded in the nationally representative household balance sheet information in the Survey of Consumer Finances (SCF).[13] This survey is very suitable for identifying household level capital gains profile because it heavily oversamples high-income and high-net-worth households.

Table 1 presents high-level income and wealth information for American households grouped under net worth distribution, from the less-than-25th percentile to the top 2%.[14] It shows that meaningful capital gains start appearing when net worth is in the top 90th-to-95th percentile, with an average net worth of $1.65 million and equity holdings of $459,502.[15] As a share of all equity holdings, realized capital gains tend to increase with net worth, from 2.1% for the 90th-to 95th percentile to 4.9% for the top 2%. The likelihood of having capital gains in a given year also rises with net worth, from 28% of the households in the 90th-to-95th percentile to 57% in the top 2%. These patterns are consistent with earlier findings by Poterba (1999) who examined the 1994 wave of SCF for a similar purpose.

9 See *IRC Sections 165, 1211, and 1212*. See also *IRS Publication 550* (2018), Investment Income and Expenses, for information about netting short-term gains and losses.

10 The opportunity cost of unused loss harvests is not negligible. TLH is a relatively high-maintenance strategy that runs additional risks in the forms of tracking error, operational complexity, and compliance with the wash-sale rule regarding replacement securities.

11 Even on a primary residence, only capital gains in excess of $250,000 (single) or $500,000 (couple) are taxable. These exemption benefits are available once every two years on a primary residence the owner has occupied for at least two of the prior five years.

12 During "transition management" at midlife involving asset allocation and location changes—closing out of certain funds, reallocating funds within and among taxable and tax-qualified accounts—realized capital gains can be quite high temporarily. The loss reserves accumulated by TLH can effectively lower the cost of transition management. See Stein and Narasimhan (1999).

13 Sponsored by the Federal Reserve Board and administered by NORC of the University of Chicago, SCF is a repeated triennial cross-sectional study that is generally thought to have the best information on American households' balance sheets. See Campbell (2006), who compares the SCF with other publicly available sources.

14 See **Appendix 2** for details on how we define net worth groupings.

15 Equity holdings include all publicly traded equities held by the household in all financial accounts, including retirement savings such as 401(k), 403(b), and IRA accounts and brokerage accounts containing mutual funds, ETFs, and individual securities. Capital gains include capital gains realized from all sources, as reported in the household's tax document. See Appendix 2 for detailed definitions of SCF variables.

As net worth rises, the asset side of the balance sheet becomes more elaborate for many households; they tend to diversify their wealth in a greater number of investment types and vehicles (see Table 2). They are likely to hold a greater share of their wealth in nonfinancial instruments such as non-primary-residence real estate and/or private businesses. They also tend to hold more in nonretirement accounts, publicly traded equities, and directly owned individual securities. This explains why top-2%-net-worth investors are most likely to have capital gains, representing a greater share of their financial wealth.

Table 1. Wealth and capital gains of American households by net worth distribution (group averages)

	Wealth and income					Capital gains		
Net worth percentile	Net worth	Leverage	Income	Financial assets	Equity holdings	Capital gains	Capital gains/equity holdings	Share of households with positive capital gains
Less than 25	–$11,896	134%	$34,213	$4,665	$1,328	$5	0.0%	0%
25 to 50	44,667	38	50,789	19,169	5,841	123	0.3	1
50 to 75	204,056	26	74,916	80,949	30,283	240	0.5	4
75 to 90	659,155	13	113,573	319,615	136,715	2,090	0.9	13
90 to 95	1,647,987	10	203,377	890,947	459,502	9,663	2.1	28
95 to 98	3,331,341	6	312,385	1,902,584	1,042,609	19,270	2.4	41
Top 2%	16,200,000	3	1,201,097	7,403,956	4,374,559	183,828	4.9	57

Source: Vanguard calculations, based on the 2016 *Survey of Consumer Finances*.

Table 2. Balance sheets of American households by net worth distribution (group averages)

	Major asset components on balance sheet			Major components of financial assets				
Net worth percentile	Financial assets/ assets	Non-primary real estate/ assets	Private business/ assets	Retirement accounts/ financial assets	Liquid assets/ financial assets	Equity holdings/ financial assets	Individual stock holdings/ financial assets	Number of individual stocks
Less than 25	42%	1%	1%	11%	77%	6%	1%	0
25 to 50	26	2	1	28	56	16	1	0
50 to 75	28	4	3	41	42	27	2	0
75 to 90	41	7	5	50	27	36	4	1
90 to 95	49	11	9	49	18	47	9	4
95 to 98	54	12	13	45	17	50	9	6
Top 2%	50	12	25	29	16	54	15	13

Source: Vanguard calculations, based on the 2016 *Survey of Consumer Finances*.

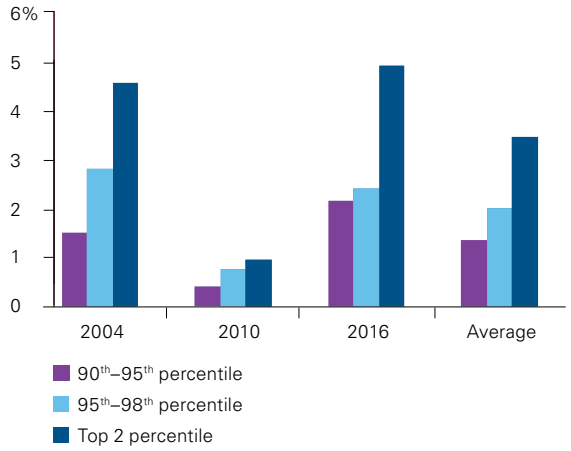
Typically, capital gains are realized in one of the following contexts: changes in and/or rebalancing to the target allocation through selling prior investments and allocating them to another investment vehicle, real estate transactions, and compensation from ownership in private businesses.[16] All three sources may be at work for the average top-2%-net-worth investor.

In addition to varying by net worth, capital gains realizations also tend to be procyclical. **Figure 6** shows statistics by net worth groupings for 2004, 2010, and 2016 and averages these three waves of the SCF. In 2010, reflecting the market crash in 2008–2009, both the likelihood and the amount of capital gains are dramatically lower than in 2016, the sixth year of a bull market. In downturns, asset returns for all risk assets—whether public or private, liquid or illiquid—tend to move together more closely, and generally downward. As a result, typical TLH investors will likely wait a number of years to realize sufficient capital gains to harvest losses from major downturns (see Figure 4).

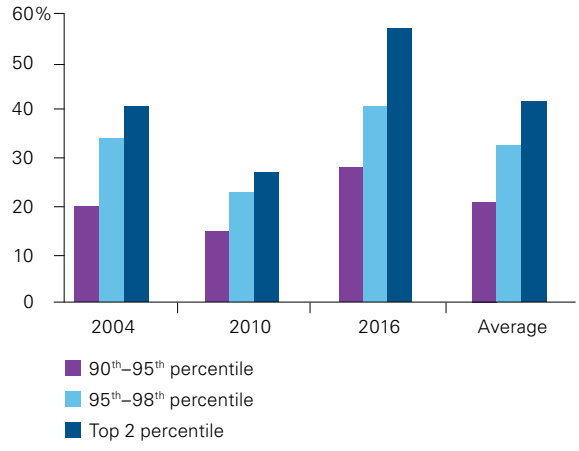
As shown in Figure 6, investors in the 90th-to-98th-percentile net-worth group should expect average capital gains realizations on the order of 1% to 2% of their total equity holdings, those in the top 2% should expect an average of about 3.5%, and investors below the 90th percentile should expect no meaningful capital gains. As we will show, capital gains profile plays a critical role in determining the size of expected TLH benefit, and it is of the utmost importance that we input a realistic expectation of capital gains profile in this analysis. Accordingly, we will pay close attention to the capital gains profile assumed or required to attain a certain level of TLH benefit in the remainder of this paper.

Figure 6. Capital gains realizations of American households by net worth distribution in 2004, 2010, and 2016

a. Capital gains realizations as share of total equity holdings, by net worth distribution



b. Share of investors with realized capital gains, by net worth distribution



Source: Vanguard calculations, based on the 2004, 2010, and 2016 *Survey of Consumer Finances*.

16 In 2016, 13.8% of American households owned additional residential property (with an average value of $358,200), 6.2% held equity in nonresidential property (average value $475,200), and 13% had equity in privately held businesses (average value $1,190,700). See Bricker et al. (2017).

Investor profile

Next, we conduct an empirical investigation of how the factors in Figure 3, grouped by investor profile and source of losses, determine TLH benefit. We start by quantifying the range of benefits for various investor profiles. Focusing on a few representative investor profiles, in the next section, we then track how this range varied by market volatility environment and granularity of investment universe.

We use the historical returns of the market-cap-weighted U.S. stock market from the beginning of 1982 to the end of 2019 to measure the potential value of TLH. This roughly 40-year period encompasses diverse market environments including the 1990s (known for the great moderation and the Roaring '90s), the dot-com bubble and burst in the early 2000s, the 2008–2009 great financial crisis, and the subsequent decade driven by highly accommodative monetary policy. Details of the empirical setup of our study are as follows.

- **Investment universe:** We use the top 400 securities by market capitalization contained in the Axioma US4 risk model to create a market-cap-weighted index portfolio, which is similar to a S&P 500 or Russell 3000 Index portfolio.[17] This index reconstitutes on the first day of each year, using market capitalizations as of the last day of the prior year. All analysis in this paper was based on this portfolio unless otherwise noted, as in the section on investment granularity, where we examine TLH benefit using individual securities. In that case, we use the constituents of the index directly.
- **Tax-loss harvest threshold:** We search for losses on a daily basis and harvest losses on tax lots that experience a loss of at least 10% of cost basis.[18]
- **Transaction cost:** We assume trading costs of 10 bps for all trading in any direction.[19] We do not assume a fixed trading commission as it has become rare in the marketplace.
- **Investment period:** We consider a 20-year investment period from January 2000 to December 2019 initially. Later, we consider 24 15-year rolling investment periods with starting years from 1982 to 2005.

Keeping the same setup in all cases, we vary the factors listed in **Figure 7** to consider a large variety of investor profiles.

Figure 7. Four components of investor profiles

Cash flow	Capital gains
We consider six types of cash flow profile. All investors invest a total sum of $500,000 in the taxable account over the investment horizon, with the following differences: • A lump-sum investor makes a one-and-only initial investment. • Four other types make regular contributions ranging from 2.5% to 10%—in increments of 2.5%—of the initial investment per year. • A fully constant-dollar-averaging investor makes the same investment every quarter.	We assume seven levels of realized capital gains available every year for loss harvest to offset: • 0% to 5%—in increments of 1%—of the taxable portfolio balance. • Unlimited realized capital gains, so any level of loss harvest will be offset.
Liquidation	**Tax rates**
We consider five levels of liquidation of the taxable portfolio at the end of the investment horizon: 0% to 100% in increments of 25%.	We consider all combinations of two separate sets of taxes for the time of harvesting and the time of liquidation:[20] • Harvesting tax rate: 12%, 24%, 37%, and 48%. • Liquidation tax rate: 0%, 15%, 23.8%, and 34.8%.

Source: Vanguard.

17 In this study, we focus on tax-loss harvesting with a long-only portfolio with exposure to the market-cap-weighted U.S. stock market—the most common scenario. However, the potency of TLH can be enhanced within long-short or 130/30 portfolios. For literature on this theme, see Means (2002), Farr (2004), Berkin and Luck (2010), and Sialm and Sosner (2018).

18 Our baseline assumption is daily harvesting with a 10% threshold. We considered other thresholds and found no economic difference using any lower value. Those above 10% had a lower TLH benefit because of fewer loss realization opportunities.

19 In an unreported analysis, we examined higher transaction cost assumptions—20 bps and 30 bps—which resulted in a slightly lower TLH benefit. The greatest difference appeared when loss harvesting would have required trading in historic downturns such as the dot-com bust and the 2008–2009 great financial crisis, periods in which intraday volatility was elevated and transaction cost assumptions were higher.

20 Assuming the current tax system, these eight rates are selected to provide a comprehensive coverage of most rates investors would have faced. They include the highest federal tax rate and an 11% state tax rate, approximating the highest level available. For the two highest liquidation rates—23.8% and 34.8%—we also include net investment income tax of 3.8%, capturing the surtax introduced with the passing of the Health Care and Education Reconciliation Act of 2010. We consider all 16 pairs of harvesting and liquidation tax rates. Some of them are unlikely for many investors; for example, a harvesting rate of 48% and a liquidation rate of 0% at the end of the investment horizon. However, we include them because they allow us to sharply quantify the role of tax rates in driving TLH benefit.

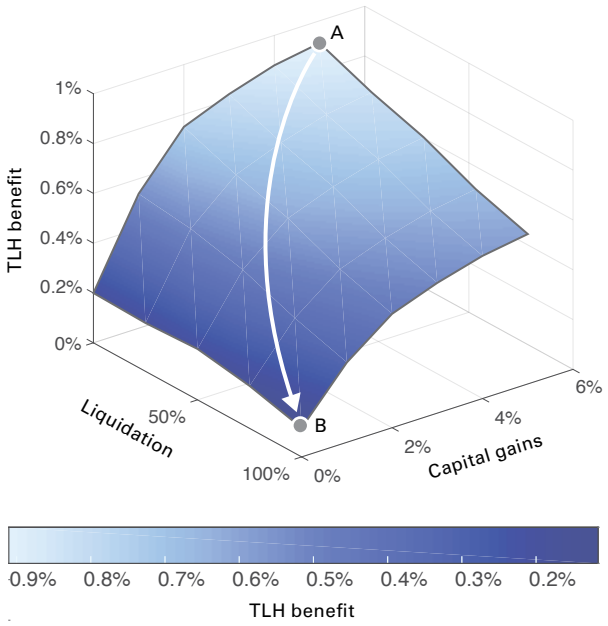
We begin with an investor who makes 5% regular contributions after the initial investment, with a harvesting tax rate of 37% and a liquidation tax rate of 23.8%. With two of the four factors from Figure 7—cash flow and tax rates—determined, we now vary the values of the remaining two factors, capital gains and liquidation, and show how they jointly determine TLH benefit in **Figure 8**.

Each point represents the TLH benefit[21] arising from that unique combination of capital gains and liquidation assumptions. Point A is the maximum TLH benefit of 85 bps, with the combination of no liquidation and 5% capital gains available to offset losses. That 5% is a rare case, relatable only to above-average capital gains even within the top-2%-net-worth group, which has an average of 3.5% available. In addition, it requires the most efficient handling of taxable portfolio gains.

Point B indicates the minimum TLH benefit of 9 bps, with the combination of full liquidation and 0% capital gains available to offset losses. This is another extreme, but one likely more common at all levels of net worth when only $3,000 of ordinary income is available to offset. The rest of the possible values for TLH benefit appear as we move from point A to B, all between the maximum of 85 bps and the minimum of 9 bps.

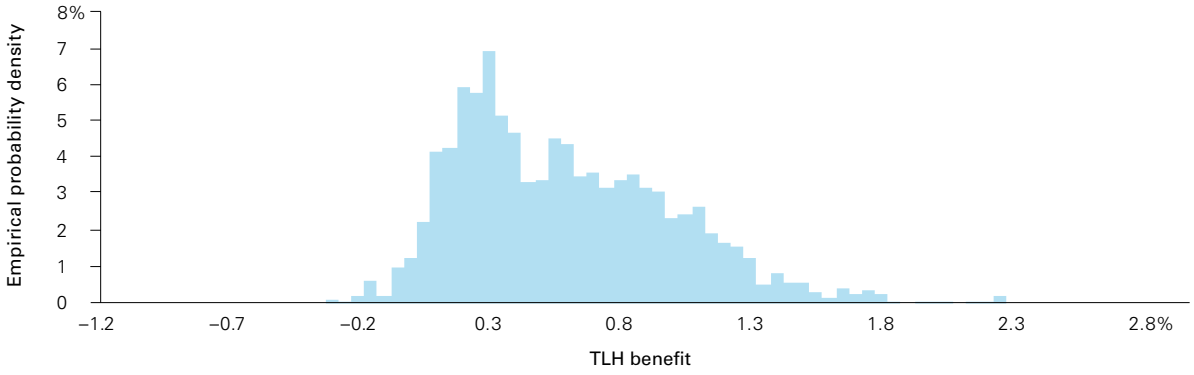
Although the figure illustrates how TLH benefit changes in response to changes in two key factors, it is limited in the number of cases and the breadth of findings it can capture. Based on the various levels we set for each factor in Figure 7, there are 3,360 separate investor profiles,[22] too many to adequately capture the underlying dynamics visually with figures such as Figure 8. Furthermore, as shown in **Figure 9**, the 3,360 cases lead to a wide range of benefits, ranging from –20 bps to 220 bps, driven by other factors we did not vary in Figure 8.

Figure 8. TLH benefit for investor with 5% recurring cash flow and tax rates of 37% and 23.8%



Source: Vanguard.

Figure 9. Empirical distribution of TLH benefits in 3,360 cases, 2000–2019



Source: Vanguard.

21 TLH benefit is calculated as the difference in internal rate of returns (IRR) of the baseline portfolio without tax-loss harvesting and the portfolio with TLH. IRR allows us to have an apples-to-apples comparison even though they have different cash flows over time.

22 Six cash flow profiles x 7 capital gains profiles x 5 liquidation levels x 16 tax-rate profiles.

To understand how all of the main factors drive TLH benefit, we regress 3,360 TLH benefits—shown in Figure 9—on four variable groups:[23] cash flow, capital gains, liquidation, and tax rates. At the outset, we note that this regression analysis is not deployed as a means of assessing a hypothesis empirically—the most common context in which regressions are used in empirical work. Instead, we use the regression results to quantify the impact of each factor in the presence of others in a succinct and integrated fashion.

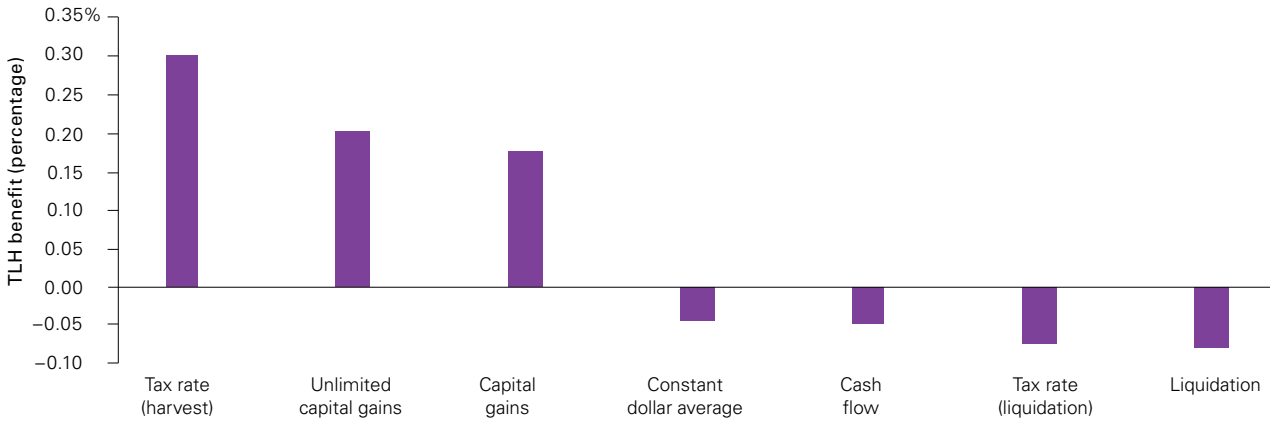
This regression has an R^2 of 83%. The marginal effect of each variable, shown in **Figure 10**, represents how a one-standard-deviation increase in the explanatory variable translates into the change in TLH benefit based on the average of the 3,360 cases. For instance, a one-standard-deviation differential from the average effective tax rate when the loss is harvested is associated with a 30-bps increase in annualized TLH benefit.

The results show that, for the 20-year investment period from 2000 to 2019, the biggest driver of TLH benefit was the effective tax rate at the time of harvest, with a marginal effect of 30 bps, followed by the two capital gains variables, unlimited capital gains (dummy variable) and capital gains (continuous variable), which had marginal effects of 20 bps and 17 bps.[24] Future tax rate had a marginal effect of –7 bps, and liquidation had a negative marginal effect of –8 bps, all consistent with our hypothesis in Figure 3.

Somewhat surprising, however, is the negative effect of greater diversification of cash flows, captured by the variables cash flow (continuous variable) and constant-dollar averaging (dummy variable), whose marginal effects are both around –5 bps. This stems from the particularity of the 2000–2019 market environment. Those starting their 20-year investment in 2000 experienced a once-in-a-decade-type market crash in the dot-com bust that started in March of that year. This created an unusually conducive environment for TLH strategy, because these investors would have been able to immediately harvest large amounts of losses shortly after their initial investment, generating streams of tax savings and reinvestment for years to come. Given this sequence, a lump-sum investment in the beginning of 2000 would have led to the greatest amount of losses harvested.

On the other hand, for those with greater cash flow diversification, the limited amount of capital invested in the beginning would have led to smaller losses to harvest. While we believe that Figure 10 provides an accurate summary of how the factors contributed to TLH benefit over the 2000–2019 period, we are much less confident that this represents future dynamics of TLH benefit, particularly different volatility environments.

Figure 10. Marginal effects of key factors on TLH benefit



Source: Vanguard.

23 All but liquidation have two variables. Cash flow is a continuous variable taking on values between 0% to 10%, and constant-dollar averaging is a dummy variable. Capital gains is a continuous variable that takes on values between 0% to 5%, and unlimited capital gains is a dummy variable. Tax rate variables are present tax rate (at the time of harvest) and future tax rate (at the time of liquidation). See **Appendix 3** for details.

24 Capital gains capture the impact of a unit increase in capital gains at the average value of 2.5%; unlimited capital gains capture the impact of having unlimited capital gains over the average value. The two cash flow variables can be interpreted similarly. See Appendix 3 for details.

Source of losses

In this section, we show how the TLH benefit depends on the underlying source of losses. First, continuing with the scenario in which investors engage in TLH via pooled investment funds and exploit time-series volatility as the sole source of losses, we examine how the benefit changed over 24 rolling 15-year periods beginning each year from 1982 to 2005. We then extend this analysis to the case in which investors pursue the strategy with individual securities, whereby they can exploit both time-series and cross-sectional volatility.

Market volatility environment

As mentioned earlier, the range of TLH benefits shown in Figure 9 likely arose from the particularity of the volatility environment between 2000 and 2019. This opportune condition is unlikely to be the experience of many investors.

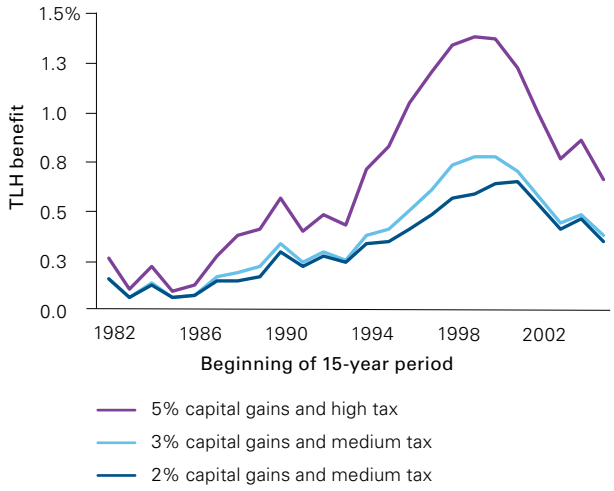
To understand TLH benefit in other conditions, we extend the sample period to include an additional 18 years, from 1982 to 2000. This period started with the Volcker disinflation of 1983 and ended with the Roaring 1990s bull markets spanning nearly two decades of an unusually benign macroeconomic environment, with generally low volatility and no market crashes or severe bear markets. This type of environment can serve as the antithesis of the tumultuous years 2000–2019 and can reveal the efficacy of TLH when time-series volatility is more muted.

Figure 11 shows how TLH benefit evolves over 24 overlapping 15-year periods between 1982 and 2019 for three types of 5%-cash-flow investor profiles with no liquidation: 5% capital gains available to offset losses, 37% harvesting tax rate, and 23.8% liquidation tax rate; 3% capital gains available, 24% harvesting tax rate, and 15% liquidation tax rate; and 2% capital gains available, 24% harvesting tax rate, and 15% liquidation tax rate. All remaining analyses focus on the 15-year investment period—five years shorter than those investigated in the previous section—since it allows us to assess the impact of various market volatility environments on TLH benefit more clearly.

Figure 11 provides two high-level observations. First, the rolling TLH benefit indeed peaks for the 15-year period starting in 2000 for all investors, confirming that it likely resulted from fortuitous timing and and may not be relied upon to recur going forward. Second, while TLH benefit shows a relatively steep decline before and after 2000, it is particularly low for starting years between 1982 and 1993—especially for the two investor profiles with more realistic capital gains assumptions of 3% and 2%—because of the generally uninterrupted bull markets of the 1980s[25] and 1990s. Absent major downturns, TLH strategy relying on time-series volatility had difficulty generating losses. These muted benefits reveal the limits of fund-based TLH in low-volatility market environments.

To further quantify the impact of a changing volatility environment and its interaction with other investor profile variables, we select eight 15-year periods starting in years 1982, 1985, 1988, 1991, 1994, 1997, 2000, and 2003. These years capture diversity in volatility environment, which we capture by standard deviation of monthly returns from each 15-year period.

Figure 11. Volatility environment is a major driver of TLH benefit



Source: Vanguard.

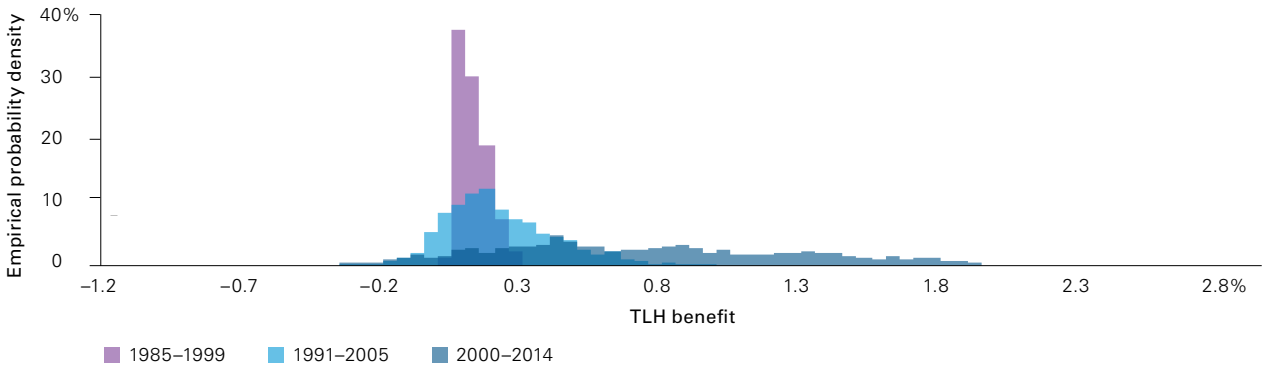
25 A notable exception is the crash on Black Monday, October 19, 1987, when the market dropped over 20% in one trading session. To take meaningful advantage of this decline, however, a TLH investor would have needed a well-timed cash flow around the crash, investing meaningful portions of his or her investment between June and October of 1987. This is because the run-up in the market leading up to Black Monday was very rapid—with the market appreciating by over 13% in three months prior to Black Monday—and, subsequent to the crash, the market did not stay near the nadir for long, finishing 1987 slightly above where it had started in the beginning of the year.

Building on the 3,360 investor profile combinations from Figure 7, we now add the variables of volatility as defined above and volatility interacted with the cash flow variables. Also, in addition to daily harvesting, we examine two other frequencies—monthly and quarterly. This results in a total of 80,640 unique volatility environment/investor profile/harvesting frequency combinations.

The 80,640 cases shown in **Figures 12a** and **12b** contain a bewilderingly wide range of TLH benefits and equally heterogeneous benefit distributions by volatility environment. Figure 12a shows three empirical distributions in three different environments—1985–1999, 1991–2005, and 2000–2014. The investment outcome would have been markedly different in each period for any TLH investor. Notably, in 2000–2014, differences in investor profile would have led to very large differences in outcome.

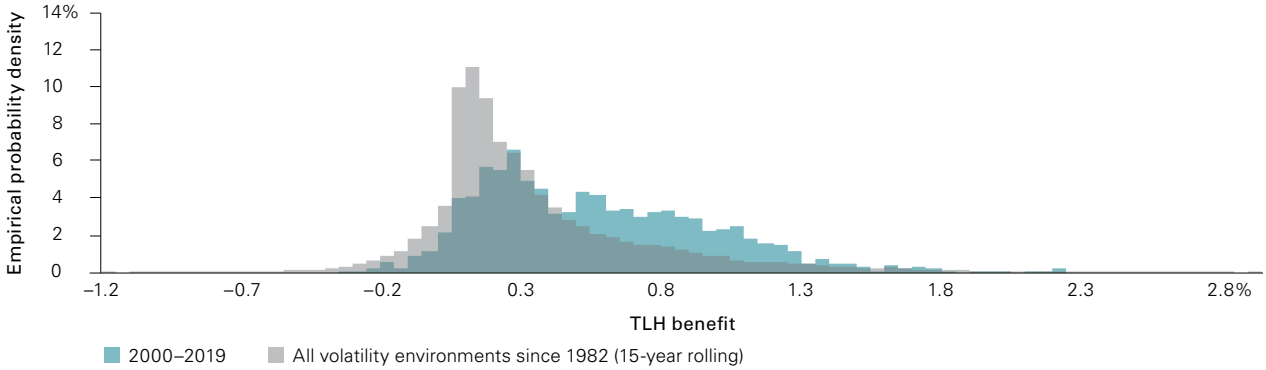
Figure 12b juxtaposes the 2000–2019 TLH benefit distribution (reproduced from Figure 9) and the pooled distribution of benefits from all eight 15-year periods. Because it again shows that the 20 years starting in 2000 generated an anomalous outsized benefit, we are concerned about recent empirical studies that rely solely on this period.[26] Expectations anchored narrowly to the post-2000 outcome can be quite inflated.

Figure 12a. Empirical distributions of TLH benefits in three volatility environments



Source: Vanguard.

Figure 12b. Empirical distributions of TLH benefits in 2000–2019 versus periods since 1982



Source: Vanguard.

26 See, for example, Wealthfront Corporation (2019) and Betterment.com (2014).

Figure 13 shows the results of our regression analysis.[27] With marginal effects of 25 and 22 bps, the two interaction variables between cash flow and volatility are the biggest drivers of TLH benefit. Intuitively, this shows that greater cash flow diversification can add significant benefit to TLH if it coincides with a higher volatility environment. At 14 bps of marginal effect, the volatility environment alone also denotes considerable benefit.

Of course, there is a flip side to the potency of volatility. For investors starting their strategy in the vicinity of major downturns, diversification in cash flow without the benefit of high volatility detracts from the benefit, as shown in the marginal effects of constant-dollar averaging and cash flow. This is consistent with the earlier findings shown in Figure 10, as are the marginal effects of all other variables.

The result of this analysis can also be used as a forecasting tool. We can input a given investor profile and volatility environment in the estimated regression equation[28] and obtain a forecast of the benefit of pursuing TLH under those assumptions.[29]

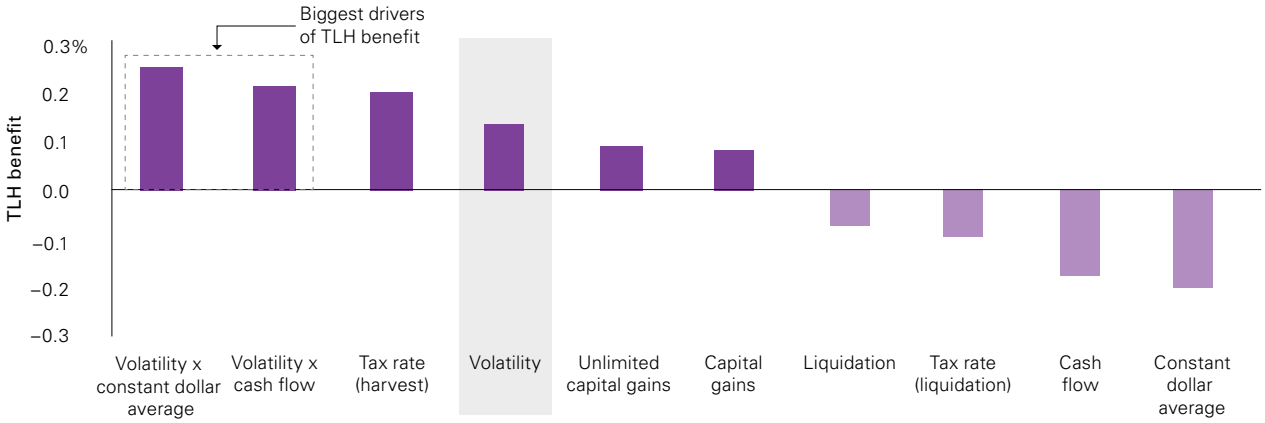
For example, consider an average volatility environment of 18% and an investor whose applicable current and future tax rates are 35% and 20%, with a capital-gains-to-total-equity-holdings ratio of 1.3% in an average year, who is able to invest 5% of the initial investment regularly, harvests daily with a 10% loss threshold, and liquidates 50% of the taxable account after 15 years of investment.

The resulting TLH benefit is 49 bps, with the 99% confidence interval between 0 bps and 98 bps.[30] Interested investors can obtain a wider (and likely more robust) range of expected benefits by repeating this exercise with a number of different input values, bearing in mind that the volatility assumption will be a critical driver.

Investment granularity

Investors pursuing TLH with individual securities can exploit cross-sectional volatility and potentially generate greater amounts of losses than by solely relying on market downturns. If they have capital gains in excess of the losses from time-series volatility alone, they can translate additional losses into potentially greater benefit.

Figure 13. Marginal effects on TLH benefit of key factors including volatility environment



Source: Vanguard.

27 See Appendix 3 for regression details.

28 See **Equation 4** in Appendix 3.

29 The input variables of investor profile and volatility environment would be within the ranges we have used to generate the 80,640 cases used in the estimation. Thus, the forecasted quantity is primarily an interpolation of the TLH benefits and associated investor profile/volatility environments we have considered.

30 See Appendix 3 for details on how we obtain this confidence interval.

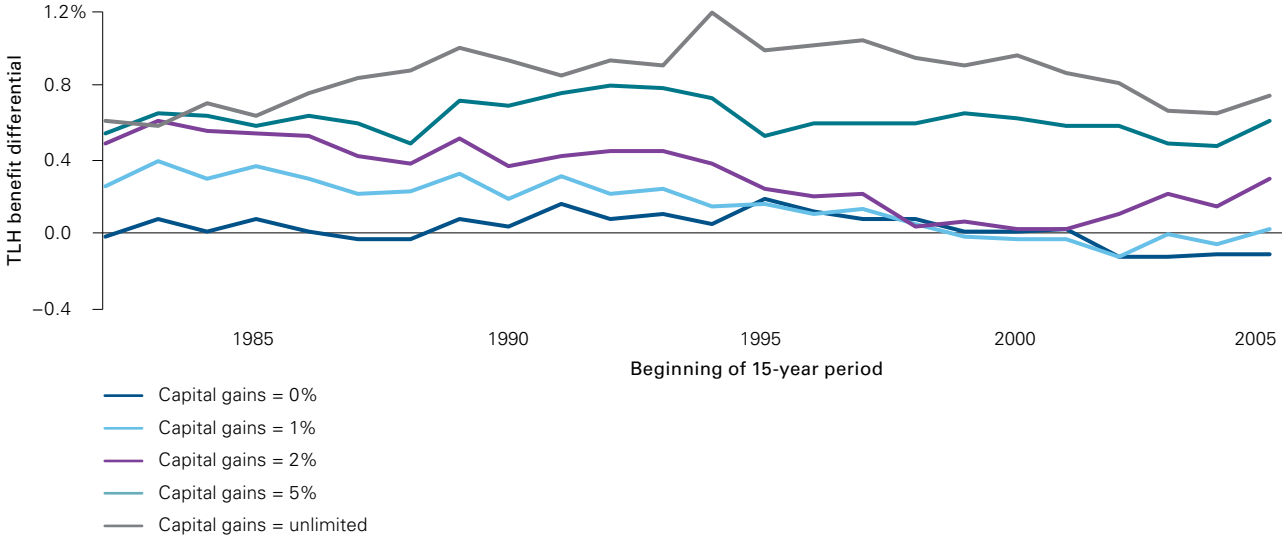
While passive investment has gained much traction in the past decade, American investors—especially those with high net worth—still hold a significant portion of their liquid wealth in individual securities[31] in addition to broadly diversified funds. As such, many of these investors will have some ability to engage in TLH using these securities if cross-sectional volatility leads to losses in some of them. Top-net-worth investors, who tend to own many individual securities,[32] are more likely to experience such losses. Extending this logic to the extreme, consider an investor who gains all of his or her equity exposure through direct ownership of individual securities.

To quantify the benefit of TLH with only individual securities (IS-TLH), we repeat the main analysis shown in Figure 11 using the individual constituents of the same index portfolio. In this case, the investor holds these stocks in exact proportion to their market-cap weights and rebalances at the same time as the index. We assume that, in the event of a sale to realize losses on an individual security, a "perfect" identical replacement security can be purchased on the same day.[33]

Figure 14 compares the IS-TLH benefit with the fund-based benefit for the common investor profile from Figure 11—with 5% cash flows, a 37% harvesting marginal capital gains tax rate, a 23.8% of liquidation marginal capital gains tax rate, and 50% liquidation at the end—under five levels of capital gains: unlimited, 5%, 2%, 1%, and 0%.[34] Under a 2% capital gains assumption, this investor would experience an average 30 bps increase in TLH benefit on average over the 24 overlapping periods.

The improvement under IS-TLH changes in different volatility environments. For the first 12 rolling periods—with starting years between 1982 and 1993—the average improvement was 46 bps, versus 16 bps for the latter 12 periods. The main benefit of IS-TLH is its ability to generate losses in relatively stable appreciating markets like the first 12 periods, when the ability to generate losses exploiting cross-sectional volatility plays a more prominent role because of the general lack of time-series volatility.

Figure 14. IS-TLH can add value over fund-based TLH, especially when volatility is low



Source: Vanguard.

31 In 2016, 14% of American households owned individual stocks directly. See Bricker et al. (2017) and Table 2 of this paper.

32 See Table 2 for details.

33 We allow only one replacement security: Upon using it for TLH, investors in our algorithm would need to wait for 31 days to be able to trade without violating the wash-sale rule. See Appendix 1 for details.

34 This is an illustrative example rather than a specific case as tax rates applied to income and capital gains changed several times over this horizon. We have abstracted away from possible interactions between tax rate changes and realized equity returns in our analysis. However, the structure of our empirical approach allows a variety of different tax regimes to be considered in estimating potential TLH benefit by varying the harvesting and liquidation tax rates.

We conclude this section by deliberating on the type of investor and volatility environment where different modes of TLH are likely to be most suitable. Figure 14 shows that IS-TLH may add considerable value for the average top-2%-net-worth investor, especially when time-series volatility is subdued, as in the salient bull market of the 1990s. Investors in this group frequently realize appreciable capital gains, on the order of an average 3.5% per year.

On the other hand, the average investor in the 90th to 98th percentile, with capital gains of about 1.3% to 2% realized more infrequently (see Figure 6), will likely be able to generate enough losses with fund-based TLH alone in the presence of moderate time-series volatility and some cash flow diversification (see Figure 4). The average investor with net worth below the 90th percentile may receive little additional benefit from pursuing TLH, other than offsetting $3,000 in ordinary income, because this group seldom has capital gains, and when it does, they are often small.[35]

To summarize, we see a potentially strong case for TLH for investors with net worth above the 90th percentile of $1.19 million, most of whom would be well-served by fund-based TLH alone. IS-TLH could additionallly benefit the average top-2% investor—with a minimum total net worth of $5.31 million—if the market experiences sustained low volatility.

Conclusion

What is the value of tax-loss harvesting for individual investors? In this paper, we showed that its potential benefit can be as wide-ranging as the panorama of investor types and wealth profiles. One size does *not* fit all, because many of the key factors determining TLH benefit—capital gains profile, present and future tax rates, and the type of role the taxable account plays in an overall portfolio—vary for different investors.

Of all the drivers of TLH benefit quantified in this paper, we found the availability of external capital gains to be of central importance in determining an appropriate strategy. Without external capital gains to offset loss harvests, TLH becomes a narrow strategy that reduces only $3,000 of ordinary taxable income annually.

Our exhortation for investors interested in TLH is to incorporate their decision in a holistic wealth and tax-planning discussion with their advisor and determine the optimal approach *specific* to their financial situation. By developing a strategy in line with the profile of capital gains they can reasonably expect in the future, investors can use TLH to help improve their after-tax return to its full potential.

35 Lower-net-worth investors who only use losses to offset $3,000 of ordinary income may see a somewhat higher after-tax performance benefit for their overall portfolio. For example, someone with $25,000 in taxable assets in the 24% income tax bracket could generate tax savings of $720 ($3,000*24%), or 2.9% of the current portfolio value. Although a 35%-tax-rate investor with $1 million dollars would generate more tax savings ($1,050), such benefit would be a much lower percentage (0.105%) of the total portfolio.

References

Arnott, Robert D., Andrew L. Berkin, and Jia Ye, 2003. Loss Harvesting: What's It Worth to the Taxable Investor? *Journal of Wealth Management,* 3(4): 10–18.

Atwill, Tim, Rey Santodomingo, and Martha Strebinger, 2017. *The Value of Tax Alpha*. Parametric Portfolio Associates LLC.

Berkin, Andrew L., and Christopher G. Luck, 2010. Having Your Cake and Eating it Too: The Before- and After-Tax Efficiencies of an Extended Equity Mandate. *Financial Analysts Journal*, 66(4): 33-45.

Berkin, Andrew L., and Jia Ye, 2003. Tax Management, Loss Harvesting, and HIFO Accounting. *Financial Analysts Journal*, 59(4): 91–102.

Betterment.com, 2014. Tax Loss Harvesting+™ Methodology, available at https://www.betterment.com/resources/tax-loss-harvesting-methodology/#results.

Bricker, Jesse, Lisa J. Dettling, Alice Henriques, Joanne W. Hsu, Lindsay Jacobs, Kevin B. Moore, Sarah Pack, John Sabelhaus, Jeffrey Thompson, and Richard A. Windle, 2017. *Changes in U.S. Family Finances from 2013 to 2016: Evidence from the Survey of Consumer Finances.*

Campbell, John, 2006. Household Finance. *Journal of Finance*, 61(4): 1553-1604.

Chaudhuri, Shomesh and Burnham, Terence C. and Lo, Andrew W., 2020. An Empirical Evaluation of Tax-Loss Harvesting Alpha. *Financial Analysts Journal*, 76(3): 99-108.

Constantinides, George M., 1984. Optimal Stock Trading With Personal Taxes: Implications for Prices and the Abnormal January Returns. *Journal of Financial Economics*, 13(1): 65–89.

Dammon, Robert M. and Chester Spatt, 1996. The Optimal Trading and Pricing of Securities with Asymmetric Capital Gains Taxes and Transaction Costs. *Review of Financial Studies*, 9(3): 921–952.

Davidson, R. and J. MacKinnon. Econometric Theory and Methods, Oxford University Press, 2003.

Dickson, Joel M., John B. Shoven, and Clemens Sialm, 2000. Tax Externalities of Equity Mutual Funds. *National Tax Journal*, 53(3): 607–628.

Farr, Dorsey D., 2004. The Long and Short of Tax Efficiency. *Journal of Wealth Management*, 6(4): 74–79.

Means, Kevin, 2002. A Proposal for Tax-Efficient Active Equity Investing: Active Long Portfolio = Index Portfolio + Market Neutral Portfolio. *Journal of Wealth Management*, 5(3): 57–66.

Poterba, James M., 1999. Unrealized Capital Gains and the Measurement of After-Tax Portfolio Performance. *Journal of Wealth Management*, 1(4): 23-34.

Sialm, Clemens, and Nathan Sosner, 2018. Taxes, Shorting, and Active Management, *Financial Analysts Journal*, 74(1): 88–107.

Stein, David M., Hemambara Vadlamudi, and Paul W. Bouchey, 2008. Enhancing Active Tax Management Through the Realization of Capital Gains. *Journal of Wealth Management*, 10(4): 9–16.

Stein, David M., and Premkumar Narasimhan, 1999. Of Passive and Active Equity Portfolios in the Presence of Taxes. *Journal of Wealth Management*, 2(2): 55–63.

Wealthfront Corporation, 2019. *Wealthfront's Stock-Level Tax-Loss Harvesting*, available at https://research.wealthfront.com/whitepapers/stock-level-tax-loss-harvesting/#8-backtested-results.

Appendix 1. Tax-loss harvesting algorithm and assumptions

The algorithm used in this research conducts tax-loss harvesting over specific time horizons, using a portfolio of funds or individual securities with corresponding sets of returns as inputs. Its flexible logic allows for various assumptions about harvest frequency, thresholds for loss harvesting, profile of available capital gains, applicable tax rates, portfolio size, pattern of recurring cash flows into the portfolio, transaction costs, and asset allocation. See Figure 7 for details on how we vary many of these assumptions in this paper.

The model steps through time, updating individual tax lot holdings of all positions in the portfolio with associated returns. Dividends are maintained in a separate cash account and reinvested at the end of each quarter. The algorithm scans all individual positions to determine which to sell for a loss, on an individual tax lot basis, at any frequency between daily and yearly.[36]

Cumulative loss harvests are used at the end of each calendar year to offset $3,000 of ordinary income and any capital gains assumed to be available, and these tax savings are reinvested into the portfolio. Unused losses are carried forward to the subsequent calendar year. At the end of the investment horizon, a specified share of the portfolio is liquidated and tax-adjusted; if less than 100% of the portfolio is liquidated, subject to maintaining the allocation (primarily in the context of IS-TLH), tax lots with the smallest capital gains per share are liquidated first.

The algorithm uses the following assumptions:

- Securities cannot be repurchased for at least 31 days following a harvest because of the wash-sale rule. The model will not generate washed sales.
- All securities are assumed to have an identical replacement security in which proceeds from a sale may be reinvested without violating the wash-sale rule. This assumption will reduce the tracking error typically associated with TLH. However, we assume there is only one such replacement security. If it continues to fall below the harvest threshold shortly after the initial harvest, the replacement security cannot be sold for another loss without violating the wash-sale rule until 31 days have passed from the initial harvest date.
- Securities that received dividends are assumed to have been held for a minimum of 61 days to ensure that the dividends received qualified status.[37]

36 A number of studies have shown the importance of accounting method in after-tax returns when tax-loss harvesting. See Dickson et al. (2000) and Berkin and Ye (2003) for examples. Our algorithm is consistent with the HIFO (highest in, first out) account method because it realizes losses on an individual tax lot basis, with a threshold of 10%.

37 Under IRS rules, qualified dividends are dividends that meet certain requirements, including a minimum holding period, to be taxed at the lower long-term capital gains tax rate rather than ordinary income tax rates.

Appendix 2. The Survey of Consumer Finances

The data sample analyzed in this paper comes from the 2004, 2010, and 2016 waves of the Survey of Consumer Finances (SCF). Its annual sample size ranges from roughly 4,500 to 6,500 households. All variables are measured for the full calendar year preceding the survey year; for example, the 2016 wave is based on information from the 2015 calendar year. All dollar amounts are adjusted to 2016 dollars. All summary statistics are calculated using the survey's weights.

The variables used in Tables 1 and 2 and Figure 6 are primarily from Bricker et al. (2017), as are our terms and definitions.[38] Net worth is defined as the difference between the household's gross assets and liabilities. Leverage is defined as a ratio of the total of all debts over the total of all assets. Income is the total amount the household received from all sources, before taxes and other deductions. Capital gains is the total annual income from gains obtained from the sale of mutual funds, stocks, bonds, or real estate, before taxes and other deductions.

Financial assets is defined as the sum of all assets held by the household in transaction accounts, certificates of deposit, directly held pooled investment funds, directly held stocks, directly held bonds, retirement accounts, cash value life insurance, and other managed assets. Equity holdings are all financial assets invested in stock, both directly and indirectly, including directly held stocks, shares of pooled investment funds in stock, shares of retirement accounts in stock, and other accounts that hold stocks or have equity exposure.

Liquid assets are the sum of assets held in transaction accounts and certificates of deposit. Non-primary real estate is the sum of other residential property and nonresidential real estate. Private business is business equity, net worth in sole proprietorships, limited partnerships, S corporations, limited liability companies, and other types of private businesses. Number of individual stocks represents the number of distinct companies whose publicly traded stocks are directly held by the survey respondent. Individual stock holdings represent the dollar value of the total of all directly held stocks.

Reporting errors are likely to result in extreme values when computing various ratios on the balance sheet, as in Tables 1 and 2. Care is taken to prevent these extreme values from unduly influencing the group averages. Specifically, we Winsorize leverage when the raw value is above 5, or 500%, which represents about the top 2.5% of the distribution. The capital-gains-to-equity ratio is Winsorized at 1% on both ends of the distribution.

For each household in the survey, the SCF provides a categorical variable "nwcat" that takes on one of the five integers from 1 to 5, corresponding to the net worth distribution group membership as follows: 1 for below-25th-percentile net worth, 2 for 25th-to-50th percentile, 3 for 50th-to-75th percentile, 4 for 75th- to-90th percentile, and 5 for above 90th percentile.

To gain more granular insights into the top-10%-net-worth households, we further break the top 10%—all households with the initial nwcat value of 5—into three groups based on the conditional median and mean values of the group's net worth: 5 for above the 90th percentile and below the median net worth of the group, 6 for above the median and below the mean, and 7 for above the mean. The households with nwcat value of 5 now represent the 90th-to-95th percentile in net worth distribution. The households with nwcat value of 6 belong to the 95th-to-approximately-98th percentile, while those with nwcat value of 7 are in the top 2%.

38 For details of the variables we do not define above, see *Appendix: Survey Procedures and Statistical Measures* in Bricker et al. (2017).

Appendix 3. Regression results

We run two regressions, shown in **Equations 3** and **4** below. The Equation 3 analysis uses 3,360 investor profiles, based on varying inputs for the listed explanatory variables (see Figure 7) over a 20-year period from 2000 to 2019, all based on daily loss harvesting.

Equation 3.

$$Benefit_{TLH_A} = \beta_1 HT + \beta_2 UCG + \beta_3 CG + \beta_4 CDA + \beta_5 CF + \beta_6 LT + \beta_7 LIQ + \varepsilon \quad (3)$$

HT is the effective harvesting tax rate. *UCG* is a dummy variable for the unlimited capital gains available at the end of every calendar year. *CG* represents the amount of capital gains available for offsetting loss harvest defined as a portion of portfolio wealth.[39] *LT* represents the effective liquidation tax rate. *CDA* is a dummy variable for the constant-dollar-averaging cash flow profile, in which a constant dollar amount is invested every quarter throughout the investment. *CF* represents the amount of quarterly cash flow invested in the portfolio as a portion of the initial investment amount. *LIQ* represents the portion of the portfolio that was liquidated at the end of the investment horizon.

In Equation 4, we extend the regression analysis to include multiple volatility environments and harvesting frequencies. We shorten the investment horizon to 15 years and include monthly and quarterly harvesting as well as daily, which yields 80,640 cases.

Equation 4.

$$Benefit_{TLH_B} = \beta_1 Vol*CDA + \beta_2 Vol*CF + \beta_3 HT + \beta_4 Vol + \beta_5 UCG + \beta_6 CG + \beta_7 Mon + \beta_8 Day + \beta_9 LIQ + \beta_{10} LT + \beta_{11} CF + \beta_{12} CDA + \varepsilon \quad (4)$$

Vol represents the annualized volatility of the market-cap-weighted benchmark portfolio's monthly returns realized in a 15-year period. *Mon* is a dummy variable for harvesting losses monthly. *Day* is a dummy variable for harvesting losses daily. *Vol*CF* is the interaction variable between volatility and cash flow. *Vol*CDA* is the interaction variable between volatility and the dummy variable for constant-dollar-averaging cash flow.

Table A-1 reports regression results along with the standard deviations of the explanatory variables. T-statistics based on White robust standard errors are in brackets. All explanatory variables are significant at 1%.

The results obtained from Equation 4 can be used to forecast TLH benefit by inputting investor profile and volatility environment as coefficients. The standard error of this forecast is quantifiable[40] and can be used to articulate the benefit's likely range.

For example, consider an average volatility environment with Vol equal to 18% and a common investor profile for the 90th-to-95th-percentile-net-worth household, with (*HT, LT, CG, UCG, CF, CDA, Mon, Day, and LIQ*) being (35%, 20%, 1.3%, 0, 5%, 0, 0, 1, and 50%). This profile describes an investor with harvesting and liquidation tax rates of 35% and 20% who has a capital-gains-to-total-equity-holdings ratio of 1.3% in an average year, is able to invest 5% of the initial investment regularly, harvests daily with a 10% loss threshold, and liquidates 50% of the taxable account after 15 years of investment. The resulting forecast of TLH benefit is 49 bps, with a 99% confidence interval of 0 bps, 98 bps.

39 Investor profiles with a *UCG* value of 1 have unlimited capital gains, and their *CG* value is set to 0. Investor profiles with a *CDA* value of 1 have a constant-dollar-averaging cash flow profile, and their *CF* value is set to 0. The baseline capital gains and cash flow profiles are those with 0% capital gains available (*CG* = 0 and *UCG* = 0) and a lump-sum cash flow (*CF* = 0 and *CDA* = 0), against which we measure the marginal effects.

40 The variance of the forecast $X_s\hat{\beta}$ is approximately $\hat{\sigma}^2 + \hat{\sigma}^2 (X_s (X^T X)^{(-1)} X_S^T)$, where $\hat{\sigma}^2$ represents the sample variance of the regression residuals, X is a $N \times K$ matrix representing N rows of sample observations and K columns of explanatory variables, X_s represents a length- K column vector of specific values of the explanatory variables input to generate the forecast, and $\hat{\beta}$ represents a length- K row vector of regression coefficients. The first term of the forecast variance, $\hat{\sigma}^2$, captures the variability not captured by the regression, while the second term, $\hat{\sigma}^2 (X_s (X^T X)^{(-1)} X_S^T)$, captures the variability that arises from using statistical estimates of the coefficients, $\hat{\beta}$, instead of the true (unknowable) coefficients, β. This assumes the model is correctly specified. For further details, see Davidson and MacKinnon (2003).

Table A-1. Regression results

Panel A: Regression 2000–2019

	Standard Deviation	Beta
Tax rate (harvest)	13.5%	2.21%
		[91.8]
Unlimited capital gains	35.0%	0.57%
		[47.2]
Capital gains	1.8%	9.59%
		[45.5]
Constant dollar average	37.3%	–0.12%
		[–13.0]
Cash flow	3.7%	–1.27%
		[–11.7]
Tax rate (liquidation)	12.7%	–0.58%
		[–23.7]
Liquidation	35.4%	–0.23%
		[–26.3]
(Intercept)		–0.15%
		[–13.8]
Adjusted R-squared	83%	
Observations	3,360	

Panel B: Multiple time period regression 1982–2017

	Standard Deviation	Beta
Volatility x constant dollar average	5.8%	4.26%
		[23.8]
Volatility x cash flow	0.6%	36.60%
		[21.1]
Tax rate (harvest)	13.5%	1.52%
		[211.7]
Volatility	1.9%	7.14%
		[65.4]
Unlimited capital gains	35.0%	0.26%
		[78.2]
Capital gains	1.8%	4.62%
		[83.2]
Monthly harvesting	47.1%	0.01%
		[5.0]
Daily harvesting	47.1%	0.01%
		[2.7]
Liquidation	35.4%	–0.21%
		[–81.4]
Tax rate (liquidation)	12.7%	–0.74%
		[–101.3]
Cash flow	3.7%	–4.58%
		[–17.9]
Constant dollar average	37.3%	–0.52%
		[–19.9]
(Intercept)		–1.24%
		[–72.8]
Adjusted R-squared	62%	
Observations	80,640	

Vanguard®

Connect with Vanguard® > vanguard.com

All investing is subject to risk, including possible loss of principal.

ISGTLH 102020