Once Burned, Twice Shy: How Naïve Learning, Counterfactuals, and Regret Affect the Repurchase of Stocks Previously Sold

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Abstract

We establish two previously undocumented patterns in the purchase selections of individual investors. These patterns hinge on investors’ previous experiences with a stock. We demonstrate that investors prefer to (1) repurchase stocks they previously sold for a gain rather than stocks they previously sold for a loss and (2) repurchase stocks that have lost value subsequent to a prior sale rather than those that have gained value. We document these trading patterns by analyzing trading records for 66,465 households at a large discount broker between January 1991 and November 1996, and 665,533 investors at a large retail broker between January 1997 and June 1999. We propose that the first trading pattern results from a simple form of learning whereby investors repeat actions that previously resulted in pleasure while avoiding actions that previously led to pain (i.e., they repurchase their previous winners more readily than their previous losers). We argue that the second trading pattern is tied to counterfactuals. Investors who buy a stock at a higher price than they previously sold it for are painfully aware that they are worse off than if they had simply never sold that stock. Investors who buy a stock at a lower price than they previously sold it experience the pleasure of knowing they are better off than if they had never sold that stock. Investor returns do not benefit from either of the two patterns we document.
Perhaps the simplest form of learning is to repeat behavior associated with pleasure and to refrain from behavior associated with pain. The benefits of this learning strategy depend, in part, upon the degree to which the behavior and outcome are correlated. For example, pressing one’s hand against a very hot stove consistently results in pain. However, betting on black at the roulette table does not consistently result in either pleasure or pain. While the pain caused by holding skin against hot metal is deterministic, outcomes in roulette are random. The stove is predictably hot; the table is not. The outcomes of a gambler’s past bets may influence the numbers he chooses to bet on next, but not where the little ball lands. So, too, an individual investor’s past wins and losses may influence his subsequent stock picks, but not the performance of those stocks.

In this paper, we establish two previously undocumented patterns in the purchase selections of individual investors. Both hinge on investors’ previous experiences with a stock and, we argue, to a large extent on investors’ tendencies to avoid painful emotions and seek out positive emotions. We find no evidence that these behaviors are tax-driven or that they reliably improve investor returns.

The first pattern that we document is that investors who previously have owned and sold a stock are more likely to buy that stock again if they earned a profit on the prior sale. Analyzing trading records for 66,465 individual investors with accounts at a large discount brokerage and 665,533 individual investors with accounts at a large retail brokerage, we find that investors are significantly more likely to buy a stock that they sold in the previous year if that sale was for a gain rather than a loss. We propose that this behavior is, at least in part, motivated by the instinct to avoid the pain of regret. An investor who sells a stock for a loss is likely to regret having purchased the stock. Thus purchasing this stock is associated with a painful experience and people instinctively avoid repeating behavior that previously resulted in pain.

The second pattern we document is that if an investor previously sold a stock for a gain, she is more likely to repurchase that stock if its price has dropped since she sold it than if its price has gone up. We propose that this behavior also is driven by investors’ desire to minimize regret. If an investor sells a stock and later repurchases it at a higher
price, she is faced with the salient counterfactual that she could have been wealthier if she simply had held onto the stock rather than selling it and buying it back later at a higher price. This counterfactual engenders feelings of regret. However, if she sells a stock and later repurchases it at a lower price, the realized outcome dominates the counterfactual. That is, she owns the same portfolio she would have held had she not sold and then repurchased, but she paid less for the portfolio than had she not traded and is thus happier. Furthermore, even if the stock falls in price after she buys it, the silver lining is that her loss would have been even greater had she not bought the stock at a lower base price the second time around.

This behavior is similar to that of consumers who, having missed an opportunity to purchase an item at a deep discount, are less likely to buy that same item at a smaller discount later on. This behavior does not arise simply because an item was sold more cheaply in the past; rather it arises as a result of the missed opportunity. The juxtaposition of the current inferior opportunity with the superior foregone opportunity triggers a comparison of the actual state with the better, but unrealized, one, thus evoking regret (see Tykocinski, Pittman, and Tuttle, 1995; Tykocinski and Pittman, 1998, 2001; Fujikawa, Niedermeier, and Ross, 2006). Thus the consumer thinks, “If I buy now at a higher price, I will regret that I didn’t buy before at a lower price.” And the investor thinks, “If I buy the stock now at a higher price than I sold it for, I will regret that I sold in the first place.”

Our field data do not enable us to definitively determine the psychological mechanisms that drive the trading patterns we document. We are, however, able to test several alternative explanations for the observed trading patterns. We find that these patterns are not tax motivated as they are found in both tax-deferred and taxable accounts. The tendency to repurchase stocks that have dropped in price after being sold does not appear to be driven by a general belief that stocks mean-revert, as the investors who exhibit this behavior tend to choose recent winners when buying stocks that they have not owned previously. Finally, the repurchase patterns are not due to superior information since investors do not earn reliably higher returns from this behavior. In fact, after factoring in commissions and other costs associated with trading, the majority of
these investors would be better off buying and holding index funds rather than trading commons stocks. Thus the ability to mitigate the pain of losses by choosing which stocks they repurchase (and which they sell) potentially lowers individual investors’ economic welfare by reducing their motivation to move to more suitable investments.

The remainder of this paper is organized as follows. In the first section, we discuss related studies of investor behavior. In Sections 2 and 3, we describe our data and our methodology. In Section 4, we present results. We then discuss our theoretical contribution to understanding investing behavior, alternative explanations for our findings, and present a summary of our conclusions.

1 Prior Research on Investor Buying and Selling Choices

Prior research has examined how investors choose which stocks to buy and which to sell. Perhaps the best-established pattern is the disposition effect, that is, the tendency of investors to sell winners more readily than losers (Shefrin and Statman, 1985; Odean, 1998; Grinblatt and Keloharju, 2001; Barber, Lee, Liu, and Odean, 2007; Dhar and Zhu, 2002; Jackson, 2003; Feng and Seasholes, 2005). This behavior clearly reduces investors’ economic welfare. For example, Odean (1998) finds that, on average, the winners investors sell go on to outperform the losers they hold. Furthermore, in taxable accounts, realizing gains rather than losses generally leads to higher capital gains taxes. In short, the pattern is both common and bad for investors.

While the disposition effect leads investors to sell stocks with strong recent performance, investors also tend to buy stocks they do not own with strong recent performance (Odean, 1999; Barber, Odean, and Zhu, 2009; Barber, Lee, Liu, and Odean, 2007; and Jackson, 2003). However, Odean (1998) finds that the preference for buying shares of stocks with strong recent performance does not hold for stocks that investors currently own.

2 Data

We analyze two datasets of investor trades. A large discount brokerage firm provided the first dataset. It includes trading and position records for the investments of
78,000 households from January 1991 through December 1996. The data include all accounts opened by each household at this discount brokerage firm. Sampled households were required to have an open account with the discount brokerage firm during 1991. Roughly half of the accounts in our analysis were opened prior to 1987, while half were opened between 1987 and 1991. We focus on investors’ common stock trades. We exclude from the current analysis investments in mutual funds (both open- and closed-end), American depository receipts (ADRs), warrants, and options. Of the 78,000 households sampled from the large discount brokerage, 66,465 had positions in common stocks during at least one month; the remaining accounts held either cash or investments other than individual common stocks. Roughly 60 percent of the market value in these households’ accounts was held in common stocks. Over 3 million trades were in all securities; common stocks accounted for slightly more than 60 percent of all trades. During our sample period, the average household held 4.3 stocks worth $47,334, though each of these figures is positively skewed. The median household held 2.61 stocks worth $16,210. In December 1996, these households held more than $4.5 billion in common stock. There were slightly more purchases (1,082,107) than sales (887,594) during our sample period, though the average value of stocks sold ($13,707) was slightly higher than the value of stocks purchased ($11,205). As a result, the aggregate values of purchases and sales were roughly equal ($12.1 and $12.2 billion, respectively). The average trade was transacted at a price of $31 per share. The value of trades and the transaction price of trades are positively skewed; the medians for both purchases and sales are substantially less than the mean values.

The second data set contains information from a large retail brokerage firm on the investments of households for the 30 months ending in June 1999. This data set includes daily trading records. Using client ownership codes supplied by the brokerage firm, we limit our analysis to the 665,533 investors with non-discretionary accounts (i.e., accounts classified as individual, joint tenants with rights of survival, or custodians for minors) with at least one common stock trade during our sample period. The average household held 5.5 stocks worth approximately $107,000. During this period, these accounts

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1 Position records are through December 1996; trading records are through November 1996. See Barber and Odean (2000) for a more complete description of these data.
executed over 10 million trades. We restrict our analysis to their common stock trades: 3,974,998 purchases with a mean value of $15,209 and 3,219,299 sales with a mean value of $21,169.

3 Individual Investor Repurchase Decisions

We argue that investors will become emotionally involved with the stocks that they own and that this emotional involvement will affect investors’ decisions. In this section, we develop two hypotheses based on our theory of emotional reactions to past experiences: Investors will prefer to repurchase (1) stocks previously sold for a gain rather than stocks sold for a loss, and (2) stocks that have gone down in price since being sold rather than stocks that have gone up in price. We also discuss the methods used to test these hypotheses.

3.1 Returning to Prior Sources of Pleasure and Avoiding Prior Sources of Pain: The Repurchase of Stocks Sold for a Gain vs. Stocks Sold for a Loss

People tend to avoid behavior that previously resulted in pain and to repeat behavior that previously resulted in pleasure. This leads us to predict that investors are more likely to repurchase stocks that they made a profit on in the past than they are to repurchase stocks that they lost money on in the past. Selling for a loss is likely to trigger painful emotions, including regret for having ever bought the stock. Investors don’t repurchase prior losers because they don’t want to repeat an experience that caused pain in the past. Furthermore investors may not want to see prior losers in their portfolio because they do not want to be reminded of their mistakes and thereby re-experience the regret of their past actions.

To test whether investors are more likely to repurchase stocks that they previously sold for a profit than stocks that they previously sold for a loss, it is not sufficient to compare the number of purchases of stocks previously sold for a gain to the number of purchases of stocks previously sold for a loss. In an upward-moving market, investors are likely to have sold more stocks for a gain than for a loss; even if the market is not trending upward, investors are likely to sell more stocks for a gain than for a loss due to the disposition effect. Suppose that investors have previously sold more stocks for gains
but are indifferent to repurchasing their prior winners and losers. These investors will tend to repurchase more stocks previously sold for a gain than stocks previously sold for a loss, simply because they have more opportunities to do so. Therefore, to test whether investors demonstrate a preference for repurchasing stocks that they previously sold for a gain rather than those they previously sold for a loss, we must look at the frequency with which they repurchase prior winners and losers relative to their opportunities to repurchase each.

We begin our analysis at the account level. Starting one year after the beginning of each dataset (i.e., January 1992 at the discount brokerage and January 1998 at the retail brokerage), we look at each day on which an investor made a purchase. We observe whether any of the stocks purchased on that day had been sold by the same investor during the previous 252 trading days (i.e., one year). If so (and when the data allow us to do so), we determine whether the last time the investor sold this stock, the sale was for a gain or a loss (based on the average share-weighted purchase price). We count the number of repurchases of stocks previously sold for a gain (winners repurchased) and the number of stocks previously sold for a loss (losers repurchased). We then count the number of those that were sold for a gain during the last year that the investor could have repurchased on this day (opportunities to repurchase winners). These include stocks sold for a gain during the last year that were repurchased on the day in question and stocks sold for a gain during the last year that could have been repurchased that day but were not. Similarly, we calculate the number of opportunities to repurchase losers on this day. On days when no purchase takes place, we do nothing; no actual winners repurchased, actual losers repurchased, opportunities to repurchase winners, or opportunities to repurchase losers are counted.

For each account, we tabulate and aggregate over time the number of stocks sold for a gain that were repurchased relative to the number of opportunities to repurchase stocks that were sold for a gain. We do the same for the number of stocks sold for a loss that were repurchased relative to the opportunities to repurchase stocks sold for a loss. We sum these tabulations for all investors at each brokerage firm and then calculate two ratios:
Our first hypothesis is that investors are more likely to repurchase a stock that they previously sold for a gain than they are to repurchase a stock they previously sold at a loss. That is:

**Hypothesis 1:** \( \frac{\text{Proportion of prior Winners Repurchased}}{\text{Proportion of prior Losers Repurchased}} \) (PWR) > (PLR).

If markets are efficient in the sense that past price patterns do not predict cross-sectional differences in future risk-adjusted returns, investors’ expectations should be unaffected by whether they have made or lost money on a stock in the past. Thus, the null hypothesis under this version of the efficient market hypothesis would be PWR = PLR. If investors sometimes sell stocks for a tax-loss with the intention of subsequently repurchasing these same stocks, then we would expect that for taxable accounts, PWR < PLR. Our null hypothesis of PWR ≤ PLR captures these two alternatives.

### 3.2 Avoiding Regret: The Repurchase of Stocks Up Since Being Sold vs. Stocks Down Since Being Sold

People frequently compare actual outcomes in life to mental simulations of what might have been, otherwise known as counterfactuals (Kahneman and Tversky 1982; Kahneman 1995). The salience of such counterfactuals increases with their “closeness” to reality, that is, the ease with which elements of reality can be cognitively altered to construct the counterfactual (Kahneman and Miller 1986; Roese and Olson 1995a). Certain features of actual scenarios are more readily mutable and give rise to easily imagined counterfactuals. For example, a passenger who misses a flight by five minutes generally experiences more regret than one who misses a flight by 30 minutes (Kahneman and Tversky 1982).

When an investor sells a stock, one obvious counterfactual is that he could have held it rather than sold it. If the investor repurchases a stock that he previously sold, the
“not sold” counterfactual moves closer to reality. Now, in both the real and the counterfactual scenarios, the investor owned the stock earlier and owns it now; the two scenarios differ in that the investor chose two actions in reality (i.e., selling and repurchasing) rather than no action at all. Thus, reality readily mutates to a salient “never sold” counterfactual. The two scenarios, one real (sell then repurchase the stock) and one that might have been (hold the stock), also differ in the investor’s wealth. If the stock is repurchased at a higher price than it was sold for, the investor is less wealthy than he might have been had he not sold it to begin with; if the stock is repurchased at a lower price, he is wealthier than he would have been had he not sold it at the higher price before repurchasing it at the lower price.

We propose that investors repurchase stocks that have decreased in value since they were sold because reality then dominates the salient “never sold” counterfactual; no matter what happens to the stock in the future, they can always tell themselves that they are better off than if they had never sold the stock at the higher price and then repurchased it at the lower price. We also propose that investors refrain from repurchasing stocks at a higher price than they sold them for because doing so will increase the salience of the “never sold” counterfactual in which they would have been wealthier. In short, repurchasing a stock at a lower price than it was sold for decreases regret, while doing so at a higher price increases regret.

We calculate the Proportion of stocks that have gone Up in price since being sold that are Repurchased (PUR) and the Proportion of stocks that have gone Down in price since being sold that are Repurchased (PDR) in a manner analogous to the calculations of Proportion of Winners Repurchased (PWR) and Proportion of Losers Repurchased (PLR). Starting one year after the beginning of each dataset, we look at each day on which an investor made a purchase. We observe whether any of the stocks purchased on that day were sold by the same investor during the previous year. If so, we determine whether the stock was repurchased at a higher, lower, or equivalent price compared to the price at which this investor most recently sold it. We count the number of times stocks were repurchased at a higher price (stocks that have increased in price since being sold and were repurchased) and the number of times stocks were repurchased at a lower price.
(stocks decreased in price since being sold and were repurchased). We ignore stocks repurchased at the same price as the most recent sales price. To calculate the number of unrealized opportunities to repurchase stocks that have gone up (and down) since being sold, we examine every stock sold from the account during the previous year, note the price at which the stock was previously sold, and determine whether its price is up, down, or the same since the most recent sale. If the high price of the day (or the actual repurchase price for stocks that are repurchased) is lower than the most recent sales price, we count that as an unrealized opportunity to repurchase a stock that has gone down in price since being sold; if the low price of the day (or the actual repurchase price for stocks that are repurchased) is above the most recent sales price, we count that as an unrealized opportunity to repurchase a stock that has gone up since being sold. We ignore cases where the stock could have been repurchased on that day at either a higher or lower price than the previous sales price.

For each account, we tabulate and aggregate over time the number of stocks that went up since being sold and were repurchased relative to the number of realized and unrealized opportunities to repurchase stocks that went up since being sold. We do the same thing for the number of stocks that went down since being sold and were repurchased relative to the opportunities to repurchase stocks that went down since being sold. We sum these tabulations for all investors at each brokerage firm. We then calculate two ratios:

\[
\frac{\text{# of Stocks Up Since being Sold Repurchased}}{\text{# of Opportunities to Repurchase Stocks Up Since being Sold}} = \text{Proportion of stocks Up since being sold Repurchased (PUR)} \tag{3}
\]

\[
\frac{\text{# of Stocks Down Since being Sold Repurchased}}{\text{# of Opportunities to Repurchase Stocks Down being Since Sold}} = \text{Proportion of stocks Down since being sold Repurchased (PDR)} \tag{4}
\]

Our second hypothesis is based on the notion that investors may use counterfactual reasoning to create a situation that is more favorable than one that they avoided. This hypothesis predicts that investors are more likely to repurchase a stock that has gone down in price since they last sold it than they are to repurchase a stock that has gone up in price since they sold it. That is:
**Hypothesis 2:** Proportion of Stocks Down Since being Sold that are Repurchased (PDR) > Proportion of Stocks Up Since being Sold that are Repurchased (PUR).

If markets are efficient in the sense that past price patterns do not predict cross-sectional differences in future risk-adjusted returns, investors should be indifferent between repurchasing stocks that have gone up or down since they were last sold. Thus, the null hypothesis under this version of the efficient market hypothesis would be PDR = PUR. Investors who sold a stock before a decline may take their fortuitous timing as evidence that they have superior information about that stock and, for this reason, buy it again. Although we do not dispute that some investors may hold such beliefs, we find no evidence that investors earn superior returns by repurchasing stocks that have lost value since they were sold. We discuss these and other alternative explanations for our findings in detail after presenting our main results.

**4 Results**

**4.1 Returning to Prior Sources of Pleasure and Avoiding Prior Sources of Pain: The Repurchase of Stocks Sold for a Gain vs. Stocks Sold for a Loss**

In Table 1, we present our calculations of the proportion of stocks that were sold for a gain that were repurchased (PWR) and the proportion of stocks that were sold for a loss that were repurchased (PLR) for both the discount broker and the retail broker. Investors might be unwilling to repurchase stocks that were sold for a loss within 30 days of a sale because doing so would prevent them from claiming the loss for tax purposes. To determine whether this or any other tax consideration influences our results, we calculate the proportions separately for taxable and tax-deferred accounts. At both the large discount broker and the large retail broker, and for both taxable and tax-deferred accounts, investors repurchase stocks previously sold for a gain at significantly higher rates than stocks previously sold for a loss.

On average, the proportion of previous winners repurchased is approximately double the proportion of previous losers repurchased at the large discount broker (e.g., in taxable accounts). In unreported analyses, we also calculate these proportions excluding any repurchases within 30 days of the most recent sale of a stock. Doing so does not qualitatively change our results. This adds support to our conclusion that this pattern is not influenced by tax considerations.
accounts PWR/PLR = 0.0354/0.0155 = 2.28) and almost 40 percent greater at the large retail firm (e.g., PWR/PLR = 0.1260/0.0926 = 1.36). The difference between these proportions is large and statistically significant at both brokers. This is noteworthy as the brokerage firms cater to substantially different investor clienteles and are sampled during different market conditions. The large discount broker caters to do-it-yourself investors, while the retail broker targets somewhat wealthier investors who might value the occasional advice of a broker. The large discount broker is sampled during the early 1990s, while the retail broker is sampled during the peak of the Internet bubble.

Overall, our results provide strong support for our first hypothesis. People prefer to return to sources of pleasure, while avoiding sources of pain. When investing, this tendency manifests itself in the repurchase decisions of investors, who prefer to buy stocks previously sold for a gain, thus recalling pleasure, rather than stocks previously sold for a loss, which would recall pain.

We make some conservative assumptions in our calculation of test statistics in Table 1. Specifically, to calculate the t-statistics in Table 1, we calculate the standard error for the difference in the proportions PWR and PLR as:

$$\sqrt{\frac{PWR(1 - PWR)}{\text{# of repurchases of prior winners}} + \frac{PLR(1 - PLR)}{\text{# of repurchase of prior losers}}}$$

where observations are aggregated across investors. The usual calculation for the standard error of the difference in two proportions would include the number of opportunities to repurchase gains and losses in the denominators, i.e.,

$$\sqrt{\frac{PWR(1 - PWR)}{\text{# of opportunities to repurchase prior winners}} + \frac{PLR(1 - PLR)}{\text{# of opportunities to repurchase prior losers}}}$$

However, the latter calculation assumes that all observations are independent. This independence assumption will not hold perfectly. For example, suppose an investor chooses not to repurchase the same stock on repeated occasions. It is likely that the decision not to repurchase on one date is not independent from the decision not to repurchase on another date. This lack of independence will inflate the test statistics, but will not bias the observed proportions. To be conservative in our calculations of
statistical significance, we only count realized repurchases as independent observations when calculating standard errors. We also later estimate a Cox proportional hazard rate model that confirms the findings based on these proportions.

4.2 Avoiding Anticipated Regret: The Repurchase of Stocks Up Since Being Sold vs. Stocks Down Since Being Sold

In Table 2, we present our calculations of the proportion of stocks that have decreased in value since being sold that were repurchased (PDR) and the proportion of stocks that have increased in value since being sold that were repurchased (PUR). To determine whether our results are influenced by tax considerations, we again calculate the proportions separately for taxable and tax-deferred accounts. At both the large discount broker and the large retail broker, and for both taxable and tax-deferred accounts, investors repurchase stocks that have decreased in value since being sold at roughly double the rate they purchase stocks that have increased in value since being sold (e.g., within taxable accounts at the large discount broker, PDR/PUR = 0.0467/0.0232 = 2.01). The difference between these proportions (PDR − PUR) is large and statistically significant.

4.3 The Interaction Between Outcome of Last Sale and Direction of Price Change Since Last Sale

In Table 3, we separately present results for stocks down since sold and stocks up since sold conditional on whether they were sold for a gain or a loss. This analysis reveals that the tendency of investors to repurchase stocks that have lost value since last being sold applies almost exclusively to stocks that were sold for a gain. Investors who have lost money when they sold their position are reluctant to buy that stock again regardless of whether it has gone up or down since they sold it. Looking only at stocks previously sold for a loss in both taxable and tax-deferred accounts at both brokerages (panel B, Table 3), the proportion of stocks down since being sold that are repurchased and the proportion of stocks up since being sold are similar and their differences not statistically significant.

When we look at stocks that previously were sold for a gain (panel A, Table 3), the story is quite different. In taxable accounts at the large discount brokerage, looking only
at stocks previously sold for a gain, the proportion of stocks down since being sold that are repurchased is 0.0513, while the proportion of stocks up since being sold that are repurchased is 0.0247. We can reject the null, that these proportions are equal (t = 13.7, p<0.01). The results are qualitatively similar at the retail brokerage and in tax-deferred accounts; relative to their opportunities to do so, investors repurchase stocks previously sold for a gain that have gone down at about twice the rate that they repurchase stocks previously sold for a gain that have gone up.

5 Hazard Rate Analysis

5.1 Cox Proportional Hazard Rate Model

The results reported in Section 4 compare ratios of repurchases to opportunities to repurchase. These analyses provide strong evidence for our hypotheses that investors repurchase prior winners more readily than prior losers and that stocks that have gone down in price since being sold are purchased more readily than stocks that have gone up in price since being sold. However, these ratio tests do not tell us how the magnitude of gains and losses affect investor behavior. To assess whether the magnitude of gains, losses and price changes after a sale affect investors’ repurchase behavior, we estimate Cox proportional hazard rate models (Cox, 1972). Specifically, we estimate models of the form

$$h(t,x(t)) = h_0(t)\exp(\beta_1 x_1 + \ldots + \beta_p x_p)$$  \hspace{1cm} (5)

where $h(t,x(t))$ is the hazard rate at time $t$ conditional on a set of $p$ observed predictors as of period $t$ (denoted $x(t)$). The baseline hazard rate, $h_0(t)$, is the hazard rate when all predictors take on a value of zero. The $\beta$ coefficients are estimated from the data. The hazard rate is the probability density function of the hazard event at time $t$ conditional on survival to time $t$ (i.e., not observing the hazard event prior to $t$).

In our analyses, the hazard event is the repurchase of a stock subsequent to the stock being sold, and time is measured in days subsequent to the original sale. The hazard rate for a particular stock being repurchased by a particular investor is conditional on the covariates for that stock and investor at time $t$.

\[3\] In related work, Feng and Seasholes (2005), Ivkovic, Poterba, and Weisbenner (2005), and Shumway and Wu (2006) use proportional hazard rate analysis to examine selling behavior.
For each \( k \)\(^{th} \) covariate, we report estimates of the hazard ratio assuming a one-unit increase in the covariate:

\[
\exp(\beta_k) = \frac{h_0(t) \exp(\beta_1 x_1 + \ldots + \beta_k (x_k + 1) + \ldots + \beta_p x_p)}{h_0(t) \exp(\beta_1 x_1 + \ldots + \beta_k x_k + \ldots + \beta_p x_p)}
\] (6)

Note that the hazard ratio, \( \exp(\beta_k) \), is the ratio of hazard rates for two stocks with the same covariates except that \( x_k \) is one unit larger for the stock whose hazard rate is given in the numerator. Thus, if \( x_k \) is a dummy variable, the hazard ratio is the ratio of the hazard when the dummy variable takes on a value of 1 to the hazard when its value is 0 and all other covariates are the same.

The Cox model makes no assumptions about how the baseline hazard rate changes over time and does not estimate the baseline hazard rate. The model does assume that hazard ratios do not change with time. For example, the model makes no assumptions about how the unconditional rate of repurchasing stocks changes from day 50 to day 100, but it assumes that if having sold a stock for a gain rather than a loss increases the hazard rate of repurchase by 20% on day 50, then it also increases the hazard rate of repurchase by 20% on day 100.

5.2 Stocks Sold for a Gain vs. Stocks Sold for a Loss

We first look at how the magnitude of gains and losses at the time that an investor sold a stock affects the repurchase rate conditional on whether the stock is up or down since sold. To do so, we create dummy variables for the size of the gain or loss at the time of sale using a series of 4% wide return categories.\(^4\) These return categories are:

\[
r \leq -46\%, -46\% < r \leq -42\%, \ldots, -2\% < r \leq 2\%, \ldots, 62\% < r \leq 66\%, 66\% < r.
\]

For example, we create a dummy variable that is one if the return at the time of the sale is greater than -2% and less than or equal to 2%. These covariates are static since the return at the time of the sale does not change subsequent to the sale. We include a time varying covariate that is one if a stock’s current price is greater than it was at the time of the sale and is otherwise zero. We include two unreported control variables: the log of the ratio of

\(^4\) Results are similar for different return category specifications.
the dollar value of all trades during the previous calendar year in the stock (as reported in the Center for Research in Securities Prices (CRSP) database) to the total dollar value of all trades during the previous calendar year in all stocks (as reported in the CRSP database); and the inverse of the number of days the investor held a stock before the original sale. Both control variables are statistically significant in all analyses.

Figures 1a and 1b graph the hazard ratios for our covariates for the investors at the large discount brokerage and the large retail brokerage, respectively. All ratios are the hazard rate for the specified covariates divided by the hazard rate for the case in which the stock was originally sold for a profit of approximately zero (i.e., \(-2% < r \leq 2\%\)) and the stock has lost value since the sale. Hazard ratio estimates for stocks currently trading above the sale price are graphed in red; those for stocks currently trading below the sale price are blue. The 95\% confidence intervals for the hazard ratio estimates are graphed in the lighter red and blue lines.

The hazard ratio graphs for both brokerage firms are remarkably similar. The likelihood of repurchasing a stock is highly dependent on whether the stock was originally sold for a gain or a loss. Regardless of whether a stock is up (blue line) or down (red line) since the original sale, a sharp kink appears in the hazard rates at the middle of both graphs, when stocks move from the domain of losses to the domain of gains. If a stock originally was sold for a loss (left-hand side of both graphs), the likelihood of repurchase drops nearly linearly in the magnitude of that loss; while if the stock originally was sold for a gain (right-hand side of both graphs), the likelihood of repurchase does not increase (or even drops slightly) in the magnitude of the gain. The sharp kink at the point that losses change to gains is consistent with loss aversion.

5.3 Stocks Up Since Being Sold vs. Stocks Down Since Being Sold

We next look at how the magnitude of the price change a stock has experienced since an investor sold it affects the repurchase rate, conditional on whether the stock was sold for a gain or loss. To facilitate this we create dummy variables for the return on the stock since sold using a series of 4\% wide return categories. These return categories are:

\[ r \leq -46\%, \ -46\% < r \leq -42\%, \ldots, \ -2\% < r \leq 2\%, \ldots, \ 62\% < r \leq 66\%, \ 66\% < r. \]
For example, we create a dummy variable that is one if the return to the stock since the sale is greater than -2% and less than or equal to 2%. These covariates are time varying because the return since the sale can change every day. We include a static covariate that is one if a stock was originally sold for a gain and is otherwise zero. As before, we also include, as unreported control variables, measures of a stocks share of total market volume and an investors holding period.

Figures 2a and 2b graph the hazard ratios for our covariates for the investors at the large discount brokerage and large retail brokerage. All ratios are the hazard rate for the specified covariate divided by the hazard rate for the case in which the stock was originally sold for a profit of approximately zero (i.e., \(-2\% < r \leq 2\%\)) and the stock has lost value since the sale. Hazard ratio estimates for stocks originally sold for a loss are graphed in red; those for stocks originally sold for a gain are blue. The 95% confidence intervals for the hazard ratio estimates are graphed in lighter red and blue lines.

Once again, the hazard ratio graphs for both brokerage firms are remarkably similar. For all levels of returns since the original sale, stocks that were originally sold for a gain (blue line) are repurchased at higher rates than those originally sold for a loss (red line). Repurchase rates go up slowly as the magnitude of a stock’s gain since the sale increases (right-hand side of both graphs) regardless of whether the stock was originally sold for a gain (blue line) or loss (red line). If a stock was originally sold for a loss (red line), repurchase rates go up slowly as the magnitude of the stock’s drop in price since the sale increases. However, if a stock originally was sold for a gain (blue line), the repurchase rates go up dramatically as the magnitude of the stock’s price drop since the sale increases. Furthermore, for stocks originally sold for a gain, repurchase rates are always much higher if the stock’s price has dropped since the sale than if it has increased a comparable amount. Investors are most likely to repurchase stocks that they originally sold for a gain and which have dropped in price by around 30% since the original sale.
6 Performance Analysis and Alternative Explanations for the Results

6.1 Skill vs. Emotionally-Motivated Repurchases

Investors appear to prefer most to repurchase stocks that they previously sold for a gain that have gone down in price since they were sold. We argue that this behavior is emotionally motivated. Buying past winners reinforces a pleasurable experience. Having those stocks in one’s portfolio can serve as a reminder of one’s past financial victory. Buying stocks that have gone up in price since being sold is avoided since doing so creates a salient and regret-filled counterfactual (“I should have never sold.”), while buying stocks that are down in price since being sold engenders no such regret and in fact reinforces the prior sale as a prudent decision.

One alternative explanation for these results is that these investors are skilled traders behaving prudently. They buy stocks they made money on before because past failures and successes are indicative of an investor’s stock specific ability to forecast future returns. Investors repurchase past winners that have gone down in price because the new, lower price, is below the investor’s valuation of that stock. If such past successes do indicate stock specific skill, buying stocks previously sold for a gain should lead to superior risk-adjusted returns. In general, individual investors do not exhibit stock picking ability (Odean 1999; Barber and Odean 2000, 2001; Barber, Lee, Liu, and Odean 2009). For investors without stock picking ability, repurchasing previous winners that have gone down since sold is unlikely to improve performance.

We test whether investors are benefiting from the repurchase of stocks previously sold for a gain that are down in price since being sold by calculating returns earned on such stocks subsequent to being repurchased. Note that this is the particular category of repurchases that are consistent with a skill story as the investor was able to earn a gain on the sale and repurchased the stock at a lower price than he had previously sold it for. To differentiate the skill story from our hypothesis, we estimate the returns on these stocks subsequent to the repurchase. The skill story predicts that these stocks will earn strong returns, while our hypothesis predicts, at best, average performance.
We calculate risk-adjusted returns under the Capital Asset Pricing Model (CAPM). To see whether any observed abnormal returns can be explained by investment style, that is, by stock characteristics known to affect returns, we also employ a four-factor model that includes market, size, value, and momentum factors (Fama and French 1993, Carhart 1997). For this analysis, we combine the discount and retail brokerage datasets. We construct a portfolio that invests a dollar in each stock repurchased and holds each investment for 252 trading days (i.e., one year). For each portfolio, we obtain the daily returns on the portfolio and estimate the following time-series regressions for the Capital Asset Pricing Model:

\[(R'_t - R_{ft}) = \alpha + \beta(R_{mt} - R_{ft}) + \epsilon_t,\]

and the four-factor model:

\[(R'_t - R_{ft}) = \alpha + \beta(R_{mt} - R_{ft}) + sSMB_t + hHML_t + wWML_t + \epsilon_t\]

where \( R'_t \) is the return on the repurchase portfolio, \( R_{ft} \) is the return on T-Bills, \( R_{mt} \) is the return on a value-weighted market index, \( SMB_t \) is the return on a value-weighted portfolio of small stocks minus the return on a value-weighted portfolio of big stocks, \( HML_t \) is the return on a value-weighted portfolio of high book-to-market (value) stocks minus the return on a value-weighted portfolio of low book-to-market (growth) stocks, and \( WML_t \) is the return on a value-weighted portfolio of recent winners minus the return on a value-weighted portfolio of recent losers.

Our results are reported in Table 4. Using the CAPM, stocks that were repurchased after being sold for a gain and a decrease in price since the sale underperform by 2.8 basis points per day or 7 percentage points per year \((p < 0.05)\). The style-adjusted results show that these repurchases tended to be of high beta small growth stocks. Given this investment style, the abnormal performance, while nominally negative, is not reliably different from zero. Clearly, these purchases are not motivated by superior skill or information.

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\(^5\) The construction of the \( SMB, HML, \) and \( WML \) portfolios is discussed in detail in Fama and French (1993). We obtain the factors from Ken French’s data library.
It is also worth noting that the returns we estimate in Table 4 are before transaction costs. Barber and Odean (2000) report that at the discount brokerage, the average round-trip trade in excess of $1,000 costs three percent in commissions and one percent in bid-ask spread. These transaction costs would further detract from the performance of stocks repurchased.

6.2 Perceived Skill vs. Emotionally-Motivated Repurchases

If an investor sells a stock that subsequently declines in value, the investor may erroneously infer that he has the ability to time trades in that particular stock. Because he believes himself to have ability to time trades in this stock, he may be more inclined to buy the stock again than if the stock price had appreciated after he sold it and he had thus inferred his ability to be low. Thus, the tendency to repurchase stocks that have dropped in price since they were sold could be driven not by the desire to avoid regret, but by an attribution bias in which investors make incorrect inferences about their ability.

To distinguish between these two explanations, we look at the tendency of investors to buy additional shares of stocks that they already own. If investors are inferring stock specific ability from their trading outcomes, then an investor who buys a stock that subsequently drops in value should infer that his ability is low, while an investor who buys a stock that gains value after the purchase should infer that his ability is high. Thus an investor who receives feedback that he is a skilled stock picker (i.e., the stock rises subsequent to purchase) is more likely to continue buying the stock than an investor who receives negative feedback about his ability (i.e., the stock drops subsequent to purchase).6 7

If repurchase behavior is driven by counterfactual reasoning and the desire to avoid regret, the prediction goes the other way. An investor who bought a stock that has gone

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6 Daniel, Hirshleifer, and Subramanyam (1998) theorize that if investors buy a stock on the basis of private information and that information is then confirmed by public information, these investors will become overconfident about their private information and drive prices higher than would have otherwise been the case.

7 Analyzing a dataset of 10,000 individual investor accounts at large discount brokerage for the period 1987-1993, Odean (1998) finds that investors are more likely to repurchase a stock they currently own if the price of the stock has decreased in value, rather than increased in value, since they purchased it.
up in price will feel regret if he buys additional shares at the higher price because doing so will highlight that he missed the opportunity to buy those additional shares at the original, lower, price. Thus investors will be less likely, not more likely, to buy additional shares of the stock that they already own if the price of the stock has gone down since they first bought it.

We test to see whether investors are more or less likely to buy additional shares of a stock that they currently own, conditional on whether the stock has gone up since it was purchased, using similar methodologies to those already discussed. We calculate the Proportion of currently Owned stocks Up since purchase that are Repurchased (POUR) and the Proportion of currently Owned stocks Down since purchase that are Repurchased (PODR) in a manner analogous to our previous calculations.

Our analysis begins at the account level. Starting at the beginning of each dataset, we look at each day on which an investor made a purchase. We then observe whether he repurchased a stock already in his portfolio. If so, we determine, if we are able to do so, whether the stock was repurchased at a higher or lower price than the average purchase price previously paid. Stocks repurchased at a higher price are counted as currently owned stocks up since purchase that are repurchased; stocks repurchased at a lower price are counted as currently owned stocks down since purchase that are repurchased. To calculate the number of opportunities to repurchase currently owned stocks that are up since purchase and the number of opportunities to repurchase currently owned stocks that are down since purchase, we examine every stock in the portfolio and determine whether it is currently held for a gain or for a loss (relative to the average purchase price). If the high price of the stock that day (or the actual repurchase price for stocks that are repurchased) is below the average price previously paid for the stock, we count that as an opportunity to repurchase at a lower price. If the low price of the stock that day (or the actual repurchase price for stocks that are repurchased) is above the average price previously paid for the stock, we count that as an opportunity to repurchase at a higher price.
For each account, we tabulate and aggregate over time the number of currently owned stocks trading at a price above the average purchase price that are purchased again. We compare that to the number of opportunities to purchase additional shares of currently owned stocks trading at a price above the average purchase price. We do the same thing for the number of currently owned stocks trading at a price below the average purchase price that are purchased again and compare that to the number of opportunities to purchase additional shares of currently owned stocks trading at a price below the average purchase price. We sum these tabulations for all investors at each brokerage firm and then calculate two ratios:

\[
\frac{\text{# of Currently Owned Stocks Up Since Purchase Repurchased}}{\text{# of Opportunities to Repurchase Stocks Currently Owned Up Since Purchase}} = \frac{\text{Proportion of currently Owned stocks Up since purchase Repurchased (POUR)}}{
\text{# of currently Owed stocks Down since purchase Repurchased}} = \frac{\text{Proportion of currently Owned stocks Down since purchase Repurchased (PODR)}}{
\text{# of opportunities to Repurchase currently owned stocks Down since purchase}}
\]

Our hypothesis, also based on counterfactual reasoning, is that investors are more likely to purchase additional shares of a currently owned stock that has gone down in price since originally purchased than they are to purchase additional shares of a currently owned stock that has gone up in price since originally purchased (i.e., PODR > POUR); the formal null hypothesis here is that PODR ≤ POUR. If markets are efficient in the sense that past price patterns do not predict cross-sectional differences in future risk-adjusted returns, investors should be indifferent between repurchasing stocks that have gone up since they were purchased and stocks that have gone down since they were purchased.

Results are reported in Table 5. For taxable accounts at the large discount brokerage, the proportion of currently owned stocks up since purchase that are repurchased is 0.0555, whereas the proportion of currently owned stocks down since purchase that are repurchased is 0.0828; the difference in the proportions is statistically significant (t = 20.0). At the large retail brokerage, and in tax-deferred accounts, the results are qualitatively similar and statistically significant.8

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8 It is unlikely that an investor who bought a stock that then declined in value would take this as an indication that he has superior information about this stock. Nevertheless, in unreported results available from the authors, we calculate CAPM and four-factor risk-adjusted returns as described in Section 6.1. The
Investors exhibit a clear preference for repurchasing stocks they currently own when the stocks are trading at a lower price than the average purchase price rather than when the stocks are trading at a higher price. This is consistent with their preference for repurchasing stocks that they previously sold when the stocks are trading at a lower price than the original sale price rather than when the stocks are trading at a higher price. However, the tendency to purchase additional shares of a stock on which an investor has lost money could appear to be at odds with the tendency to avoid repurchasing stocks that were sold for a loss. There is, though, a salient difference between purchasing additional shares of a stock that has decreased in value since being purchased and repurchasing a stock that one previously sold for a loss. Once a stock is sold for a loss, the investor can choose to put that stock out of his mind and not even consider buying it again. However, the investor who still owns a stock is unlikely to forget about that stock. If he buys additional shares at a lower price he can be happy that he spread his purchases out and achieved a lower average purchase price than he would have gotten if he had simply bought all the shares to begin with; but, if he buys additional shares at a higher price, he will regret that he didn’t simply buy more shares at the original price.

6.3 A Belief in Mean Reversion vs. Emotionally-Motivated Repurchases

We observe that investors are more likely to repurchase a stock that they previously sold if that stock is now trading for less than the price at which they sold it. We argue that by repurchasing a stock that she previously sold, an investor highlights the counterfactual in which she would own the stock today because she never sold it. If she repurchases the stock at a lower price than she sold it, repurchasing makes her better off than she would have been under the counterfactual; the comparison makes her feel good. If she repurchases the stock at a higher price than she sold it, repurchasing makes her worse off than under the counterfactual; the comparison makes her feel bad. Thus, investors increase the emotional pleasure associated with trading stocks when they repurchase stocks at prices lower than they sold them for. In contrast, repurchasing at a portfolio of currently owned stocks repurchased at a lower price has a negative risk-adjusted return of just over 7 percent per year under the CAPM ($t = 2.49, p < 0.01$). The four-factor alpha also is negative, but not reliably so.
higher price than one has sold a stock for increases regret at having sold the stock in the first place.

One alternative explanation for our results is that investors may (rightly or wrongly) believe that stock returns are mean reverting. Investors who believe that stocks are mean reverting will prefer to buy stocks with poor recent performance. We test this alternative by observing that, if investors simply believe that stock returns are mean reverting, this belief should apply both to stocks the investor has owned before and to other stocks. We form a partition of investors who exhibit a preference for buying stocks at a lower price than they sold them (i.e., the partition of investors for whom PDR > PUR). We then look to see whether this group of investors tends to select stocks with poor recent performance when they are buying stocks that they have not owned during the past year. We do so by calculating the mean market-adjusted return on purchases in event time, where day 0 is the day of purchase for stocks purchased by these investors but not owned by them during the previous year. These means are cumulated beginning one year (252 trading days) prior to the purchase.

In Figure 3, we see that at both the discount and retail brokerage houses cumulative market-adjusted returns prior to purchase are, on average, strongly positive for stocks not owned during the last year. In general, these investors chase performance rather than bet on mean reversion. Only when they have previously owned, or currently own, a stock do they buy after poor performance. Thus, having different experiences with a stock can cause two investors to treat that same stock differently. A widespread belief in mean reversion cannot explain these results.

7 Discussion

While our field data enable us to thoroughly document investor repurchase behavior, we are not able to definitively distinguish among motivations for that behavior. We believe that the tendency to repurchase past winners at a higher rate than past losers is consistent with simple learning: realizing gains triggers pleasurable emotions while realizing losses is emotionally painful. Selling a stock for a loss is likely to cause one to regret having purchased the stock. Not all investors will experience the same emotions
when realizing losses, and some investors may experience more than one negative emotion, including regret, disappointment and, in the case of very large losses, fear. Similarly, not all investors will experience the same emotions when realizing gains, and some may experience more than one positive emotion, including relief, excitement, and pride. Still, we can argue that, generally, gains lead to positive emotions and losses lead to negative emotions.

If the stock market were a level playing field and trading costless, one might argue that the ability to enhance the emotional experience of investing by timing one’s repurchases in a way that feels good is welfare increasing. However, the enhanced emotional experience often will come with a price tag for two distinct reasons: the playing field is not level—on average institutional investors gain through trading and individuals lose. Furthermore, due to commissions and other transaction costs, trading is costly. Barber, Lee, Liu and Odean (2009) document that, as a group, individual investors in Taiwan lose the equivalent of two percent of GDP in trading losses to institutions, market timing losses, commissions, and transactions taxes. Barber and Odean (2000) show that the same U.S. discount brokerage clients studied in this paper reduce their annual return by about 1.8 percentage points a year through trading. And, on average, these investors earn significantly lower net returns than they would receive from a market-wide index fund.

We find that the dominant behavior we document, repurchasing stocks previously sold for a gain that have declined since the sale, leads to economically large and statistically significant reduction in (CAPM) risk-adjusted performance even before factoring in commissions and bid-ask spreads. With the exception of trades that are economically motivated (e.g., liquidity demands or tax-loss sales), trading lowers the welfare of the individual investor. Not only do investors pay commissions and bid-ask spreads, but also on average they lose to institutions (Barber, Lee, Liu, and Odean, 2009). The more individual investors trade, the lower their net returns (Barber and Odean, 2000). The ability to improve the emotional experience of investing by selecting which stocks to repurchase may induce investors to continue trading common stocks and even
to trade more actively, thus reducing individual investors’ economic welfare relative to buying and holding a low-cost well-diversified index funds.

8 Conclusion

Analyzing trading records for hundreds of thousands of individual investors at a large discount brokerage and large retail brokerage, we establish two previously undocumented patterns in the purchase selections of individual investors. Both patterns hinge on investors’ prior experience with a stock. Investors prefer to repurchase:

(1) stocks previously sold for a gain, and

(2) stocks that have gone down in price since they were last sold.

The first pattern dominates the second, that is, investors are reticent to repurchase stocks they previously sold for a loss, regardless of whether the price has gone up or down since the last time they sold it. Additional analyses demonstrate that the greater the initial loss, the less likely an investor is to repurchase the stock. However, investors are much more likely to repurchase a stock previously sold for a gain if it has gone down in price since it was sold; the more the price has gone down, the more likely the investor is to repurchase it.

We argue that repurchasing stocks that were sold for a gain results from naïve learning whereby investors repeat actions that previously resulted in pleasure while avoiding actions that previously led to pain (i.e., they repurchase their previous winners more readily than their previous losers). Since many investors view their portfolios regularly, we also believe that they may desire to avoid painful reminders of prior losses. We argue that the preference for repurchasing stocks that are down in price since they were sold is tied to counterfactuals. Investors who buy a stock at a higher price than they previously sold it for are painfully aware that they are worse off than if they had simply never sold that stock. Investors who buy a stock at a lower price than they previously sold it experience the pleasure of knowing they are better off than if they had never sold that stock.

Our large and detailed datasets enable us to document robust trading patterns of a large sample of real investors. These data are not as well suited for establishing the
reasons investors behave as they do. Yet, we are still able to provide evidence that the trading behavior we document reduces investor returns and that the behavior is not driven primarily by tax considerations, superior skill (perceived or real), or a widespread belief that stock prices mean-revert. Furthermore, the explanations we offer are both intuitive and consistent with previous psychological research.

The phenomena identified here remind us that stock trading, like so many other human behaviors, is affected by emotions. It makes emotional sense that investors repurchase stocks that have decreased in value since being sold. Investors who do so feel the pleasure of making a choice that results in a better outcome than what might have been had they not previously sold the stock, while investors who repurchase at higher prices feel regret from knowing that they could have easily done better. Similarly, avoiding what has been a source of pain in the past is one of the most basic instincts that humans possess. Investors are unlikely to wish to be reminded of or to risk reliving their previous failures. Thus, it is not surprising that investors are attracted to stocks that have treated them well in the past but shy away from stocks by which they were once burned.
References


Feng, Lei and Mark S. Seasholes (2005), ”Do investor sophistication and trading experience eliminate behavioral biases in financial markets,” Review of Finance, 9, 305-351.


Tykocinski, Orit, and Thane Pittman (2001), Product aversion following a missed opportunity: Price contrast or avoidance of anticipated regret?,” *Basic and Applied Social Psychology*, 23, 149-156.

Table 1: Preferences for Repurchasing Stocks Previously Sold for a Gain vs. Stocks Previously Sold for a Loss

This table compares the aggregate Proportion of prior Winners Repurchased (PWR) to the aggregate Proportion of prior Losers Repurchased (PLR). PWR is the number of stocks sold for a gain in the previous year that were repurchased divided by the number of opportunities to repurchase stocks sold for gain in the previous year. PLR is calculated similarly. All counters are incremented only on days when purchases are made. Results are separately aggregated across accounts for taxable accounts and tax-deferred accounts at the large discount brokerage (January 1991 through November 1996) and the large retail brokerage (January 1997 through June 1999). The t-statistics test the null hypotheses that the differences in proportions are equal to zero assuming that all purchases and non-purchases result from independent decisions.

<table>
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<tr>
<th></th>
<th>Large Discount Broker</th>
<th>Large Retail Broker</th>
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<tr>
<td></td>
<td>Taxable</td>
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<tr>
<td>Winners Repurchased</td>
<td>37,739</td>
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<td>276,820</td>
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<td>Losers Repurchased</td>
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<td>Unrealized Opportunities to Repurchase Losers</td>
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<td>Proportion of Prior Losers Repurchased (PLR)</td>
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<td>Difference (PWR – PLR)</td>
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<td>t-statistic (H₀: PWR ≤ PLR)</td>
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<td>7.7</td>
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This table compares the aggregate Proportion of Stocks Up Since being Sold that were Repurchased (PUR) to the aggregate Proportion of Stocks Down Since being Sold that were Repurchased (PDR). PUR is the number of stocks sold in the previous year that were repurchased for a higher price than the price at which they were sold, divided by the number of opportunities to repurchase stocks sold in the previous year for a higher price than the price at which they were sold. PDR is calculated similarly. All counters are incremented only on days when purchases are made. Results are separately aggregated across accounts for taxable accounts and tax-deferred accounts at the large discount brokerage (LDB) (January 1991 through November 1996) and the large retail brokerage (LRB) (January 1997 through June 1999). The t-statistics test the null hypotheses that the differences in proportions are equal to zero assuming that all purchases and non-purchases result from independent decisions.

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<tr>
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<td>Stocks Down Since being Sold that were Repurchased</td>
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<td>Stocks Up Since being Sold that were Repurchased</td>
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Table 3: Interaction Effects

This table separately compares the aggregate Proportion of Stocks Up Since being Sold that were Repurchased (PUR) to the aggregate Proportion of Stocks Down Since being Sold that were Repurchased (PDR) for stocks that were previously sold for a gain (panel A) and for stocks that were previously sold for a loss (panel B). PUR is the number of stocks sold in the previous year that were repurchased for a higher price than the price at which they were sold divided by the number of opportunities to repurchase stocks sold in the previous year for a higher price than the price at which they were sold. PDR is calculated similarly. All counters are incremented only on days when purchases are made. Results are separately aggregated across accounts at the large discount brokerage (LDB) (January 1991 through November 1996) and the large retail brokerage (LRB) (January 1997 through June 1999). The t-statistics test the null hypotheses that the differences in proportions are equal to zero assuming that all purchases and non-purchases result from independent decisions.

<table>
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<th>Panel A: Stocks Previously Sold for a Gain</th>
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<tr>
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<td>Stocks Down Since being Sold that were Repurchased</td>
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<td>Unrealized Opportunities to Repurchase Stocks Down Since being Sold</td>
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<td>Proportion Stocks Down Since being Sold that were Repurchased (PDR)</td>
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<td>Stocks Up Since being Sold that were Repurchased</td>
<td>15,730</td>
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<tr>
<td>Unrealized Opportunities to Repurchase Stocks Up Since being Sold</td>
<td>620,100</td>
<td>171,569</td>
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<tr>
<td>Proportion of Stocks Up Since being Sold that were Repurchased (PUR)</td>
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<td>Difference (PDR – PUR)</td>
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<td>t-statistic (H₀: PDR = PUR)</td>
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Table 3, continued

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<th></th>
<th>Large Retail Broker</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Taxable</td>
<td>Deferred</td>
<td>Taxable</td>
<td>Deferred</td>
</tr>
<tr>
<td>Stocks Down Since being Sold that were Repurchased</td>
<td>4,593</td>
<td>1,223</td>
<td>8,759</td>
<td>3,065</td>
</tr>
<tr>
<td>Unrealized Opportunities to Repurchase Stocks Down Since being Sold</td>
<td>284,808</td>
<td>65,151</td>
<td>82,155</td>
<td>24,546</td>
</tr>
<tr>
<td>Proportion Stocks Down Since being Sold that were Repurchased (PDR)</td>
<td>0.0159</td>
<td>0.0184</td>
<td>0.0963</td>
<td>0.1110</td>
</tr>
<tr>
<td>Stocks Up Since being Sold that were Repurchased</td>
<td>5,852</td>
<td>1,577</td>
<td>12,832</td>
<td>4,566</td>
</tr>
<tr>
<td>Unrealized Opportunities. to Repurchase Stocks Up Since being Sold</td>
<td>380,189</td>
<td>93,021</td>
<td>129,369</td>
<td>40,456</td>
</tr>
<tr>
<td>Proportion of Stocks Up Since being Sold that were Repurchased (PUR)</td>
<td>0.0152</td>
<td>0.0167</td>
<td>0.0902</td>
<td>0.1014</td>
</tr>
<tr>
<td>Difference (PDR – PUR)</td>
<td>0.0007</td>
<td>0.0018</td>
<td>0.0061</td>
<td>0.0096</td>
</tr>
<tr>
<td>t-statistic (H₀: PDR = PUR)</td>
<td>0.29</td>
<td>0.34</td>
<td>1.50</td>
<td>1.30</td>
</tr>
</tbody>
</table>
Table 4: Percentage Return Performance and Style Tilts of Repurchased Stocks that were Previously Sold for a Gain and Decreased in Value Since Previously Sold

Trades data are for investors at a large discount brokerage and investors at a large retail brokerage (January 1991 through June 1999). For investors at each brokerage, we form portfolios of stocks sold for a profit during the previous 12 months and repurchased at a lower price than sold. We construct a portfolio that invests a dollar in each stock repurchased and holds each investment for 252 trading days (i.e., one year). We estimate the following daily time-series regressions for the Capital Asset Pricing Model and for a four-factor model:

\[ (R'_t - R_f) = \alpha + \beta(R_m - R_f) + \epsilon_t, \]

and the four-factor model:

\[ (R'_t - R_f) = \alpha + \beta(R_m - R_f) + \delta SMB_t + \delta HML_t + \delta WML_t + \epsilon_t \]

where \( R'_t \), is the return on the repurchase portfolio, \( R_f \) is the return on T-Bills, \( R_m \) is the return on a value-weighted market index, \( SMB_t \) is the return on a value-weighted portfolio of small stocks minus the return on a value-weighted portfolio of big stocks, \( HML_t \) is the return on a value-weighted portfolio of high book-to-market (value) stocks minus the return on a value-weighted portfolio of low book-to-market (growth) stocks, and \( WML_t \) is the return on a value-weighted portfolio of recent winners minus the return on a value-weighted portfolio of recent losers.

<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>( R_m - R_f )</th>
<th>SMB</th>
<th>HML</th>
<th>WML</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPM</strong></td>
<td>-0.028**</td>
<td>1.401***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.04)</td>
<td>(81.23)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Four-Factor</strong></td>
<td>-0.005</td>
<td>1.265***</td>
<td>0.475***</td>
<td>-0.662***</td>
<td>-0.029</td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td>(-0.49)</td>
<td>(61.02)</td>
<td>(17.86)</td>
<td>(-19.73)</td>
<td>(-1.11)</td>
</tr>
</tbody>
</table>

***, ** Significant at the 1% and 5% level (two-tailed test), respectively.
Table 5: Preferences for Purchasing Currently Owned Stocks
Up Since Purchase vs. Currently Owned Stocks Down Since Purchase

This table compares the aggregate proportion of currently owned stocks down since purchases that are repurchased (PODR) to the aggregate proportion of currently owned stocks up since being purchased that repurchased (POUR). The proportion of currently owned stocks up since purchase that are repurchased is the number of stocks purchased and still owned that were purchased again for a higher price than the average price at which they were previously purchased in the past year, divided by the number of opportunities to purchase currently owned stocks for a higher price than the average price at which they were previously purchased in the past year. The proportion of currently owned stocks down since purchase that are repurchased is calculated similarly. All counters are incremented only on days when purchases are made. The t-statistics test the null hypotheses that the differences in proportions are equal to zero assuming that all purchases and non-purchases result from independent decisions.

<table>
<thead>
<tr>
<th></th>
<th>Large Discount Broker</th>
<th>Large Retail Broker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Taxable</td>
<td>Tax-Deferred</td>
</tr>
<tr>
<td>Currently Owned Stocks Down</td>
<td>75,698</td>
<td>21,296</td>
</tr>
<tr>
<td>Since Purchase Repurchased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrealized Opportunities to</td>
<td>837,979</td>
<td>173,707</td>
</tr>
<tr>
<td>Repurchase Currently Owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stocks Down Since Purchase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of Currently</td>
<td>0.0828</td>
<td>0.1092</td>
</tr>
<tr>
<td>Owned Stocks Down Since</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Repurchased (PODR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently Owned Stocks Up</td>
<td>60,186</td>
<td>15,967</td>
</tr>
<tr>
<td>Since Purchase Repurchased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrealized Opportunities to</td>
<td>1,025,190</td>
<td>230,596</td>
</tr>
<tr>
<td>Repurchase Currently Owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stocks Up Since Purchase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of Currently</td>
<td>0.0555</td>
<td>0.0648</td>
</tr>
<tr>
<td>Owned Stocks Up Since</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase Repurchased (POUR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference (PODR – POUR)</td>
<td>0.0274</td>
<td>0.0445</td>
</tr>
<tr>
<td>t-statistic (H₀: PODR ≤ POUR)</td>
<td>20.0</td>
<td>15.4</td>
</tr>
</tbody>
</table>

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Figure 1: Hazard Ratio by Return Earned on Original Sale, conditional on whether the stock was up since sold (blue line) or down since sold (red line)

Figure 1a: Large Discount Broker, 1992 to 1996
Figure 1b: Large Retail Broker, 1998 to 1999
Figure 2: Hazard Ratio by Return on Stock since Sold, conditional on whether the stock was sold for a gain (blue) or loss (red)

Figure 2a: Large Discount Broker, 1992 to 1996
Figure 2b: Large Retail Broker, 1998 to 1999
Figure 3: Equally-Weighted Cumulative Market-Adjusted Returns for Stocks Purchased that had NOT been sold in the Previous 12 Months