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ORIGINAL ARTICLE

A guide to 130/30 loss harvesting

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Abstract
We analyze the effect of leverage on tax-managed public equity strategies for different types of investors by running backtests on hypothetical portfolios. We found the average 130/30 long/short portfolio funded with cash generates 2.7 times more capital losses than the average long-only portfolio over the first 10 years. For an investor with a sufficient supply of short- and long-term gains, these additional losses translate to average pre-liquidation tax alpha ("TA") of 4.41% per year. Liquidation reduces TA by about half, while a lack of short-term capital gains to offset reduces TA by approximately 40%. In combination, those investor characteristics may render a long-only loss harvesting portfolio or a low-cost ETF more desirable than a long/short tax-managed equity portfolio after costs and fees are taken into consideration. Leverage can also be used to revitalize an ossified portfolio whose loss-generating capacity has diminished.

Keywords Tax alpha · Tracking error · Leverage · Liquidation · Loss harvesting · Long-short

Introduction

For decades, delaying the realization of capital gains while accelerating the realization of capital losses in diversified, long-only equity portfolios has created value for taxable investors. While there is a growing audience for this strategy, and its potential value is well-documented, a common concern is that it may lead to *ossification,* meaning the losses that may generate value tend to be more abundant in the early years of a portfolio's life.[1]

Ossification stems from the inverse relationship between the level of appreciation in a portfolio and its potential for realizing capital losses. If equities as an asset class have a *positive* expected return, it follows that opportunities to realize losses in long-only equity portfolios decrease with time. This feature of long-only loss harvesting is observed in practice.

With the introduction of margin and shorting, we expand opportunities for loss harvesting in public equities in two ways. First, if we assume equities have a positive expected return, a short equity position would have a negative expected return. In other words, shorting can provide new ways to realize losses. Second, the full investment constraint in a portfolio with short positions requires additional long exposure, which scales the dollar value of harvested losses relative to an otherwise equivalent fully invested long-only portfolio. In combination, these effects can lead to a significant increase in the dollar amount of the losses realized in a long/short portfolio relative to a long-only portfolio.

An additional feature of a long/short, tax-managed strategy is its potential for temporally smoother delivery of

[1] Even in the presence of front-loading, compounding generates a deferred benefit of tax management that can persist through the life of the strategy.

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losses relative to a long-only strategy. While the imperfect correlation across equities means that a long-only strategy can deliver losses even when the total portfolio return is positive, there is a tendency for losses to be more abundant in turbulent periods when markets are down.[2] This effect can be dampened by shorting, which historically has tended to deliver losses in calm, upward-trending markets.

Relative to a long-only loss harvesting strategy, the addition of short positions increases potential tax benefits but also risk[3] and costs. Taking into account these features of short-selling equities, we consider in detail the question of which types of investors may best be suited to benefit from the increased, more smoothly delivered, losses in a long/short loss harvesting strategy. Our findings suggest that the greatest beneficiary would be an investor with abundant short-term gains who does not plan to liquidate the portfolio, regardless of how it is funded.[4]

Literature review

The study of how timing the realization of gains and losses may be valuable for a taxable investor dates back, at least, to Constantinides (1983, 1984). Since then, a growing library of research has assessed the value of tax management. Investor profiles, including tax rates and the availability of external gains as well as the disposition of a portfolio at horizon end contribute to the economic value of the timing of gain and loss realization.

In a series of articles, Jeffrey and Arnott (1993), Arnott et al. (2000), (2011), (2018) argue that active equity funds tend to be tax inefficient. Stein (1998) emphasizes that taxable investors should measure after-tax return rather than pre-tax return, and outlines some of the challenges for doing so. Berkin and Ye (2003) use a Monte Carlo simulation to quantify the benefits of highest in, first out (HIFO) accounting and the incremental benefits of loss harvesting in a market with relatively high stock-specific risk, low average return, and high dividend yield. An exposition of tax-managed investing is in Wilcox et al. (2006).

Geddes (2011), and Shalett et al. (2022) use Monte Carlo simulations to demonstrate the after-tax benefits of loss harvesting in a separately managed account relative to holding an exchange-traded fund (ETF). An empirical study by Goldberg et al. (2019a) relies on data from 1987 to 2018 to quantify the benefit of tax management and demonstrates the lifecycle of a tax-managed portfolio pre- and post-liquidation. Using a history of empirical data from the period 1926–2018, Chaudhuri et al. (2020) assess the value of a loss harvesting strategy post-liquidation.

Based on an analysis of tax return and survey data, Sosner et al. (2022) argue that high-net-worth investors with allocations to hedge funds and derivatives are most likely to benefit from loss harvesting strategies. Khang et al. (2021) document the high degree of heterogeneity in the distribution of unrealized capital gains across investor types.

The success of loss harvesting in index-tracking strategies prompted an expansion to active strategies. Using empirical data, Bergstresser and Pontiff (2013) document the impact of taxes on value, growth, and size portfolios, showing that taxes exacerbate the equity premium puzzle. Israel and Moskowitz (2012) explore the impact of tax management on size, value, growth, and momentum. Sialm and Sosner (2018) quantify after-tax returns in tax-managed 130–30 and market-neutral strategies. Using historical back-tests, Santodomingo et al. (2016) and Goldberg et al. (2019a) examine after-tax return and risk profiles of popular factor tilts. Analogous profiles of index-tracking and carbon-free strategies are studied in Goldberg et al. (2019b). Liberman et al. (2020) argue that the technique of separating alpha from beta, commonly used in the management of tax-exempt portfolios, can benefit taxable investors. Davis et al. (2024) study loss harvesting and gain deferral in a factor-based model portfolio.

Since loss harvesting tends to become more challenging as a tax-managed strategy ages, refreshment techniques that selectively realize long-term gains to facilitate harvesting of more valuable short-term losses come into play. This "tax-rate arbitrage" technique is studied in Constantinides (1984); Dammon et al. (1989); Stein et al. (2008); and Goldberg et al. (2022).

Stein and Narasimhan (1999) and Stein (2001) argue for the benefits of combining a passive loss harvesting portfolio with allocations to active strategies in public equities. Stein and McIntire (2003) use simulation to assess the value of an overlay portfolio manager, who coordinates multimanager separate accounts for a taxable investor. Geddes et al. (2015) illustrate the value of an indexed loss harvesting portfolio as part of an asset allocation that regularly generates capital gains.

Loss harvesting in a long-only strategy tends to be most valuable in turbulent markets, when security prices decline. The addition of short positions may smooth the delivery of the benefits of loss harvesting and, for certain types of investors, increase its economic value. This is explored in Berkin and Luck (2010); Quinton and Brunetti (2014); Sialm and Sosner (2018); and Sosner et al. (2020). Sosner et al. (2019) find that the incremental tax benefits of a long-short loss harvesting strategy are largely due to what they term character:

[2] The relationship between turbulence and down markets is the leverage effect, which is first posited in Black (1976).

[3] Shorting has regulatory risk, a discussion of which is outside the scope of this paper.

[4] For an investor with external gains, tax alpha in a loss harvesting 130–30 strategy is far more reliable than pre-tax alpha.

the fraction of short-term capital gains relative to all gains. Sosner et al. (2020) quantify the tax benefits in a long-short defensive strategy. Goldberg et al. (2022a, b) show how tax management can be combined with margin and shorting to diversity concentrated positions.

For decades, quantitative equity managers have deployed factor investing to diversify stock-specific risk through portfolios with large numbers of stocks to collectively provide exposure to just the desired factors. The value is first discussed in 1930s, when Graham and Dodd (1934) studied the discrepancies between the intrinsic value of a stock and its market price. Historically, stocks with lower valuations have outperformed stocks with higher valuations with similar risk levels. Using metrics such as price-to-book and price-to-earnings (P/E), Graham and Dodd tilt a portfolio toward cheaper stocks. Basu (1983) considers the relationship among stock returns, the earnings-to-price (E/P) ratio, and firm size, finding that high-E/P stocks earned higher risk-adjusted returns on average than low-E/P stocks, even as the strength of the earnings yield effect varied inversely with size. Leshem et al. (2016) compare the effects of book-to-price (B/P) and E/P ratios on performance and determine that while neither metric uniformly outperformed the other in a values strategy, a combination of the two outperformed both single-factor strategies, with positive contributions from sector constraints.

In the early 1990s, Fama and French (1992; 1993) developed a three-factor (market, value, and size) asset pricing model that expands on the capital asset pricing model (CAPM) used since the 1960s to determine a theoretically appropriate required rate of return of an asset. They identify two factor anomalies that generated return premiums inconsistent with the CAPM: High book-to-price stocks outperformed low-B/P stocks, and small-size stocks outperformed large-size stocks. Shumway and Warther (1999) look at small, distressed stocks to assess the impact of negative returns of delisted stocks on the size premium, determining that correcting for a delisting bias removed the risk-based explanations for the size effect.

Carhart (1997) finds that a (price) momentum factor generated returns inconsistent with not only the CAPM but also the Fama–French model. He observes that stocks with strong recent returns outperformed stocks with poor recent returns. Additionally, the momentum factor returns were negatively correlated with value factor returns, so each provided factor diversification benefits.

Among strategies that are designed to enable investors to outperform a benchmark by tilting toward factors while maintaining reasonably low levels of tracking error, high dividend yield strategies also provide a solution for investors seeking greater cash flow from their accounts. The specific impact that dividends have on market value and performance has been widely studied. Miller and Modigliani (1961) challenge the notion that dividend policy is crucial to a firm's valuation, reasoning that earnings and real investments are instead decisive. Hartzmark and Solomon (2016) find that market participants do not fully appreciate the downward pressure on prices that dividend payments exert and note that dividend-paying stocks achieve lower returns during periods of low interest rates and poor market performance, when demand for dividends is high.

Traditional quality factors have sought to proxy quality companies, managements, and financial statements. Black (1972) documents the outperformance of low-beta and low-volatility stocks, observing that low-beta performed better than the CAPM predicted. Haugen and Heins (1975) survey the then existing studies of the relationship between risk and realized return and reinforce the finding that higher-beta stocks were not compensated for in higher returns. More recently, Novy-Marx (2013) finds that profitable firms delivered higher average returns than unprofitable firms, despite their lower book-to-market ratios, and that a profitability strategy significantly increased values strategies' performance. Frazzini and Pedersen (2014) apply leverage and margin constraints to a portfolio that is long leveraged low beta and short deleveraged high beta, confirming the underperformance of high-beta assets over a long period, and develop a "betting against beta" factor that delivers high average return that varies with the tightness of constraints and spread between low- and high-beta securities.

In applying a behavioral model of security prices, Baker et al. (2011) determine that institutional investors' mandates to outperform fixed benchmarks contributed to the underperformance of high-beta and high-volatility stocks. Goldberg et al. (2014) show that minimum variance strategies outperformed by tilting toward stocks with lower market capitalization and volatility and higher E/P ratios.

Individual factors may go through periods of positive or negative performance, and certain factor strategies have exhibited low correlations to one another, so a diversified portfolio of factors may help to reduce the cyclicality of single-factor returns. Fama and French (2015) extend their earlier work by adding the contributions of profitability and investment patterns to average return. Their five-factor model finds the highest expected returns for small, profitable, value companies.

Quality value and long-only index-tracking strategies

To quantify the benefits and risks of relaxing the long-only constraint for diversified equity portfolios, we constructed a back-test study to compare the hypothetical performance of two tax-managed strategies: long/short 130/30 quality value

("LS") and long-only index-tracking ("LO").[5] In the analysis below, we use these acronyms to refer to hypothetical strategies that we back-test. All performance data presented herein is hypothetical and based on these back-tests.

For these strategies, we use an optimizer to construct hypothetical tax-managed portfolios by 1) minimizing forecast tracking error[6] to the S&P 500® Index while harvesting losses, and 2) ensuring that portfolios are fully invested; in other words, that portfolio weights sum to 100%. While our benchmark is the S&P 500 Index, our investment universe is the Russell 1000® Index. All back-tests include the reinvestment of dividends or other income received. LO portfolios are constrained to prohibit shorting (weights must be non-negative), but LS portfolios deliberately target a short exposure of 30% of portfolio value. To remain fully invested, LS portfolios also have an additional long exposure of 30%. The resulting LS portfolios have notional long exposure of 130% and notional short exposure of 30%. This means they are leveraged 1.6x: An investor would have $1.60 of exposure for every dollar invested.[7]

Both our long-only and long/short portfolios are constructed quantitatively, i.e., by using optimization to minimize forecast tracking error to a benchmark. For established, tax-aware portfolios, each position's cost basis can serve as an important signal for what to trade. However, when constructing new portfolios (i.e., funded entirely from cash) there is no cost basis information, and we rely on other constraints to construct portfolios.

For new, long-only portfolios, it is sufficient to rely on simple transaction cost constraints—do not establish small positions; do not establish thousands of positions when a few hundred will do.

However, if we want to target selling 30% of the value of a new portfolio short, we need to signal which companies should be sold short. To construct the necessary signal, we build LS portfolios to tilt toward both "quality" companies (e.g., high profitability, high earnings quality, and low leverage) and "value" companies (e.g., low P/E and P/B ratios).

In practice, it is possible to construct long/short portfolios with a variety of factor tilts.[8] We have chosen factors widely adopted by index sponsors and industry practitioners, and they are available in our risk models. Historical performance of each factor is consistent with risk-based or behavioral hypotheses documented in the academic literature.[9]

Table 1 Observation counts in our empirical study

Launch	10 Years	20 Years
Cash	73	33
Ossified	53	N/A

Both LS and LO portfolios incur trading costs, while shorting and financing costs are a drag on return only for LS. The assumptions on costs that we use in our study and their consequences are specified below, along with the empirical results. Additional portfolio construction details are in Appendix A. All back-tested portfolio return data are shown on a net basis, with deduction of an annual management fee of 0.25% for LO and 0.45% for LS and estimated commissions/expenses as noted below. We assume reinvestment of all dividends and other income received. We assume that management fees and transaction costs for the benchmark are zero.

Empirical study architecture

In our study, we look at the rewards and risks of hypothetical long/short and long-only portfolios at horizons up to 20 years. Historical data used in the study begin in June 1995 and end in June 2023. We rebalance monthly and launch portfolios quarterly.[10] This approach yields multiple outcomes obtained from different historical market regimes for each strategy. The path dependency created by tax management renders these observations relatively independent. The approach also mitigates, to some extent, the period dependence of a historical simulation that looks at a single run over an extended period. Multiple observations at each horizon allow us to create boxplots[11] of outcomes and put error bars around averages.

It is commonplace for investors to fund tax-managed, long/short equity portfolios with existing long-only portfolios of appreciated equity securities. In those cases, we do not generally expect the legacy long positions to provide a significant source of losses going forward. In this paper, we will refer to these as "Ossified Launch" portfolios in contrast to portfolios funded entirely with cash ("Cash Launch").

Using our approach, we obtain 73 10-year hypothetical outcomes of a cash-funded strategy and 53 when the strategy

[5] Related studies of tax management in long/short portfolios include Sialm and Sosner (2018), Goldberg et al. (2022a, b).

[6] Forecast tracking error is a risk calculation as of a given date. Any changes in underlying assumptions, such as volatility, will alter these numbers, potentially significantly. See "Important notes."

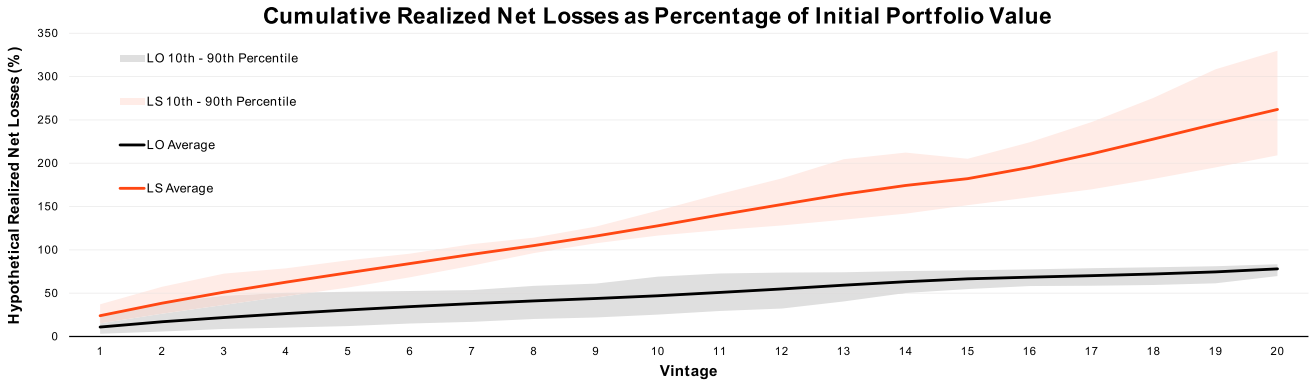
[7] Even though 130-30 strategies have struggled to deliver pre-tax alpha in the past, this does not impede their ability to deliver tax alpha.

[8] Tax-managed factor tilts are studied in Israel and Moskowitz (2012), Santodomingo et al. (2016), Goldberg et al. (2019a), and Goldberg et al. (2019b).

[9] Expositions of some of the factors in our strategy are in Graham and Dodd (1934), Basu (1983), Fama and French (1992, 1993, 2015), Carhart (1997), and Novy-Marx (2013).

[10] Since tax management introduces path dependency, observations obtained from overlapping runs are relatively independent.

[11] For a guide to boxplots, please see Appendix C.



	5-Year	10-Year	20-Year
LS	73.5%	127.9%	262.0%
LO	30.6%	47.0%	78.0%
Difference	42.9%	80.9%	184.0%

Fig. 1 Average cumulative hypothetical realized net losses as a percentage of initial portfolio value. Hypothetical strategies are launched quarterly between June 30, 1995, and June 30, 2023. Cumulative hypothetical net losses are more abundant in LS than LO, especially in years 10 through 20. The difference in average cumulative hypothetical net losses between LS and LO increased with horizon. Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model.

is funded with an ossified portfolio since the ossification process consumes five years of data. At a 20-year horizon, data constraints lead us to consider only cash-funded strategies, for which we obtain 33 observations. These values are summarized in Table 1.

Loss generation

The extended exposure of a long/short strategy to the market and its ability to harvest losses in both up and down markets suggest that it may generate more losses than its long-only counterpart. This is borne out in our empirical study.[12] Figure 1 shows cumulative net losses realized as a percentage of initial portfolio value over time for LS and LO strategies funded with cash.

After 20 years, the average long-only portfolio realized about 78% of its starting value in losses while the average long/short portfolio realized about 262%——more than *tripling* losses. In Fig. 1, the shaded regions around the average losses constitute the 10-90 percentile range, demonstrating there can be quite a bit of variation in the percentage of losses harvested by a given strategy. In Fig. 2, we select two periods of interest for a closer look.

While our study indicates that shorting can significantly increase the percentage of losses that can be realized, it is also interesting to note how our study highlighted the impact that significant market events can have on loss harvesting. Consider the period 2003-2022. While hypothetical LS and LO portfolios experienced a clear uptick in losses harvested during the Great Financial Crisis (vintage year 6), the LO portfolio did not yield many additional losses beyond that point, whereas the LS portfolio continued to deliver losses, even during strong bull markets.

While LO provided most of its losses in the first 10 years, LS produced losses consistently at least to year 20. This has important implications for investors that already have an older, long-only loss harvesting portfolio. Shorting can rejuvenate an ossified long-only portfolio whose loss harvesting capacity has diminished. We explore that capability in our empirical study.

Loss valuation

In our empirical study, we transform the dollar value of the hypothetical realized losses into financial terms for different types of investors. We discuss the details of that transformation here.

[12] Lieber et al. (2023) have similar findings on the value of losses in a long/short tax-managed strategy.

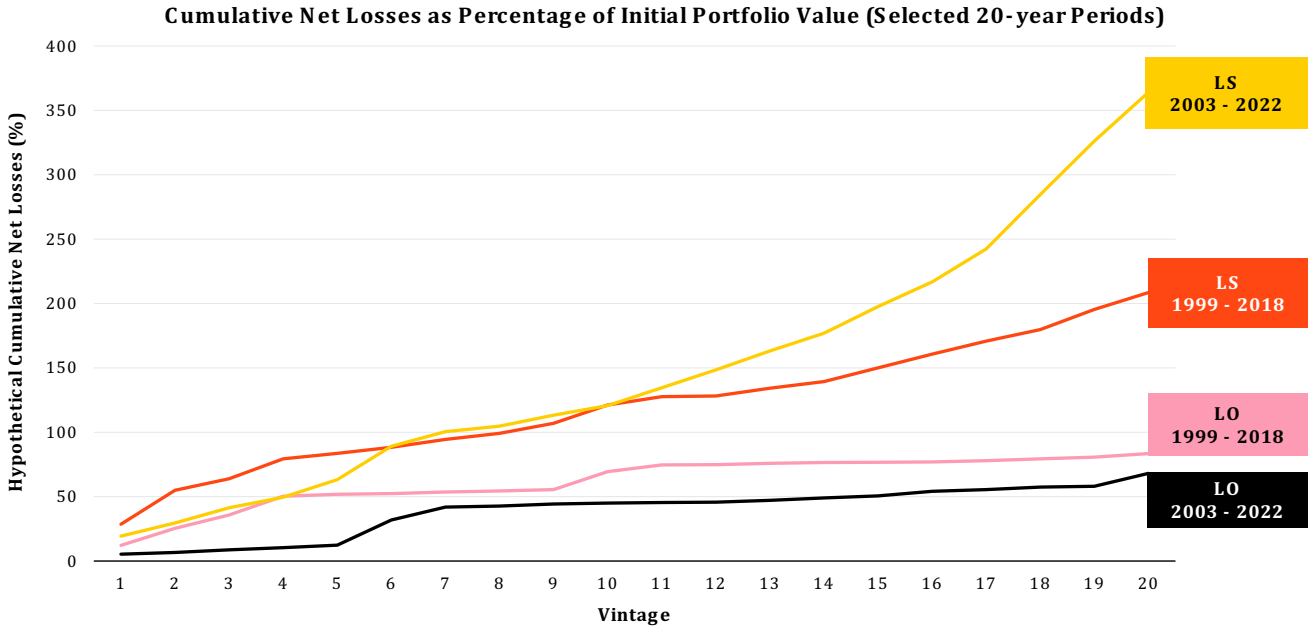


Fig. 2 Cumulative hypothetical realized net losses as a percentage of initial portfolio value for selected paths. Market events had a significant impact on loss harvesting for both LO and LS. Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model.

Pre- and post-liquidation

The tax treatment of a portfolio at the end of the investment horizon varies with investment vehicle and investor disposition. For example, in an estate event, a long-only portfolio held in a separately managed account may be transferred to an heir. In this case, cost basis can be reset to contemporaneous market price—eliminating a potentially significant tax liability. The end-of-horizon treatment of a long/short portfolio is more complicated because short positions may not be bequeathed. Some investors liquidate their portfolios, in which case tax must be paid on capital gains. Since the benefits of tax management depend materially on what happens at horizon end, we include both pre- and post-liquidation analyses in our study.

Tax rates

For a long position, a capital loss or gain is short-term if it is realized within a year of purchase; otherwise, it is long-term. In contrast, a realization in a short position is always treated as short-term—no matter how long it has been open. We assume the highest federal tax rates as of 2023: 40.8% and 23.8% for short- and long-term realization, respectively. Short- and long-term losses must be used to offset gains of a similar type to the extent possible. Excess losses can offset dissimilar gains. Consider, for example, a typical situation where an investor has only long-term gains and both short- and long-term losses. Once the long-term losses are exhausted, the investor can offset long-term gains with short-term losses, diminishing their nominal value. Unused losses may be carried forward.

Now consider a less common situation where an investor has both short- and long-term gains but only long-term losses. The latter can take on extra value since they can be used to offset short-term gains once all long-term gains have been offset.

Table 2 Valuations of capital losses for the purpose of offsetting capital gains in hypothetical strategies

Investor type	Tax rate by loss type	
	Short-term (ST) (%)	Long-term (LT) (%)
ST + LT	40.8	23.8
LTO	23.8	23.8

Table 3 Eight hypothetical scenarios for analysis in our empirical study

Hypothetical scenario	Type of launch portfolio	Liquidation status (End-of-horizon tax treatment)	Type of external gains
1	Cash	Pre	ST + LT
2	Cash	Pre	LTO
3	Cash	Post	ST + LT
4	Cash	Post	LTO
5	Ossified	Pre	ST + LT
6	Ossified	Pre	LTO
7	Ossified	Post	ST + LT
8	Ossified	Post	LTO

In our study, we consider both a "Full-Utility" investor (ST + LT) who has ample short-term and long-term gains and an investor who has long-term gains only (LTO). Table 2 summarizes how we value losses for these types of investors. It is a simplification of the rules outlined above, and it has no impact on how embedded gains are valued at horizon end in the event of liquidation.

Launch portfolios

As noted in the "Empirical study architecture" section, it is common for investors to fund a tax-managed portfolio with appreciated equity securities. We examine the effect of an ossified launch on tax benefit using hypothetical low-cost basis portfolios manufactured according to the prescription detailed in Appendix B.

Scenarios for analysis

In summary, we consider eight hypothetical scenarios specified in terms of two end-of-horizon tax treatments (pre- and post-liquidation), two assumptions on the types of external gains realized by an investor (Full-Utility (ST + LT) and long-term gains only (LTO)), and two types of launch portfolio types (Cash and Ossified). Table 3 lists our eight scenarios.

Tax alpha, risk, and costs

We explore how the excess hypothetical losses generated by a long/short tax-managed strategy translate to benefit-cost tradeoffs. The results varied substantially across our eight cases determined by pre- and post-liquidation, full utility and long-term gains only, cash and ossified launch.

Tax alpha

To quantify the potential benefit of tax management, we introduce after-tax active return ($ATAR_N$), the net of costs return difference between a portfolio and its benchmark[13] after accounting for taxes. $ATAR_N$ can be decomposed into three components: pre-tax active return ($PTAR_G$) that is gross of costs, tax alpha (TA), and costs (C)[14]:

$$ATAR_N = PTAR_G + TA - C$$

Rearranging terms gives an expression for TA, which is a measure meant to isolate the benefit to an investor of the loss harvesting component of running a strategy:

$$TA = ATAR_N - PTAR_G + C$$

Figure 3 shows average TA for the hypothetical LS and LO strategies accompanied by boxplots of path-by-path incremental differences between TA for the two strategies.

Average TA was uniformly positive for LS and LO but varied considerably in magnitude across the eight scenarios, as did the incremental TA offered by LS. Unsurprisingly, full liquidation, a lack of short-term gains, and an ossified launch diminished TA. The first two of these effects also diminished the *difference* in TA between LS and LO. That difference showed little dependence on whether the launch portfolio was cash or ossified.

In a long-only strategy, TA tends to be higher in turbulent, down markets, when the prices of many securities fall below their cost bases, than in upward-trending markets. The introduction of short positions facilitates loss harvesting in both up and down markets, smoothing the delivery of TA. This is illustrated in Fig. 4 which shows TA averaged over quintiles sorted by ten-year performance of the S&P 500 Index. For LO (right panel), TA declined materially as index performance increased from worst (quintile 1) to best (quintile 5). This effect was dampened in LS (left panel).

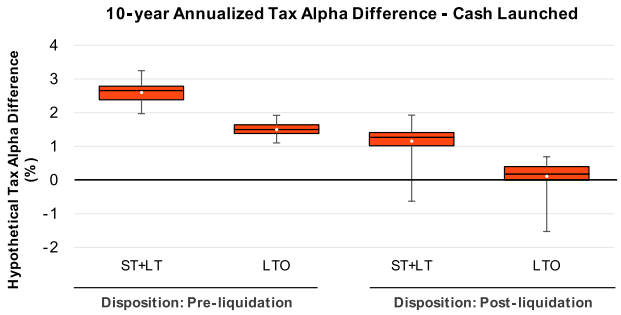
The higher and more consistent TA that LS delivered relative to LO in our empirical study must be evaluated in the context of cost and risk, which we explore next.

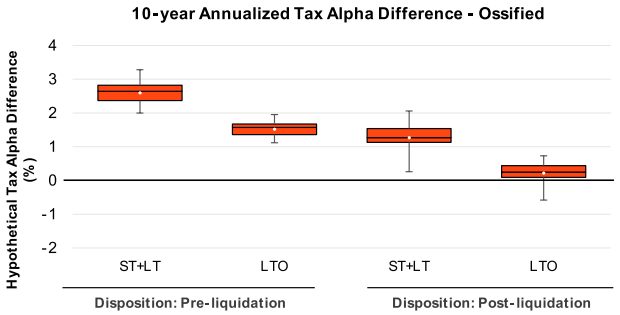
Risk

The first risk we consider is tracking error relative to our benchmark, the S&P 500 Index. We show boxplots of 10-year realized tracking error for LS and LO along with

[13] Pre-liquidation, benchmark returns are adjusted only for taxes on dividends. Post-liquidation, benchmark returns are adjusted for price appreciation as well.

[14] To be concise, we use "costs" to refer collectively to estimated explicit and implicit trading costs, the estimated costs of margin and shorting when applicable, and management fees.

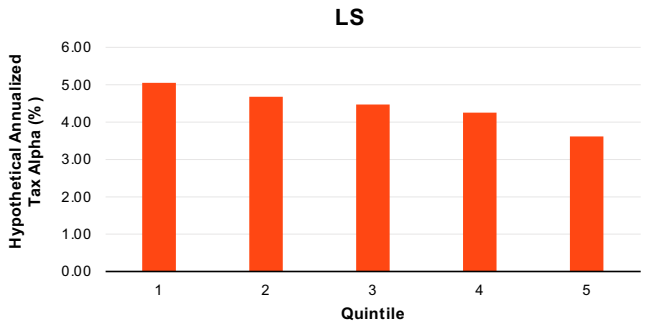


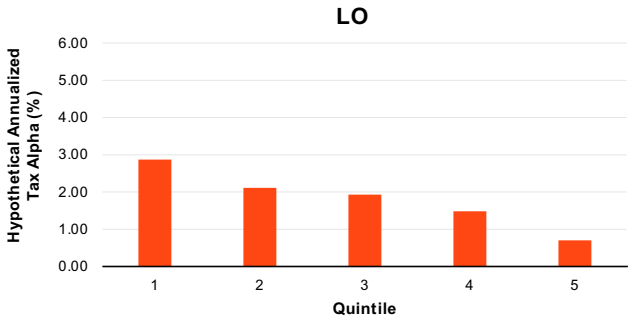


Cash Launched 10-year Avg Annualized TA (%)	Pre-Liquidation		Post-Liquidation	
	ST+LT	LTO	ST+LT	LTO
LS	4.41	2.64	2.22	0.50
LO	1.81	1.14	1.06	0.39
Difference	**2.60**	**1.50**	**1.16**	**0.11**

Ossified 10-year Avg Annualized TA (%)	Pre-Liquidation		Post-Liquidation	
	ST+LT	LTO	ST+LT	LTO
LS	3.34	1.86	1.71	0.42
LO	0.74	0.48	0.44	0.19
Difference	**2.60**	**1.52**	**1.27**	**0.22**

Fig. 3 Hypothetical annualized TA for strategies benchmarked against the S&P 500 Index in eight scenarios. June 30, 1995, to June 30, 2023. Top panels: Boxplots of incremental TA of LS over LO. Bottom panels: Tables of average TA. While both TA and the incremental TA of LS over LO varied across scenarios, the latter showed little dependence on the initial launch portfolio. Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model



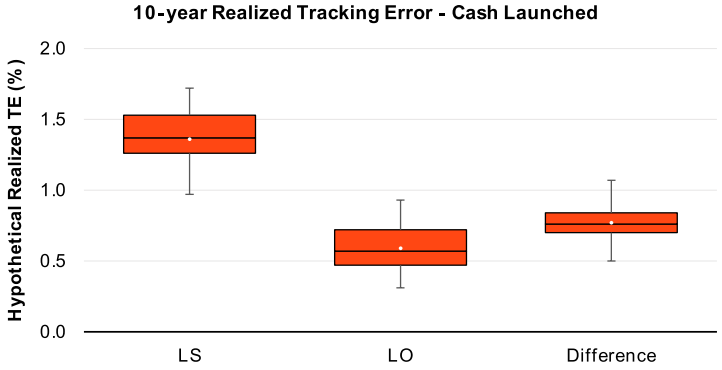


	Pre-Liquidation ST + LT Cash Launched				
Quintile	1	2	3	4	5
LS Tax Alpha (%)	5.05	4.68	4.47	4.25	3.61
LO Tax Alpha (%)	2.87	2.11	1.93	1.48	0.70

Fig. 4 Hypothetical annualized 10-year TA for strategies averaged over index performance quintiles ranging from lowest (1) to highest (5) in the pre-liquidation, LT + ST, cash-launched scenario. June 30, 1995, to June 30, 2023. Left panel: LS. Right panel: LO. Dependence of TA on index performance was more pronounced for LS than LO. Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model

path-wise differences in Fig. 5. The average incremental tracking error of 0.77% for LS is largely explained by the strategy's tilts. The additional tracking error in LS means that returns tended to stray further from the benchmark in LS than in LO. In particular, periods of benchmark underperformance may be deeper in LS than in LO.

Short positions are subject to stock recalls and margin calls. A stock recall arises from the terms of the loan facilitating the short position, which entitle the lender to demand



Average (%)	10-Year Realized TE
LS	1.36
LO	0.59
Difference	0.77

Fig. 5 Hypothetical annualized 10-year realized tracking error for hypothetical strategies in the pre-liquidation, LT + ST, cash-launched scenario. June 30, 1995, to June 30, 2023. Tracking error was higher for LS than LO, principally due to the tilts in the former. Source: Barra US Total Market Equity Model for Long-Term Investors (USS-LOW) model

that the borrower return the stock at any time. This may happen when the short position has increased in value, potentially leading to a realized capital gain. A margin call arises from an upward drift in leverage ratio, which may lead to demand for more collateral.

Costs

Shorting incurs additional costs. First, higher turnover in LS relative to LO translates to higher trading costs. Further, a LS investor pays interest on money borrowed to finance the 30% long extension and typically receives interest on the proceeds from the 30% short position. As such, there is a financing cost on the spread between the two interest rates. For the purposes of our study, we assume the financing cost to be 0.8% per year, or 0.24% per year for the 30% short position. This spread applies to general collateral securities. For more exotic positions, the investor may receive a lower rate of interest on the proceeds from the sale of the short position, leading to a hard-to-borrow cost.

To avoid additional borrowing costs, an investor may choose to short only general collateral securities at portfolio inception. It is worth noting that a shorted name may later become hard to borrow possibly due to a corporate action, market turbulence, or a company- or sector-specific event. In practice, these hard-to-borrow securities can result in significant costs[15]; however, this tends to be applicable only to a very small number of securities, making overall average borrowing costs relatively low. Our estimate of this average is 0.01% per year, or 0.03% per year times the notional short exposure (30% for LS). A schematic diagram showing the costs of LS assumed in our study is in Fig. 6.

[15] We apply an average value to all transactions and do not take into account the skew in hard-to-borrow costs.

Finally, we note that the relative complexity of long/short investing translates to higher management fees for LS than for LO. In our study, we assume an annual fee of 0.25% for LO and 0.45% for LS.

After-tax active return

The bottom line for a taxable investor is the after-tax return difference between a portfolio and its benchmark, or $ATAR_N$, after-tax active return. As noted above, there is a useful expression for after-tax active return in terms of pre-tax active return, costs, and tax alpha:

$$ATAR_N = PTAR_G - C + TA$$

Breakdown of after-tax active return

In Table 4, we show the average breakdown of $ATAR_N$ into pre-tax active return ($PTAR_G$), cost (C), and tax alpha (TA) for the best and worst of the eight cases: pre-liquidation, ST + LT, cash launch and post-liquidation, LTO, ossified launch, at a 10-year horizon. $ATAR_N$ averaged 1.50% for LO and 4.14% per year for LS in the best case. The corresponding values for the worst case are −0.01% and −0.08%. This illustrates the two main conclusions of our study:

- Leverage may dramatically increase the loss harvesting capacity of a tax-managed strategy
- The additional losses may translate into tax benefits for certain types of investors

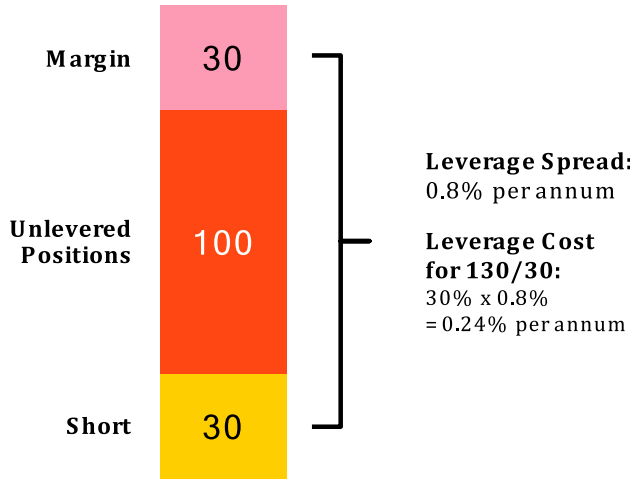


Fig. 6 Schematic diagram of the costs associated with LS. Interest payments are on the spread between interest paid on funds borrowed to finance the 30% long position and interest earned on proceeds from sales in the 30% short position

Note that pre-tax active return differs in the two scenarios due to interaction with tax management and risk.

Leverage

We look briefly at the impact of leverage on after-tax performance in the context of fully invested strategies, which are long (100 + X)% and short X%. While higher leverage may allow investors to amplify their factor bets, a thorough exploration of tilt strength at different leverage levels is beyond the scope of this paper. As such, we have applied the same factor profile across all leverage options, which enables us to isolate and explore the tax value-add and cost considerations in relation to leverage. In Fig. 7, we consider the impact of varying leverage on $ATAR_N$. All portfolios are cash-launched, 10-year tax-managed quality value strategies, and X varies from 0% (a long-only strategy) to 150% (250/150).

Pre-liquidation $ATAR_N$ increased almost linearly with leverage, although the absence of short-term gains led to a more gradual increase. However, post-liquidation $ATAR_N$ *declined* starting at 150/50 for ST + LT investors and declined monotonically for LTO investors.

Increasing leverage can negatively impact $ATAR_N$ in two important ways. First, for all investor types, increasing leverage will increase financing costs. Second, for investors who must liquidate a substantial portion of a portfolio, unwinding a short exposure can generate significant short-term capital gains. This is especially problematic for an LTO

Table 4 Breakdown of hypothetical average annualized after-tax active return for strategies over a 10-year horizon for two scenarios: pre-liquidation, ST+LT, cash launch and post-liquidation, LTO, ossified launch

	Pre-Liquidation, ST+LT, Cash Launch			Post-Liquidation, LTO, Ossified Launch		
Hypothetical Average 10-year:	**LO**	**LS**	**Difference**	**LO**	**LS**	**Difference**
Pre-Tax Active Return Net of Costs and Fees	**-0.31%**	**-0.26%**	**0.05%**	**-0.20%**	**-0.50%**	**-0.30%**
Pre-Tax Active Return Gross of Costs and Fees	**-0.01%**	**0.59%**	**0.60%**	**0.04%**	**0.26%**	**0.22%**
Transaction Costs	-0.03%	-0.10%	-0.07%	-0.01%	-0.09%	-0.08%
Leverage Cost (Margin Interest minus Rebate Rate)	—	-0.26%	-0.26%	—	-0.26%	-0.26%
Additional Hard to Borrow Cost	—	-0.01%	-0.01%	—	-0.01%	-0.01%
Management Fees	-0.27%	-0.48%	-0.21%	-0.23%	-0.40%	-0.17%
Subtotal: Costs and Fees	**-0.30%**	**-0.85%**	**-0.55%**	**-0.24%**	**-0.76%**	**-0.52%**
Tax Alpha	**1.81%**	**4.39%**	**2.58%**	**0.19%**	**0.42%**	**0.23%**
After-Tax Active Return Net of Costs and Fees	**1.50%**	**4.14%**	**2.64%**	**-0.01%**	**-0.08%**	**-0.07%**

Values take account of compounding over many periods and may differ from single period numbers. June 30, 1995, to June 30, 2023. Net of costs and fees, pre-tax active return is a sum of three components: pre-tax active return gross of costs and fees, tax alpha, and costs and fees. After fees, loss harvesting strategies were more favorable for some clients than others. Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model

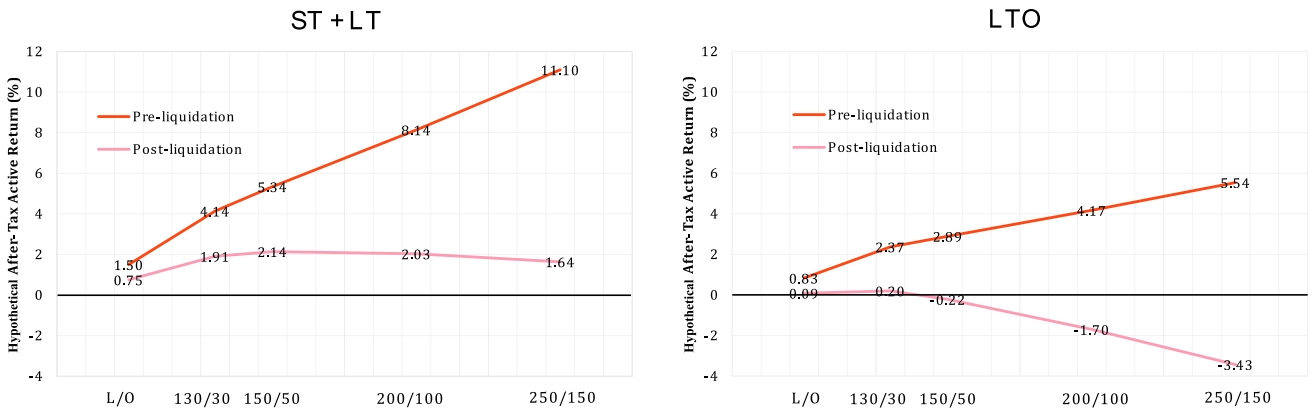


Fig. 7 Impact of leverage on hypothetical, 10-year cash-launched strategies. Left panel: ST + LT. Right panel: LTO. June 30, 1995, to June 30, 2023 Source: Barra US Total Market Equity Model for Long-Term Investors (USSLOW) model.

investor who is not able to realize the full benefit from short-term losses generated.[16]

Summary

By increasing the potential to harvest losses in upward-trending markets and enlarging gross exposure, margin and shorting promises to enhance the tax benefits of traditional long-only loss harvesting strategies for certain types of investors. In an empirical study, we explored the extent to which this promise translates to reality. Our main focus was the rewards, costs, and risks of a 130-30 quality value tilt (LS) strategy and a long-only (LO) strategy for eight types of investors distinguished by end-of-horizon tax treatment (pre- and post-liquidation), assumptions on the types of external gains realized by an investor (Full-Utility (ST + LT)) and long-term gains only (LTO), and type of launch portfolio (Cash and Ossified).

We found LS to be most suitable for an investor who plans to not liquidate their portfolio and has ample short-term and long-term gains[17]. Full liquidation or the lack of short-term gains each diminished TA somewhat, but when taken together, may make leverage unsuitable. The incremental TA of LS relative to LO showed little dependence on the launch portfolio, suggesting that rejuvenation of ossified portfolios may be a viable application of LS.

A tax-managed 130-30 quality value portfolio may be the right choice for an investor with the appropriate financial profile and an appetite for complexity. As always, one size does not fit all.

Important Notes: Investing involves risk, including possible loss of principal

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 calculations would not apply.

The hypothetical data used in this document do not reflect actual investments or trades. Back-testing may have fundamental errors and may produce inaccurate outputs when viewed against its design objective and intended business uses. The mathematical calculation and quantification exercise underlying the models embedded in back-testing systems, for example, generally involves the application of theory, choice of sample design and numerical routines, selection of inputs and estimation, and implementation in information systems. Errors may have occurred and can occur at any point from design through implementation. In addition, shortcuts, simplifications, or approximations used to manage complicated problems could compromise the integrity and reliability of outputs from those calculations. Finally, the quality of the outputs from back-testing depends on the quality of input data and assumptions, and errors in inputs or incorrect assumptions will lead to inaccurate outputs. Even assuming that the back-testing systems are a fundamentally sound tool, producing accurate outputs consistent with its design objective may still exhibit high risk if it is misapplied or misused. Such modeling tools, by

[16] In addition, an LTO investor cannot benefit from tax-rate arbitrage, where long-term gains are realized to facilitate the future realization of short-term losses.

[17] Levered loss harvesting tends to be most valuable when paired with strategies that generate significant capital gains.

their nature, are simplifications of reality, and real-world events may prove those simplifications inappropriate.

Appendix A: portfolio construction details for back-test study

Our hypothetical strategies minimize a weighted sum of squared tracking error and transaction costs (trading, shorting, and leverage) while seeking to realize capital losses. Mathematically, the objective function is given by:

$$f(h) = \left(h - h_B\right)^T \left(\lambda_D D + \lambda_F X F X^T\right)\left(h - h_B\right) + \lambda_T CTC\left(h, h_0\right) + \lambda_S LCSLC\left(h, h_0\right) + \lambda_T T\left(h, h_0, r_S T, r_L T\right)$$

Subject to:

$\sum h_i = 100\%$	Portfolio balance constraint
$l_h \ll h \ll u_h$	Absolute asset weight ranges
$l_a \ll h - h_b \ll u_a$	Active asset weight ranges
$l_X \ll X^T h \ll u_X$	Factor exposure ranges
$l_\beta \ll \beta(h) \ll u_\beta$	Market beta constraint
$l_{Con} \ll Con(h) \ll u_{Con}$	Additional constraints

Where,

λ_F	Common factor risk aversion	X	Factor exposures
λ_D	Specific risk aversion	r_{ST}	Short-term tax rate
λ_{TC}	Transaction cost multiplier	r_{LT}	Long-term tax rate
λ_{SLC}	Short and leverage cost multiplier	$TC\left(h, h_0\right)$	Transaction cost function
λ_T	Tax multiplier	$SLC\left(h, h_0\right)$	Short and leverage cost function
h	Portfolio holding weights	$T\left(h, h_0, r_{ST}, r_{LT}\right)$	Tax liability function
h_0	Initial portfolio weights	$\beta(h)$	Market beta function
h_B	Benchmark holding weights	$Con(h)$	Additional non-standard constraints
D	Specific covariance matrix	l	Lower bounds, per constraint
F	Factor covariance matrix	u	Upper bounds, per constraint

Hypothetical study portfolio construction parameters for long-only index-tracking

Tax multiplier	1
Common factor risk aversion	0.5
Specific risk aversion	0.5
Asset bound	Min 0; Max 100%
Market beta	Min 0.95; Max 1.05
Benchmark	S&P 500®
Investment universe	Russell 1000®
Tax rates	Short-term: 40.8%; Long-term: 23.8%
Transaction cost, commissions/expenses	0.04% per trade
Management fees	25bps per annum

Hypothetical study portfolio construction parameters for long/short 130/30 quality value

Tax multiplier	1
Common factor risk aversion	1
Specific risk aversion	1
Asset bound	Min: −1%; Max: Benchmark +2%
Market beta	Min 0.95; Max 1.05
Benchmark	S&P 500®
Investment universe	Russell 1000®
Tax rates	Short-term: 40.8%; Long-term: 23.8%
Transaction cost, commissions/expenses	0.04% per trade
Leverage cost	0.80% per security
Hard-to-borrow cost	0.03% per security
Management fees	45bps per annum
Long leverage	Min 130%; Max 130%
Short leverage	Min 30%; Max 30%
Sector constraint	Benchmark +/− 5%
Industry constraint	Benchmark +/− 5%
Factor—earnings quality	+
Factor—earnings yield	+
Factor—leverage	−
Factor—profitability	+
Factor—residual volatility	−
Factor—value	+

Unique portfolio construction parameters for long/short 150/50 quality value, long/short 200/100 quality value, and long/short 250/150 quality value

Hypothetical strategy	Long leverage	Short leverage
Long/short 150/50 quality value	Min 150%; Max 150%	Min 50%; Max 50%
Long/short 200/100 quality value	Min 200%; Max 200%	Min 100%; Max 100%
Long/short 250/150 quality value	Min 250%; Max 250%	Min 150%; Max 150%

Appendix B: manufacturing ossified portfolios in our back-test study

In this study, we construct ossified portfolios to launch hypothetical strategies by turning the clock back five years from our target start date. We launch a hypothetical long-only index-tracking (LO) strategy from cash on this earlier date, and the result after five years is the starting portfolio for an ossified run. Because we dedicate some of our data to generating ossified portfolios, the time period for the empirical study of ossified portfolios begins later, in June 2000, than for the study of our cash-launched portfolios, which begins in June 1995. An indication for the loss harvesting potential of a launch portfolio is its cost basis to market value (CBMV), and a boxplot of CBMV is shown in Fig. 8.

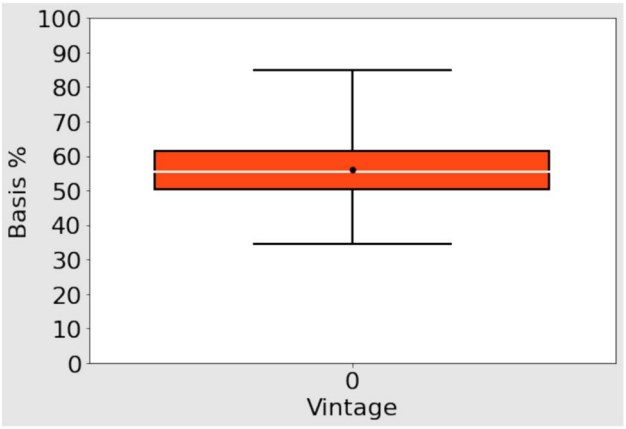
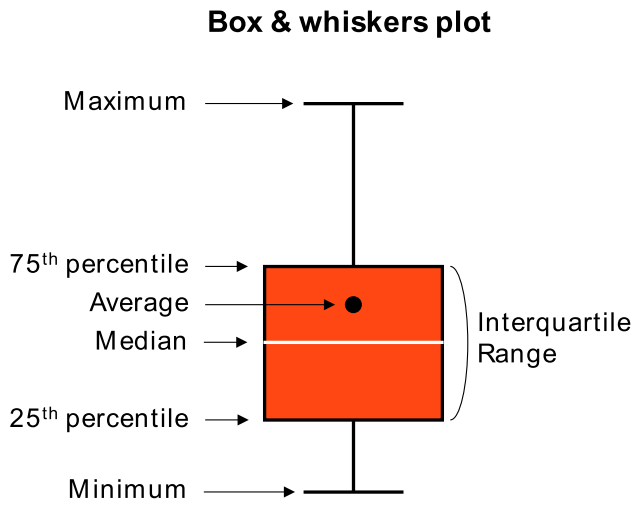


Fig. 8 Boxplot that shows launch portfolio's cost basis as a percentage of portfolio market value.

Appendix C: boxplots

Each boxplot shows a median value at the central line, the 25th and 75th percentiles at the bottom and top of the box, and the minimum and maximum value at the extremes of the plot. Note that different boxplots may use different percentiles. The boxplot percentiles shown below reflect the ones used in this presentation.



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