Harvesting Capital Gains and Losses

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Abstract

Monte Carlo simulations are used to demonstrate that a very attractive tax-based trading strategy is to realize all capital losses, using excess losses to offset realized gains in order to rebalance the portfolio. This strategy increases the mean and median return by taking advantage of the tax-deductibility of losses, and mitigates risk by allowing low-cost portfolio rebalancing. This portfolio rebalancing also restarts the basis and time clock, thereby planting the seeds for a future harvesting of capital losses that can be deducted from income and used to rebalance the portfolio perpetually.

1. Introduction

An old Wall Street adage advises investors to lock in profits by selling winners: "Nobody ever went broke taking a profit." On the other hand, Gerald Loeb argues that investors should sell losers: "[Losses] must be cut quickly before they become of any financial consequence… Cutting losses is the one and only rule of the market that can be taught with the assurance that it is always the correct thing to do." (Loeb 1965)

Each rule is remarkably pessimistic. The first rule works if stocks that have gone up will probably go down; the second rule works if stocks that have gone down are likely to continue going down. These rules should be viewed with skepticism if we accept the considerable historical evidence that past price movements are a poor predictor of future price movements (for example, Jensen 1978; Fama 1991).

The tax code provides a more persuasive reason for deciding whether it is winners or losers that should be sold. Several plausible strategies have been proposed previously to exploit the differential tax rates applied to short-term and long-term capital gains and losses. Unfortunately, these strategies have generally been analyzed with unrealistic assumptions because a theoretical analysis is too difficult for more complicated models. We use Monte Carlo simulations to evaluate several strategies.

Section 2 distinguishes asset allocation and location issues. Section 3 summarizes the relevant tax laws and Section 4 describes several tax-based strategies that have been proposed previously. Section 5 introduces risk and Section 6 describes the Monte Carlo model that will be used to compare several strategies. The results are presented in Section 7 and discussed in Section 8.

2. Asset Allocation and Asset Location

Harry Markowitz's pioneering work (1952, 1959) focused on asset allocation issues—the allocation of funds among different assets or asset classes. Assets can be defined very broadly; for example, Boscaljon (2004) includes human capital as part of the asset allocation decision. With the rapid growth of defined-contribution retirement plans and the relative decline of defined-benefit plans, a rich literature has developed regarding asset *location* issues—the placement of assets in tax-advantaged retirement accounts or conventional taxable accounts.

Investors should generally place their most heavily taxed assets in tax-advantaged retirement accounts and place their less heavily taxed assets in taxable accounts. This typically means that bonds belong in retirement accounts and stocks belong in taxable accounts (Reichenstein 2007). However, this traditional advice may be modified if the investor holds tax-exempt municipal bonds or tax-inefficient (e.g., actively managed) stock mutual funds. Thus, Shoven and Sialm (2003) show that a tax-deferred account is the optimal location for taxable bonds and tax-inefficient mutual funds, and that a taxable account is the optimal location for tax-exempt bonds and for individual stocks (and tax-efficient stock mutual funds). (See also Shoven and Sialm, 1998; Poterba, Shoven, and Sialm, 2001; Dammon, Spatt, and Zhang, 2004.) Other work, which is less relevant here, has compared Roth IRAs with traditional IRAs and other tax-advantaged savings accounts (Horan, 2003, 2004).

Reichenstein (2007) shows that asset allocation decisions should be based on the after-tax value of one's investments; e.g., converting the funds in tax-deferred accounts into after-tax equivalents and taking into account potential tax liabilities on unrealized capital gains in taxable accounts. (Also see Sibley, 2002; Dammon, Spatt, and Zhang, 2004.) After converting all

investments to after-tax values. Reichenstein again concludes that the optimal asset location is generally bonds in retirement accounts and stocks in taxable accounts. Reichenstein also shows that, because of limitations on contributions to defined-contribution plans, asset allocation decisions sometimes trump asset location decisions; e.g., an investor who wants to hold more bonds than she has room for in her retirement account may want to hold bonds only in the retirement account and both stocks and bonds in her taxable account. However, it generally doesn't make sense to hold both bonds and stocks in retirement and in taxable accounts.

These asset location and allocation models apply to broad asset classes—in the simplest case, to stocks and taxable bonds. Our paper focuses on the tax consequences of selling individual assets (including mutual funds) and consequently concentrates on taxable accounts, where the realization of capital gains and losses are taxable events and consequently may have persuasive tax-based costs and benefits.

3. Capital Gains Taxes

Tax laws are notoriously complex. For our purposes, the following general rules are sufficient. All realized capital gains are taxable; realized losses can be used to a limited extent to reduce taxable income. Capital gains and losses are long-term if the asset is held for more than a year, and short-term otherwise. To determine taxes, three separate calculations must be made:

net short-term gain: short-term capital gains minus short-term capital losses

net long-term gain: long-term capital gains minus long-term capital losses

taxable gain: net short-term gain plus net long-term gain

If the taxable gain is positive, and neither the net short-term gain or net long-term gain are negative, the net short-term gain is taxed as ordinary income and the net long-term gain is taxed

at a 15% rate (or 5%, if the tax rate on ordinary income is 15% or lower). If the taxable gain is positive, but net long-term gain is negative, the taxable gain is taxed as ordinary income; if the taxable gain is positive, but the net short-term gain is negative, the taxable gain is taxed at the 15% rate.

If the taxable gain is negative, up to $3,000 ($1,500 if married filing separately) of this loss can be deducted from taxable income; any excess over this limit is carried forward for possible use in future years. Losses that are carried forward retain their designation as short-term or long-term. If there are both short-term and long-term losses, the $3,000 allowable loss comes out of short-term losses first. Thus if the short-term loss is less than $3,000, all of the loss carried forward is long-term. If the short-term loss is more than $3,000, only the excess over $3,000 is carried forward as a short-term loss and all of the long-term loss is carried forward.

When an investor dies, the basis is revised to the current market value, thereby eliminating all unrealized gains and losses. Unused carryover losses also expire with the taxpayer's death.

4. Tax-Based Strategies

4.1. Deferring Gains

The lower tax rate on long-term gains provides an obvious incentive to defer the realization of gains, at least until they become lightly taxed long-term gains. Even after they become long-term, there are persistent benefits from deferring taxes since the investor can continue earning dividends and capital gains on the deferred taxes.

An investor who is confident that a stock's price is about to decline may want to realize the gain and pay the tax. Investors who have no good reason for selling an appreciated asset have a good reason not to sell—the deferral of taxes.

4.2. Harvesting Losses

One good reason for selling a stock is to realize capital losses so that additional money can be invested. Just as postponing taxes on capital gains allows the investment of funds that otherwise would be paid to the IRS, the realization of capital losses allows the investment of funds provided by the IRS. Investors cannot make money by losing money; but once a loss has occurred, it can be profitable to realize the loss so that more money can be invested. The tax treatment of capital losses provides a powerful incentive to realize losses in a timely manner because the tax value of unrealized losses doesn't earn dividends or capital gains and evaporates when the investor dies.

4.3. Exploiting the Difference Between Short-Term and Long-Term Rates

Even if the tax rate on short-term gains and losses equals the tax rate on long-term gains and losses, the preceding section explained why investors can profit by deferring gains and harvesting losses (also see Constantinides 1983). Unless they are confident that their winners will soon do poorly, this logic suggests that investors should hold on to investments with unrealized capital gains as long as possible. For investments with capital losses, investors should realize these losses if the tax saving is larger than the transaction costs of liquidating the investment and reinvesting the proceeds.

More sophisticated strategies attempt to take advantage of opportunities to deduct capital losses from fully taxed ordinary income while paying lower tax rates on long-term capital gains. Constantinides (1984) argues that when the tax rate on short-term gains is higher than the tax rate on long-term gains, investors should realize long-term gains in order to increase a stock's tax

basis and restart the clock for possible future short-term losses; that is, investors should realize gains in order to create opportunities to realize losses.

The problem with continuously implementing this strategy is that gains and losses realized in the same year are offset for tax purposes, effectively equalizing their tax rates and eliminating the benefits from this strategy. (Even if long-term gains exceed short-term losses, the long-term gains are taxed at short-term rates.) Constantinides's ingenious solution is to realize losses in odd-numbered years (thereby obtaining their tax benefits) and to realize both gains and losses in even-numbered years (thereby resetting the basis of stocks that have appreciated). In his empirical analysis of the period 1962-1977, this strategy substantially outperforms a strategy of realizing losses and deferring gains every year.

However, his conclusions rely on several assumptions. He assumes that the investor's portfolio is liquidated at the end of a 15-year holding period. Thus the competing strategy of not realizing gains can only defer taxes for a maximum of 15 years (and typically for a much shorter period) and does not benefit from the favorable treatment of unrealized gains at an investor's death. Realizing gains to reset the basis is clearly more advantageous if the gains will soon be realized in any case.

Constantinides also assumes that the proceeds from a stock sale are always used to purchase an equal number of shares in that stock. The tax refund from the realization of short-term losses is invested in Treasury bills taxed at a 50% rate; funds needed to pay capital gains taxes are borrowed at this same interest rate. The primary advantage of realizing losses is to obtain additional investable funds; this strategy is clearly hobbled if the additional funds are invested in

low-return assets. Similarly, the main cost of realizing gains is the loss of investable funds; this strategy is helped if these funds can be replenished at a low interest rate.

Dammon, Dunn, and Spatt (1989) show that Constantinides' results also depend on the specific historical period he used (1962-1977). The market rose during the years 1962-1968 and then fell back to its 1962 level over the next five years. The strong 1962-1968 market reduced the opportunities for profitably realizing short-term losses; the 1969-1974 market decline rewarded investors who realized capital gains during the 1962-1968 period to restart their bases. They redo Constantinides' simulations over 15-year horizons using randomly selected monthly returns for 75 randomly selected stocks during the period 1963-1983. They find that the benefits from restarting are generally much smaller than reported by Constantinides and are generally less than the costs if unrealized gains are not taxed at the end of the 15-year period.

Dammon, Dunn, and Spatt buttress their conclusions with Monte Carlo simulations involving a single stock with mean annual returns ranging from 5% to 20% and annual standard deviations ranging from 10% to 80%. They again use a 15-year horizon and assume that the cash fund earns 5% before taxes. They report only 25,000 simulations though they note that more simulations are needed to provide an accurate approximation of highly skewed distributions.

Dammon and Spatt (1996) show that it may be advantageous to not realize modest short-term losses near the expiration of the short-term holding period because these losses may turn into lightly taxed long-term gains. This argument for not restarting the clock so that short-term losses might turn into long-term gains is a nice complement to Constantinides' argument for realizing long-term gains in order to restart the clock for future short-term losses.

However, Dammon and Spatt ignore the reality that gains and losses must be offset. (Although they analyze only a single security, they assume it is traded weekly and ignore the offsetting of gains and losses on the same security.) The mandated offset vitiates their strategy. And if an investor avoids the offset by never realizing losses, the foregone benefits from deducting losses will generally far exceed the benefits from a lower tax rate on realized gains—particularly if the realization of gains can be postponed indefinitely.

Dammon and Spatt also make the unrealistic assumption that each stock has a tax-exempt counterpart with a riskless tax-free rate of return equal to the expected value of the stock's risky, taxable return. Tax refunds are invested at this interest rate and tax bills are paid with funds borrowed at this interest rate. This peculiar assumption is in sharp contrast to Constantinides' assumption that funds are invested and borrowed at the taxable and tax-deductible T-bill rate. These different assumptions clearly underlie their differing conclusions about whether it is profitable to realize long-term gains in order to restart the basis.

Another problem with all of these analyses is that they ignore the $3,000 limit on capital losses that can be realized in any year.

5. Risk and Diversification

Most investors care about risk as well as return. One of the lessons of portfolio theory is that it pays to diversify. This fundamental principle is usually ignored by analyses of tax-based strategies, most obviously when the portfolio consists of a single stock.

In the Constantinides (1984) model, the investor always holds the same number of shares of each stock. He argues that this restriction ensures that each strategy is equally risky. This isn't entirely true since the strategies hold different amounts of cash, or are leveraged. More

importantly, an equal number of shares doesn't ensure a balanced portfolio, even when the portfolio is formed, since prices per share may vary widely from stock to stock.

Unbalanced portfolios are generally riskier than balanced ones, and a portfolio consisting of an equal number of shares of each stock may become increasingly unbalanced over time as some stocks do much better than others. Because investors may want to reduce their risk by rebalancing their portfolios, an important difference between two strategies may be how well they facilitate such rebalancing. For example, a buy-and-hold strategy only allows rebalancing through the investment of dividends; in contrast, a strategy of realizing gains allows the redeployment of funds invested in the stocks that have increased in value.

Similarly, the analysis of trading strategies involving a single stock ignores the fact that losses on one stock can be used to offset gains on another stock. Instead of being carried forward, perhaps for many years, realized losses that exceed the $3,000 limit can be used to offset realized gains and thereby rebalance the portfolio.

We should note that Warren Buffett has expressed skepticism about rebalancing: "To suggest than an investor should sell off portions of his most successful investments simply because they have come to dominate his portfolio is akin to suggesting that the Bulls trade Michael Jordan because he has become so important to the team." (Buffett 1997) The crucial difference between Michael Jordan (in his prime) and a successful stock in an efficient market is that Michael Jordan's performance could be reliably predicted from his past performance. Perhaps Buffett's record justifies his confidence that his best-performing investments will continue to do well. Investors who cannot predict stock returns reliably from past performance should be wary of unbalanced portfolios.

6. A Monte Carlo Simulation Model

A Monte Carlo simulation model can be used to illustrate these points concretely. The investor begins with $250,000 that is divided equally among 25 assets; we will call these assets stocks. We simplify the analysis by assuming that trading occurs at one-year intervals, or a day later to allow capital gains to become long-term. More frequent trading would increase the potential advantages from tax-based trading strategies.

Each stock pays an annual dividend (or other cash flow) equal to 1% of the stock's current market value. The annual change in market value is described by a lognormal distribution:

$$\ln\left[\frac{P_t}{P_{t-1}}\right] \sim N[\mu, \sigma]$$

The values of μ and σ are set so that the annual percentage change in each stock's price has an expected value of 5% and a standard deviation of 40%. The correlation coefficient between each pair of stock returns is 0.25.

The 6% expected return is intended to reflect current expectations that future stock market returns will, on average, be substantially lower than historical returns. The assumed values for the dividend yield and standard deviation of prices reflect the observation that investors employing tax-based strategies should select stocks with relatively low dividends (which are fully taxed) and relatively high volatility (which create opportunities for capital gains and losses).

We assume that the annual maximum tax-deductible capital loss is $3,000 and that this amount does not increase over time. Using discount brokers, brokerage fees are negligible and

are ignored. The tax rate on short-term gains is 36% and the tax rate on dividends and long-term capital gains is 15%.

The investor does not try to time the market or to identify over-valued or under-valued securities, but does try to profit from the tax code. Five strategies are considered:

1. *Buy and hold*: never sell any stocks. This is the benchmark for the tax-based strategies.
2. *Realize gains and losses*: realize all capital gains and losses each year. This strategy allows the investor to rebalance the portfolio completely each year.
3. *Realize gains in even-numbered years*: realize losses every year and realize gains in alternate years in order to create opportunities to realize future losses.
4. *Realize losses*: realize all losses and defer all gains; excess losses are carried forward.
5. *Realize losses and rebalancing gains*: realize all capital losses each year. Excess losses are used to offset realized capital gains on those stocks that have become the largest part of the portfolio. If there are insufficient capital gains to absorb the capital losses, the excess capital losses are carried forward.

All of these strategies generate cash each year, from dividends and (possibly) stock sales. This cash is invested in the 10 stocks that are the smallest components of the portfolio, with two exceptions. Strategy 2 invests equal amounts in all stocks, and Strategy 3 does the same in alternate years. The terminal dates are interpreted as the time of the investor's death, so that the terminal portfolios are untaxed.

7. Results

As noted above, when working with compounded returns from lognormal distributions over long horizons, a large number of simulations are needed to provide accurate estimates of the

probability distribution. We consequently report the results of one million simulations of the model.

Table 1 shows the mean and median values of the ratio of each strategy's wealth to benchmark buy-and-hold wealth, for horizons up to 60 years. By these measures, a strategy of realizing losses and rebalancing gains substantially outperforms buy and hold and is, by far, the most successful of the tax-based strategies. The repeated realization of capital losses allows all four tax-based strategies to outperform buy-and-hold. The strategy of realizing losses and rebalancing gains does better than the first two strategies in Table 1 because it doesn't pay taxes paid on excess capital gains, and does better than the third strategy because the realization of gains restarts the basis, thereby planting seeds that allow a continual harvesting of future capital losses. The first two strategies realize too many capital gains and consequently pay too much taxes, the third strategy realizes too few gains and consequently reduces the investor's opportunities to harvest future capital losses.

If a stock that is purchased for $10,000 increases in value to $20,000 and then falls back to $15,000, the third strategy misses an opportunity to realize a $5,000 loss. This loss can be harvested if the investor sells at $20,000 (using an offsetting $13,000 loss on other stocks to avoid paying capital gains taxes and deduct a $3,000 capital loss), and reinvests the $20,000, thereby creating a $20,000 basis for future gains and losses. This is why, longer term, a strategy of realizing only losses (the third column in Table 1) does even worse than the strategies in the first two columns in Table 1, which reset the basis for stocks that have appreciated, but also sometimes pay excess taxes by realizing gains that exceed losses. In terms of the mean and median return, it is better to realize all losses and to not realize gains that exceed losses.

There is another, more subtle, advantage to harvesting all of the losses that can be offset by gains. Table 2 shows the ratio of the standard deviation of wealth for each strategy to the standard deviation of wealth for buy and hold. The strategies of realizing gains and losses or realizing gains in alternate years have very compact distributions because they completely rebalance the portfolio every year or every other year. Among the other three strategies, a strategy of realizing losses and rebalancing gains reduces the dispersion of wealth substantially by combatting the tendency of unmanaged portfolios to become increasingly concentrated in a few stocks.

Table 3 gauges the degree to which a portfolio is unbalanced by looking at the average fraction of the portfolio that is invested in the largest stock holding. With buy and hold, after 10 years 17.7% of wealth, on average, is invested in a single stock; after 30 years, this fraction is up to 29.1%. A strategy of realizing losses each year has only a modest effect. A strategy of realizing losses and rebalancing gains cuts this fraction approximately in half.

One way of gauging the riskiness of strategies with different means and standard deviations is to compute the shortfall risk for a 0% target return—here, the probability that wealth is less than the initial $250,000. Figure 1 shows that, by this measure, the strategy of realizing losses and rebalancing gains is the safest. (The alternate-year strategy is not shown because it is so similar to the strategy of realizing all gains and losses.)

If we assume that the observed simulation frequencies are approximately equal to the probabilities of obtaining various levels of wealth, stochastic dominance allows us to compare risky strategies while making the weakest possible assumptions about preferences (Quirk and Saposnik 1962, Fishburn 1964, Hadar and Russell 1969).

Strategy A exhibits first-degree stochastic dominance over Strategy B if the cumulative probability distribution of wealth for A is never to the left (and sometimes to the right) of the cumulative probability distribution for B. This requirement that the cumulative probability distributions don't cross means that the probability that wealth will be less than or equal to any specified amount W is never larger for Strategy A than for Strategy B and is sometimes smaller. Equivalently, the probability that wealth will be larger than or equal to any specified amount W is never smaller for Strategy A than for Strategy B and is sometimes larger. Any investor who prefers more wealth to less unambiguously prefers a strategy that exhibits first-degree stochastic dominance.

Strategy A exhibits second-degree stochastic dominance over Strategy B if, for all specified levels of wealth, the area under A's cumulative probability distribution is never larger (and is sometimes smaller) than the area under B's cumulative probability distribution. This requirement means that A's cumulative distribution must start to the right of B's cumulative distribution and can cross it as long it as the difference in the areas before they cross is greater than the difference in the areas after they cross. Roughly speaking, A has a lower probability of both relatively low and high levels of wealth, and the differences in the low-wealth probabilities are larger than the differences in the high-wealth probabilities. A risk-averse investor who prefers more wealth to less (a concave, positively sloped utility function) prefers a strategy that exhibits second-degree stochastic dominance.

A strategy of realizing losses and rebalancing gains exhibits first-degree stochastic dominance over a strategy of realizing gains in alternative years for horizons longer than 28 years, second-degree stochastic dominance over a strategy of realizing losses for horizons longer

than 3 years, and second-degree stochastic dominance over a buy-and-hold strategy for horizons longer than 6 years.

8. Discussion

Portfolio rebalancing is relatively inexpensive within tax-deferred retirement accounts because transaction costs are low and there are no tax consequences from realizing gains or losses. However, shuffling assets in a retirement portfolio will be of little use in rebalancing a portfolio that has become unbalanced because a small number of stocks have come to dominate the taxable portfolio. Thus, the existence of retirement accounts does not negate the benefits from realizing losses and rebalancing gains in the taxable portfolio.

One implication of our analysis that is relevant for asset location issues is that tax harvesting gives investors another reason for putting stocks in their taxable account—specifically, stocks with relatively low dividends and high volatility. *Ceteris paribus*, investors want their tax harvesting portfolio to contain assets whose anticipated returns are (a) mostly capital gains that need not be realized; and (b) highly uncertain so that profits can be made from the combination of unrealized gains and realized losses. Stocks are more likely than bonds to meet these criteria.

It has been argued that investors should reduce their risk exposure as they age and their investment horizon shortens (Van Eaton & Conover, 2002; Booth, 2004). In the conventional two-asset model, this means shifting from stocks to bonds—as, for example, in the "your age in bonds" rule. In our multiple-asset model, a strategy of holding on to winners in order to avoid capital gains taxes has the opposite effect: the portfolio becomes increasingly unbalanced and riskier as the investor ages. If investors do, indeed, want to reduce their portfolio's riskiness as they age, this makes the argument for portfolio rebalancing even stronger.

Strategies that involve the realization of losses will also become even more attractive if the $3,000 limit on tax-deductible capital losses is increased in the future. Anything is possible with the tax code, but it seems unlikely that the current limit will persist indefinitely. The Monte Carlo simulations also assume that transactions are only made once a year. More frequent transactions would increase an investor's chances of realizing annual capital losses up to the tax-deductible limit and would also increase the investor's opportunities to use excess losses to rebalance the portfolio. This strategy would also benefit from higher values for the mean and standard deviation of individual stock returns and lower dividends.

Even with our conservative assumptions, a strategy of realizing losses and rebalancing gains is very attractive. This strategy not only increases the mean and median return by taking advantage of the tax-deductibility of losses, but also mitigates risk by allowing low-cost portfolio rebalancing. The basis and time clock are also restarted when stocks with capital gains are sold and the proceeds are reinvested in rebalancing stocks. There is no direct profit from this restarting since the implicit tax rate on the capital gains equals the tax rate on losses; however, this restarting plants the seeds for a future harvesting of capital losses that can be deducted from income and used to rebalance the portfolio perpetually.

In comparison, buy and hold foregoes the profits from deducting losses and leads to very unbalanced portfolios when some stocks do much better than others. Realizing losses takes advantage of the deductibility of losses, but does little to rebalance the portfolio: selling stocks that have gone down in value and reinvesting the proceeds doesn't alleviate the problem that past winners now dominate the portfolio. The strategies of realizing all gains and losses annually or realizing losses every year and gains every other year permit complete rebalancing and thereby

reduce the variability of wealth; however, the taxes paid on the excess capital gains drag down the return.

There are several implications for financial planning and asset management. Regarding financial planning, the parameterization of future scenarios, either stochastic or nonstochastic, should be based on the after-tax rates of return and these returns can be enhanced by tax-based trading strategies. If a financial planner is using nonstochastic projections, the enhanced after-tax returns can first be estimated from simulations of the kind used in this paper. If a planner is using stochastic projections incorporating uncertainty regarding future rates of return (and perhaps also income, mortality, and various economic and socio-demographic events), the planner's Monte Carlo simulation model can be modified to incorporate the tax implications of realizing capital losses and rebalancing gains.

Regarding asset management, it is well known that tax-inefficient mutual funds are seldom in investors' best interests. Mutual funds that habitually churn their portfolios without improving their performance incur unnecessary transaction costs and capital gains taxes. For investors with sufficient wealth to diversify their portfolios without relying on mutual funds, self-constructed portfolios of individual stocks can be more profitable than even tax-efficient mutual funds because homemade diversification offers more opportunities for tax-based trading. The primary advice here is to implement our strategy by realizing losses and rebalancing gains.

A more complex situation is where the asset manager uses a mean-variance model to analyze the risk-return tradeoff. These are typically static models that assume a fixed horizon, perhaps a year, with the analysis is redone at the end of the planning horizon using updated parameter values. The problem is that tax laws can make portfolio adjustments expensive. Many planners

simply ignore this adjustment cost and do their portfolio analysis as if they were starting with a clean slate, with no regard for the tax consequences.

Suppose, for example, that the value of one stock has fallen by 50 percent, but there has been no change in the parameter values used to determine the Markowitz frontier. In order to reestablish the initial portfolio allocation, the investor is advised to buy more of the stock with the lower price, even though there is a tax advantage to selling this stock.

One simple way to account for the tax consequences is to first implement the strategy described here by realizing all capital losses. The Markowitz portfolio optimization is then done with the modification that excess losses can be used to offset capital gains that are realized as a result of the portfolio optimization and taxes must be paid on realized capital gains that are not offset by losses. One problem with this simple approach is that ignores the potential benefits from portfolios that facilitate the harvesting of future capital losses. To take these benefits into account, a dynamic portfolio optimization model is needed.

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Table 1

Mean (Median) of the Ratio of Wealth to Buy-and-Hold Wealth

horizon (years)	Realize Gains & Losses	Realize Gains in Alternate Years	Realize Losses	Realize Losses & Rebalancing Gains
10	0.97 (0.97)	0.98 (0.97)	1.04 (1.03)	1.05 (1.05)
20	1.00 (0.99)	1.00 (0.99)	1.08 (1.06)	1.13 (1.12)
30	1.05 (1.03)	1.06 (1.02)	1.12 (1.08)	1.23 (1.20)
40	1.12 (1.08)	1.13 (1.06)	1.15 (1.10)	1.34 (1.29)
50	1.21 (1.13)	1.22 (1.11)	1.19 (1.12)	1.46 (1.38)
60	1.30 (1.18)	1.31 (1.16)	1.22 (1.14)	1.60 (1.48)

Table 2

Standard Deviation of Wealth Relative to Buy and Hold Strategy

horizon (years)	Realize Gains & Losses	Realize Gains in Alternate Years	Realize Losses	Realize Losses & Rebalancing Gains
10	0.76	0.79	1.02	1.00
20	0.63	0.67	1.04	0.98
30	0.50	0.53	1.05	0.93
40	0.38	0.41	1.05	0.92
50	0.28	0.31	1.06	0.88
60	0.18	0.20	1.10	0.86

Table 3

Average Fraction of Portfolio in Largest Stock Holding

horizon (years)	Buy & Hold	Realize Gains & Losses	Realize Gains in Alternate Years	Realize Losses	Realize Losses & Rebalancing Gains
10	17.7	4.0	4.0	19.2	9.1
20	24.8	4.0	4.0	24.8	11.3
30	29.1	4.0	4.0	28.6	13.3
40	31.7	4.0	4.0	30.7	14.9
50	33.2	4.0	4.0	32.1	15.9
60	34.1	4.0	4.0	33.0	16.5

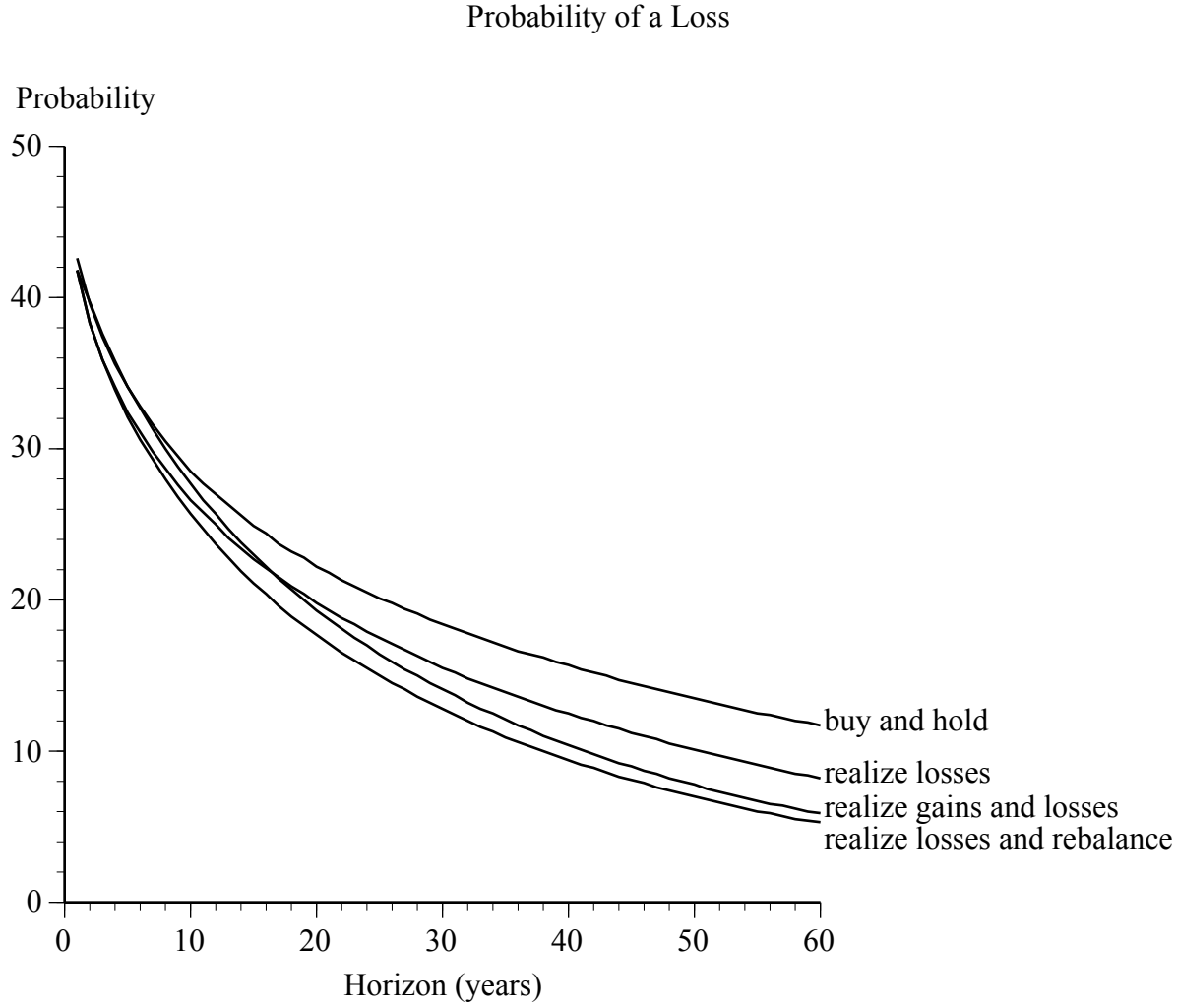
Probability of a Loss
Probability
50
40
30
20
10
0
0
10
20
30
40
50
60
Horizon (years)
buy and hold
realize losses
realize gains and losses
realize losses and rebalance

Fig. 1