

Does it pay to realize tax losses at the year-end?

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Abstract

Motivated by the widely touted practice, we examine the effects of realizing tax losses at the year-end on simulated stock portfolios. Our results indicate that the timing of portfolio formation, the cutoff that triggers the loss realization, the length of an investor's holding period, and to a lesser extent, the timing of the tax benefits, all affect the probability that the tax-loss strategy outperforms a simple buy-and-hold strategy. Collectively, our findings support the tax-loss strategy in general, but they also suggest that factors other than an investor's applicable tax rate affect the effectiveness of this strategy as well. © 2013 Academy of Financial Services. All rights reserved.

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*"I am merciless with the losers, however. With few exceptions, I sell before the end of each calendar year any stocks on which I have a loss." . . . Burton G. Malkiel,
A Random Walk Down Wall Street (Malkiel, 2007)*

1. Introduction

The tax-loss selling hypothesis, first proposed by Wachtel (1942) as a possible explanation for the higher returns of stocks in January, essentially states that investors would realize their

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losses at the year-end to lock in the deductibility for tax purposes. Popular presses also frequently tout the benefits of harvesting tax losses, especially at the year-end (see, e.g., Stern, 2005; Lim, 2006; Laise, 2009; Saunders, 2011; Herman, 2012). Although numerous studies have investigated the existence of the tax-loss selling behavior and its possible impacts on security prices, notably the January effect, virtually none has provided an empirical assessment on the general effects of practicing the tax-loss strategy on individuals' investment performance.¹ This article fills this gap in the case of stock investments. Specifically, we investigate the effects of realizing tax losses at the year-end on the investment performance of stock portfolios.

We estimate the probability that the tax-loss strategy outperforms a simple buy-and-hold strategy using a nonparametric simulation method. Motivated by the literature on return momentum and return continuation (e.g., Jegadeesh and Titman, 1993; De Bondt and Thaler, 1985), we also examine whether the timing of portfolio formation, the cutoff that triggers the loss realization, the timing of the tax benefits, and the length of an investor's holding period affect the probability of tax-loss strategy. Empirically, we construct stock portfolios of 30 randomly picked U.S. stocks and repeat the portfolio formation 100 times at the end of each previous calendar quarter from 1963 to 2009. At the end of each year (e.g., 1963), stocks that experience a capital loss of either any magnitude, 5%, 10%, or 15% in a portfolio are sold, and the proceeds are reinvested in the S&P 500 total return index. Investors realize the tax benefits at the end of either January, February, March, or April of the following year (e.g., 1964), and the benefits are again reinvested in the S&P 500 total return index. The positions are then held until the end of June, September, or December in the year the tax benefits are realized. We obtain the probability of tax-loss strategy outperformance across the 100 portfolios formed at each quarter-end, and we consider all the federal personal income tax rates in these scenarios.

Our results indicate that the timing of portfolio formation, the cutoff that triggers the loss realization, the length of an investor's holding period, and to a lesser extent, the timing of the tax benefits, all affect the probability that the tax-loss strategy outperforms a simple buy-and-hold strategy. Specifically, although the probability of the tax-loss strategy outperforming the buy-and-hold strategy is generally larger than 50%, it is not so for investors who are in the lowest tax brackets with late portfolio formation, short holding periods, and small loss cutoffs. In particular, using the S&P 500 total return index for reinvestments, the tax-loss strategy is more effective with a higher probability of outperforming the buy-and-hold strategy when the portfolio is formed earlier in the year, has a larger loss cutoff, has a later holding period end, and has the tax benefits realized in either January or February. We obtain the statistical significance of our results in both univariate and multivariate frameworks, and the results using an alternative set of data and a different reinvestment strategy are largely consistent with our previous findings.

This article makes several contributions: First, our results provide the empirical support to the tax-loss strategy, using an intuitively appealing probability measure to quantify its outperformance relative to a buy-and-hold strategy. We also show that although tax-loss selling at the year-end is beneficial to investors in general, its positive effect on the investment performance is not a sure thing with a 100% probability. Second, we document the specific instances in which practicing the tax-loss strategy would have an adverse effect

on the investment performance. Third, we identify several factors other than an investor's applicable tax rate that could possibly affect the effectiveness of the tax-loss strategy, and we confirm their statistical significance. These results collectively provide a guideline for investors attempting to practice the tax-loss strategy.

The remainder of this article is organized as follows: In the following section we review the related literature. We describe the sample and illustrate our methods in Section 3. Section 4 presents the empirical results and Section 5 shows the results using an alternative set of data and a different reinvestment strategy. We conclude this article in Section 6.

2. Tax-loss selling

2.1. The tax-loss selling hypothesis

Wachtel (1942), noting that stocks included in the Dow Jones Industrial Average Index display frequent bullish tendencies from December to January, posits that the January performance is a normal reaction of depressed stock prices because investors realize their tax losses in December. Central in the tax-loss selling hypothesis is thus that investors would realize their losses at the year-end to lock in the deductibility for tax purposes.² Rozeff and Kinney (1976) formally document the January effect, the phenomenon that stocks tend to earn higher returns in January. They also identify the tax(-loss) selling hypothesis as one of the possible explanations for this phenomenon.

2.2. Evidence of tax-loss selling

Dyl (1977) finds that stocks experiencing large losses (gains) in the preceding year have particularly large (small) trading volume at the year-end. In addition, the year-end volume of past winners and losers are sensitive to the overall market condition that changes investors' incentives to realize gains and/or losses. Ritter (1988) examines the buy/sell ratios of individual investors using aggregated brokerage-level data, and finds a relative net selling in December and a relative net buying in January. Using retail brokerage account data, both Badrinath and Lewellen (1991) and Odean (1998) find elevated levels of loss realization near the year-end. Poterba and Weisbenner (2001) show that the correlation between early year losses and the January effect is affected by shifts in personal income tax regimes, suggesting that tax-loss selling by individuals contributes to the January effect. Grinblatt and Moskowitz (2004) also find that different tax regimes affect the relation between past stock returns and expected returns, and that tax-loss selling plays a role on the relation. D'Mello, Ferris, and Hwang (2003), using intraday data, show that stocks with large capital losses experience abnormal selling pressure before the year-end. In particular, the average trade size decreases for those stocks, suggesting that individuals are those who engage in tax-loss selling. Using trade and holding data, Grinblatt and Keloharju (2004) provide direct evidence that Finnish investors engage in tax-loss selling. These findings collectively are consistent with a taxation effect on investor behavior at the year-end and support the existence of tax-loss selling.

2.3. Tax-loss selling and the January effect

Branch (1977) defines stocks reaching a new low price in the week ending with the last Friday of a year as depressed by tax-loss selling, and finds that a strategy of holding those stocks enjoy superior performance in the following January relative to a buy-and-hold strategy on the market. Reinganum (1983) finds that the January effect on small firms is consistent with tax-loss selling, but the tax-loss selling effect does not appear to be the sole reason explaining the January effect. Specifically, small firms that are past winners and thus less likely subject to tax-loss selling also earn higher returns in January.

Constantinides (1984) uses a simulation method to show that the optimal trading rules, involving realizing long-term gains and short-term losses when the long-term tax rate is lower than the short-term tax rate, outperform a buy-and-hold strategy. In addition, the January effect on security prices should only be obtained when investors ignore the optimal trading rules. Chan (1986) finds evidence consistent with the prediction of Constantinides (1984). Specifically, he finds the January effect on stocks with short-term losses and on stocks with long-term losses, of which the latter should not be subject to rational tax-loss selling.

Givoly and Ovadia (1983) show that tax-loss selling appears to be the major explanation for the January return pattern of stocks that are most likely subject to tax sales. They also point out that brokerage firms/analysts issue tax-switch lists that recommend substitutive stocks for tax-sale candidates, highlighting the tax-loss selling practice. Chang and Pinegar (1986) find that both stocks and bonds of low-grade firms exhibit the January effect. In particular, the January effect is stronger for those that experienced larger capital losses, a result consistent with tax-loss selling.

Using international data, Brown, Keim, Kleidon, and Marsh (1983) find that the smallest firms in Australia earn the largest return premium in both January and July. This finding is inconsistent with the tax-loss selling hypothesis as a sole explanation for the return seasonalities because the Australian tax year ends in June. Berges, McConnell, and Schlarbaum (1984) and Tinic, Barone-Adesi, and West (1987) both examine Canadian data, for which there is no capital gains tax before 1973. Their findings of the January effect in both the pre- and post-1973 periods suggest that tax-loss selling is unlikely the only reason for the observed January effect. Van Den Bergh and Wessels (1985) examine Dutch data, for which neither capital gains nor capital losses have tax consequences. They also find the existence of the January effect.

Schultz (1985), Jones, Pearce, and Wilson (1987), and Jones, Lee, and Apenbrink (1991) all examine stock return before the War Revenue Act of 1917, which introduces personal income taxes in the United States, albeit they use different samples and methods. Both Schultz (1985) and Jones, Lee, and Apenbrink (1991) find no January effect before the Act and conclude that the tax-loss selling hypothesis is a possible explanation for the January effect. Jones, Pearce, and Wilson (1987), on the other hand, identify the January effect before 1917 and interpret their results as inconsistent with tax-loss selling. Jones, Lee, and Apenbrink (1991) later attribute the conflicting findings to the potentially inflated January returns on the value-weighted index examined in Jones, Pearce, and Wilson (1987).

Brauer and Chang (1990) document the January effect on closed-end fund shares but not

on their net asset values. In addition, funds that have lower mean returns and larger return variability in the preceding year experience a larger January effect. Starks, Yong, and Zheng (2006) examine municipal bond closed-end funds, which are most likely held by individuals. They also find a January effect on the funds but not on the underlying bonds. In particular, funds associated with brokerage firms display more tax-loss selling behavior, suggesting that brokerage firms advise their clients to engage in tax-motivated trading.

3. Data and methods

3.1. Data

Our sample includes all public-traded U.S. ordinary common stocks (share type code 10 or 11) covered by the Center for Research in Security Prices (CRSP) database from 1963 to 2009. We exclude securities such as certificates, American depository receipts (ADRs), shares of beneficial interest, units, American trust components, closed-end funds, real estate investment trusts, and stocks of companies incorporated outside the United States. We obtain the monthly stock returns from the CRSP database, and the monthly returns of the S&P 500 total return index over the same period from the Ibbotson SBBI Classic Yearbook (2009) and through the Bloomberg terminal.

3.2. Methods

We use a nonparametric simulation (see, e.g., Davison and Hinkley, 1997) to generate stock portfolios and evaluate the performance of the tax-loss strategy on those portfolios against the corresponding buy-and-hold benchmarks. Specifically, at the end of each previous calendar quarter from 1963 to 2009, we randomly pick 30 stocks to be included in a portfolio and repeat the portfolio formation 100 times. We choose the portfolio size of 30 stocks for the size to be statistically large while remain reasonable for individuals. Because *ex ante* the portfolio of 30 randomly picked stocks should have the same risk as the market, if a stock in a portfolio is delisted or encounters a missing return in the CRSP database before the year-end, we replace the stock with a position in the S&P 500 total return index, our market proxy.³ We then impose the tax-loss strategy of realizing tax losses at the year-end on the remaining stocks in the portfolio. Both the proceeds from the disposition of stocks with tax losses larger than certain magnitudes and the realized tax benefits are invested in the S&P 500 total return index, albeit at different points in time, and we compare the portfolio return with that of a buy-and-hold strategy at the end of a holding period. We obtain the probability that the tax-loss strategy outperforms the buy-and-hold strategy across the 100 portfolios formed at a given quarter-end. Using the scale-free probability of tax-loss strategy outperformance allows us to aggregate the results across different specifications later. Using the passive S&P 500 total return index for reinvestments is easier for individuals to execute, and it avoids the possible confounding effects of alternative reinvestment strategies on the performance of realizing tax losses at the year-end. The simulation method we use is similar in spirit to Haugen and Wichern (1973) and Constantinides (1984), but our method uses

realized returns and it does not require us to specify an ad hoc return generating process. Although we use historical data, we are not examining whether the tax-loss strategy has worked in the past (because of the changing tax regimes), but how the strategy would work given the current income tax regime. Our method of using the performance of a buy-and-hold strategy as the benchmark parallels that of Branch (1977) and Constantinides (1984).

3.3. Factors affecting the effectiveness of the tax-loss strategy

The factors other than the personal income tax rate that we consider could possibly affect the effectiveness of the tax-loss strategy include the timing of portfolio formation, the cutoff that triggers the loss realization, the timing of the tax benefits, and the length of an investor's holding period. Specifically, Jegadeesh and Titman (1993) document the momentum in stock returns. If stock returns reveal such pattern over intermediate horizons, we expect the tax-loss strategy of selling stocks that are confirmed losers over a longer horizon to outperform the buy-and-hold strategy more frequently than the tax-loss strategy of selling stocks that are confirmed losers over a shorter horizon. Because our simulated portfolios are formed at each previous quarter-end, each year we have four different timing of portfolio formation (i.e., the January portfolio, the April portfolio, the July portfolio, and the October portfolio) before the execution of the tax-loss strategy at the year-end. In addition, the existence of return momentum also suggests that the cutoff that triggers the loss realization could be a factor that affects the effectiveness of the tax-loss strategy. If extreme stock losers continue to be losers as documented in Jegadeesh and Titman (1993), the tax-loss strategy with a larger loss cutoff to identify extreme losers should outperform the buy-and-hold strategy more frequently than the tax-loss strategy with a smaller loss cutoff. We consider the loss cutoffs of a loss of any magnitude (i.e., 0%, 5%, 10%, and 15% below the original purchase price). At the last trading day of each year, stocks that lose more than the cutoff in a portfolio are sold at the market close, and the proceeds are reinvested in the S&P 500 total return index at the same time.

We define the tax benefit generated by each losing stock as the tax loss of a stock at the year-end times the federal personal income tax rate of either 10%, 15%, 25%, 28%, 33%, 35%, or 39.6%. The tax benefits, however, are not realized until the end of either January, February, March, or April of the following year, and the realized tax benefits are immediately reinvested in the S&P 500 total return index to maintain the ex ante portfolio risk. We consider the timing of the tax benefits as a factor that could possibly affect the effectiveness of the tax-loss strategy for a practical reason: Although by realizing the tax losses at the year-end an investor locks in the tax deductibility for that year, the real benefits would not be realized until after the investor files the income tax return. Given that any unrealized tax benefit effectively lowers the portfolio risk and return, we expect the tax-loss strategy with a sooner timing of the tax benefits to outperform the buy-and-hold strategy more frequently than the tax-loss strategy with a delayed timing of the tax benefits.

We also consider the length of an investor's holding period as a factor that could possibly affect the effectiveness of the tax-loss strategy. Specifically, the return reversal documented in De Bondt and Thaler (1985) and the return continuation documented in Jegadeesh and Titman (1993) may interact once we lengthen the holding period. Because we cannot

ascertain the direction of the possible effect, we leave it an empirical question and compare the performance of the tax-loss strategy with that of the buy-and-hold strategy at the end of June, September, and December in the year the tax benefits are realized.

3.4. Other considerations

Because our purposes are to assess the effects of practicing the tax-loss strategy at the year-end on individuals' investment performance in general, and to identify the factors that could possibly affect the effectiveness of the tax-loss strategy, our empirical methods do not distinguish long-term capital gains (losses) from short-term capital gains (losses) at the end of a holding period. Specifically, under the current tax regime capital gains from assets held less than one year are taxed at an individual's ordinary income tax rate. Capital gains from assets held longer than one year are taxed at the 0% tax rate for individuals in the 10% and 15% tax brackets, at the 20% tax rate for individuals in the 39.6% tax bracket (since 2013), and at the 15% tax rate for other individuals. Long-term gains, however, would offset both long-term losses and short-term losses before the favorable tax rate applies. Short-term gains would also offset both long-term losses and short-term losses. If an individual incurs a net capital loss during a year, up to \$3,000 of the loss could offset the individual's ordinary income and the rest of the loss would carry forward to the following year(s). To the extent that the gains and the losses could offset each other regardless of the length of the holding period, and that the favorable tax status of long-term capital gains remain uncertain in the future, we opt for the approach of treating long-term capital gains (losses) as short-term capital gains (losses) to maintain the generality of our results.⁴ We also treat all dividends as ordinary dividends to simplify the analyses.⁵

Another consideration arises from the fact that past tax-loss selling activities may have impacted the historical stock data we use for simulation. In particular, the impacts under different tax regimes may be different (e.g., Grinblatt and Moskowitz, 2004; Poterba and Weisbenner, 2001). To alleviate this concern, we explicitly control for subperiods in our multivariate analysis. We also note that although tax-loss selling activities in aggregate could affect security prices (e.g., the January effect), the tax-loss selling activities of an individual are unlikely to alter security prices and cause a feedback effect.

Finally, in light of the prevalence of discount brokerages (i.e., brokerage accounts with low commissions) in recent years and the existence of asset-based traditional brokerages (i.e., brokerage accounts with asset-based fees but no commission for trades), we impose a 0.2% commission (e.g., \$10 commission on a \$5,000 trade) each time a trade occurs. Ignoring the commissions does not change any of our conclusions.

4. Empirical results

Table 1 shows the summary statistics on the number of sample stocks each month, the average of the monthly median stock price, and the average of the monthly median market capitalization of our sample in a given year from 1963 to 2010. Although the last simulated

Table 1 Summary statistics on sample stocks

Year	Number of observations			Price (\$)	Cap. (\$ million)	Year	Number of observations			Price (\$)	Cap. (\$ million)
	Mean	Max.	Min.				Mean	Max.	Min.		
1963	1,975	1,985	1,957	19.30	28.36	1987	6,206	6,371	6,010	10.03	40.60
1964	2,018	2,045	1,988	19.88	30.24	1988	6,195	6,307	6,089	8.21	33.46
1965	2,062	2,077	2,045	21.98	34.47	1989	5,933	6,045	5,843	8.69	36.57
1966	2,090	2,108	2,070	21.53	37.14	1990	5,800	5,850	5,725	6.97	30.66
1967	2,102	2,107	2,094	25.13	49.74	1991	5,687	5,746	5,646	7.76	37.26
1968	2,098	2,110	2,087	29.41	67.96	1992	5,815	5,848	5,752	9.69	53.47
1969	2,162	2,213	2,111	25.26	64.58	1993	6,063	6,335	5,878	11.36	68.37
1970	2,263	2,300	2,218	16.31	40.60	1994	6,602	6,735	6,420	11.30	70.80
1971	2,332	2,387	2,298	18.77	48.26	1995	6,780	6,906	6,711	12.07	81.11
1972	2,452	2,508	2,397	18.42	49.62	1996	7,167	7,419	6,948	13.11	97.12
1973	5,224	5,406	4,965	9.43	15.94	1997	7,438	7,458	7,414	13.98	107.68
1974	4,781	4,912	4,606	6.94	12.65	1998	7,284	7,424	7,047	12.94	112.54
1975	4,611	4,633	4,584	7.62	14.73	1999	6,796	6,996	6,668	11.60	118.30
1976	4,631	4,717	4,417	9.23	17.94	2000	6,569	6,645	6,418	10.89	135.36
1977	4,667	4,695	4,632	10.26	20.14	2001	5,998	6,349	5,682	10.33	123.94
1978	4,566	4,614	4,540	12.16	25.70	2002	5,440	5,643	5,248	10.62	137.00
1979	4,524	4,549	4,512	12.69	28.60	2003	5,028	5,220	4,896	12.63	192.57
1980	4,563	4,669	4,521	12.97	31.70	2004	4,854	4,893	4,827	16.14	284.79
1981	4,879	5,047	4,695	12.58	32.85	2005	4,798	4,830	4,768	16.76	316.63
1982	5,033	5,084	4,979	10.21	27.56	2006	4,733	4,763	4,722	17.58	369.01
1983	5,218	5,554	5,015	13.95	43.13	2007	4,665	4,712	4,623	16.95	380.68
1984	5,744	5,802	5,634	10.19	33.66	2008	4,519	4,619	4,380	11.29	271.44
1985	5,721	5,758	5,700	10.53	36.30	2009	4,208	4,351	4,106	9.02	234.54
1986	5,830	6,012	5,701	11.34	43.47	2010	4,039	4,092	3,980	12.16	335.44

Notes: This table shows the summary statistics on the publicly traded ordinary common stocks in the U.S. from 1963 to 2010 with valid monthly returns (include delisting returns) from the CRSP database. The reported mean, maximum, and minimum of the *Number of Observations* are monthly statistics within the specific year. The *Price* and *Cap.* (capitalization) columns show the averages of the monthly medians within the specific year.

portfolios from our sample are formed in 2009, we also require the stock return data in 2010 because the holding period extends into the year after the portfolio formation.

Table 1 suggests that the median prices are relatively stable in the sample across the years, a result consistent with Weld, Michaely, Thaler, and Benartzi (2009). The market capitalization, on the other hand, increases in recent years. In addition, because the CRSP database does not include Nasdaq stocks before 1973, there is a significant discontinuity in sample size before and after 1973. For instance, the average monthly number of stocks in the sample is 2,452 in 1972 and 5,224 in 1973. Later we explicitly control for this discontinuity in our analyses.

Table 2 shows the probability that an investment in a sample stock is switched to the S&P 500 total return index because of delisting or missing CRSP return before the year-end (i.e., *Probability of Forced Realization*), and the proportion of stocks sold in the 30-stock portfolio at the year-end under the loss cutoff of either a loss of any magnitude (i.e., 0%), 5%, 10%, or 15%. The reported numbers are the averages across the portfolios formed at a given quarter-end within a decade. For instance, on average 5.41% of the sample stocks in the January portfolio from 1963 to 1969 have incomplete data before the year-end, and they are

Table 2 Proportion of stocks sold under different loss cutoffs

Portfolio month	Probability of forced realization	Proportion of stocks sold under different loss cutoffs			
		0%	5%	10%	15%
1963–1969					
January	0.0541	0.3823	0.3279	0.2761	0.2298
April	0.0382	0.4321	0.3658	0.3006	0.2390
July	0.0249	0.4436	0.3478	0.2560	0.1870
October	0.0115	0.4636	0.3142	0.1935	0.1096
1970–1979					
January	0.0700	0.4336	0.3823	0.3311	0.2858
April	0.0568	0.5502	0.4848	0.4193	0.3573
July	0.0379	0.5269	0.4450	0.3619	0.2859
October	0.0135	0.5427	0.4310	0.3275	0.2416
1980–1989					
January	0.0845	0.4044	0.3578	0.3149	0.2751
April	0.0621	0.4752	0.4225	0.3702	0.3192
July	0.0408	0.5384	0.4669	0.4006	0.3361
October	0.0174	0.5159	0.4191	0.3333	0.2597
1990–1999					
January	0.0861	0.4323	0.3912	0.3503	0.3069
April	0.0622	0.4749	0.4228	0.3718	0.3243
July	0.0392	0.4934	0.4295	0.3699	0.3123
October	0.0148	0.4849	0.3886	0.3086	0.2399
2000–2009					
January	0.0939	0.4367	0.3939	0.3538	0.3178
April	0.0663	0.4507	0.4027	0.3593	0.3164
July	0.0393	0.4814	0.4162	0.3573	0.3054
October	0.0184	0.4418	0.3531	0.2848	0.2321

Notes: This table shows the probability that an investment in a sample stock is switched to the S&P 500 total return index because of delisting or missing CRSP return before the year-end (i.e., *Probability of Forced Realization*), and the proportion of stocks sold in a 30-stock portfolio at the year-end under different loss cutoffs. The portfolios are formed at each previous quarter-end (e.g., the January portfolio is formed at the end of the preceding December), and the reported numbers are the averages across the portfolios formed at a given quarter-end within a decade.

replaced with investments in the S&P 500 total return index. Only 3.82%, 2.49%, and 1.15% of the sample stocks in the April portfolio, the July portfolio, and the October portfolio, respectively, have incomplete data before the year-end. We observe similar monotonic relations between the probability of forced realization and the timing of portfolio formation (i.e., *Portfolio Month*) across the decades. This observation is consistent with the intuition that stocks in a portfolio formed later in the year are more likely to remain listed and have valid return data at the year-end. Because investors may not be able to avoid the forced realization of gains and losses when some stocks in the portfolio are delisted before the year-end, we consider the tax consequences of such realized gains and/or losses in both the performance of the tax-loss strategy and the performance of the buy-and-hold strategy.

Given the portfolio month, we observe a decreasing proportion of stocks that are sold under the tax-loss strategy across the loss cutoffs from 0% to 15%. Because a larger loss cutoff naturally represents a more stringent criterion for a stock to meet at the year-end, the decreasing proportions are as expected. On the other hand, the relation between the propor-

tion of stocks sold and the portfolio month is not monotonic most of the time: The proportion typically peaks in the April or June portfolios except under the 0% cutoff from 1963 to 1969. For instance, the proportion of stocks sold from 1970 to 1979 under the 0% cutoff is 43.36% for the January portfolio. It is 55.02% for the April portfolio, 52.69% for the June portfolio, and 54.27% for the October portfolio. These results suggest that the timing of portfolio formation does not necessarily affect the proportion of stock sold in a portfolio under the tax-loss strategy in a linear fashion.

4.1. Probability of tax-loss strategy outperformance

Table 3 shows the probabilities that the tax-loss strategy of realizing tax losses at the year-end outperforms the buy-and-hold strategy under different timing of portfolio formation (*Portfolio Month*), personal income tax rates (*Tax Rate*), holding period ends (*Holding Period End*), and loss cutoffs (*Loss Cutoff*). We aggregate the results across the different timing of tax benefits for this table, and the (untabulated) results by the different timing of tax benefits are similar. The reported probabilities are time-series averages across the portfolios of a given specification from 1963 to 2009.

From the results in Table 3, the probabilities that the tax-loss strategy outperforms the buy-and-hold strategy seem to depend on not only the personal income tax rate, but also the timing of portfolio formation, the loss cutoff, and the holding period end. For instance, given the personal income tax rate of 10% (39.6%) and the loss cutoff of 0%, the January portfolio that ends in June has a 0.4980 (0.7435) probability of tax-loss strategy outperformance. The probability is 0.4769 (0.7315) for the April portfolio, 0.4592 (0.6585) for the July portfolio, and 0.4346 (0.5870) for the October portfolio. Across the specifications, the probability of tax-loss strategy outperformance is always larger for the January portfolio than for the October portfolio while holding other things equal. Given the January portfolio that ends in June and the personal income tax rate of 10% (39.6%), the probability of tax-loss strategy outperformance is 0.4980 (0.7435) when the loss cutoff is 0%. The probability is 0.5201 (0.7731) under the 5% cutoff, 0.5353 (0.7919) under the 10% cutoff, and 0.5498 (0.8030) under the 15% cutoff. We observe similar monotonic relations between the probability and the loss cutoffs across the specifications.

In the case in which the holding period end differs, the probability of tax-loss strategy outperformance tends to increase with a later holding period end when the personal income tax rate is lower. This relation becomes weaker or even reverses when the personal income tax rate is higher. For instance, the probability is 0.5498 (0.8030) with the January portfolio ending in June under the 15% loss cutoff when the personal income tax rate is 10% (39.6%). The probability is 0.5681 (0.7911) when the portfolio ends in September and 0.6195 (0.7932) when the portfolio ends in December.

Collectively, the results in Table 3 suggest that the probabilities of tax-loss strategy outperformance are generally larger than 50% across the specifications, a finding consistent with the conventional wisdom of realizing tax losses at the year-end. On the other hand, the outperformance of the tax-loss strategy relative to the buy-and-hold strategy is not a sure thing with a 100% probability. The results also reveal that there are specific instances in which practicing the tax-loss strategy would have an adverse effect on the investment

Table 3 Probability of tax-loss strategy outperformance

Portfolio month	Tax rate	Holding period end											
		June				September				December			
		Loss cutoff				Loss cutoff				Loss cutoff			
		0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
January	0.10	0.4980	0.5201	0.5353	0.5498	0.5119	0.5359	0.5524	0.5681	0.5613	0.5873	0.6057	0.6195
	0.15	0.5522	0.5786	0.5963	0.6111	0.5555	0.5831	0.6055	0.6201	0.6043	0.6304	0.6512	0.6605
	0.25	0.6433	0.6741	0.6928	0.7087	0.6415	0.6743	0.6935	0.7078	0.6713	0.6997	0.7179	0.7243
	0.28	0.6678	0.6962	0.7170	0.7336	0.6649	0.6962	0.7177	0.7295	0.6867	0.7152	0.7336	0.7397
	0.33	0.7045	0.7327	0.7522	0.7668	0.7004	0.7325	0.7494	0.7583	0.7116	0.7400	0.7565	0.7627
	0.35	0.7160	0.7462	0.7647	0.7777	0.7106	0.7449	0.7608	0.7674	0.7211	0.7474	0.7648	0.7711
	0.396	0.7435	0.7731	0.7919	0.8030	0.7359	0.7673	0.7861	0.7911	0.7407	0.7652	0.7849	0.7932
April	0.10	0.4769	0.4995	0.5109	0.5260	0.4896	0.5146	0.5209	0.5351	0.5468	0.5652	0.5749	0.5873
	0.15	0.5287	0.5560	0.5722	0.5898	0.5329	0.5569	0.5709	0.5828	0.5834	0.6055	0.6153	0.6272
	0.25	0.6240	0.6595	0.6809	0.6944	0.6191	0.6439	0.6624	0.6767	0.6453	0.6712	0.6834	0.6971
	0.28	0.6527	0.6880	0.7048	0.7205	0.6396	0.6682	0.6827	0.6971	0.6616	0.6870	0.6998	0.7133
	0.33	0.6906	0.7234	0.7413	0.7553	0.6719	0.7021	0.7172	0.7309	0.6861	0.7113	0.7257	0.7402
	0.35	0.7037	0.7373	0.7541	0.7671	0.6842	0.7140	0.7282	0.7435	0.6956	0.7209	0.7349	0.7487
	0.396	0.7315	0.7611	0.7751	0.7911	0.7127	0.7393	0.7541	0.7651	0.7173	0.7411	0.7535	0.7659
July	0.10	0.4592	0.4845	0.5047	0.5281	0.4853	0.5085	0.5277	0.5431	0.5330	0.5573	0.5759	0.5891
	0.15	0.4968	0.5260	0.5474	0.5735	0.5145	0.5446	0.5668	0.5774	0.5524	0.5838	0.6019	0.6210
	0.25	0.5615	0.5969	0.6253	0.6474	0.5747	0.6104	0.6343	0.6504	0.6011	0.6332	0.6574	0.6741
	0.28	0.5803	0.6177	0.6492	0.6684	0.5909	0.6282	0.6521	0.6692	0.6140	0.6495	0.6735	0.6891
	0.33	0.6172	0.6519	0.6809	0.7004	0.6214	0.6605	0.6840	0.7001	0.6335	0.6714	0.6964	0.7110
	0.35	0.6305	0.6640	0.6958	0.7139	0.6322	0.6701	0.6957	0.7113	0.6429	0.6793	0.7052	0.7193
	0.396	0.6585	0.6906	0.7240	0.7396	0.6577	0.6915	0.7226	0.7352	0.6621	0.6979	0.7245	0.7398
October	0.10	0.4346	0.4563	0.4726	0.4737	0.4617	0.4900	0.5168	0.5230	0.5200	0.5484	0.5690	0.5719
	0.15	0.4582	0.4826	0.5043	0.5080	0.4827	0.5161	0.5410	0.5477	0.5391	0.5677	0.5910	0.5965
	0.25	0.5139	0.5406	0.5632	0.5752	0.5285	0.5631	0.5865	0.5955	0.5740	0.6047	0.6320	0.6373
	0.28	0.5316	0.5569	0.5814	0.5916	0.5412	0.5777	0.6009	0.6097	0.5842	0.6188	0.6446	0.6488
	0.33	0.5571	0.5855	0.6103	0.6212	0.5619	0.6010	0.6220	0.6327	0.5993	0.6364	0.6634	0.6686
	0.35	0.5660	0.5973	0.6213	0.6332	0.5695	0.6088	0.6301	0.6407	0.6051	0.6438	0.6696	0.6736
	0.396	0.5870	0.6205	0.6477	0.6581	0.5881	0.6273	0.6510	0.6608	0.6181	0.6571	0.6838	0.6885

Notes: This table shows the probabilities that a tax-loss strategy of realizing tax losses at the year-end outperforms a buy-and-hold strategy under different timing of portfolio formation (*Portfolio Month*), personal income tax rates (*Tax Rate*), holding period ends (*Holding Period End*), and loss cutoffs (*Loss Cutoff*). We aggregate the results across the different timing of tax benefits. The portfolios are formed at each previous quarter-end (e.g., the January portfolio is formed at the end of the preceding December), and the portfolios are held until the end of June, September, or December of the following year. The loss cutoffs are either 0%, 5%, 10%, or 15%. The personal income tax rates considered are either 10%, 15%, 25%, 28%, 33%, 35%, or 39.6%. Under the tax-loss strategy, the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits are reinvested in the S&P 500 total return index. The reported probabilities are time-series averages across the portfolios of a given specification from 1963 to 2009.

performance. For instance, the probability of tax-loss strategy outperformance is less than 50% for investors subject to the 10% personal income tax rate, holding the October portfolio, and having the portfolio ends in June of the following year, regardless of the loss cutoff. The probability is also less than 50% for investors subject to the 15% personal income tax rate, holding the October portfolio, having the portfolio ends in June of the following year, and under the loss cutoff of either 0% or 5%. Finally, the results suggest that the probability of

Table 4 Aggregated probability of tax-loss strategy outperformance by category

								Insignificance differences within category at the 10% level
<i>Portfolio Month</i>	January	April	July	October				None
	0.6878 (0.00)	0.6640 (0.00)	0.6284 (0.00)	0.5819 (0.00)				
<i>Loss Cutoff</i>	0%	5%	10%	15%				None
	0.6045 (0.00)	0.6348 (0.00)	0.6553 (0.00)	0.6676 (0.00)				
<i>Tax Benefit Realization</i>	January	February	March	April				January vs. February (0.39); January vs. March (0.25)
	0.6419 (0.00)	0.6425 (0.00)	0.6407 (0.00)	0.6370 (0.00)				
<i>Holding Period End</i>	June	September	December					June vs. September (0.64)
	0.6290 (0.00)	0.6326 (0.00)	0.6600 (0.00)					
<i>Tax Rate</i>	10%	15%	25%	28%	33%	35%	39.6%	None
	0.5276 (0.00)	0.5669 (0.00)	0.6373 (0.00)	0.6559 (0.00)	0.6844 (0.00)	0.6947 (0.00)	0.7170 (0.00)	

Notes: This table shows the aggregated probabilities that a tax-loss strategy of realizing tax losses at the year-end outperforms a buy-and-hold strategy by the timing of portfolio formation (*Portfolio Month*), the loss cutoff at the year-end (*Loss Cutoff*), the timing of tax benefits (*Tax Benefit Realization*), the end of the holding period in the following year (*Holding Period End*), and the personal income tax rate (*Tax Rate*). The portfolios are formed at each previous quarter-end (e.g., the January portfolio is formed at the end of the preceding December), and the portfolios are held until the end of June, September, or December of the following year. The loss cutoffs are either 0%, 5%, 10%, or 15%. Tax benefits are realized at the end of either January, February, March, or April. The personal income tax rates considered are either 10%, 15%, 25%, 28%, 33%, 35%, or 39.6%. Under the tax-loss strategy, the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits are reinvested in the S&P 500 total return index. The reported probabilities by portfolio month are time-series averages across the portfolios formed at a given quarter-end from 1963 to 2009. The other probabilities are pooled averages across the timing of portfolio formation from 1963 to 2009. The *p*-values associated with the probabilities are reported within the parentheses.

tax-loss strategy outperformance seems to depend on factors other than the personal income tax rate as well. We formally test the dependence and report the results next.

4.2. Aggregated probability of tax-loss strategy outperformance by category

Table 4 shows the aggregated probabilities of tax-loss strategy outperformance by the timing of portfolio formation (*Portfolio Month*), the loss cutoff at the year-end (*Loss Cutoff*), the timing of the tax benefits (*Tax Benefit Realization*), the end of the holding period in the following year (*Holding Period End*), and the personal income tax rate (*Tax Rate*). The reported probabilities by portfolio month are time-series averages across the portfolios formed at a given quarter-end from 1963 to 2009. The other probabilities are pooled averages across the timing of portfolio formation from 1963 to 2009. The *p*-values associated with the probabilities are reported within the parentheses.

The results in Table 4 show that the probabilities of tax-loss strategy outperformance are each significant and differ significantly across the different timing of portfolio formation.

Specifically, the average probability of tax-loss strategy outperformance is 0.6878 for the January portfolio, 0.6640 for the April portfolio, 0.6284 for the July portfolio, and 0.5819 for the October portfolio. The probabilities are also each significant and differ significantly across the different loss cutoffs. Specifically, the average probability of tax-loss strategy outperformance is 0.6045 under the 0% loss cutoff, 0.6348 under the 5% cutoff, 0.6553 under the 10% cutoff, and 0.6676 under the 15% cutoff. These findings suggest that portfolios formed earlier in a year and portfolios with a larger loss cutoff at the year-end have larger probabilities of tax-loss strategy outperformance.

The timing of the tax benefits, on the other hand, has a weaker effect on the probability of tax-loss strategy outperformance. Specifically, although the 0.6370 probability of tax-loss strategy outperformance associated with the April tax benefit realization is significantly smaller than those associated with the January (0.6419), February (0.6425), and March (0.6407) realization, the differences in the probabilities between the January realization and the February realization, and between the January realization and the March realization are not significant. We observe a similar weaker relation between the probability and the holding period ends. Specifically, although the 0.6600 probability of tax-loss strategy outperformance associated with the December holding period end is significantly larger than those associated with the June (0.6290) and September (0.6326) holding period ends, the difference in the probabilities between the June and September holding period ends is not significant. The results across the different tax rates confirm that the personal income tax rate plays an important role on the effectiveness of the tax-loss strategy. The probability of tax-loss strategy outperformance increases monotonically from 0.5276 for an investor subject to the 10% personal income tax rate to 0.7170 for an investor subject to the 39.6% personal income tax rate. The probabilities also differ significantly across the different tax rates.

4.3. *Determinants of the probability of tax-loss strategy outperformance*

Our results in Table 4 are univariate in nature. To examine the joint effects of the factors that could possibly affect the probability of tax-loss strategy outperformance, we use both a linear probability (LP) model and a Probit model. Specifically, the dependent variable is 1 for a simulated portfolio if the tax-loss strategy outperforms the buy-and-hold strategy, otherwise the dependent variable is 0. We use dummy variables exclusively for the independent variables including *Subperiod*, *Portfolio Month*, *Loss Cutoff*, *Tax Benefit Realization*, *Holding Period End*, and *Tax Rate*. The baseline portfolio for which all the dummy variables equal to 0 is one that is in the 1963–1972 period (*Subperiod*), is formed in January (*Portfolio Month*), has a loss cutoff of 0% (*Loss Cutoff*), has the tax benefit realized at the end of January in the following year (*Tax Benefit Realization*), has a holding period that ends at the end of June in the year the tax benefits are realized (*Holding Period End*), and is for an investor subject to the personal income tax rate of 10% (*Tax Rate*). The sample includes all the simulated portfolios from 1963 to 2009, and the subperiods are not all of equal length because we set up the 1963–1972 subperiod to control for the smaller number of sample stocks in that period (see Table 1). Using dummy variables for the independent variables allows us to incorporate the discrete nature of the variables and to accommodate the pos-

Table 5 Determinants of the probability of tax-loss strategy outperformance

	(1)		(2)		(3)	
	LP	Probit	LP	Probit	LP	Probit
Intercept	0.5117 (0.00)	0.0075 (0.00)	0.6246 (0.00)	0.3184 (0.00)	0.6416 (0.00)	0.3674 (0.00)
<i>Subperiod</i>						
1973–1979	−0.2402 (0.00)	−0.6274 (0.00)	−0.2402 (0.00)	−0.6176 (0.00)		
1980–1989	0.1623 (0.00)	0.4909 (0.00)	0.1623 (0.00)	0.4815 (0.00)		
1990–1999	0.0601 (0.00)	0.1694 (0.00)	0.0601 (0.00)	0.1651 (0.00)		
2000–2009	0.0256 (0.00)	0.0732 (0.00)	0.0256 (0.00)	0.0700 (0.00)		
<i>Portfolio Month</i>						
April	−0.0238 (0.00)	−0.0691 (0.00)	−0.0238 (0.00)	−0.0676 (0.00)	−0.0238 (0.00)	−0.0665 (0.00)
July	−0.0594 (0.00)	−0.1722 (0.00)	−0.0594 (0.00)	−0.1685 (0.00)	−0.0594 (0.00)	−0.1625 (0.00)
October	−0.1059 (0.00)	−0.3027 (0.00)	−0.1059 (0.00)	−0.2965 (0.00)	−0.1059 (0.00)	−0.2836 (0.00)
<i>Loss Cutoff</i>						
5%	0.0303 (0.00)	0.0862 (0.00)	0.0303 (0.00)	0.0847 (0.00)	0.0303 (0.00)	0.0801 (0.00)
10%	0.0507 (0.00)	0.1458 (0.00)	0.0507 (0.00)	0.1431 (0.00)	0.0507 (0.00)	0.1353 (0.00)
15%	0.0631 (0.00)	0.1822 (0.00)	0.0631 (0.00)	0.1789 (0.00)	0.0631 (0.00)	0.1692 (0.00)
<i>Tax Benefit</i>						
<i>Realization</i>						
February	0.0007 (0.18)	0.0019 (0.21)	0.0007 (0.19)	0.0018 (0.21)	0.0007 (0.20)	0.0018 (0.20)
March	−0.0011 (0.03)	−0.0033 (0.03)	−0.0011 (0.03)	−0.0033 (0.03)	−0.0011 (0.04)	−0.0030 (0.04)
April	−0.0048 (0.00)	−0.0141 (0.00)	−0.0048 (0.00)	−0.0138 (0.00)	−0.0048 (0.00)	−0.0130 (0.00)
<i>Holding Period</i>						
<i>End</i>						
September	0.0036 (0.00)	0.0112 (0.00)	0.0036 (0.00)	0.0114 (0.00)	0.0036 (0.00)	0.0095 (0.00)
December	0.0310 (0.00)	0.0907 (0.00)	0.0310 (0.00)	0.0903 (0.00)	0.0310 (0.00)	0.0834 (0.00)
<i>Tax Rate</i>						
15%	0.0393 (0.00)	0.1057 (0.00)				
25%	0.1096 (0.00)	0.3010 (0.00)				
28%	0.1283 (0.00)	0.3547 (0.00)				
33%	0.1568 (0.00)	0.4389 (0.00)				
35%	0.1670 (0.00)	0.4701 (0.00)				
39.6%	0.1894 (0.00)	0.5394 (0.00)				
Adjusted R ²	0.0927	—	0.0746	—	0.0102	—

Notes: This table shows the coefficient estimates and the corresponding *p*-values (in parentheses) from a linear probability (LP) model and a Probit model on the factors explaining whether the tax-loss strategy of realizing tax losses at the year-end outperforms a buy-and-hold strategy. Under the tax-loss strategy, the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits are reinvested in the S&P 500 total return index. The dependent variable is 1 for a simulated portfolio if the tax-loss strategy outperforms the buy-and-hold strategy, and 0 otherwise. The independent variables are all dummy variables that take the value of 1 if the individual condition is met, and 0 otherwise. The baseline portfolio (i.e., all the dummy variables equal to 0) is one that is in the 1963–1972 period (*Subperiod*), is formed in January (*Portfolio Month*), has a loss cutoff of 0% (*Loss Cutoff*), has the tax benefit realized at the end of January in the following year (*Tax Benefit Realization*), has a holding period that ends at the end of June in the year the tax benefits are realized (*Holding Period End*), and is for an investor subject to the personal income tax rate of 10% (*Tax Rate*).

sibility that the relation between a variable category and the probability of tax-loss strategy outperformance may not be linear. In addition, by varying the baseline portfolio, the dummy variables allow us to test the significance of the differences in coefficient estimates within a variable category. We report the coefficient estimates and the corresponding *p*-values (in parentheses) in Table 5.

The results in Table 5 suggest that relative to the 1963–1972 subperiod, the 1973–1979

subperiod is associated with a smaller probability of tax-loss strategy outperformance (coefficient estimate = -0.2402 ($p = 0.00$) in the full LP Model (1)) and -0.6274 (0.00) in the full Probit Model (1)), but the later subperiods are associated with larger probabilities of tax-loss strategy outperformance. In particular, the 1980–1989 subperiod is associated with the largest probability of tax-loss strategy outperformance (coefficient estimate = 0.1623 ($p = 0.00$) in the full LP model and 0.4909 (0.00) in the full Probit model; all the coefficient estimates reported in this Table within a variable category differ significantly from each other at the 1% level, unless otherwise mentioned). We suspect that changes in the tax regime (e.g., Tax Reform Act of 1986) might have affected stock price behavior and render the tax-loss strategy of realizing tax losses at the year-end more or less effective if stock returns were to repeat their patterns in a given subperiod. Although the findings in Poterba and Weisbenner (2001) and Grinblatt and Moskowitz (2004) are consistent with this conjecture, we leave it a potential topic for future research but provide a starting point in Section 5.

The results on the timing of portfolio formation (*Portfolio Month*) suggest that the probability of tax-loss strategy outperformance is larger when the portfolio is formed earlier in the year. Specifically, the full LP (Probit) model coefficient estimate is -0.0238 (0.00) (-0.0691 (0.00)) for the April portfolio, -0.0594 (0.00) (-0.1722 (0.00)) for the July portfolio, and -0.1059 (0.00) (-0.3027 (0.00)) for the October portfolio.

The results on the loss cutoff suggest that the probability of tax-loss strategy outperformance increases monotonically with the loss cutoff. Specifically, the full LP (Probit) model coefficient estimate is 0.0303 (0.00) (0.0862 (0.00)) for the 5% cutoff, 0.0507 (0.00) (0.1458 (0.00)) for the 10% cutoff, and 0.0631 (0.00) (0.1822 (0.00)) for the 15% cutoff.

The results on the timing of the tax benefits (*Tax Benefit Realization*) suggest that the probability of tax-loss strategy outperformance is usually larger when investors realize their tax benefits sooner. Specifically, the full LP (Probit) model coefficient estimate is 0.0007 (0.18) (0.0019 (0.21)) for the February realization, -0.0011 (0.03) (-0.0033 (0.03)) for the March realization, and -0.0048 (0.00) (-0.0141 (0.00)) for the April realization. However, in this case the difference in the effects between the January realization and the February realization is not significant, and the difference in the effects between the January realization and the March realization is significant only at the 5% level.

The results on the holding period end suggest that the probability of tax-loss strategy outperformance is larger when the holding period ends later. Specifically, the full LP (Probit) model coefficient estimate is 0.0036 (0.00) (0.0112 (0.00)) for the September holding period end and 0.0310 (0.00) (0.0907 (0.00)) for the December holding period end. The results on the different tax rates are consistent with expectation: There is a monotonically increasing relation between the tax rates and the probability of tax-loss strategy outperformance.

We notice that the adjusted R^2 is 9.27% in the full LP Model (1). Given that we include the tax rate variables in the model and a significant relation between the tax rates and the probability of tax-loss strategy outperformance is expected, we exclude the tax rate variables in Model (2) to assess their impact on the explanatory power of the model. The coefficient estimates on the remaining variables in Model (2) are all consistent with the previous results from Model (1). The adjusted R^2 of 7.46% in the LP Model (2) suggests that a large part of the explanatory power remains.

Because we use historical stock return data for our simulation, and history may or may not repeat itself, we exclude the subperiod variables together with the tax rate variables in Model (3) to assess their impact on the explanatory power of the model. Although the coefficient estimates on the remaining variables in Model (3) are still consistent with the previous results from Models (1) and (2), the adjusted R^2 of 1.02% in the LP Model (3) suggests that a substantial portion of the explanatory power of Models (1) and (2) comes from the subperiod variables. Given that investors have no control over the subperiods (i.e., investors cannot ask the history to repeat itself), this finding highlights the importance of the remaining variables that are under control of the investors and affect the effectiveness of the tax-loss strategy. Our results in Section 5 shed further light on the source of the explanatory power of the subperiod variables.

4.4. Timing of portfolio formation and the probability of forced realization

Our results in Table 5 suggest that portfolios formed earlier in a year have larger probabilities of tax-loss strategy outperformance. Table 2, on the other hand, indicates that those earlier portfolios also have larger probabilities of forced realization. To see whether the probability of forced realization contributes to the relation between the timing of portfolio formation and the probability of tax-loss strategy outperformance, we include the probability of forced realization as an independent variable in both the full LP model and the full Probit model. Our results remain effectively the same after controlling for the probability of forced realization (which carries a negative coefficient estimate in both models).

5. Alternative data and reinvestment strategy

Our sample of all public-traded U.S. ordinary common stocks covered by the CRSP database leads to the possible forced realization of gains and losses because of stock delistings and missing CRSP returns. In addition, our reinvestment strategy using the passive S&P 500 total return index may have an impact on the effectiveness of the tax-loss strategy and its determinants. To assess the robustness of our results, we repeat our simulation using an alternative set of data and a different reinvestment strategy. Specifically, we require all stocks to be included in a portfolio to have nonmissing return data from the portfolio formation to the end of the following year, therefore eliminating the possibility of forced realization throughout the entire holding period. In addition to the reinvestment strategy of using the S&P 500 total return index, we also consider an alternative strategy of reinvesting the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits equally in the remaining stocks of the portfolio. In the case all 30 stocks in a portfolio are sold at the year-end, the proceeds as well as the realized tax benefits are reinvested in the S&P 500 total return index.

The (untabulated) results using the alternative set of data and the reinvestment strategy of the S&P 500 total return index are effectively the same as our earlier results in terms of the magnitudes of the probabilities of tax-loss strategy outperformance under different scenarios (i.e., Table 3), the aggregated probability by category (i.e., Table 4), the determinants of the

Table 6 Aggregated probability of tax-loss strategy outperformance by category—alternative data and reinvestment strategy

								Insignificance differences within category at the 10% level
<i>Portfolio Month</i>	January	April	July	October				None
	0.7471 (0.00)	0.7272 (0.00)	0.6928 (0.00)	0.6428 (0.00)				
<i>Loss Cutoff</i>	0%	5%	10%	15%				None
	0.6748 (0.00)	0.6967 (0.00)	0.7151 (0.00)	0.7233 (0.00)				
<i>Tax Benefit Realization</i>	January	February	March	April				None
	0.7047 (0.00)	0.7035 (0.00)	0.7016 (0.00)	0.7000 (0.00)				
<i>Holding Period End</i>	June	September	December					June vs. September (0.19); June vs. December (0.59)
	0.7033 (0.00)	0.6967 (0.00)	0.7074 (0.00)					
<i>Tax Rate</i>	10%	15%	25%	28%	33%	35%	39.6%	None
	0.6031 (0.00)	0.6363 (0.00)	0.6985 (0.00)	0.7154 (0.00)	0.7412 (0.00)	0.7509 (0.00)	0.7718 (0.00)	

Notes: This table shows the aggregated probabilities that a tax-loss strategy of realizing tax losses at the year-end outperforms a buy-and-hold strategy by the timing of portfolio formation (*Portfolio Month*), the loss cutoff at the year-end (*Loss Cutoff*), the timing of tax benefits (*Tax Benefit Realization*), the end of the holding period in the following year (*Holding Period End*), and the personal income tax rate (*Tax Rate*). The portfolios are formed at each previous quarter-end (e.g., the January portfolio is formed at the end of the preceding December), and the portfolios are held until the end of June, September, or December of the following year. The loss cutoffs are either 0%, 5%, 10%, or 15%. Tax benefits are realized at the end of either January, February, March, or April. The personal income tax rates considered are either 10%, 15%, 25%, 28%, 33%, 35%, or 39.6%. All stocks included in a portfolio are required to have nonmissing return data from the portfolio formation to the end of the following year. In addition, under the tax-loss strategy the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits are reinvested equally in the remaining stocks of the portfolio. The reported probabilities by portfolio month are time-series averages across the portfolios formed at a given quarter-end from 1963 to 2009. The other probabilities are pooled averages across the timing of portfolio formation from 1963 to 2009. The *p*-values associated with the probabilities are reported within the parentheses.

probability, and the explanatory power of the determinants (i.e., Table 5). All our previous conclusions also hold in this case. These findings suggest that our treatments of missing return data and the possibility of forced realization of gains and losses do not affect the results.

Table 6 shows the aggregated probabilities of tax-loss strategy outperformance by category using the alternative set of data and the reinvestment strategy of the remaining stocks in a portfolio. The monotonic relations between the probability of tax-loss strategy outperformance and the timing of portfolio formation (*Portfolio Month*), loss cutoffs (*Loss Cutoff*), and tax rates (*Tax Rate*) are similar to what we report in Table 4. In addition, the relation between the probability and the timing of tax benefits (*Tax Benefit Realization*) is also monotonic in this case. Specifically, the probability is 0.7047 under the January tax benefit realization, 0.7035 under the February realization, 0.7016 under the March realization, and 0.7000 under the April realization. The probabilities also differ significantly from each other.

The relation between the probability of tax-loss strategy outperformance and the holding period ends (*Holding Period End*), however, is weaker than before. Although the 0.7074 probability associated with the December holding period end is significantly larger than the probability associated with the September (0.6967) holding period end, it is not significantly different from the probability associated with the June (0.7033) holding period end. The difference in the probabilities between the June and September holding period ends is also insignificant.

In addition to weakening the relation between the probability of tax-loss strategy outperformance and the holding period ends, we notice that using the reinvestment strategy of the remaining stocks in a portfolio increases the probability of tax-loss strategy outperformance under each scenario (e.g., Table 6 vs. Table 4). In fact, untabulated results indicate that the probabilities are larger than 50% even for investors in the lowest tax brackets with late portfolio formation, short holding periods, and small loss cutoffs. We interpret this finding as reinvesting in the remaining stocks of a portfolio effectively incorporates a momentum strategy of selling relative losers and buying relative winners into the tax-loss strategy, thus inflating the probability of tax-loss strategy outperformance relative to the buy-and-hold strategy. This finding also highlights the importance of the reinvestment strategy when an investor adopts the tax-loss strategy.

Table 7 shows the determinants of the probability of tax-loss strategy outperformance using the alternative set of data and the reinvestment strategy of the remaining stocks in a portfolio (all the coefficient estimates reported in this Table within a variable category differ significantly from each other at the 1% level, unless otherwise mentioned). The monotonic relations between the probability of tax-loss strategy outperformance and the timing of portfolio formation (*Portfolio Month*), loss cutoffs (*Loss Cutoff*), timing of tax benefits (*Tax Benefit Realization*), and tax rates (*Tax Rate*) are similar to what we report in Table 5 and consistent across the model specifications. In addition, in this case the difference in the effects between the January tax benefit realization and the February realization is significant at the 5% level, and the difference in the effects between the January realization and the March realization is significant at the 1% level.

The results on the holding period end, on the other hand, suggest that portfolios with the December holding period end still have the largest probability of tax-loss strategy outperformance. The holding period end associated with the smallest probability of outperformance, however, is the September holding period end instead of the June holding period end we find in Table 5. Specifically, the full LP (Probit) model (i.e., Model (1)) coefficient estimate is 0.0041 ($p = 0.00$) (0.0099 (0.00)) for the December holding period end and -0.0067 (0.00) (-0.0213 (0.00)) for the September holding period end. Because we still find a monotonic relation between the probability of tax-loss strategy outperformance and the holding period ends when we use the alternative set of data and the reinvestment strategy of the S&P 500 total return index, this finding suggests that the reinvestment strategy of the remaining stocks in a portfolio alters the relation.

Finally, the results in Table 7 suggest that relative to the 1963–1972 subperiod, the 1973–1979 subperiod and the 1990–1999 subperiod are associated with smaller probabilities of tax-loss strategy outperformance (1973–1979: coefficient estimate = -0.0830 ($p = 0.00$) in the full LP model and -0.2307 (0.00) in the full Probit model; 1990–1999:

Table 7 Determinants of the probability of tax-loss strategy outperformance—alternative data and reinvestment strategy

	(1)		(2)		(3)	
	LP	Probit	LP	Probit	LP	Probit
Intercept	0.6187 (0.00)	0.3084 (0.00)	0.7180 (0.00)	0.5829 (0.00)	0.7225 (0.00)	0.5963 (0.00)
<i>Subperiod</i>						
1973–1979	−0.0830 (0.00)	−0.2307 (0.00)	−0.0830 (0.00)	−0.2280 (0.00)		
1980–1989	0.0880 (0.00)	0.2820 (0.00)	0.0880 (0.00)	0.2771 (0.00)		
1990–1999	−0.0125 (0.00)	−0.0356 (0.00)	−0.0125 (0.00)	−0.0357 (0.00)		
2000–2009	0.0038 (0.00)	0.0124 (0.00)	0.0038 (0.00)	0.0110 (0.00)		
<i>Portfolio Month</i>						
April	−0.0199 (0.00)	−0.0625 (0.00)	−0.0199 (0.00)	−0.0608 (0.00)	−0.0199 (0.00)	−0.0611 (0.00)
July	−0.0542 (0.00)	−0.1667 (0.00)	−0.0542 (0.00)	−0.1629 (0.00)	−0.0542 (0.00)	−0.1615 (0.00)
October	−0.1043 (0.00)	−0.3094 (0.00)	−0.1043 (0.00)	−0.3030 (0.00)	−0.1043 (0.00)	−0.2998 (0.00)
<i>Loss Cutoff</i>						
5%	0.0219 (0.00)	0.0645 (0.00)	0.0219 (0.00)	0.0633 (0.00)	0.0219 (0.00)	0.0621 (0.00)
10%	0.0403 (0.00)	0.1201 (0.00)	0.0403 (0.00)	0.1177 (0.00)	0.0403 (0.00)	0.1156 (0.00)
15%	0.0485 (0.00)	0.1456 (0.00)	0.0485 (0.00)	0.1428 (0.00)	0.0485 (0.00)	0.1402 (0.00)
<i>Tax Benefit</i>						
<i>Realization</i>						
February	−0.0012 (0.02)	−0.0035 (0.02)	−0.0012 (0.02)	−0.0034 (0.02)	−0.0012 (0.03)	−0.0033 (0.02)
March	−0.0031 (0.00)	−0.0094 (0.00)	−0.0031 (0.00)	−0.0092 (0.00)	−0.0031 (0.00)	−0.0090 (0.00)
April	−0.0047 (0.00)	−0.0142 (0.00)	−0.0047 (0.00)	−0.0139 (0.00)	−0.0047 (0.00)	−0.0137 (0.00)
<i>Holding Period</i>						
<i>End</i>						
September	−0.0067 (0.00)	−0.0213 (0.00)	−0.0067 (0.00)	−0.0203 (0.00)	−0.0067 (0.00)	−0.0200 (0.00)
December	0.0041 (0.00)	0.0099 (0.00)	0.0041 (0.00)	0.0112 (0.00)	0.0041 (0.00)	0.0109 (0.00)
<i>Tax Rate</i>						
15%	0.0332 (0.00)	0.0891 (0.00)				
25%	0.0954 (0.00)	0.2646 (0.00)				
28%	0.1122 (0.00)	0.3148 (0.00)				
33%	0.1380 (0.00)	0.3946 (0.00)				
35%	0.1478 (0.00)	0.4259 (0.00)				
39.6%	0.1686 (0.00)	0.4949 (0.00)				
Adjusted R ²	0.0379	—	0.0221	—	0.0093	—

Notes: This table shows the coefficient estimates and the corresponding *p*-values (in parentheses) from a linear probability (LP) model and a Probit model on the factors explaining whether the tax-loss strategy of realizing tax losses at the year-end outperforms a buy-and-hold strategy. All stocks included in a portfolio are required to have nonmissing return data from the portfolio formation to the end of the following year. In addition, under the tax-loss strategy the proceeds of stocks sold in a portfolio at the year-end as well as the realized tax benefits are reinvested equally in the remaining stocks of the portfolio. The dependent variable is 1 for a simulated portfolio if the tax-loss strategy outperforms the buy-and-hold strategy, and 0 otherwise. The independent variables are all dummy variables that take the value of 1 if the individual condition is met, and 0 otherwise. The baseline portfolio (i.e., all the dummy variables equal to 0) is one that is in the 1963–1972 period (*Subperiod*), is formed in January (*Portfolio Month*), has a loss cutoff of 0% (*Loss Cutoff*), has the tax benefit realized at the end of January in the following year (*Tax Benefit Realization*), has a holding period that ends at the end of June in the year the tax benefits are realized (*Holding Period End*), and is for an investor subject to the personal income tax rate of 10% (*Tax Rate*).

coefficient estimate = −0.0125 (0.00) in the full LP model and −0.0356 (0.00) in the full Probit model). The 1980–1989 subperiod and the 2000–2009 subperiod are associated with larger probabilities of tax-loss strategy outperformance, and the 1980–1989 subperiod is still associated with the largest probability of tax-loss strategy outperform-

mance (1980–1989: coefficient estimate = 0.0880 (0.00) in the full LP model and 0.2820 (0.00) in the full Probit model; 2000–2009: coefficient estimate = 0.0038 (0.00) in the full LP model and 0.0124 (0.00) in the full Probit model). We further notice that the adjusted R^2 of 3.79% in the full LP Model (1) (2.21% in the LP Model (2) without the tax rate variables) in Table 7 is substantially less than the 9.27% (7.46% in the LP Model (2)) reported in Table 5, even though the adjusted R^2 in the LP Model (3) without the subperiod and tax rate variables are comparable across the two Tables (1.02% in Table 5 and 0.93% in Table 7). Because the explanatory power of the models using the alternative set of data and the reinvestment strategy of the S&P 500 total return index is similar to that reported in Table 5, this finding suggests that the explanatory power of the subperiod variables we document in Table 5 comes mostly from the reinvestments in the S&P 500 total return index. Together with the larger magnitudes of the coefficient estimates on the subperiod variables in Table 5 than in Table 7, if the changes in the tax regime affect stock price behavior and render the tax-loss strategy of realizing tax losses at the year-end more or less effective as suspected, this finding also suggests that we find the impacts revealed largely through the S&P 500 total return index we use.

6. Conclusion

In this article we examine the performance of a tax-loss strategy realizing tax losses at the year-end relative to that of a buy-and-hold strategy, using simulated stock portfolios from 1963 to 2009. Our major findings are as follows: 1) Although the tax-loss strategy usually outperforms the buy-and-hold strategy, a result consistent with the conventional wisdom, the outperformance is not a sure thing with a 100% probability. 2) For investors in the lowest tax brackets with late portfolio formation, short holding periods, and small loss cutoffs, practicing the tax-loss strategy may have an adverse effect on the investment performance, i.e., the probability that the tax-loss strategy outperforms the buy-and-hold strategy is less than 50%. 3) In addition to an investor's applicable tax rate, factors including the timing of portfolio formation, the cutoff that triggers the loss realization, the length of an investor's holding period, and to a lesser extent, the timing of the tax benefits, all affect the probability of tax-loss strategy outperformance. 4) Whether (and to what extent) the tax-loss strategy outperforms the buy-and-hold strategy depends on the reinvestment strategy on the proceeds from the disposition of stocks with tax losses and on the realized tax benefits. In addition, stock return paths in the subperiod investors face affect the effectiveness of the tax-loss strategy. Because investors cannot ask the history to repeat itself, investors practicing the tax-loss strategy should focus on the remaining factors that they can control.

Notes

- 1 See Rozeff and Kinney (1976) for the January effect. Studies that provide evidence on the existence of tax-loss selling include Dye (1977), Ritter (1988), Badrinath and

- Lewellen (1991), Odean (1998), Poterba and Weisbenner (2001), D’Mello, Ferris, and Hwang (2003), Grinblatt and Keloharju (2004), and Grinblatt and Moskowitz (2004). Studies that examine the relation between tax-loss selling and the January effect include Branch (1977), Reinganum (1983), Brown, Keim, Kleidon, and Marsh (1983), Givoly and Ovadia (1983), Constantinides (1984), Berges, McConnell, and Schlarbaum (1984), Van Den Bergh and Wessels (1985), Schultz (1985), Chan (1986), Chang and Pinegar (1986), Jones, Pearce, and Wilson (1987), Tinic, Barone-Adesi, and West (1987), Brauer and Chang (1990), Jones, Lee, and Apenbrink (1991), and Starks, Yong, and Zheng (2006). See Section 2 for a complete review.
- 2 Earlier studies on the premise that capital gains taxes could have an impact on investor behavior and security prices include Holt and Shelton (1961) and Sprinkel and West (1962), who examine the optimal investment decisions when investors face capital gains. Haugen and Wichern (1973), using a computer simulation model, find that although capital gains taxes destabilize the prices of non-dividend-paying stocks, capital gains taxes can have a stabilizing effect on the prices of dividend-paying stocks.
 - 3 Specifically, if a stock in a portfolio is delisted in month t , we include the monthly delisting return of the stock in month t from CRSP as a valid return. Missing delisting returns from CRSP are set to -30% if the stock is liquidated or dropped from an exchange (i.e., CRSP delisting code between 400 and 599), and zero otherwise. We assume that the proceeds from the disposition of a stock in its delisting month are received in cash before the month end, and we reinvest the proceeds at the month end in the S&P 500 total return index. For the treatments of CRSP delisting returns, see, e.g., Chen (2012) and Shumway (1997). In the case of missing CRSP returns (most of the missing returns in our sample are because of a stock “not trading on an included exchange for this file” with a CRSP missing return code of -77), we assume that a stock is sold at the end of the last month with a valid return, and we reinvest the proceeds in the S&P 500 total return index at the same time. We also note that both stock delistings and missing CRSP returns result in missing return data in the CRSP database for an intended holding period.
 - 4 Alternatively, this approach assumes that an investor has a net capital loss across all types of investments, so the benefits of tax losses are realized at the personal income tax rate (that maximizes the value of the benefits). This assumption is consistent with Seyhun and Skinner’s (1994) finding that the \$3,000 limit on capital loss deductions represents an important constraint for individuals’ tax strategies.
 - 5 Although ordinary dividends are taxed at the ordinary income tax rates, qualified dividends are taxed at the 0% tax rate for individuals in the 10% and 15% tax brackets, at the 20% tax rate for individuals in the 39.6% tax bracket (since 2013), and at the 15% tax rate for other individuals. To be eligible as qualified dividends, the dividends must be from a U.S. corporation or a qualified foreign corporation, not subject to certain exclusions, and the dividend-paying stock must be held for more than 60 days during the 121-day period that begins 60 days before the ex-dividend date. See also Internal Revenue Service (2011) Publication 550.

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