The Courage of Misguided Convictions: The Trading Behavior of Individual Investors

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Modern financial economics assumes that we behave with extreme rationality; but, we do not. Furthermore, our deviations from rationality are often systematic. Behavioral finance relaxes the traditional assumptions of financial economics by incorporating these observable, systematic, and very human departures from rationality into standard models of financial markets. This paper highlights two common mistakes investors make; they tend to disproportionately hold onto their losing investments while selling their winners and they trade excessively. We argue that these systematic biases have their origins in human psychology. The human desire to avoid regret causes investors to sell their winners, while holding their losers; the tendency for human beings to be overconfident prompts them to trade excessively.

There is one important caveat to the notion that we live in a new economy, and that is human psychology… which appears essentially immutable.

Alan Greenspan

September 4, 1998

People do not always behave rationally. While departures from rationality are sometimes random, often they are systematic. For example, far more people overestimate, rather than underestimate, their driving ability (Svenson (1981)). Behavioral models of financial markets consider not only how people should act, but how they do act. Consideration for the observed traits of economic agents is not entirely new. In 1738, Daniel Bernoulli noted that people behave as if they are risk-averse. Prior to Bernoulli most scholars considered it normative behavior to value a gamble at its expected value. Today economists usually assume people are risk-averse. Nineteenth century economists believed that, ideally, the present and the future should be treated equally; yet they observed that generally people value present consumption more highly than future (Loewenstein (1992)). Today, economists usually assume that people discount the utility of future consumption. In reality people are not always risk-averse nor do they always discount the future. Millions of people engage in regular risk-seeking activity, such as buying lottery tickets; others "bite the bullet" to get unpleasant experiences, which they might otherwise delay, over with. However, risk-aversion and discounting future consumption are sufficiently pervasive behaviors that they are standard assumptions in economic models.

In recent years psychologists have identified ways in which people systematically depart from optimal judgment and decision making. Behavioral finance enriches our economic understanding by incorporating what we know about human nature into financial models. Doing so is consistent with economic tradition, if not practice in financial economics over the last several decades. Behavioral theories, like traditional theories, provide formal hypotheses and predictions, which can be empirically tested.

This paper describes empirical tests of the predictions of two behavioral finance

theories. Shefrin and Statman (1985) extend the prospect theory of Kahneman and Tversky (1979) to predict that investors will tend to hold their losing investments too long and to sell their winners too soon; they label this tendency the disposition effect. Odean (1998b) predicts that, due to their overconfidence, investors will trade too frequently, thus reducing their returns. Many of the results presented here were first reported in Odean (1998a), Odean (1999), and Barber and Odean (1999a, 1999b).

The next section describes the primary data for the tests reported in Sections 2 and 3. These data where first obtained for the purpose of testing the disposition effect. Section 2 reports the tests of the disposition effect. Section 3 reports tests of overconfidence and excessive trading. In Section 4, we discuss more generally the motivations for the buying and selling decisions of individual investors. We make concluding remarks in Section 5.

I. The Data

A national discount brokerage house provided the data for the studies we summarize. The primary dataset that we discuss is 10,000 randomly selected accounts that were active in 1987 (those with at least one transaction). The data include trading and position records for these accounts from January 1987 through December 1993. 162,948 trades are reported. Each record includes an account identifier, a buy-sell indicator, the number of shares traded, the commission paid, and the principal amount.

Price and returns data are from the 1993 Center for Research in Security Prices daily stock file for NYSE, AMEX, and Nasdaq stocks. The tests are limited to stocks for which this information is available. Of the 10,000 accounts, 6,380 make 97,483 common stock trades: 49,948 purchases and 47,535 sales. 62,516,332 shares are traded: 31,495,296 shares, with a market value of $530,719,264, are purchased and 31,021,036 shares, with a market value of $579,871,104 are sold. Average monthly turnover is 6.5 percent.[1] The average size decile of a purchase is 8.65 and of a sale is 8.68, 10 being the decile of the companies with the largest capitalization.

[1] Turnover is estimated as one half the average monthly equity value of all trades (purchases and sales) divided by the average equity value of all monthly position statements.

II. The Disposition Effect

The disposition effect is one implication of extending Kahneman and Tversky's (1979) prospect theory to investments. Under prospect theory, when faced with choices involving simple two and three outcome lotteries, people behave as if maximizing an "S"-shaped value function (see Figure 1). This value function is similar to a standard utility function except that it is defined on gains and losses rather than on levels of wealth. The function is concave in the domain of gains and convex in the domain of losses. It is also steeper for losses than for gains, which implies that people are generally risk-averse. Critical to this value function is the reference point from which gains and losses are measured. Usually the status quo is taken as the reference point; however, "there are situations in which gains and losses are coded relative to an expectation or aspiration level that differs from the status quo.... A person who has not made peace with his losses is likely to accept gambles that would be unacceptable to him otherwise" (Kahneman and Tversky (1979)).

For example, suppose an investor purchases a stock that she believes to have an expected return high enough to justify its risk. If the stock appreciates and the investor continues to use the purchase price as a reference point, the stock price will then be in a more concave, more risk-averse, part of the investor's value function. It may be that the stock's expected return continues to justify its risk. However, if the investor somewhat lowers her expectation of the stock's return, she will be likely to sell the stock. What if, instead of appreciating, the stock declines? Then its price is in the convex, risk-seeking, part of the value function. Here the investor will continue to hold the stock even if its expected return falls lower than would have been necessary for her to justify its original purchase. Thus the investor's belief about expected return must fall further to motivate the sale of a stock that has already declined than one that has appreciated. Similarly, consider an investor who holds two stocks. One is up; the other is down. If she is faced with a liquidity demand, and has no new information about either stock, she is more likely to sell the stock that is up.

Throughout this study, investors' reference points are assumed to be their

purchase prices. Though the results presented here appear to vindicate that choice, it is likely that for some investments, particularly those held for a long time over a wide range of prices, the purchase price may be only one determinant of the reference point. The price path may also affect the level of the reference point. For example, a homeowner who bought her home for $100,000 just before a real-estate boom and had the home appraised for $200,000 after the boom, may no longer feel she is "breaking even" if she sells her home for $100,000 plus commissions. If purchase price is a major component, though not the sole component, of reference point, it may serve as a noisy proxy for the true reference point. Using the proxy in place of the true reference point will make a case for the disposition effect more difficult to prove. It seems likely that if the true reference point were available the evidence reported here would be even stronger.

A. Taxes

Investors' reluctance to realize losses is at odds with optimal tax-loss selling for taxable investments. For tax purposes investors should postpone taxable gains by continuing to hold their profitable investments. They should capture tax losses by selling their losing investments, though not necessarily at a constant rate. Constantinides (1984) shows that when there are transactions costs, and no distinction is made between the short-term and long-term tax rates (as is approximately the case from 1987 to 1993 for U.S. federal taxes[2]), investors should gradually increase their tax-loss selling from January to December. Dyl (1977), Lakonishok and Smidt (1986), and Badrinath and Lewellen (1991) report evidence that investors do sell more losing investments near the end of the year.

Shefrin and Statman (1985) propose that investors choose to sell their losers in December as a self-control measure. They reason that investors are reluctant to sell for a loss but recognize the tax benefits of doing so. The end of the year is the deadline for

[2] Prior to 1987 long-term capital gains tax rates were 40 percent of the short-term capital gains tax rates; from 1987 to 1993 long-term and short-term gains were taxed at the same marginal rates for lower income taxpayers. The maximum short-term rate at times exceeded the maximum long-term rate. In 1987 the maximum short-term rate was 38.5 percent and the maximum long-term rate was 28 percent. From 1988 to 1990 the highest income taxpayers paid a marginal rate of 28 percent on both long-term and short-term gains. In 1991 and 1992 the maximum long-term and short term-rates were 28 percent and 31 percent. In 1993 the maximum long-term and short-term rates were 28 percent and 39.6 percent.

realizing these losses. So each year, investors postpone realizing losses until December when they require themselves to sell losers before the deadline passes.

B. Methodology

To determine whether investors sell winners more readily than losers, it is not sufficient to look at the number of securities sold for gains versus the number sold for losses. Suppose investors are indifferent to selling winners or losers. Then in an upward-moving market they will have more winners in their portfolios and will tend to sell more winners than losers even though they had no preference for doing so. To test whether investors are disposed to selling winners and holding losers, we must look at the frequency with which they sell winners and losers relative to their opportunities to sell each.

By going through each account's trading records in chronological order, a portfolio of securities is constructed for which the purchase date and price are known. Clearly this portfolio represents only part of each investor's total portfolio. In most accounts there will be securities that were purchased before January 1987 for which the purchase price is not available, and investors may also have other accounts that are not part of the data set. Though the portfolios constructed from the data set are only part of each investor's total portfolio, it is unlikely that the selection process will bias these partial portfolios toward stocks for which investors have unusual preferences for realizing gains or losses.

Each day that a sale takes place in a portfolio of two or more stocks, the selling price for each stock sold is compared to its average purchase price to determine whether that stock is sold for a gain or a loss. Each stock that is in that portfolio at the beginning of that day, but is not sold, is considered to be a paper (unrealized) gain or loss (or neither). Whether it is a paper gain or loss is determined by comparing its high and low price for that day (as obtained from CRSP) to its average purchase price. If both its daily high and low are above its average purchase price it is counted as a paper gain; if they are both below its average purchase price it is counted as a paper loss; if its average purchase price lies between the high and the low, neither a gain nor loss is counted. On days when

no sales take place in an account, no gains or losses, realized or paper, are counted.

In Table I we consider two investors: Randy and Naomi. Randy has five stocks in his portfolio: A, B, C, D, and E. A and B are worth more than he paid for them; C, D, and E are worth less. Another investor, Naomi, has three stocks in her portfolio: F, G, and H. F and G are worth more than she paid for them; H is worth less. On Monday, Randy sells shares of A and of C. Wednesday, Naomi sells shares of F. Randy's sale of A and Naomi's sale of F are counted as realized gains. Randy's sale of C is a realized loss. Since B and G could have been sold for a profit but weren't, they are counted as paper gains. D, E, and G are paper losses. So, for these two investors over these two days, two realized gains, one realized loss, two paper gains, and three paper losses are counted. Realized gains, paper gains, realized losses, and paper losses are summed for each account and across accounts. Then two ratios are calculated:

$$\text{Proportion of Gains Realized (PGR)} = \frac{\text{Realized Gains}}{\text{Realized Gains} + \text{Paper Gains}}$$

$$\text{Proportion of Losses Realized (PLR)} = \frac{\text{Realized Losses}}{\text{Realized Losses} + \text{Paper Losses}}$$

In the example of Randy and Naomi, $PGR = 1/2$ and $PLR = 1/4$. A large difference in the proportion of gains realized (*PGR*) and the proportion of losses realized (*PLR*) indicates that investors are more willing to realize either gains or losses.

Any test of the disposition effect is a joint test of the hypothesis that people sell gains more readily than losses and of the specification of the reference point from which gains and losses are determined. Some possible choices of a reference point for stocks are the average purchase price, the highest purchase price, the first purchase price, or the most recent purchase price. The findings of this study are essentially the same for each choice; results are reported for average purchase price. Commissions and dividends may or may not be considered when determining reference points, and profits and losses. Although investors may not consider commissions when they remember what they paid for a stock, commissions do affect capital gains and losses. And because the normative

standard to which the disposition effect is being contrasted is optimal tax-motivated selling, commissions are added to the purchase price and deducted from the sales price in this study except where otherwise noted. Dividends are not included when determining which sales are profitable because they do not affect capital gains and losses for tax purposes. The primary finding of these tests, that investors are reluctant to sell their losers and prefer to sell winners, is unaffected by the inclusion or exclusion of commissions or dividends. In determining whether the stocks that are not sold on a particular day could have been sold for a gain or a loss, the commission for the potential sale is assumed to be the average commission per share paid when the stock was purchased.[3] All gains and losses are calculated after adjusting for splits.

C. Results

Figure 2 reports PGR and PLR for the entire year, for January through November, and for December. We see that for the entire year investors do sell a higher proportion of their winners than of their losers.

Suppose investors frequently realize small gains and less frequently take large losses. It is then possible that they are selling similar proportions of the values of their gains and losses, though realizing gains at a higher rate on a trade-counted basis. This is, however, not the case. The average PGR and PLR per account can be calculated by measuring losses, gains, potential losses, and potential gains in terms of dollars rather than shares or trades. The dollar-based PGR (averaged across accounts) is 0.58 and the average dollar-based PLR (averaged across accounts) is 0.42.[4]

In Figure 2 the ratio of PGR to PLR for the entire year is a little over 1.5, indicating that a stock that is up in value is over 50 percent more likely to be sold from day to day than a stock that is down. In Weber and Camerer's (1995) experimental studies of the disposition effect, a stock that is up is also about 50 percent more likely to be sold

[3] If, for potential sales, the commission is instead assumed to be the same percentage of principal as paid when the stock was purchased, the results do not significantly change.

[4] It should be noted that the PGR and the PLR measures are dependent on the average size of the portfolios from which they are calculated. When the portfolio sizes are small and when average account proportions, rather than aggregate sample proportions are calculated, both of these proportions tend to be larger.

than one that is down. Figure 3 charts the ratio of PGR to PLR for each month. This ratio declines from 2.1 in January to 0.85 in December. This decline is consistent with Constantinides' tax-loss selling model and suggests that at least some investors pay attention to tax-motivated selling throughout the year. From January through November, however, the observed ratio of PGR to PLR is reliably greater than 1.[5]

It is worth emphasizing that the results described here hold up to a classic principle of scientific inquiry; they are robust to out-of-sample testing. Specifically, subsequent to Odean (1998a), we obtained trading records for 78,000 households from 1991 to 1996 from the same discount brokerage house. (These data are described in more detail in Section IV.D.) For this new dataset, the PGR measure is 0.1442 and the PLR measure is 0.0863. During this sample period, stocks that had increased in value were approximately 65 percent more likely to be sold than stocks that had declined in value.

D. Alternative Reasons to Hold Losers and Sell Winners

Previous research[6] offers some support for the hypothesis that investors sell winners more readily than losers, but this research is generally unable to distinguish among various motivations investors might have for doing so. Recent studies have found

[5] In the reported PLR and PGR calculations, realized and unrealized losses are tabulated on days that sales took place in portfolios of two or more stocks. One objection to this formulation is that for portfolios that hold only winners or only losers an investor cannot choose whether to sell a winner or to sell a loser, but only which winner or loser to sell. Another objection is that if an investor has net capital losses of more than $3,000 for the current year (in non-tax-deferred accounts) if may be normative for that investor to choose to sell a winner rather than a loser. The analyses reported in the tables were repeated subject to the additional constraints that there be at least one winner and one loser in a portfolio on the day of a sale for that day to be counted and that the net realized capital losses for the year to date in the portfolio be less than $3,000. When these constraints are imposed, the difference in PGR and PLR is, for each analysis, greater. For example, for the entire sample and the entire year (as in Figure 2) there are 10,111 realized gains, 71,817 paper gains, 5,977 realized losses, and 94,419 paper losses. Thus the PLR is 0.060; the PGR is 0.123; their difference is 0.063; and the t-statistic for the difference in proportions is 47.

[6] Starr-McCluer (1995) finds that 15 percent of the stock-owning households interviewed in the 1989 and 1992 Surveys of Consumer Finances have paper losses of 20 percent or more. She estimates that in the majority of cases the tax advantages of realizing these losses would more than offset the trading costs and time costs of doing so. Heisler (1994) documents loss aversion in a small sample of futures speculators. In a study of individual federal tax returns, Poterba (1987) finds that although many investors do offset their capital gains with losses, more than 60 percent of the investors with gains or losses realized only gains. Weber and Camerer (1995) report experimental evidence of the disposition effect. Lakonishok and Smidt (1986) and Ferris, Haugen, and Makhija (1988) find a positive correlation between price change and volume. Bremer and Kato (1996) find the same correlation for Japanese stocks. Such a correlation could be caused by investors who prefer to sell winners and hold losers, but it could also be the result of buyers' trading preferences.

evidence of the disposition effect in the exercise of company stock options (Heath, Huddart, and Lang (1999)), residential housing (Genesove and Mayer (1999)), professional futures traders (Locke and Mann (1999)), and Finnish investors (Grinblatt and Keloharju (1999)). We believe the disposition effect best explains the tendency for investors to hold losers and sell winners. In this section, we present evidence that allow us to discount competing explanations for this investor behavior.

D.1. Anticipation of Changes in Tax Law

One reason investors might choose to sell winners rather than losers is that they anticipate a change in the tax law under which capital gains rates will rise. The tax law of 1986 made such a change. If investors sold off winners in anticipation of higher tax rates, they might have entered 1987 with a larger percentage of losers in their portfolio than usual. Because such stocks are purchased prior to 1987 they would not show up in the portfolios reconstructed here. It is possible therefore that the rate at which winners are being realized relative to losers is lower in the investors' total portfolio than in the partial reconstructed portfolios. As old stocks are sold and new ones purchased the partial portfolios become more and more representative of the total portfolio. We would expect that if a sell-off of winners in anticipation of the 1986 tax law affects the observed rate at which gains and losses are realized in the partial portfolios, that effect would be greater in the first part of the sample period than in the last part. However the ratio PGR/PLR is virtually the same for the periods 1987 to 1990 and 1991 to 1993.

D.2. Desire to Rebalance

Lakonishok and Smidt (1986) suggest that investors might sell winners and hold on to losers in an effort to rebalance their portfolios. Investors who sell winners for the purpose of rebalancing their portfolios are likely to make new purchases. To eliminate trades that may be motivated by a desire to rebalance, PGR and PLR are calculated using only sales and dates for which there is no new purchase into a portfolio on the sale date or during the following three weeks. When sales motivated by a desire to rebalance are eliminated in this way, investors continue to prefer to sell winners. Once again, investors realize losses at a higher rate than gains in December.

D.3. Belief that One's Losers Will Bounce Back

Another reason investors might sell winners and hold losers is that they expect their losers to outperform their winners in the future. An investor who buys a stock because of favorable information may sell that stock when it goes up because she believes her information is now reflected in the price. On the other hand, if the stock goes down she may continue to hold it, believing that the market has not yet come to appreciate her information. Investors could also choose to sell winners and hold losers simply because they believe prices mean revert. It is possible to test whether such beliefs are justified, ex post.

To test whether losing stocks investors continue to hold outperform winners that they sell, Odean (1998a) calculates market-adjusted returns for losing stocks held and winning stocks sold subsequent to each sales date. For winners that were sold, he calculates market-adjusted returns (the average return in excess of the CRSP value weighted index) starting the day after the transaction for the next 84 trading days (four months), 252 trading days (one year), and 504 trading days (two years). For the same horizons, he calculates market-adjusted returns subsequent to paper losses. That is, for stocks held for a loss in portfolios on which sales did take place, market-adjusted returns are calculated starting the day after the sale for the next 84, 252, and 504 trading days. For winners that are sold, the average excess return over the following year is a highly statistically significant 3.4 percent more than it is for losers that are not sold.[7] (Winners sold subsequently outperform paper losses by 1.03 percent over the following four months and 3.58 percent of the following two years.) Investors who sell winners and hold losers because they expect the losers to outperform the winners in the future are, on average, mistaken. The superior returns to former winners noted here are consistent with Jegadeesh and Titman's (1993) finding of price momentum in security returns at horizons of up to eighteen months.[8]

[7] Here and in Section 3, statistical significance is determined using a bootstrapping technique similar to those discussed in Brock, Lakonishok, and LeBaron (1992), Ikenberry, Lakonishok, and Vermaelen (1995), and Lyon, Barber, and Tsai(1999). This procedure described in greater detail in Odean (1998a) and Odean (1999).

[8] At the time of this study CRSP data were available through 1994. For this reason two-year subsequent returns are not calculated for sales dates in 1993.

D.4. Attempt to Limit Transaction Costs

Harris (1988) suggests that investors' reticence to sell losers may be due to their sensitivity to higher trading costs at lower stock prices. To contrast the hypothesis that losses are realized more slowly due to the higher transactions costs with the disposition effect, we can look at the rates at which investors purchase additional shares of stocks they already own. If investors are avoiding the sale of losing investments because of the higher transaction costs associated with selling low price stocks, we would also expect them to avoid purchasing additional shares of these losing investments. In fact, this is not the case; investors are more inclined to purchase additional shares of their losing investments than additional shares of their winning investments. In this sample, investors are almost one and one half times as likely to purchase additional shares of any losing position they already hold than any winning position.

D.5. Belief that All Stocks Mean Revert

The results presented so far are not able to distinguish prospect theory and the mistaken belief that losers will bounce back to outperform current winners. Both prospect theory and a belief in mean reversion predict that investors will hold their losers too long and sell their winners too soon. Both predict that investors will purchase more additional shares of losers than of winners. However a belief in mean reversion should apply to stocks that an investor does not already own as well as those she does, but prospect theory applies only to the stocks one owns. Thus a belief in mean reversion implies that investors will tend to buy stocks that had previously declined even if they don't already own these stocks, while prospect theory makes no prediction in this case. Odean (1999) finds that this same group of investors tends to buy stocks that have, on average, outperformed the CRSP value-weighted index by about 25 percent over the previous two years. This would appear inconsistent with a pervasive belief in mean reversion.

III. Overconfidence and Excessive Trading

It is difficult to reconcile the volume of trading observed in equity markets with the trading needs of rational investors. Rational investors make periodic contributions and withdrawals from their investment portfolios, rebalance their portfolios, and trade to minimize their taxes. Those possessed of superior information may trade speculatively, though rational speculative traders will generally not choose to trade with each other. It is

unlikely that rational trading needs account for a turnover rate of 76 percent on the New York Stock Exchange in 1998.

We believe there is a simple and powerful explanation for high levels of trading on financial markets: overconfidence. Human beings are overconfident about their abilities, their knowledge, and their future prospects. Odean (1998) shows that overconfident investors trade more than rational investors and that doing so lowers their expected utilities. Greater overconfidence leads to greater trading and to lower expected utility.

Overconfidence increases trading activity because it causes investors to be too certain about their own opinions and to not consider sufficiently the opinions of others. This increases the heterogeneity of investors beliefs -- the source of most trading. Overconfident investors also perceive their actions to be less risky than generally proves to be the case.

The study reported in this section tests whether a particular class of investors, those with accounts at discount brokerages, trade excessively in the sense that their trading profits are insufficient to cover their trading costs. The surprising finding is that, not only do the securities that these investors buy not outperform the securities they sell by enough to cover trading costs, but on average the securities they buy underperform those they sell. This is the case even when trading is not apparently motivated by liquidity demands, tax-loss selling, portfolio rebalancing, or a move to lower-risk securities. While investors' overconfidence in the precision of their information may contribute to this finding, it is not sufficient to explain it. These investors must be systematically misinterpreting information available to them. They do not simply misconstrue the precision of their information, but its very meaning.

A. Overconfidence

Studies of the calibration of subjective probabilities find that people tend to overestimate the precision of their knowledge (Alpert and Raiffa (1982), Fischhoff, Slovic and Lichtenstein (1977); see Lichtenstein, Fischhoff, and Phillips (1982) for a

review of the calibration literature). Such overconfidence has been observed in many professional fields. Clinical psychologists (Oskamp (1965)), physicians and nurses, (Christensen-Szalanski and Bushyhead (1981), Baumann, Deber, and Thompson (1991)), investment bankers (Staël von Holstein (1972)), engineers (Kidd (1970)), entrepreneurs (Cooper, Woo, and Dunkelberg (1988)), lawyers (Wagenaar and Keren (1986)), negotiators (Neale and Bazerman (1990)), and managers (Russo and Schoemaker (1992)) have all been observed to exhibit overconfidence in their judgments. (For further discussion, see Lichtenstein, Fischhoff, and Phillips (1982) and Yates (1990).)

Miscalibration is only one manifestation of overconfidence. Researchers also find that people overestimate their ability to do well on tasks and these overestimates increase with the personal importance of the task (Frank (1935)). People are also unrealistically optimistic about future events. They expect good things to happen to them more often than to their peers (Weinstein (1980); Kunda (1987)). They are even unrealistically optimistic about pure chance events (Marks (1951), Irwin (1953), Langer and Roth (1975)).

People have unrealistically positive self-evaluations (Greenwald (1980)). Most individuals see themselves as better than the average person and most individuals see themselves better than others see them (Taylor and Brown (1988)). They rate their abilities and their prospects higher than those of their peers. For example, when a sample of U.S. students -- average age 22 -- assessed their own driving safety, 82 percent judged themselves to be in the top 30 percent of the group (Svenson (1981)). And 81 percent of 2994 new business owners thought their business had a 70 percent or better chance of succeeding but only 39 percent thought that any business like theirs would be this likely to succeed (Cooper, Woo, and Dunkelberg (1988)). People overestimate their own contributions to past positive outcomes, recalling information related to their successes more easily than that related to their failures. Fischhoff (1982) writes that "they even misremember their own predictions so as to exaggerate in hindsight what they knew in foresight." And when people expect a certain outcome and the outcome then occurs, they often overestimate the degree to which they were instrumental in bringing it about (Miller

and Ross (1975)). Taylor and Brown (1988) argue that exaggerated beliefs in one's abilities and unrealistic optimism may lead to "higher motivation, greater persistence, more effective performance, and ultimately, greater success." These beliefs can also lead to biased judgments.

B. Overconfidence in Financial Markets

In a market with transaction costs we would expect rational informed traders who trade for the purpose of increasing returns to increase returns, on average, by at least enough to cover transaction costs. That is, over the appropriate horizon, the securities these traders buy will outperform the ones they sell by at least enough to pay the costs of trading. If speculative traders are informed, but overestimate the precision of their information (one form of overconfidence), the securities they buy will, on average, outperform those they sell, but possibly not by enough to cover trading costs. If these traders believe they have information, but actually have none, the securities they buy will, on average, perform about the same as those they sell before factoring in trading costs. Overconfidence in only the precision of unbiased information will not, in and of itself, cause expected trading losses beyond the loss of transactions costs.

If in addition to being overconfident about the precision of their information, investors are overconfident about their ability to interpret information, they may incur average trading losses beyond transactions costs. Suppose investors receive useful information but are systematically biased in their interpretation of that information; that is, the investors hold mistaken beliefs about the mean, instead of (or in addition to) the precision of the distribution of their information. If they unwittingly misinterpret information, they may choose to buy or sell securities which they would not have otherwise bought or sold. They may even buy securities that, on average and before transaction costs, underperform the ones they sell.

C. Methodology

To test for overconfidence in the precision of information, it is determined whether the securities investors in this dataset buy outperform those they sell by enough to cover the costs of trading. To test for biased interpretation of information, it is

determined whether the securities they buy underperform those they sell when trading costs are ignored. Return horizons of four months (84 trading days), one year (252 trading days), and two years (504 trading days) following each transaction are examined.[9] Returns are calculated from the CRSP daily return files.

To calculate the average return to securities bought (sold) in these accounts over the *T* (*T=84*, *252*, or *504*) trading days subsequent to the purchase (sale), each purchase (sale) transaction is indexed with a subscript *i*, *i=1* to *N*. Each transaction consists of a security, j_i, and a date, t_i. If the same security is bought (sold) in different accounts on the same day, each purchase (sale) is treated as a separate transaction. Market-adjusted returns are calculated as the security return less the return on the CRSP value-weighted index. The market-adjusted return for the securities bought over the *T* trading days subsequent to the purchase is:

$$R_{P,T} = \frac{1}{N}\sum_{i=1}^{N}\left(\prod_{t=1}^{T}\left(1+R_{j_i,t_i+t}\right)-\prod_{t=1}^{T}\left(1+R_{VW,t_i+t}\right)\right)$$

Where $R_{j,t}$ is the CRSP daily return for security *j* on date *t* and $R_{VW,t}$ is the daily return for the CRSP value-weighted index on date *t*. Note that return calculations begin the day after a purchase or a sale so as to avoid incorporating the bid-ask spread into returns.

In this dataset, the (equally weighted) average commission paid when a security is purchased is 2.23 percent of the purchase price. The average commission on a sale is 2.76 percent of the sale price.[10] Thus if one security is sold and the sale proceeds are used to buy another security the total commissions for the sale and purchase average about 5 percent. The average effective bid-ask spread is 0.94 percent.[11] Thus the average total cost of a round-trip trade is about 5.9 percent. An investor who sells securities and buys others because he expects the securities he is buying to outperform the ones he is selling,

[9] Investment horizons will vary among investors and investments. Benartzi and Thaler (1995) estimate the average investor's investment horizon to be one year, and, during this period, NYSE securities turned over about once every two years. At the time of this analysis CRSP data was available through 1994. For this reason two year subsequent returns are not calculated for transactions dates in 1993.

[10] Weighting each trade by its equity value, rather than equally, the average commission for a purchase (sale) is 0.9 (0.8) percent.

will have to realize, on average and weighting trades equally, a return nearly 6 percent higher on the security he buys just to cover trading costs.

The first hypothesis tested here is that, over horizons of four months, one year, and two years, the average returns to securities bought minus the average returns to securities sold are less than the average round-trip trading costs of 5.9 percent. This is what we expect if investors are sufficiently overconfident about the precision of their information. The null hypothesis (N1) is that this difference in returns is greater than or equal to 5.9 percent. The null is consistent with rationality. The second hypothesis is that over these same horizons the average returns to securities bought are less than those to securities sold, ignoring trading costs. This hypothesis implies that investors must actually misinterpret useful information. The null hypothesis (N2) is that average returns to securities bought are greater than or equal to those sold.

D. Results

Table II, Panel A reports results for all purchases and all sales of stocks in the database. For all three follow-up periods the average subsequent market-adjusted returns to stocks which were bought is less than that to stocks which were sold. Figure 4 provides a graph of the difference between the market-adjusted returns to stocks that were bought and the market-adjusted returns to stocks that were sold. Regardless of the horizon, the stocks that investors bought underperformed the stocks that they sold. (This is also true when actual returns are calculated instead of market-adjusted returns). Not only do the investors pay transactions costs to switch stocks, but the stocks they buy underperform the ones they sell. For example, for the entire sample over a one year horizon the average market-adjusted return on a purchased stock is 3.2 percent lower than the average market-adjusted return on a stock sold.

The null hypothesis that the expected returns to stocks purchased are 5.9 percent (the average cost of a round trip trade) or more greater than the expected returns to stocks sold is comfortably rejected ($p < 0.001$). The second null hypothesis, that the expected

[11] Barber and Odean (1999a) estimate the bid-ask spread of 1.00 percent for individual investors from 1991 to 1996. Carhart (1997) estimates trading costs of 0.21 per cent for purchases and 0.63 per cent for sales

returns to stocks purchased are greater than or equal to those of stocks sold (ignoring transactions costs), is also comfortably rejected (*p-values* less then 0.002 depending on the horizon).

These investors are not making profitable trades. Of course investors trade for reasons other than to increase profit. They trade to meet liquidity demands. They trade to move to more, or to less, risky investments. They trade to realize tax-losses. And they trade to rebalance; for example if one stock in her portfolio appreciates considerably, an investor may sell part of her holding in that stock and buy others to rebalance her portfolio. Panel B examines trades for which these alternative motivations to trades have been largely eliminated. This panel examines only sales and purchases where a purchase was made within three weeks of a sale; such transactions are unlikely to be liquidity motivated since investors who need cash for three weeks or less can borrow more cheaply (e.g. using credit cards) than the cost of selling and later buying stocks. All of the sales in this panel were for a profit; so these stocks were not sold in order to realize tax-losses (and they were not short sales). These sales were of an investor's complete holding in the stock sold; so most of these sales were not motivated by a desire to rebalance the holdings of an appreciated stock. Also this panel examines only sales and purchases where the purchased stock is from the same size decile as the stock sold or it is from a smaller size decile (CRSP size deciles for the year of the transaction); since size has been shown to be highly correlated with risk, this restriction is intended to eliminate most instances where an investor intentionally buys a stock of lower expected return than the one he sells because he is hoping to reduce his risk.

We see in Panel B that when all of these alternative motivations for trading are eliminated, investors actually perform worse over all three evaluation periods; over a one year horizon the stocks these investors sell underperform those they buy by about 5 percent. Sample size is, however, greatly reduced and statistical significance slightly lower. Nonetheless, both null hypotheses can still be comfortably rejected.

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made by open-end mutual funds from 1966 to 1993.

As was the case for the tests of the disposition effect, we have been able to replicate these results out-of-sample. Subsequent to Odean (1999), we obtained trading records for 78,000 households from 1991 to 1996 from the same discount brokerage house. (These data are described in more detail in Section IV.E.) On average, the 1,082,106 stocks that these households buy reliably underperform ($p<0.001$) the 887,638 they sell by 2.35 percent over the 252 trading days subsequent to each transaction.

Overconfidence alone cannot explain these results. These investors appear to have some ability to distinguish stocks that will subsequently perform better and worse. Unfortunately, somehow they get the relationship wrong. In part, this may lie in the differences in how they choose which stocks to buy and which to sell.

E. Additional Tests of Overconfidence

E.1. Turnover and Performance

Odean (1998b) predicts that the more overconfident investors are the more they will trade and the more they will thereby lower their expected utilities. If overconfidence is an important motivation for investor trading, then we would expect that, on average, those investors who trade most actively will most reduce their returns through trading. As reported in Barber and Odean (1999a), we find that this is the case.

We examine trading and position records for 78,000 households with accounts at the same discount brokerage house as supplied the data described above. The records are from January 1991 through December 1996 and include all accounts at this brokerage for each household. (See Barber and Odean (1999a) for a detailed description of these data.) Of the 78,000 sampled households, 66,465 had positions in common stocks during at least one month; the remaining accounts either held cash or investments in other than individual common stocks. Roughly 60 percent of the market value in the accounts was held in common stocks. There were over 3 million trades in all securities; common stocks accounted for slightly more than 60 percent of all trades. In December 1996, these households held more than $4.5 billion in common stock. In addition to trade and position records, for much of our sample, our dataset identifies demographic

characteristics such as age, gender, marital status, and income.

We partition the households into quintiles on the basis of the average monthly turnover of their common stock portfolios. Mean monthly turnover for these quintiles ranges from 0.19 percent (low turnover quintile) to 21.49 percent (high turnover quintile). Households that trade frequently (high turnover quintile) earn a net annualized geometric mean return of 11.4 percent, while those that trade infrequently (low turnover quintile) earn 18.5 percent. Because the households in each quintile may (and do) vary in their average risk characteristics of their portfolios, we compare the annual net return earned by each household to the annual net return that would have been earned had the household's beginning of the year portfolio been held for a year without any trading. This is a reasonable measure of the impact of trading on returns. The quintile of households that trade most infrequently underperform their "buy-and-hold" portfolios, on average, by a mere 0.25 percent annually, while the quintile of households that trade most frequently underperform their "buy-and-hold" portfolios, on average, by 7.04 percent annually.

Our finding that the more investors trade the more they reduce their expected returns is consistent with the prediction that more overconfident traders will trade more actively and earn less. However, we still haven't tested directly whether overconfidence is motivating trading. To do so, we partition our data into two groups which psychologists have shown to differ in their tendency to overconfidence: men and women.

E.2. Gender, Overconfidence and Performance

While both men and women exhibit overconfidence, men are generally more overconfident than women (Lundeberg, Fox, and Puncochar (1994)).[12] Gender differences in overconfidence are highly task dependent (Lundeberg, Fox, and Puncochar (1994)). Deaux and Ferris (1977) write "Overall, men claim more ability than do women, but this difference emerges most strongly on … masculine task[s]." Several studies confirm that differences in confidence are greatest for tasks perceived to be in the masculine domain (Deaux and Emswiller (1994), Lenney (1977), Beyer and Bowden

(1997)). Men are inclined to feel more competent than women do in financial matters (Prince (1993)). Indeed, casual observation reveals that men are disproportionately represented in the financial industry. We expect, therefore, that men will generally be more overconfident about their ability to make financial decisions than women.

Additionally, Lenney (1977) reports that gender differences in self-confidence depend on the lack of clear and unambiguous feedback. When feedback is "unequivocal and immediately available, women do not make lower ability estimates than men. However, when such feedback is absent or ambiguous, women seem to have lower opinions of their abilities and often do underestimate relative to men." The stock market does not generally provide clear unambiguous feedback. All the more reason to expect men to be more confident than women about their ability to make common stock investments.

Our prediction, then, is clear: we expect men, the more overconfident group, to trade more actively than women and, in doing so, to detract from their net return performance more. As reported in Barber and Odean (1999b), we find that this prediction holds true. Men trade 45 percent more actively than do women (76.9 percent turnover annually versus 52.8 percent). And men reduce their net annual returns through trading by 0.94 percent more than do women. (Men underperform their "buy-and-hold" portfolios by 2.652 percent annually; women underperform their "buy-and-hold" portfolios by 1.716 percent annually.) The differences in the turnover and performance of men and women are highly statistically significant and robust to the introduction of other demographic variables such as marital status, age, and income.

IV. Buying vs. Selling

Our analysis of the trading behavior of individual investors reveals that most investors treat the decision to buy a security quite differently from the decision to sell. On the one hand, consider the selling behavior of individual investors. Since most investors don't short -- less than 1 percent of the sales in the datasets are short sales -- those seeking

[12] While Lichtenstein and Fishhoff (1981) do not find gender differences in calibration of general knowledge, Lundeberg, Fox, and Puncochar (1994) argue that this is because gender differences in

a security to sell need only consider the ones they already own. This is usually a manageable handful; in both datasets the average number of securities, including bonds, mutual funds, and options as well as stocks, per account is less than 7. Investors can carefully consider selling each security they own regardless of the attention given it in the media.

Though the search for securities to sell is simple, in other respects the decision to sell a security is more complex than the decision to buy. When choosing securities to buy, an investor only needs to form expectations about the future performance of those securities. When choosing securities to sell, the investor will consider past as well as future performance. If the investor is rational he will want to balance the advantages or disadvantages of any tax losses or gains he realizes from a sale against future returns he expects a security to earn. If an investor is psychologically motivated he may wish to avoid realizing losses and prefer to sell his winners, as do the majority of the investors studied here, and this psychological motivation for sales generally dominates tax-motivated sales. Thus, ceterus paribus, securities that have appreciated in value become candidates for a sale.

On the other hand, consider the buying behavior of individual investors. Investors face a formidable challenge when looking for a security to buy. There are well over 10,000 securities to be considered. These investors do not have a retail broker available to suggest purchase prospects. While the search for potential purchases can be simplified by confining it to a subset of all securities (e.g., the S&P 500) even then, the task of evaluating and comparing each security is beyond what most non-professionals are equipped to do. Unable to evaluate each security, investors are likely to consider purchasing securities to which their attention has been drawn. Investors may think about buying securities they have recently read about in the paper or heard about on the news. Securities that have performed unusually well or poorly are more likely to be discussed in the media, more likely to be considered by individual investors, and ultimately, more likely to be purchased. Odean (1999) finds that these investors tend to buy stocks with

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calibration are strongest for topics in the masculine domain.

recent returns of greater absolute value than the stocks they sell.

Once their attention has been directed to potential purchases, investors vary in their propensity to buy previous winners or previous losers.[13] It may be that those who buy previous winners believe that securities follow trends, while those who buy previous losers believe they revert. The investors who believe in trend may buy previous winners to which their attention has been directed, while those who believe in reversion buy previous losers to which their attention has been directed. If investors were as willing to sell securities short as to buy, we might expect them to actively sell as well as to actively buy securities to which their attention was directed. But, for the most part, these investors do not sell short.

V. Conclusion

One of the major contributions of behavioral finance is that it provides insights into investor behavior where such behavior cannot be understood using traditional theories. In this paper we test two behavioral finance theories. As predicted, we find that investors tend to sell their winning stocks and to hold on to their losers and that, as a result of overconfidence, investors trade too much. These behaviors reduce investor welfare. Understanding these behaviors is therefore important for investors and for those who advise them.

But the welfare consequences of investor behavior extend beyond individual investors and their advisors. Modern financial markets depend on trading volume for their very existence. It is trading -- commissions and spreads -- that pays for the brokers and market-makers without whom these markets would not exist. Traditional models of financial markets give us very little insight into why people trade as much as they do. In some models investors hardly trade, or don't trade at all (e.g., Grossman (1976)). Other models simply stipulate a class of investors -- noise or liquidity traders -- that are required to trade (e.g., Kyle (1985)). Harris and Raviv (1993) and Varian (1989) point out that heterogeneous beliefs are needed to generate significant trading. But it is behavioral

[13] Odean (1999) rejects the hypothesis that the probability of buying previous winners (or losers) is the same for all investors in the dataset described above.

finance that gives us insights into why and when investors form heterogeneous beliefs.

Both of the behavioral theories tested in this paper offer insights into trading volume. The disposition effect says that investors will generally trade less actively when their investments have lost money. The overconfidence theory suggests that investors will trade more actively when their overconfidence is high. Psychologists find that people tend to give themselves too much credit for their own success and do not attribute enough of that success to chance or outside circumstance. Gervais and Odean (1999) show that this bias leads successful investors to become overconfident. And, in a market where most investors are successful (e.g., a long bull market), aggregate overconfidence and consequent trading rise. Statman and Thorley (1999) find that over even short horizons, such as a month, current market returns predict subsequent trading volume.

In the last two decades researchers have discovered many anomalies that apparently contradict established finance theories.[14] New theories, both behavioral (e.g., (Barberis, Shleifer, and Vishny (1997), Daniel, Hirshleifer, and Subrahmanyam (1998)) and rational (e.g., Berk (1995)) have been devised to explain anomalies in asset prices. It is not yet clear what contribution behavioral finance will make to asset pricing theory.

The investor behaviors discussed in this paper have the potential to influence asset prices. The tendency to refrain from selling losing investments may, for example, slow the rate at which negative news is impacted into price. The tendency to buy stocks with recent extreme performance could cause recent winners to overshoot. For biases to influence asset prices, investors must be sufficiently systematic in their biases and sufficiently willing to act on them.[15]

Our common psychological heritage insures that we systematically share biases. Overconfidence provides the will to act. It gives us the courage of our misguided convictions.

[14] See, for example, Thaler's (1992) collection of "Anomalies" articles originally published in the *Journal of Economic Perspectives*.
[15] Of course, there must also be limits to arbitrage (see Shleifer and Vishny (1998)).

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Table 1: Example of Calculation of Proportion of Gains Realized (PGR) and Proportion of Loses Realized (PLR)

	Randy	Naomi
Panel A: Positions		
Holdings	A, B, C, D, E	F, G, H
Winners	A, B	F, G
Losers	C, D, E	H
Panel B: Sales		
Sales on Monday	A and C	none
Sales on Wednesday	none	F
Panel C: Calculation of Gains and Losses		
Paper Gains	1 (B)	1 (G)
Paper Losses	2 (D and E)	1 (G)
Realized Gains	1 (A)	1 (F)
Realized Losses	1 (C)	0

Table 2: Average Percentage Market-Adjusted Returns Following Purchases and Sales

Average returns less the CRSP value-weighted index are calculated for the 84, 252, and 504 trading days following purchases and following sales in the dataset trades file. Using a bootstrapped empirical distribution for the difference in excess returns following buys and following sells, the null hypotheses that the mean market-adjusted return subsequent to sales is at least 5.9 percent greater than the mean market-adjusted return subsequent to sales is comfortably rejected. The average round-trip trade cost (commission and spread) is 5.9 percent for trades in the dataset. Similarly, we are able to comfortably reject the null hypothesis that the mean market-adjusted return subsequent to purchases is greater than or equal to the mean market-adjusted return subsequent to sales.

		Number of Trading Days following Transaction:		
	No. of Transactions	84 days	252 days	504 days
Panel A: All Transactions				
Purchases	49,948	-1.33%	-2.68%	-0.68%
Sales	47,535	0.12	0.54	2.89
Difference (Purchases less Sales)		-1.45	-3.22	-3.57
p-value for test of Difference ≥ 5.9%		0.001	0.001	0.001
p-value for test of Difference ≥ 0		0.001	0.001	0.002
Panel B: Restricted Sample (Purchases within three weeks of sale. Sales for profit and of total position. Size decile of purchase less than or equal to size decile of sale.)				
Purchases	7,503	-2.54%	-2.28%	-1.30%
Sales	5,331	-0.08	2.79	7.31
Difference (Purchases less Sales)		-2.46	-5.07	-8.61
p-value for test of Difference ≥ 5.9%		0.001	0.001	0.001
p-value for test of Difference ≥ 0		0.002	0.001	0.018

Figure 1: Prospect Theory Value Function

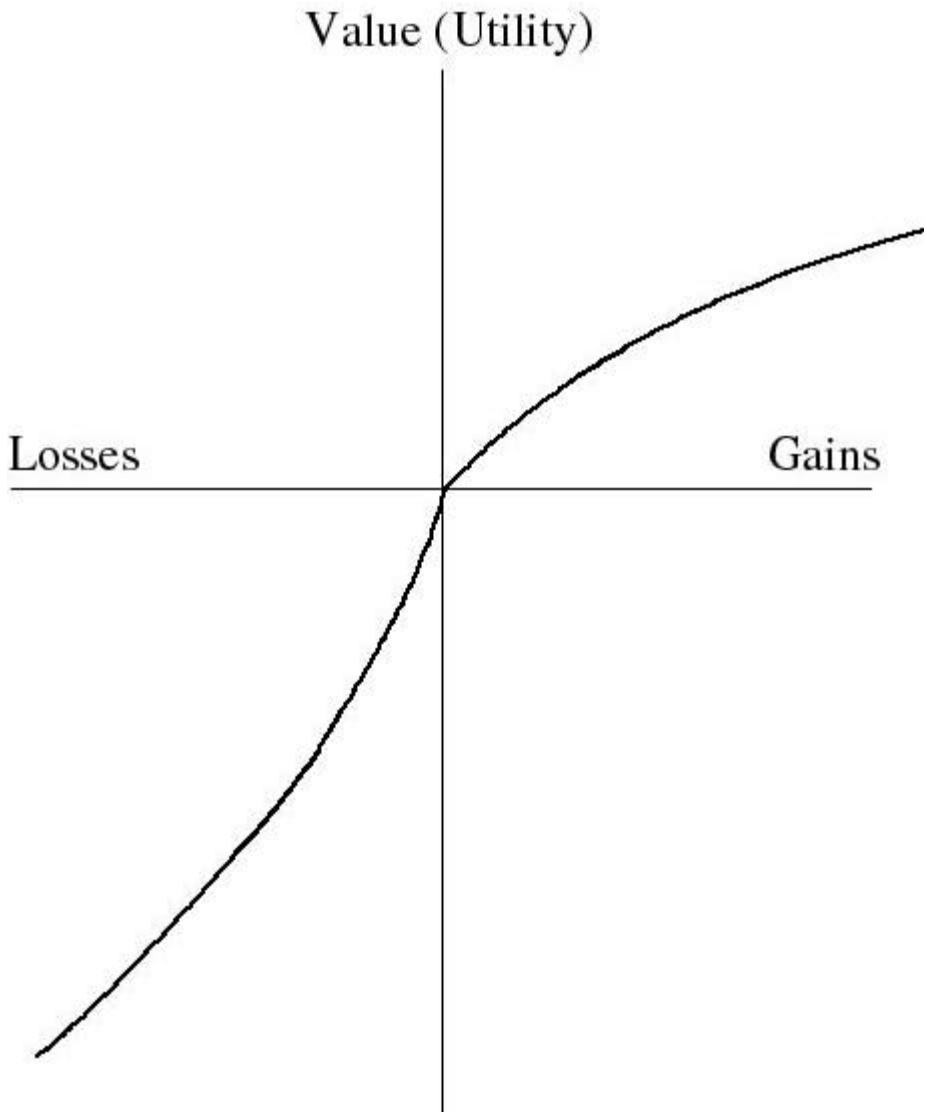

Figure 2: Proportion of Gains Realized (PGR) and Proportion of Loses Realized (PLR)

This figure compares the aggregate Proportion of Gains Realized (PGR) to the aggregate Proportion of Losses Realized (PLR), where PGR is the number of realized gains divided by the number of realized gains plus the number of paper (unrealized) gains, and PLR is the number of realized losses divided by the number of realized losses plus the number of paper (unrealized) losses. Realized gains, paper gains, losses, and paper losses are aggregated over time (1987-1993) and across all accounts in the data set. PGR and PLR are reported for the entire year, for December only, and for January through November. For the entire year there are: 13,883 realized gains, 79,658 paper gains, 11,930 realized losses, and 110,348 paper losses. For December there are: 866 realized gains, 7,131 paper gains, 1,555 realized losses, and 10,604 paper losses. The t-statistics test the null hypotheses that the differences in proportions are equal to zero assuming that all realized gains, paper gains, realized losses, and paper losses result from independent decisions.

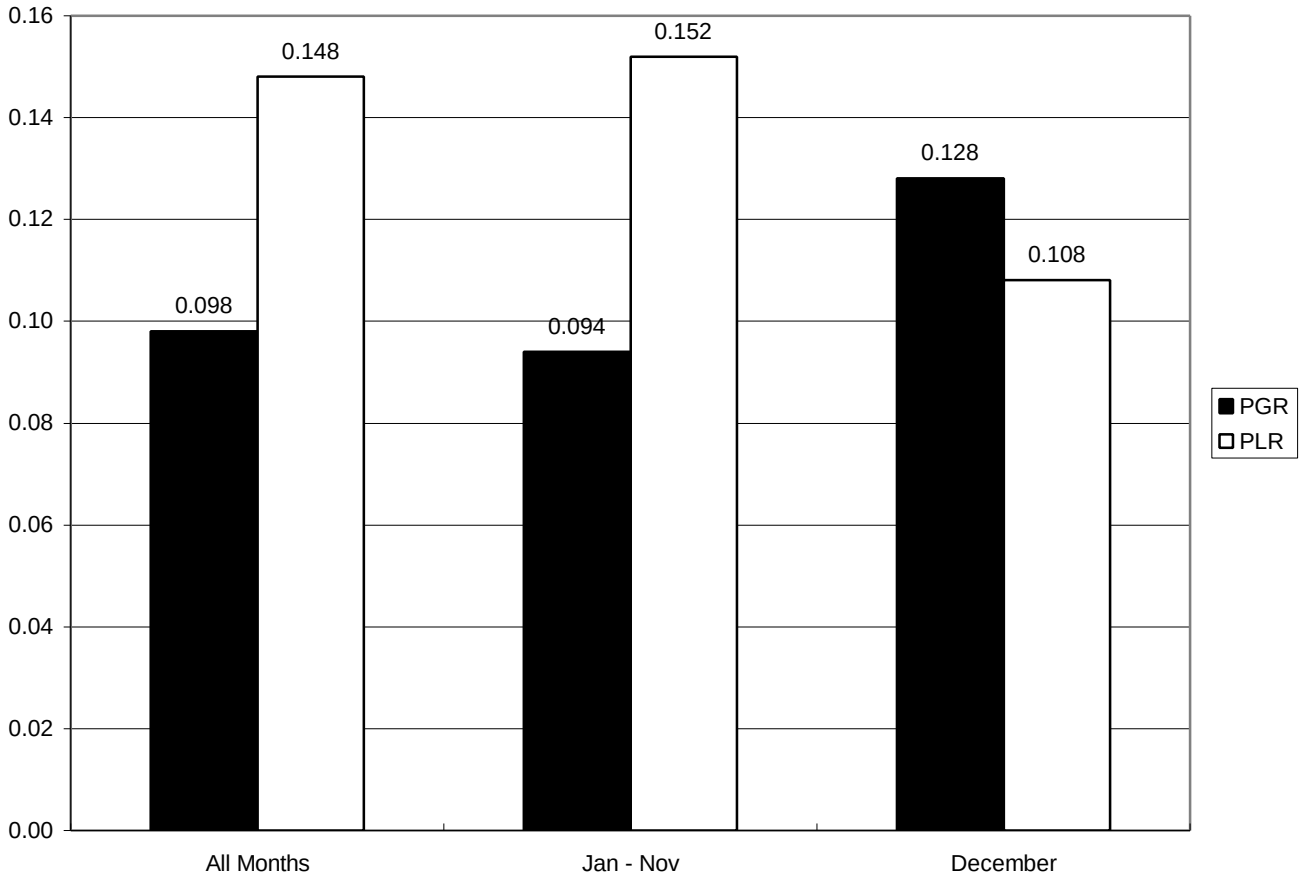

Figure 3: Ratio of Proportion of Gains Realized (PGR) to the Proportion of Losses Realized (PLR) for each Month

PGR is the number of realized gains divided by the number of realized gains plus the number of paper (unrealized) gains, and PLR is the number of realized losses plus the number of (unrealized) losses. Realized gains, paper gains, losses, and paper losses are aggregated over time (1987-1993) and across all accounts in the data set.

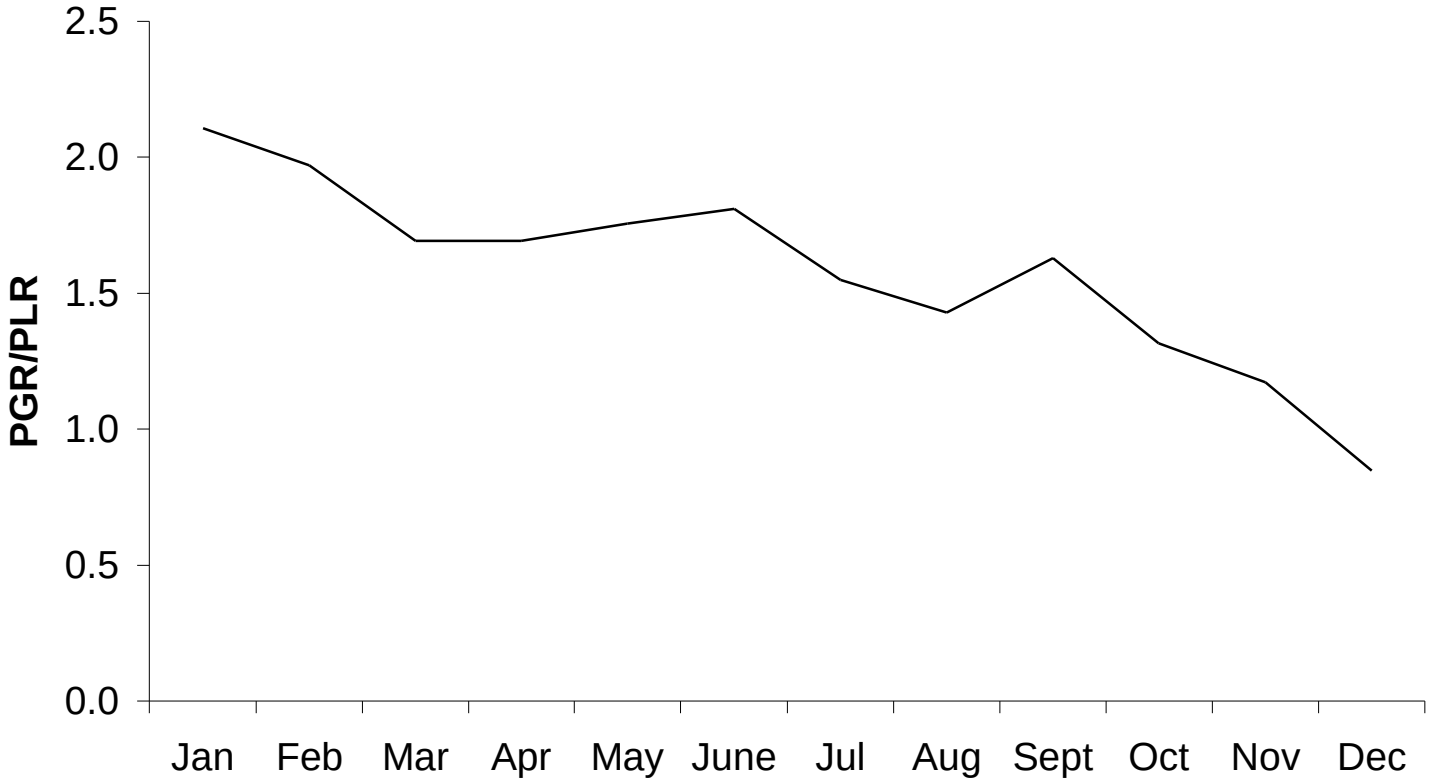

Figure 4: Market-Adjusted Returns subsequent to Buys less Market-Adjusted Returns subsequent to Sells

Market-adjusted returns are security returns less the CRSP value-weighted NYSE/ASE/Nasdaq index. Day 0 is the day of a buy or sell. The graph depicts the market-adjusted returns subsequent to buys less the market-adjusted returns subsequent to sells. There are 49,948 buys and 47,535 sells.