Rolling Mental Accounts

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Abstract: When investors sell one asset and quickly buy another ("reinvestment days"), their trades suggest the original mental account is not closed, but is instead rolled into the new asset. Investors display a rolled disposition effect, selling the new position when its value exceeds the investment in the original position. On reinvestment days, investors display no disposition effect (consistent with no disutility from realizing a loss) and make better selling decisions. Mutual funds exhibit a larger disposition effect when outflows prevent them from rolling accounts. Using a laboratory experiment, we show that reinvestment causally reduces the disposition effect and improves trading.

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How do investors evaluate their portfolio decisions over time? This question gets to the heart of whether asset pricing models have microfoundations that resemble the behavior of investors in the real world. In models such as the CAPM (Sharpe 1964) and portfolio theory (Markowitz 1952), portfolio evaluation reduces to periodic rebalancing to maintain fixed weights. While this is excellent normative advice given the assumptions of the models, it is sharply at odds with the active trading of many investors (Barber and Odean 2013), a fact which may contribute to the difficulty of such models in explaining asset returns.

Perhaps the most successful theories of how investors *actually* rebalance their portfolios rely on mental accounting (Thaler 1980, 1999). Mental accounting describes the heuristics people use to break complex financial decision-making into smaller, more manageable parts. The first key component of mental accounting is the grouping of financial decisions and outcomes into particular mental accounts. Outcomes within an account are combined and evaluated jointly, whereas outcomes in different accounts are evaluated separately. Different accounts are not fully fungible, so success in one account does not cancel out failure in another. Second, within each account, individuals keep track of gains and losses relative to a reference point, rather than tracking total wealth. The central questions in applying mental accounting involve understanding how outcomes are grouped together, and what preferences are used to evaluate gains and losses.

In the literature that examines the impact of mental accounting on trading decisions, the dominant (if often implicit) assumption made regarding the grouping of outcomes is stock-by-stock narrow framing. Under this assumption, an investor considers each stock in a separate mental account, so that he *narrowly frames* his gains and losses at the stock level.[1] When mental

[1] The narrow framing assumption of evaluating gains or losses at the stock level is discussed in Barberis and Huang (2001), Barberis and Xiong (2012), and Ingersoll and Jin (2013), although framing at the portfolio level has also been examined (Barberis and Huang 2001).

accounting is combined with preferences such as cognitive dissonance or realization utility (Chang, Solomon, and Westerfield 2015; Barberis and Xiong 2012) investors will be reluctant to sell assets that have declined in value. In this way, mental accounting is used to explain the disposition effect: the tendency for investors to be more likely to sell assets that are at a gain than assets at a loss (Shefrin and Statman 1985; Odean 1998).[2] While there is a large debate on the preferences investors use to evaluate mental accounts (e.g. Barberis and Xiong 2012; Frydman et al. 2014; Chang, Solomon and Westerfield 2015; Ingersoll and Jin 2013), there has been less focus on how investment episodes are constructed. When modeling narrow framing, it is typically assumed that buying a stock opens a mental account and selling the stock closes that account. Each stock is a separate investing episode, and the sale completes the episode.

In this paper, we argue that mental accounts are not always closed when an investor sells a stock. Instead, investors may "roll" an account from one asset to another, by selling the original asset and buying another within a short period of time. We present evidence that when investors reinvest in this manner, their decisions of what to sell, what to buy, and how to trade the new asset are all consistent with the new asset being evaluated within the original mental account. Our evidence suggests that investors track and evaluate their performance by constructing a set of investing episodes, but that selling an asset does not necessarily conclude the episode.

When a mental account is rolled, the reference point used to assess gains and losses for a newly purchased asset remains linked to the amount paid for the *original asset.* In this case there should be a "rolled disposition" effect – analogous to the standard disposition effect, but where

[2] The disposition effect has been documented for individual investors (Odean 1998; Feng and Seasholes 2005; Kaustia 2010a), mutual fund managers (Frazzini 2006), futures traders (Locke and Mann 2005), real estate purchases (Genesove and Mayer 2001), and prediction markets (Hartzmark and Solomon 2012). See Kaustia (2010b) for a recent overview. Explanations such as prospect theory (Shefrin and Statman 1985), realization utility (Barberis and Xiong 2009) and cognitive dissonance (Hartzmark and Solomon 2012; Chang, Solomon and Westerfield 2015) can provide a foundation for why closing losing accounts is painful.

gains and losses are defined relative to the amount paid for the *original asset* that is no longer in the portfolio. This provides a stark testable prediction of rolling mental accounts. To test this, we examine assets that are purchased on the same day that another asset is sold ("reinvestment days"), and consider when investors choose to sell the newly purchased asset.

Consistent with the prediction from rolling mental accounts, we find that investors exhibit a rolled disposition effect - they are more likely to sell the new asset if its value exceeds the amount invested in the original asset. This holds even after controlling for whether the new asset is at a gain or a loss relative to its own cost basis, as under the standard disposition effect. The interpretation under mental accounting is straightforward: because the new asset's performance is framed as a continuation of the initial investing episode, an investor is more willing to sell the new asset once the combined position on the rolled account reaches a gain.

The concept of rolling mental accounts also makes predictions about which assets are sold. If the standard disposition effect is due to the pain of closing a mental account at a loss, then rolling a mental account should alleviate this pain and reduce the disposition effect. Consistent with this prediction, we show that the disposition effect is not present on reinvestment days (31% of sell-day observations). Instead, the unconditional disposition effect is driven by the 69% of observations when a sale is not accompanied by a purchase ("liquidation days").

The rolling of mental accounts also has implications for which assets are purchased on reinvestment days. We show that when an investor rolls a position sold at a loss, he tends to reinvest in a stock with higher volatility compared with when he rolls a position sold at a gain. This behavior follows from prospect theory, as a loss-averse investor who rolls a position at a loss is willing to take on more risk in order to get back to zero, compared to a situation in which the investor has a prior gain (Kahneman and Tversky 1979). This prediction only holds if the two stocks are in the same rolled mental account – if the stocks are in separate mental accounts, then prospect theory would not predict a difference in volatility of the purchased assets.

Next, we show that investors make significantly better *ex-post* selling decisions on reinvestment days compared with liquidation days. On reinvestment days, the subsequent returns of the asset which gets sold are lower than the returns on (i) assets sold on liquidation days, and (ii) assets retained in the portfolio on reinvestment days. The discount brokerage data does not allow us to isolate the specific psychological mechanism that generates this performance result; however, our results suggest that if investors can avoid the utility associated with closing a mental account, they can make better investment decisions.

In order to test whether reinvestment has a causal impact on the disposition effect and trading outcomes (as under a rolled mental accounts explanation), we conduct a laboratory experiment. We design an experimental asset market where the optimal strategy for a risk-neutral Bayesian trader is to exhibit a large reverse disposition effect. We randomly assigned subjects to a control group and a treatment group. The only difference between the two groups is that subjects in the treatment group were given the option to immediately reinvest the proceeds of a sale into a negative expected value gamble, whereas control subjects did not have this option.

We find that there is a disposition effect in the control group, but not in the treatment group. Subjects in the treatment group are significantly more likely to reinvest sale proceeds into the gamble after selling at a loss than after selling at a gain. Allowing reinvestment also causes subjects to exhibit an increase in optimal trading decisions, as they are more likely to sell losing stocks (which on average have negative expected returns) compared with subjects in the control condition. The experimental results indicate that the opportunity to reinvest causally decreases the disposition effect, consistent with rolled mental accounts, and that competing theories – both rational and behavioral – are unlikely to fully explain the results in the discount brokerage data.

We also show that the lack of a disposition effect on reinvestment days is unlikely to be driven by investor sophistication, as mutual fund managers exhibit similar behavior. Mutual fund data is limited to quarterly reports rather than precise trades, so to proxy for mental account closure we examine fund flows. A fund experiencing outflows must sell positions without reinvesting into financial assets. We show that mutual funds with inflows (whose managers can roll mental accounts) exhibit a disposition effect that is lower by 2.1% compared with the same fund experiencing outflows (which require the closure of mental accounts).

The rolling of mental accounts also has implications for the rank effect (Hartzmark 2015), whereby investors are more likely to sell their highest and lowest ranked stocks in terms of returns. This effect is asymmetric: the best position is more likely to be sold than the worst and the second best position is more likely to be sold than the second worst. Hartzmark (2015) provides evidence that extreme positions are attention grabbing, but it is not clear that salience alone predicts the asymmetry. If an investor’s attention is similarly attracted to the extreme stocks in his portfolio, then the reluctance to close a mental account at a loss may induce him to sell the best stock instead of the worst, accounting for the asymmetry. Thus the asymmetry should be attenuated if investors roll mental accounts. Consistent with this conjecture, we show that on reinvestment days, extreme ranked stocks are the most likely to be sold, but the asymmetric pattern disappears.

The results in this paper suggest that investors evaluate their performance and make trading decisions in a manner that systematically deviates from the predictions of portfolio theory. Rather than tracking total wealth and correlations, investors track investing episodes. Importantly, we show that the end of each investment episode need not coincide with the realization of a position, as reinvestment is more consistent with the continuation of the same mental account. While this distinction between realization and closing a mental account appears in the first paper on the disposition effect (Shefrin and Statman 1985), it has since received little attention or empirical support.[3]

The idea of extending narrow framing to cover multiple positions over time complements the finding in Hartzmark (2015) that individuals compare positions across stocks and trade extreme ranked positions. Our paper adds to the literature which has examined stock-level attributes that are associated with greater investor trading. These include geographic proximity (Coval and Moskowitz 1999), having a capital gain (Shefrin and Statman 1985), having extreme returns (Ben-David and Hirshleifer 2012), being in the news (Barber and Odean 2008; Engelberg and Parsons 2011), and having lottery-like characteristics (Kumar 2009).

This paper also contributes to a growing literature that examines how investors establish and update reference points in a trading context (Barberis, Huang and Santos 2001; Barberis and Huang 2001; Arkes et al. 2008; Pagel 2014; Birru 2015; Imas 2016). We document a new aspect not heretofore considered, that reference points can persist across different assets. Finally, our paper contributes to the debate on whether the disposition effect is driven by preferences or

[3] Shefrin and Statman (1985) posit that "the fundamental reluctance is not so much loss realization as the closure of a mental account at a loss."

beliefs.[4] The existence of a rolled disposition effect suggests that the original asset's purchase price serves as a reference point for evaluating the performance of the new asset, which provides some support for a preference-based explanation. If instead the disposition effect were driven through a beliefs channel, then the original asset's purchase price would need to affect beliefs about the new asset. While we cannot fully reject this alternative beliefs-based hypothesis, a preference-based explanation is a more parsimonious explanation.

2. Conceptual Framework: Mental Accounting and Resetting Reference Points

In this section we put forth a basic conceptual framework to help formalize our definition of rolling a mental account. Consider, for instance, the assumptions used in Barberis and Xiong (2012). In this model, an investor derives prospect theory utility over realized gains and losses. Like in Barberis and Xiong (2012), we consider that when an investor purchases a stock, he opens a mental account in which he tracks the gains or losses accrued on that stock. A second key assumption in the Barberis and Xiong (2012) model is that as long as the proceeds from a realization are not immediately reinvested in the *same* stock, a realization will close the mental account and generate a burst of realization utility.

We instead propose that if the proceeds from a realization are reinvested in a different stock within a short period of time, the mental account used to track the sold stock is not closed. Instead, the mental account remains open, no realization utility is generated, and the reference point of the purchased stock remains at the amount initially invested in the *original stock*. We refer to this event in which an investor sells one stock and quickly buys a different stock as

[4] Examples of preference based explanations include prospect theory (e.g. Shefrin and Statman 1985; Odean 1998), realization utility (e.g. Barberis and Xiong 2012; Frydman et al. 2014) and cognitive dissonance (e.g. Chang et al. 2015). Examples of belief based explanations include mean reversion (e.g. Odean 1998) and a speculative motive for trade (e.g. Ben-David and Hirshleifer 2012). See Kaustia (2010b) for a recent overview.

rolling a mental account.[5] For most of the paper, we consider a rolled account to be when the sale and purchase occur on the same day, although we examine effects at longer horizons as well.

A simple example may help to illustrate the idea. Assume on date 0 that an investor buys $10 of stock in the Alpha Company. On date 1, the value of this investment decreases to $8 and the investor sells his $8 of Alpha and buys $8 of the Beta Company. On date 2 the value of the Beta Company increases to $9. Under the standard assumption that equates a realization with closing a mental account, the investor evaluates the sale of Alpha at date 1 as a realization of a $2 loss and views his investment in Beta at date 2 as a $1 paper gain. If instead the investor rolls his mental account, he does not view the realization of Alpha at date 1 as a closing the mental account. Further, at date 2 he views his investment as standing at a $1 paper loss because the reference point remains at the initial $10 investment in Alpha.

3. Data

The analysis in this paper is mainly based on data on individual investors trading on their own accounts. This is the same dataset used in Barber and Odean (2000) and Strahilevitz, Odean and Barber (2011). It includes information on individual investors trading on their own accounts from January 1991 to November 1996. The data is linked to CRSP information on price, returns and other stock characteristics.

The analysis looks at days when investors sell a position in their portfolio (sell days), or days that investors buy a new position or add to an existing position in their portfolio (buy days). The exact time that a trade occurs is not included in the dataset, only the date of trade. Thus if multiple trades of the same security are made within the same day, the value weighted price and

[5] See Imas (2016) for a discussion on the theoretical relation between realization and resetting the reference point.

net quantity are used. Furthermore, on days that a new position is purchased, the analysis does not include the new position as available to be sold, because it is unclear whether it was held at the time the investor sold the original position. Short positions are not included in the analysis and a position is considered short when it is sold with prior holdings of zero or when it is purchased and the resulting quantities are zero or negative. Following Ben-David and Hirshleifer (2012), all positions with a negative commission are dropped. The initial purchase price of positions purchased before the sample period began is not known, so positions present in the first month of the holdings file for a given account are excluded from the analysis.

Returns are calculated as in Hartzmark (2015) from the purchase price to the closing price on the day prior to the sale. If a position is purchased and subsequently more shares of that position are purchased, the purchase price used to calculate the total return on that position is the value-weighted average purchase price across the multiple purchases.

Mutual fund data is taken from Thompson-Reuters for fund holdings, and this is combined with price and volume information from CRSP. The two files are merged using the WFICN files. Only report dates (not the actual date of trade) are known, so returns are calculated analogously to the individual investor data, but using the report dates rather than the actual dates of trade. A position is considered a sale if the number of shares decreases (or is not reported) in the subsequent quarter and it is considered a purchase if the number of shares increases or if it appears after being absent in the previous quarter. The analysis examines the sample from January 1990 to June 2010, though data from as early as 1980 is utilized to construct the price history. We apply a number of filters to the Thompson-Reuters data as suggested by Frazzini (2006). Specifically, holdings are set to missing if the number of shares that a fund holds is more than the total number of shares outstanding in the stock, the value of a holding is greater than the fund's total asset value or the value of the fund's reported holdings is more than 100% different from the CRSP value.

Summary statistics for the individual investor data are presented in Table 1. We examine 56,546 accounts that sell at least one position on 352,152 days on which there were slightly more than 2 million positions that they could have sold. The mean portfolio size is 5.7 stocks with many investors holding 3 or fewer stocks. Of the sell days, 82,688 of them were days where another position was purchased.

4. Results using Individual Investor Data

4.1 The Rolled Disposition Effect

The main hypothesis of this paper is that investors who sell one asset and buy another in quick succession may treat the new asset as a continuation of the old mental account. We examine a number of aspects of trading behavior to see if it is consistent with this notion. First, we investigate whether attributes of a previously sold asset impact the decision to sell the new asset. If the new asset is considered a continuation of the old mental account, then trading in the new asset will be influenced by the gains or losses generated from the old asset. Conversely, any theory based on stock-by-stock narrow framing predicts no impact from the position that was previously sold and is no longer held by the investor, as the two assets are considered in separate mental accounts.

The most direct test of this conjecture relates to the rolled disposition effect and the previously sold asset. If the new asset is placed in the original mental account and investors are averse to closing a mental account at a loss, then the propensity to sell the new asset will be higher when the mental account is at a gain than at a loss based on the original amount invested in the old asset. This generates a sharp prediction that investors should be more likely to sell the new asset when its value places it at a gain relative to the amount initially invested in the old asset. In other words, investors should exhibit a rolled disposition effect with respect to a reference point of the dollar amount invested in the old asset.

To examine whether investors engage in such behavior, we examine holdings that were purchased as part of a reinvestment day, conditioning on the investor selling only one stock and buying only one stock on that day. In this sample, if the investor rolled a mental account it must be from the single stock sold to the single stock purchased. We examine the propensity of investors to subsequently sell the newly purchased asset.

On each day with a sale, we calculate the gain or loss of the reinvested position based on the initial value invested in the original position that was sold. We calculate two variables. The first variable, *Gain*, is equal to one if the position has a positive return since it was purchased. This captures the sign of the holding period capital gain, which is the key variable that is traditionally used to measure the disposition effect. The variable that is unique to our analysis is *Original Gain*, which is equal to one if the position is at a gain relative to the amount that was initially invested in the previously sold position.

For example, assume that an investor initially buys $110 of stock in Apple, which he subsequently sells when its value has fallen to $100. At this point, he simultaneously buys $100 of Microsoft. Observations would be taken for Microsoft on each subsequent day that the investor sold some asset. Now suppose the investor sells an asset on a day that his position in Microsoft is worth $105. On this day *Gain* is equal to one (as the price has increased from $100 to $105), but *Original Gain* is equal to zero, as the $105 price is less than the original purchase amount of $110 of Apple stock.

To examine trading decisions of investors based on the return from the original position we examine selling propensities of positions that are at a small gain or a small loss relative to the original position. Figure 1 examines how the propensity to sell a position varies with the level of the return from the original position, limiting the sample to observations that are within negative 15% to positive 15% of the original position. The left portion of Figure 1 Panel A graphs the probability of selling a position based on the return from the amount initially invested in the original position (the continuous analogue to *original gain*). Each bar is a bin containing all observations on a sell day with returns in the indicated 1% range, and the height of the bar represents the proportion of positions with a return in that bin that were sold. The maroon bars are positions at a loss relative to the original position and the navy bars are positions at a gain.

In general, the maroon bars indicate a lower probability of sale than the navy bars, which is consistent with the rolled disposition effect. The binning of positions at the 1% level is ad hoc, so as an alternative the right panel utilizes the raw data to fit two local linear polynomials estimated with the optimal bandwidth. The maroon line is estimated using only positions at a loss relative to the original position, while the navy line is estimated using only positions at a gain. The two graphs each illustrate a similar pattern of a rolled disposition effect.

These results are clearly correlated with other variables based on return from purchase that have been shown to impact the propensity to sell a position. To account for such effects we regress *sell* on a dummy variable equal to one if a position is at a gain, *Gain*, and the other controls from Ben-David and Hirshleifer (2012) including the return from purchase if the position is at a gain, *Return*Gain*, the return from purchase if the position is at a loss, *Return*Loss*, the square root of the number of holding days, √*Holding Days*, and the following interactions: *Return*√Holding Days*Gain, Return*√Holding Days*Loss, Variance *Gain, Variance *Loss*.

In Panel B of Figure 1 we take the residuals from this regression and examine how they respond to the return from the original position. The results are largely unchanged. The maroon bars are generally below the navy bars indicating a rolled disposition effect. The charts are visually similar, the magnitude of the jump in both panels is roughly 5%, and the statistical significance is also about the same magnitude. These results suggest that investors' selling decisions are directly impacted by the level of return from their previously held position, and that this pattern is not explained simply by the level of return on the position since purchase.

In Table 2 we extend the analysis of the rolled disposition effect to the full sample and explore the graphical pattern using regression analysis. In the first column, we regress a dummy variable, *Sell*, which is equal to one if a position is sold, on *Original Gain*. The coefficient on *Original Gain* is 0.035 with a *t*-statistic greater than 5. This coefficient provides a measure of the rolled disposition effect. The coefficient indicates that investors are 3.5% more likely to sell a position that is at a gain relative to the original position, compared to a position at a loss.

Of course, if the new stock is at a gain relative to the investment in the original position, it is more likely to be at a gain relative to the investment in the current position. As such, this result could simply be capturing a noisy measure of the standard disposition effect. The next column adds a dummy that controls for the standard disposition effect, and we find that investors remain 2.3% more likely to sell a position that is at a gain relative to the original amount invested.

In addition to a greater willingness to sell a position at a gain compared to a loss, Ben-David and Hirshleifer (2012) highlight the importance of the *level* of return from purchase, among other variables. The third column adds the controls from Ben-David and Hirshleifer (2012) discussed above. With these added controls, we find that the coefficient increases to 2.8% with a t-statistic of 4.88. These results suggest that, on average, the amount invested in the original position remains an important determinant of trading decisions in the reinvested asset, consistent with a rolled mental accounts explanation.

In the final two columns we explore how the amount of money reinvested when a position is rolled impacts subsequent behavior. While outside the scope of the motivating example sketched above, an investor buying a similar amount in a new position to what they sold in an old position is more likely to be doing so as part of rolling a mental account. As such, we expect a stronger rolled disposition effect for positions where the dollar amount sold is similar to the dollar amount purchased.

Column 4 examines the rolled disposition effect for a sample where a similar amount was purchased and sold. If the difference between what is sold and purchased is within 5% of the amount reinvested, the rolled disposition effect is 3.0% with a t-statistic of 3.6. When limiting the sample to cases where the amount reinvested is more than 5% different from what was sold, there is no statistically significant rolled disposition effect.

4.2. The Disposition Effect and Reinvestment Days

The next hypothesis we examine relates to the choice of which assets investors sell on reinvestment days. In general, mental accounting predicts that the reluctance to close a mental account at a loss will cause investors to display a disposition effect, whereby they are more likely to sell assets at a gain than assets at a loss. If investors purchase a new stock on a sell day and the original mental account is rolled over, there is no utility generated upon the realization of the asset. Because this allows investors to realize a loss without generating a negative utility jolt, this predicts that the disposition effect should be reduced on days in which there is a sale and a purchase. Table 3 tests this prediction by examining whether investors exhibit the disposition effect on days that they also buy another position.

Following Odean (1998), we measure the disposition effect using the difference in the proportion of gains realized (PGR) and the proportion of losses realized (PLR). PGR and PLR are defined as follows:

$$PGR = \frac{\#\ of\ Gains\ Sold}{\#\ of\ Gains\ Sold + \#\ of\ Gains\ Not\ Sold}$$

$$PLR = \frac{\#\ of\ Losses\ Sold}{\#\ of\ Losses\ Sold + \#\ of\ Losses\ Not\ Sold}$$

where *# of Gains Sold* is the total number of positions realized at a gain and *# of Gains Not Sold* is the total number of gains that could have been sold, but were not (on days that some position in the portfolio is sold). Similarly, *# of Losses Sold* is the total number of positions realized at a loss and *# of Losses Not Sold* is the total number of losses that could have been sold, but were not (on days that some position in the portfolio is sold). Table 3 presents measures of the disposition effect using a stock's purchase price as a reference point. Examining the *All* column of Panel A, PGR for all investors is 22.7% and PLR is 17.3%. Thus the disposition effect for these investors is 5.4%, which is significant with a *t*-statistic of 11.88 (*t*-statistics are clustered by firm and date). There are a number of investors that hold very few stocks and exhibit a very strong disposition effect. Panel B examines only investors that hold at least 5 stocks and shows they exhibit a smaller disposition effect of 2.4%, while Panel C examines investors that hold fewer than 5 stocks and shows they exhibit a disposition effect of 13.4%.

The second column examines the disposition effect when an investor sells a position in his portfolio and does not buy another position on the same day (liquidation days, 69% of observations) while the third column examines the 31% of observations where an investor sells a position in his portfolio and buys another position on the same day (reinvestment days). On liquidation days, investors exhibit a larger disposition effect. The magnitude of the disposition effect on liquidation days is 8.1% across all investors, 3.8% for investors holding at least five stocks, and 17.1% for investors holding less than five stocks.

On reinvestment days, investors do not exhibit a disposition effect. Examining all investors, the difference between PGR and PLR on reinvestment days is -0.7% with a t-statistic of -1.23. Examining investors that hold five or more stocks, we find the disposition effect is -0.2% with a t-statistic of -0.35. Investors that hold fewer than five stocks exhibit an insignificant disposition effect of -0.7% with a t-statistic of -1.37. As a whole, these results are consistent with the hypothesis that investors are less likely to close a mental account and derive a jolt of utility on days when they purchase another position.

While the magnitude of the disposition effect (that is, the difference between PGR and PLR) is easy to compare across reinvestment and liquidation days in Table 3, comparing PGR or

PLR across reinvestment and liquidation days is more involved. The main complication is that there may be differences in overall selling propensity between the types of investors who reinvest assets and those who do not. Such differences, whatever their origin, will influence the individual PGR and PLR values, but will be canceled out in the PGR-PLR measure. The key idea we wish to test is that if an investor rolls a mental account he does not experience utility from closing out a position at a gain or loss.

Thus, when rolling a mental account we predict that investors will be equally likely to sell a position at a gain or loss, and that the likelihood is simply equal to the base rate of selling a position for that individual. To test this, we must first estimate a base selling rate for each account, and examine which set of days and positions (reinvestment vs liquidation, gain vs loss) display a greater deviation from this baseline propensity. We therefore repeat the analysis from columns 2 and 3, but include fixed effects for each account. More concretely, we run a regression of a sell dummy on account fixed effects, examining all days with a sale (both reinvestment and liquidation). Then we take the average of the residuals for four categories – reinvestment day for assets at a gain, reinvestment day for assets at a loss, liquidation day for assets at a gain, and liquidation day for assets at a loss. Figure 2 provides the results where each bar represents the difference in selling propensity from the baseline of the account. As these are residuals and must sum to zero, they reveal which categories drive the overall difference, but they do not speak to the level.

The left side of the chart shows that on liquidation days, investors are more likely to sell positions at a gain and less likely to sell positions at a loss, as compared with their baseline probability of selling assets. The right side of the figure shows that on reinvestment days, there is no disposition effect, evidenced by the fact that the deviations from baseline selling propensity are the same for gains and losses. More importantly, the level of deviations for both categories is roughly zero. This indicates that on reinvestment days, the selling propensities for gains and losses are both equal to the unconditional average selling rate for that investor. This fits the intuition that there is no utility burst at such times, and hence no deviation in gain and loss realization propensities from the overall rate at which the investor sells assets. Deviations from the baseline occur on liquidation days, consistent with the idea that closing a mental account generates a burst of utility which affects trading decisions.

We further explore the disposition effect on reinvestment days in Section 7. We find that when the entire proceeds of a sale are reinvested in the new position the disposition effect is lower. The disposition effect is also lower as the time between the two trades becomes shorter. Finally we find that investor specific characteristics or taxable status of the account do not appear to account for the lack of disposition effect on reinvestment days.

4.3 Reinvestment Days and the Decision of What to Purchase

The previous section provides evidence in favor of rolling mental accounts by looking at the choice of what investors sell on reinvestment days. In this section, we examine the decision of which assets investors buy on reinvestment days. In particular, if the two stocks are considered to be in the same mental account, then attributes from the old stock may influence the subsequent purchase decision.

One major attribute that may affect purchase choices is the level of gains and losses on the old investment. In particular, mental accounting posits that investors consider gains and losses relative to reference points, as in models such as prospect theory (Kahneman and Tversky 1979). Furthermore, if investors are loss averse – that is, they are more sensitive to losses than to gains – then an investor who is faced with a paper loss may be willing to take on more risk (in order to avoid the loss) than if he were facing a paper gain (Imas 2016).

This generates the prediction that if the realization involves rolling a mental account, then investors will want to take on more (less) volatility in the new stock if the old stock is sold at a loss (gain). If the two transactions are not linked through a mental account, it is not clear why volatility levels should be different. Standard portfolio theory predicts that investors should care about covariances rather than variances, and it makes no obvious predictions about the relation between realized gains and losses on the old investment and volatility in the new investment. To the extent that rolling a position at a gain may be associated with increased investor wealth, risk aversion also seems unlikely to generate the same predictions as rolled mental accounts, as this would require that investors take on *less* risk as they get richer.

Table 4 examines this question and finds that investors tend to purchase more volatile stocks when the old asset is sold at a loss. We examine days where only one position is sold and at least one other position is purchased, and consider as a dependent variable the volatility (over the previous year) of stocks that are purchased.[6] This is regressed on a dummy variable equal to one if the stock sold that day is at a loss. Panel A examines the variance measured as percentiles of all stocks on the day of the sale, and Panel B examines the raw measure of variance winsorized at the 1st and 99th percentile. The constant represents the average variance measure for positions purchased on days when the investor sold his positions at a gain, and the dummy variable shows the difference from this amount on days when positions are sold at a loss.

[6] We require at least 50 trading days over the previous year to calculate the volatility. If the position lacks the requisite number of data points we do not include it in the analysis.

Examining the first column of Table 4 Panel A, we see that on reinvestment days when a stock is sold at a loss, investors buy positions that are more than one percentile higher in the distribution of variance. This could simply be indicative of certain days being more volatile than others, or investors having systematically different preferences for volatility over the sample period, so column 2 adds in a date fixed effect. The effect is larger after its inclusion, suggesting that such an explanation does not account for the effect. In the third column we add investor fixed effects to examine whether the measure is simply capturing systematic differences in volatility preferences. We find a positive coefficient of 0.659 for the *Loss* variable, with a *t*-statistic of 2.46. In Panel B we examine the winsorized level of the variance rather than our percentile measure and find a similar pattern, suggesting our results are not driven by specific scaling choices. Thus we find that investors purchase more volatile positions when they close out other positions at a loss rather than a gain. This is consistent with investing in riskier assets to increase the chances of converting a rolled mental account from a loss to a gain.

4.4 Reinvestment Days and the Subsequent Performance of Trades

The disposition effect is now widely considered a trading mistake due to poor ex-post performance and suboptimal tax implications (Odean 1998). If the disposition effect is driven by the disutility from closing a mental account at a loss, then rolling a mental account (which avoids such account closure) may result in better trading decisions. In this section, we examine the returns of positions after they are sold and find that decisions made on reinvestment days are more profitable (measured by ex-post returns) than those made on liquidation days.

Table 5 examines the subsequent returns of all positions sold, both on reinvestment days and liquidation days. Returns following the sale are measured over the subsequent quarter (65 trading days), year (255 trading days) and two years (505 trading days), both as the return in excess of the CRSP value weighted market return and characteristic adjusted returns similar to Daniel, Grinblatt, Titman and Wermers (1997). We compute the returns of portfolios of stocks sorted into quintiles based on their book to market ratio, market capitalization and return from *t*-20 to *t*-250. The characteristic-adjusted return for each stock is calculated by taking the stock return and subtracting the return of the portfolio with the same quintiles of the three variables.

For each measure and time period, three regressions are run on the returns of positions in the period after they are sold. The first regression is of the return on a dummy variable for whether a position is purchased on the same day (i.e. the asset was sold on a reinvestment day) and on a constant. Thus the constant gives the return on the position that is sold on a liquidation day. Note that a positive point estimate is indicative of a poor sell decision (subsequent returns are high) while a negative point estimate is indicative of a good sell decision (subsequent returns are low). Using any of the return measures and any of the holding periods, we find that, on average, a stock sold on a reinvestment day subsequently earns a lower return compared to that of stocks sold on liquidation days. Over the next quarter this excess return differential is -0.70% (with a *t*-statistic of -5.93), over the next year it is -2.34% (with a *t*-statistic of -8.48) and over the next two years it is -4.74% (with a *t*-statistic of -10.27). Examining the characteristic adjusted numbers yields similar results of -0.61% per quarter, -2.05% per year and -4.28% over two years, significant at the 1% level in all cases.

In general, selling a position at a gain has been found to be a poor decision based on ex-post returns (Odean 1998) and our previous results show that investors exhibit a higher propensity to sells gains on liquidation days. Thus the improved trading decisions in the first regression might simply capture this reduction in the disposition effect and associated subsequent returns. To test this, the second regression includes a dummy variable for when a position is at a gain. For each return measure and for each time period the coefficient on this dummy variable is positive, indicating that selling a position at a gain typically leads to foregone positive returns in the future. However, the coefficient on *Reinvestment Day* decreases only slightly in most specifications. Column three allows for a differential effect of disposition-related selling on reinvestment days, and finds little difference in most specifications. The robustness of the coefficient on *Reinvestment Day* suggests that only a small portion of the effect is due to the fact that there is a decreased propensity to sell gains on reinvestment days.

Another alternative explanation for our result is that some investors have skill, and skilled investors exhibit both a lower disposition effect and a greater ability to generate higher returns. To the extent that such skill is correlated with the decision to reinvest assets, this could account for the robust negative coefficient found on *Reinvestment Day* in the previous regression. Table 6 attempts to control for this by re-running the same regressions with individual fixed effects to account for a persistent component of skill in selling decisions. In general the results look similar to the regression without the individual fixed effects. Some coefficients decrease slightly, suggesting that investors with more skill are more likely to buy and sell on the same day, but this alone does not account for the entire effect.

The analyses above compare the subsequent returns of stocks sold on reinvestment days with the subsequent returns of stocks sold on liquidation days. This is designed to compare the returns following reinvestment sales with the returns following sales that occur on other days. Another relevant comparison group for stocks being sold is the set of stocks that could have been sold on the day that a sale occurred, but were retained in the portfolio. If an investor sells a position that does poorly over the next year, but the other positions in his portfolio do worse, the decision to sell may not be viewed in as favorable a light. We examine this relative subsequent performance of sold stocks (relative to stocks retained in the portfolio) for both reinvestment days and liquidation days. Table 7 again considers observations from days with a sale, and examines the subsequent returns on all positions that could have been sold that day. These returns are regressed on *Sell*Reinvestment Day*, a dummy variable equal to one if the asset in question is sold and the day was a reinvestment day, and *Sell*No Reinvestment Day*, which is equal to one if the asset is sold on a day that no other position is purchased. To control for the average performance of holdings that could have been sold on a given day, fixed effects for the interaction of account and date are included. Thus the variation examined is relative to the return of all positions in the portfolio that were not sold on that sell date. Again, we see a strong pattern of significant negative coefficients on *Sell*Reinvestment Day*. This indicates that on reinvestment days investors make better choices about which positions to sell, as measured by ex-post performance.

5. An Experimental Investigation of Rolling Mental Accounts

The main argument of this paper is that investors display different behavior around reinvestment decisions because of the psychological effects of mental accounting. The alternative is that reinvestment is associated with different behavior because of another economic or psychological effect that coincides with the reinvestment decision. It is difficult to think of an alternative theory that explains all of our findings with the same parsimony as rolled mental accounts. Nonetheless, there are other attributes of the reinvestment decision that may explain some of the results.

For example, one possible explanation of the reduction in the disposition effect on reinvestment days involves beliefs about the future returns of assets. On liquidation days, if beliefs are driving trading behavior, they must relate to the asset being sold (since this is the only trade taking place). On reinvestment days, investors may trade based on their beliefs about the stock being sold *or* beliefs about the newly purchased asset. It is possible that on reinvestment days, investors exhibit a reduced disposition effect because they lack strong opinions about which asset to sell, and only care about the asset being purchased. This would not necessarily generate a reduced disposition effect (since the different beliefs must relate to the gain or loss of each stock), and it does not predict either the rolled disposition effect or the results about volatility. Nonetheless, beliefs might explain why selling behavior is generally different on reinvestment days. In a similar vein, while standard portfolio theory does not seem to explain the results, it is hard to test every variant of portfolio theory using brokerage data alone.

To rule out such alternatives, we examine the effects of reinvestment in a laboratory setting where the ability to reinvest can be exogenously and randomly assigned. This allows us to strip away several factors that might influence trading in the data set used in the previous sections. Subjects in our experiment are told the data generating process of stock prices, so they do not need to form expectations of the underlying model. More importantly, the option to reinvest is randomly assigned as a treatment, so it is exogenous to any beliefs subjects may have. In addition, the asset that treatment subjects can reinvest in is one that a risk-neutral or risk-averse Bayesian would never choose to hold, making portfolio theory an unlikely explanation. Taken together, these design features allow us to conduct tests of the *causal* effect of reinvestment on trading behavior, for which we find results that are consistent with a rolled mental accounts explanation.

5.1 Experimental Design

The experimental design is based on Frydman and Rangel (2014) which we modify in the treatment condition to examine the impact of reinvestment. We endow subjects with $350 in experimental cash and give them the opportunity to trade three stocks – A, B, and C. The experiment consists of two sessions of 108 trials separated by a two-minute break. Subjects are required to buy one share of each stock at the price of $100 to start each session, leaving them with $50. At the end of each of the two sessions, we liquidate subjects' stock holdings. Payment is based on the final cash balance at a conversion rate of 20:1, plus a $5 participation fee.

The majority of the 108 trials (10 – 108) are divided into two parts: a price update screen and a trading screen. During the price update screen, one stock is chosen at random and the subject is shown the price change for that stock only. Subjects see the entire price path for each stock.[7] During the trading screen, one of the three stocks is chosen at random and the subject is then given the opportunity to trade this stock. Trials 1-9 only contain the price update screen, and thus subjects are not given the opportunity to trade in these trials. This design feature allowed subjects to accumulate information about the stocks before making their first trading decision.

We constrain subjects to hold either one or zero shares of each stock. Thus, a subject's decision is whether to sell the stock (if he owns it) or whether to buy the stock (if he does not own it). The price path of each stock is independent of the other two stocks and is governed by a two-state Markov chain, with a good state and a bad state. In the good state, a stock has a 70% chance of a price increase and a 30% chance of a decrease. In the bad state, a stock has a 30%

[7] If a price update on trial t is about stock i, then stock $j \neq i$ does not change price.

chance of a price increase and a 70% chance of a price decrease. The magnitude of the price increase or decrease is drawn uniformly from {$5, $10, $15}.

The hidden state of each stock evolves as follows. Before trial 1, each stock is randomly assigned to a state. A state is updated only after a stock receives a price update. If the price update is about stock *i*, then the state of stock *i* in trial *t* remains in the same state as in trial *t-1* with probability 0.8, and it switches states with probability 0.2. The state of each stock is hidden and is never revealed to subjects, but they can make inferences using the realized price changes. The price process is explained in detail to subjects before the experiment.[8] This price process generates positively autocorrelated price changes, which is a critical feature of the design. The key implication is that optimal behavior entails a reverse disposition effect of selling losing stocks and holding winning stocks.

The treatment condition is identical to the control, except that we introduce the option to reinvest a position into a negative expected value gamble. During the trading screen, if a subject owns a stock, he is asked if he would like to "rebalance." If he enters "no" the stock remains in his portfolio. If he says "yes" the stock is liquidated, but he is then asked whether he would like to "transfer funds." If he declines to transfer funds, the proceeds from the liquidation are added to his cash account exactly as in the control condition. If he transfers funds, the sale amount is invested in a new asset that increases by $10 with probability 0.5 and decreases by $15 with probability 0.5. If the subject transfers funds, the new asset is immediately liquidated after its price change is realized. As with the three original stocks, subjects are given the information

[8] For complete instructions please see:
https://sites.google.com/site/samhartzmark/files/Frydman_Hartzmark_Solomon_Rolling_Mental_Accounts_Experiment_instructions.pdf

about the new asset's return distribution, so they are aware that it always has a negative expected return.

In the control condition, the optimal strategy for a risk neutral Bayesian trader is to trade based on their posterior that each stock is in the good state. This trader sells (or does not buy) when this posterior is less than 0.5, and holds (or buys) when this posterior is greater than 0.5. Given the positive autocorrelation of price changes in this experiment, the optimal strategy is to, on average, sell losers and hold winners. With the specific price path used in our experiment, a risk neutral Bayesian trader would exhibit a disposition effect of -0.55 (see Frydman and Rangel (2014) for a derivation of this optimal strategy).[9] The optimal strategy in the treatment condition is identical to that of the control. The only difference in the treatment condition is the opportunity to invest in a negative expected value gamble, which a risk-neutral or risk-averse Bayesian would never take.

In contrast, if subjects are rolling mental accounts in the treatment condition in order to avoid the pain of closing a mental account at a loss, then we expect that the opportunity to reinvest will decrease the level of the disposition effect. Moreover, rolling should be more frequent after selling a loss than a gain.

5.2 Causal Effect of Reinvestment on the Disposition Effect

One hundred and seventeen subjects from the University of Chicago and the California Institute of Technology participated in the experiment.[10] Each subject was randomly assigned to

[9] The same realized price path was used for all subjects in the experiment (both control and treatment condition). This design feature allows us to more easily compare trading behavior across subjects.
[10] Data from thirty-three subjects in the control condition were taken from a previous study that used an identical control condition to study the impact of salience on the disposition effect (Frydman and Rangel 2014). For these subjects, the exchange rate from experimental cash to US dollars was 24:1.

one of two conditions. Sixty-three subjects were assigned to the control condition and fifty-four subjects were assigned to the treatment. Average total earnings were $25.89 with a standard deviation of $6.94.

We measure the disposition effect in this experiment using the same methodology used for the field data. Specifically, on every trial that a subject has the opportunity to sell a stock, we classify the trial as a paper loss or gain (if he chooses to hold) and as a realized loss or gain (if he chooses to sell). PGR and PLR are then computed using these trial classifications.

In the control condition, we find a positive disposition effect of 4.5%, which is significantly above the optimal level of -55%, but also significantly above 0 at the 10% level (*t*-statistic: 1.76). In the treatment condition, when subjects are given the opportunity to reinvest into a negative expected return gamble in the same period that they sell a stock, we find a disposition effect of -1.9%, which is 6.4% lower than in the control condition (*t*-statistic: -1.71). Table 8 Panel A shows that this difference is driven by an increase in PLR (*t*-statistic: 2.44), but that there is no significant difference in PGR across conditions (*t*-statistic: 0.23). Because we exogenously manipulate the ability to reinvest in the treatment condition, these results provide evidence that the ability to reinvest causally reduces the disposition effect.

We can further investigate the mechanism that generates this reduced disposition effect by analyzing the situations when subjects choose to roll. If subjects are rolling to avoid the disutility from realizing a loss, then we would expect rolling to be more frequent on trials where subjects realize a loss compared with trials where subjects realize a gain. Table 8 Panel B provides evidence consistent with this, as subjects are significantly more likely to roll into the new asset after selling a loss compared with selling a gain (*t*-statistic: -3.37).

By design, the disposition effect is a suboptimal behavior in our experiment. This suggests that the reduced disposition effect in the treatment condition is closer to the optimal behavior of a risk neutral Bayesian, and should therefore generate higher overall earnings. We find that subjects in the treatment group outperformed those in the control group by (an insignificant) 4.7%. This is noteworthy as the only difference across the two groups is the opportunity to purchase a negative expected return asset in the treatment group. If we ignore the gains and losses generated by the negative expected value gamble that subjects purchase during reinvestment, we can better measure the optimality of selling decisions. Using this measure the treatment group earned 9.2% more money than the control group (t=1.65). Thus, these results are consistent with the finding that individual investors in the brokerage database make better *ex-post* selling decisions when they reinvest.

In summary, the results from the laboratory experiment provide evidence that the opportunity to purchase a new asset immediately following a stock sale causally reduces the disposition effect in a setting where the disposition effect is a costly mistake. Moreover, this reduction takes place through the loss channel in our experiment. The experimental results suggest that the change in the disposition effect in the brokerage data is unlikely to be driven exclusively by belief-based theories of trading, but is instead consistent with the predictions of rolled mental accounts.

6. Mutual Funds, Rolling Mental Accounts and the Disposition Effect

The paper to this point has examined individual investors trading on their own accounts and university students trading in an experimental laboratory. Ideally it would be possible to analyze other investors and time periods to see the extent to which they exhibit similar behavior.

Unfortunately, we do not have data that allows for such a detailed examination. Instead we examine the quarterly reporting of mutual funds. These funds do not report trade by trade activity, making it difficult to assign a particular sale and purchase to the same mental account. Nonetheless, we can test a proxy for the ability to roll mental accounts and examine its effect on the disposition effect as in section 4.2.

In particular, we can calculate whether a fund has recently experienced inflows or outflows. A fund that has experienced outflows will be forced to sell positions and send that money to investors. This will reduce the ability of the fund to sell an asset and reinvest the proceeds into a new asset, because more of the sales are needed to pay for the redemptions. If funds consider each stock separately, outflows will constrain the ability of funds to roll mental accounts, whereas inflows provide funds with the flexibility to roll mental accounts. As a consequence, we predict that funds experiencing outflows will display a larger disposition effect among their holdings than funds experiencing inflows.

The results in Table 9 provide supporting evidence for this hypothesis. In column 1 the following regression is run:

$$Sell_{ijt} = \alpha + \beta_1 Gain_{ijt} * (Pos\ Flow_{it}) + \beta_2 Gain_{ijt} + \beta_3 (Pos\ Flow_{it})$$

where *i* indicates a mutual fund, *j* indicates a stock and *t* indicates a report date. *Gain* is a dummy variable equal to one if a position is at a gain. *Flow* is calculated using the following formula:

$$Flow_{it} = \frac{TNA_{it} - TNA_{it-1} * (1 + Return_{it})}{TNA_{it-1}}$$

where *Return* is the fund return from *t-1* to *t* and *TNA* is the total net assets of the fund. We examine the annual flow from sixteen months to four months before the announcement.[11] The dummy *Pos Flow* is equal to one if $Flow_{it}$ is positive. Thus the coefficient on β_2 measures the disposition effect for funds that experienced outflows while the coefficient on β_1 measures the difference in disposition effect between funds with inflows and those with outflows.

Examining column 1 we see that funds that have experienced outflows – and are thus forced to send money to investors and close mental accounts – display a disposition effect of 1.9% (with a *t*-statistic of 2.10) while funds that have experienced inflows and may thus reinvest display a disposition effect that is 4% less (*t*-statistic of -4.59), so they display a reverse disposition effect of -2.1%. Mutual funds have been shown to sell based on other characteristics of their holdings (see Hartzmark 2015; An and Argyle 2015), so column 2 includes the controls from Hartzmark (2015). These controls are *Gain*Ret* which controls for the impact of return magnitude in the positive domain, *Loss*Ret* which controls for the impact in the negative domain, *Gain*Variance* which controls for the impact of a positions variance in the past year if that position is at a gain and *Loss*Variance* which does the same for positions at a loss, *Gain*Ret*$\sqrt{}$HoldingPeriod* and *Loss*Ret*$\sqrt{}$HoldingPeriod* control for interactions of past return and holding period in for gains and losses respectively. Including these controls in Column 2 yields a similar pattern.

One alternative possibility is that some mutual funds have a fixed tendency to exhibit the disposition effect, and that this attribute is responsible for fund flows. To test whether a fixed

[11] The decision to examine only up to four months before the announcement is to use only publicly available information and avoid a look-ahead bias (as we are looking at changes from the previous quarter's report). Similar results are obtained looking at monthly flows, annual flows, or examining flows up to the month before the announcement rather than utilizing the four-month lag.

fund characteristic is responsible for the impact of flows on the disposition effect, column 3 adds a fund fixed effect. With this addition, funds experiencing outflows exhibit a statistically significant disposition effect of 0.9% (*t*-statistic of 2.42), while funds experiencing inflows exhibit an effect 2.6% below that (with a *t*-statistic of -5.30). Finally, it could be that certain periods of time are more likely to be associated with inflows or outflows. The fourth column adds a report date fixed effect and yields a similar gap in disposition effect between inflows and outflows, though the disposition effect for fund with outflows is only marginally significant.

Thus, mutual funds exhibit a stronger disposition effect when they have experienced outflows rather than inflows. In such a scenario they are forced to sell positions and not reinvest the proceeds back into the portfolio. This suggests that even sophisticated market participants utilize mental accounting when making their decisions.

7. Further Examination of the Disposition Effect and Reinvestment Days

This section returns to the lack of disposition effect on reinvestment days explored in section 4.2, examining extensions and robustness checks to the previous analysis. In our previous analyses, we proxy for an investor rolling a mental account by the presence of a purchase on the same day as a sale. The notion, consistent with the discussion in section 2, is that on a reinvestment day the previous pool of money is transferred into the new asset. While outside the basic framework of section 2, this intuition suggests that the measure can be refined further by considering the relative size of the amount sold and the amount purchased. In particular, days with both a purchase and a sale can be broken into cases when a) the entire sale amount is reinvested, b) more than the sale amount is invested (e.g. the investor sold a position, added extra cash and bought a larger total position in the new stock), and c) less than the sale amount is reinvested (e.g. the investor sold a position, reinvested some component and kept some in cash).

The most straightforward prediction applies to cases where the amount reinvested is approximately equal to the amount sold, and thus the pool of money remains the same. However, when more money is added to the account, the entirety of the money from the old stock is still in the investment account, which makes it more likely that the returns in the new asset are considered part of the same investing episode. In the third case there is some transfer to a different account, which may make it more likely that the investor is treating the episode as finished. As a result, cases with only partial reinvestment should have more of a disposition effect than those with full reinvestment.

Table 10 tests this hypothesis and finds evidence in support of it. Investors who sell a position and reinvest the entire proceeds of the sale back into their account on the same day do not exhibit a disposition effect, but actually exhibit a negative disposition effect. When the sum of what is purchased is greater than 105% of the sum of what is sold, we find a negative disposition effect of -4.2% with a *t*-statistic of -7.28. When investors reinvest roughly the same amount of the proceeds back into their account (plus or minus 5% of the sale amount), we find a negative disposition effect of -3.3% with a *t*-statistic of -4.58. In contrast, when investors reinvest less than the amount sold they exhibit a positive disposition effect of 1.4% with a *t*-statistic of 2.29.[12]

To this point the paper has only examined purchases that occur on the same day as a sale. It is possible that investors may still connect a purchase and a sale as being part of the investment

[12] Using finer cutoffs for what constitutes approximately the same investment amount, such as plus or minus 1% of the sale amount, produces similar results.

episode in a rolled account even though they do not occur simultaneously. For instance, an investor might be waiting for the funds to clear on the sold asset, waiting for a particular price point on the new asset, or waiting for a previously submitted limit order to execute. In such instances, near-in-time purchases and sales may still be part of the same rolled mental account. It seems likely that the closer in time two trades are observed, the more likely it is that investors are treating the two transactions as involving the same mental account (Read et al. 1998).

Table 11 examines how the disposition effect varies as the length of time between a sale and a purchase increases. We consider observations where a sale and a purchase occurred within one month (20 trading days) of each other. The table has regressions of *Sell*, a dummy variable equal to one if a position is sold, on a gain dummy as before, as well an interaction term between a gain dummy and the time until the nearest buy. In a second version of the regression, we interact the gain variable with dummy variables for purchases that are 1, 2, 3 and 4 weeks away from the sale (with the omitted category being purchases that occur on the same day as the sale).

We find that as the length of time between the sale and the purchase increases (making it less likely that the two trades are part of a rolled mental account) the disposition effect gets larger. In column 1, each additional day between the sale and the purchase increases the propensity to sell gains relative to losses by 0.7%. When the disposition effect is broken out week by week, there is a monotonic increase in disposition effect as the time until purchase increases. When a purchase is made within a week of the sale (but not on the exact sell day), investors are 7.2% more likely to sell winners than losers. By contrast, when a purchase is made four weeks from a sale, investors are 9.9% more likely to sell winners than losers. This is consistent with the idea that purchases within a week are more likely to be part of a rolled mental account, whereas purchases further away are less likely to be part of the same investing episode and thus in a different mental account.[13]

The analysis in Table 3 examines the average disposition effect across all investors aggregated together. This could mask systematic differences in investors that are correlated with the variables of interest. For example, the apparent relationship between reinvestment days and the disposition effect may simply be capturing fixed differences in the types of investors likely to engage in reinvestment, not the reinvestment days themselves. Relatedly, Kumar and Lim (2008) show that investors who trade more frequently exhibit less of a disposition effect. If these investors who cluster their trades are also more likely to buy positions on the same day, this could account for our results.

To test for this, Table 12 Panel A examines the disposition effect on reinvestment days for a subset of investors who both reinvest at some point and liquidate at some point. The sample is limited to investors who have at least five reinvestment days and five liquidation days. Thus for investor *i* we calculate:

$$\Delta Disp.Effect = \left(PGR_i^{No\ Buy} - PLR_i^{No\ Buy}\right) - \left(PGR_i^{Buy} - PLR_i^{Buy}\right)$$

We find that investors display a disposition effect 7.7% higher on liquidation days compared with reinvestment days. The effect is not restricted to investors with a small number or large number of stocks in their portfolio. Investors holding four or fewer stocks exhibit a disposition effect 10.8% larger on days they do not purchase another position, while those with five or more stocks exhibit a disposition effect 4.8% larger.

[13] In untabulated results, when observations are split according to whether the sale occurred before or after the associated purchase, the results are similar for both subsets.

Another possible concern is that the difference in disposition effect based on reinvestment day is due to tax-based selling. To examine such a possibility, Table 12 Panel B examines how the disposition effect varies between reinvestment and liquidation days for taxable and tax deferred accounts. Both types of accounts show a positive and significant disposition effect on liquidation days, but on no statistically significant disposition effect on reinvestment days. This suggests that simple tax-based selling motivations cannot account for our findings.

8. Rolling Mental Accounts and the Rank Effect

This paper has focused on the disposition effect as its theoretical connection to mental accounting is straightforward and the concept of rolling mental accounts offers stark testable predictions. Another related trading pattern with possible links to mental accounting is the rank effect (Hartzmark 2015). This effect refers to the empirical predilection of investors to sell positions with extreme ranks (based on the return from purchase price) in their portfolio. Hartzmark (2015) shows that the most likely positions for an investor to sell in their portfolio are stocks with the highest-ranked and lowest-ranked returns, and that the effect is related to the attention grabbing nature of extreme ranks within the portfolio.

An additional result in Hartzmark (2015) is the asymmetry between the selling propensity of the best and worst ranked stocks. In particular, investors are more likely to sell their best-ranked stock relative to their worst-ranked stock, even though it is not clear why the best-ranked stock should be more attention-grabbing. One possible explanation of the asymmetry in selling propensity is due to a hesitation to close a mental account at a loss. If investors dislike closing a mental account on a poorly performing stock, then they will be less likely to sell their worst-ranked position relative to their best-ranked position. In such a scenario, the extreme rankings attract an investor's attention to both positions (and thus increase the propensity to sell them), but the difference in selling propensity arises due to the difference in utility from closing the mental account for the best-performing account relative to the worst-performing account. Therefore, if rolling a mental account reduces the pain of realizing a position at a loss, the asymmetry in the rank of effect should be lower on reinvestment days compared to liquidation days.

To examine the relation between rolling mental accounts and the asymmetry in the rank effect we examine the effect separately on reinvestment and liquidation days in Table 13. The Table shows the proportion of best, worst, 2^{nd} best and 2^{nd} worst position realized calculated analogously to PGR and PLR described in section 4.2, but utilizing rank rather being at a gain or loss. The first column replicates the results from Hartzmark (2015) examining the full sample of investors that hold at least five stocks in their portfolio. Both best and worst positions are likely to be sold, but the best is 6.9% more likely to be sold than the worst. Also, the 2^{nd} best position is 5.1% more likely to be sold than the 2^{nd} worst position. The second column examines liquidation days and finds that this asymmetry is even more pronounced. The best position is 10.2% more likely to be sold than the worst position and the 2^{nd} best position is 7.1% more likely to be sold than the 2^{nd} worst.

The third column examines reinvestment days and finds that the asymmetry disappears. On days when another position is purchased investors are roughly as likely to sell their best and worst position. Additionally, we find no statistically significant difference in the propensity to sell the worst and second to worst position. The difference in the rank effect between liquidation and reinvestment days suggests that the asymmetry in the rank effect is due to the emotions associated with closing mental accounts. The lack of such an asymmetry on reinvestment days suggests that on these days investors are likely to be rolling their mental accounts.

9. Conclusion

In this paper, we examine how investors apply mental accounting rules to their stock trades. In particular, we examine the assumption generally made in the mental accounting literature that investors open a mental account when a stock is purchased and they close it when the stock is sold. Contrary to this assumption, we present evidence that when investors sell an asset and buy a different asset in quick succession, the original mental account may instead remain open. Across a range of investment behaviors, investors act as if they treat the new asset as a continuation of the same pool of money that was invested in the old stock.

For assets purchased on an investment day, investors are more likely to sell when at a profit relative to the amount initially invested in the old position. When investors sell assets on a reinvestment day, they display no disposition effect, consistent with not experiencing the disutility of closing a mental account at a loss. Our experimental results indicate that this reduction in the disposition effect is a causal result of reinvestment. When investors reinvest at a loss, they purchase more volatile assets than when they reinvest at a gain. Investors generally make better selling decisions on reinvestment days, consistent with them not trading due to the utility or disutility of closing a mental account. All of these results can be parsimoniously explained by rolled mental accounts, but are difficult to explain with other theories.

Overall, our results support the importance of mental accounting as an explanation for many aspects of investor behavior, but they also explore a heretofore ignored component of how mental accounts work in practice. The idea of a rolled mental account can be thought of as an extension of the idea in Barberis and Xiong (2012) that traders consider stocks in terms of investing episodes. We show that selling an asset and buying another one in quick succession is a way of extending the original investing episode and maintaining the initial mental account.

Rolling a mental account has parallels with the idea discussed in Chang, Solomon and Westerfield (2015) that investors sometimes react to the cognitive dissonance of losses by blaming an intermediary. Here, we explore another means by which investors can avoid admitting to mistakes – namely by transferring assets across mental accounts so that the question of whether the investing episode was a mistake is now considered across the combination of two stocks, rather than one.

In this sense, rolling a mental account allows an investor to make return-improving trades while avoiding the pain of closing mental accounts at a loss. While rolling a mental account may be a second-best solution relative to standard portfolio theory, it offers a considerable improvement over the third-best disposition effect that many individuals display. The question of how to encourage investors to so behave is one worthy of further study.

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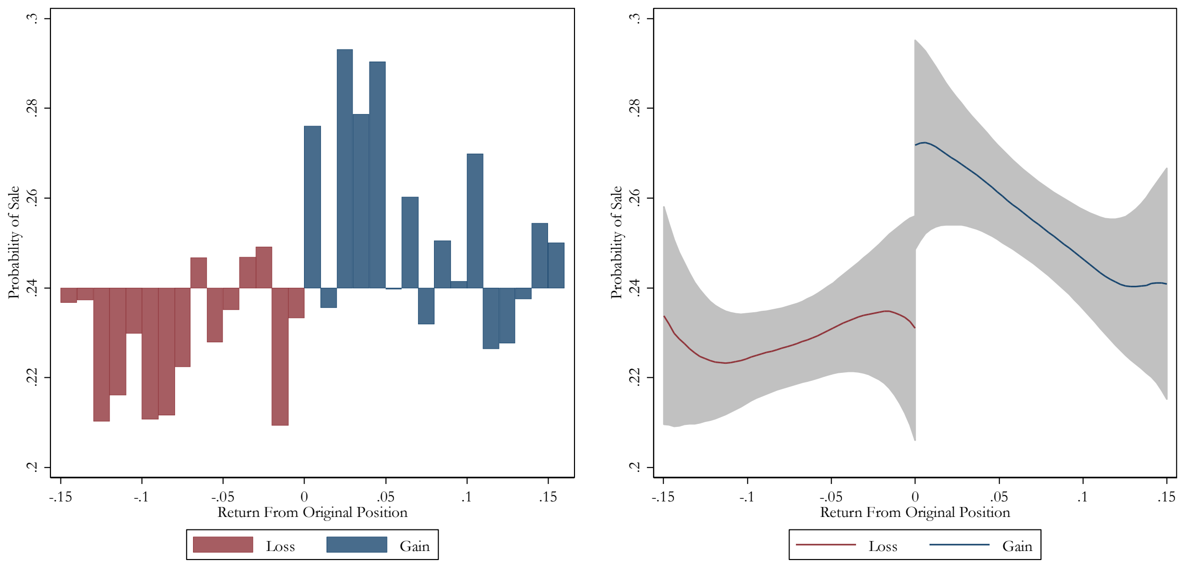
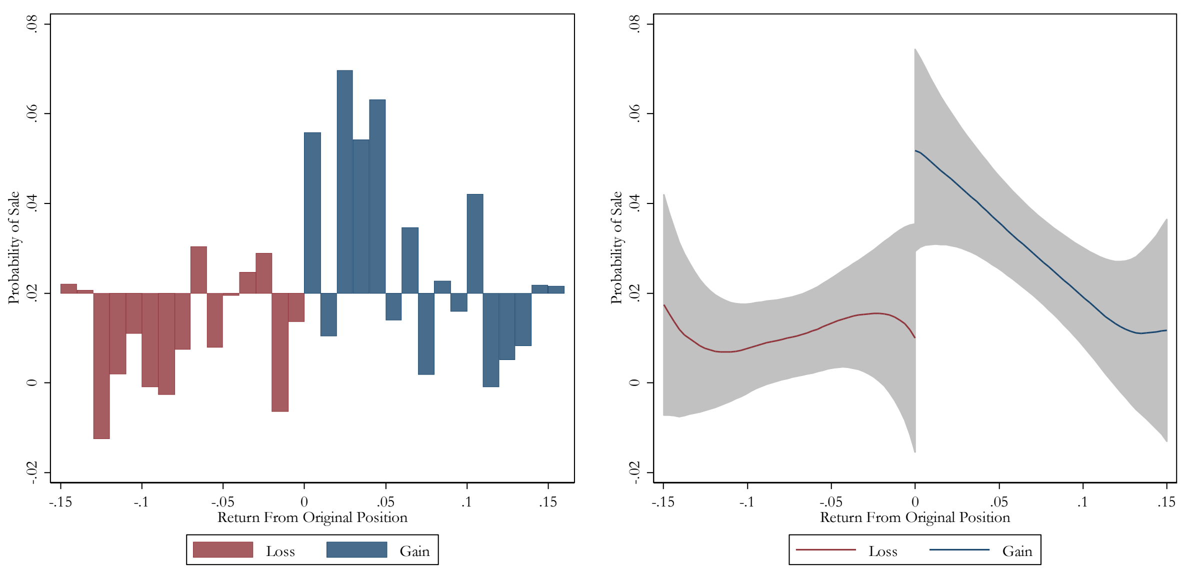
Figure 1 – Probability of Sale by Return from Original Position

Panel A: Without Controls

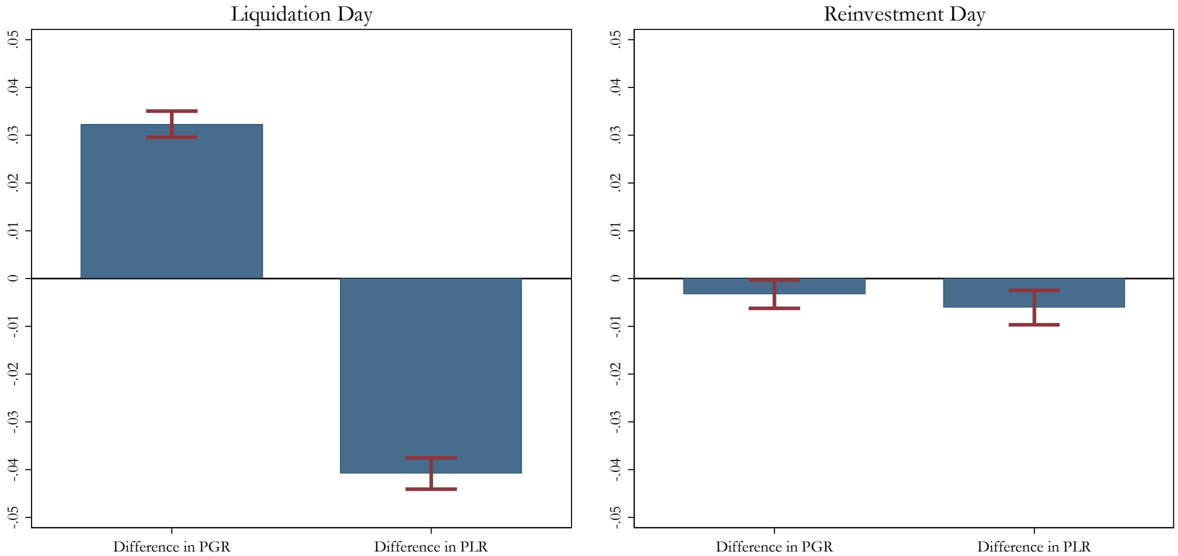


Panel B: Residual after controlling for Current Position's Gain/Loss, Returns, Holding Period and Volatility



This figure presents the probability of sale based on the return from the amount initially invested in the previously held position. The sample is limited to positions that were previously purchased on a day where exactly one other position was sold. The return is calculated relative to the value originally invested in the previously sold position. The left graph shows the raw probability of sale for bins of 1% return. The right graph shows a local linear plot conducted separately on positions at a loss or a gain relative to the original position with the 95% confidence interval. Panel A does not include controls. In Panel B a sell dummy is regressed on *Gain*, *Return*Gain*, *Return* Loss*, *Return*√Holding Days*Gain*, *Return*√Holding Days*Loss*, *Variance *Gain*, *Variance *Loss*, and *√Holding Days*, and the residual from this regression is used for the analysis.

Figure 2 - Deviation from Investor-Specific Selling Propensity
Split by Gains versus Losses and Reinvestment versus Liquidation Days



This figure presents deviations from the baseline selling propensity for each investor, according to whether or not it is a reinvestment day and whether or not the stock in question is at a gain (PGR) or a loss (PLR). A dummy equal to 1 if a position is sold is regressed on an account fixed effect. The average of this residual is graphed for each of the four samples. The maroon lines represent the 95% confidence interval where standard errors are clustered by acount and date. Only days where a stock is sold are included in the sample. Stocks are not included on the day the position is opened.

Table 1 – Summary Statistics

	Obs	Mean	SD	Minimum	25th Pctile	Median	75th Pctile	Maximum
# Observations	2,015,264							
# Accounts	56,546							
# Sell days	352,152							
# Reinvestment Days	82,688							
Proportion Sold	352,152	0.438	0.333	0.002	0.167	0.333	0.500	1.000
Number of Stocks Held	352,152	5.723	9.370	1	2	3	7	478

This table presents summary statistics on investors from January 1991 to November 1996. Only days where a stock is sold are included. Stocks are not included on the day their position is opened.

Table 2 – The Rolled Disposition Effect

	Full Sample			Roll Similar	Roll Different
Original Gain	0.035 ***	0.023 ***	0.028 ***	0.030 ***	0.016
	(5.49)	(3.64)	(4.88)	(3.58)	(1.33)
Gain		0.050 ***	0.061 ***	0.057 ***	0.058 ***
		(7.11)	(6.99)	(5.46)	(5.64)
Constant	0.204 ***	0.185 ***	0.232 ***	0.244 ***	0.224 ***
	(30.93)	(27.66)	(26.08)	(23.55)	(14.43)
Obs	98,877	98,877	98,168	50,619	47,549
R2	0.002	0.005	0.022	0.024	0.021
Additional Controls			X	X	X

This table presents linear regressions of a dummy variable equal to one if a position is sold on controls. The sample is limited to positions that were previously purchased on a day where exactly one other position was sold. Column 4 includes only observations where the amount purchased is within 5% of the amount sold, while Column 5 includes only observations where the difference was greater than 5%. *Original Gain* is a dummy variable equal to one if the value of the current position is greater than the value originally invested in the previously sold position. *Gain* is a dummy variable equal to one if a position is at a gain from its own purchase price. Additional controls are *Return* Gain*, *Return* Loss*, *Return*√Holding Days*Gain*, *Return*√Holding Days*Loss*, *Variance *Gain*, *Variance *Loss*, and *√Holding Days*. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 3 – The Disposition Effect on Reinvestment and Liquidation Days

	Panel A: All Observations		
	All	Liquidation Day	Reinvestment Day
PGR	0.227	0.258	0.158
PLR	0.173	0.177	0.165
Difference	0.054 ***	0.081 ***	-0.007
	(11.88)	(19.72)	(-1.23)
Observations	2,032,255	1,397,032	635,223

	Panel B: 5 or more stocks		
	All	Liquidation Day	Reinvestment Day
PGR	0.129	0.141	0.105
PLR	0.104	0.103	0.106
Difference	0.024 ***	0.038 ***	-0.002
	(7.00)	(12.16)	(-0.35)
Observations	1,551,917	1,017,184	534,733

	Panel C: 4 or Fewer stocks		
	All	Liquidation Day	Reinvestment Day
PGR	0.537	0.557	0.454
PLR	0.403	0.386	0.460
Difference	0.134 ***	0.171 ***	-0.007
	(36.50)	(42.71)	(-1.37)
Observations	480,338	379,848	100,490

This table presents measures of the disposition effect by liquidation and reinvestment days (days where a position is purchased). PGR is the #Gains Sold/(#Gains Sold+#Gains Not Sold) and PLR is the #Losses Sold/(# Losses Sold+# Losses Not Sold). Difference is PGR-PLR with a *t*-statistic (clustered by date and account) for the test that this difference is zero underneath. All includes all observations, Liquidation Day includes sell days where no position is purchased and Reinvestment Day includes only sell days where another position is purchased. The number of stocks in the various panels is the total number of stocks the investor could have sold. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 4 –Variance of Assets Purchased on Reinvestment Days

	Panel A: Variance in Percentiles		
Previous Stock Sold at Loss	1.210 ***	1.732 ***	0.659 **
	(4.88)	(6.72)	(2.46)
Constant	44.181 ***	43.963 ***	
	(122.09)	(153.27)	
Observations	69,005	69,005	69,005
R2	0.001	0.078	0.557
Date FE		X	X
Account FE			X

	Panel B: Winsorized Variance (x100,000)		
Previous Stock Sold at Loss	5.626 ***	8.699 ***	4.414 **
	(4.15)	(5.99)	(2.42)
Constant	112.986 ***	111.699 ***	
	(72.77)	(96.12)	
Observations	69,005	69,005	69,005
R2	0.000	0.054	0.479
Date FE		X	X
Account FE			X

This table examines the variance of assets purchased on reinvestment days as a function of whether the amount sold on a day was a gain or a loss. The sample consists of all purchased positions on days that something else is sold. The main dependent variables are the variance of the stock that was purchased calculated over the previous year, either as a percentile of the distribution (Panel A) or in raw values, winsorized at the 1% level (Panel B). The independent variable is a dummy variable equal to one if the assets sold that day were at an overall loss, so the omitted category are purchased positions on days when the assets being sold were at a gain. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 5 – Returns of Sold Positions after the Sale

	Panel A: One Quarter (65 trading Days) Post Sale					
	Excess Returns			Characteristic Adjusted Returns		
Reinvestment Day	-0.698 ***	-0.640 ***	-0.492 ***	-0.609 ***	-0.571 ***	-0.443 ***
	(-5.93)	(-5.43)	(-2.79)	(-5.50)	(-5.15)	(-2.61)
Gain		0.547 ***	0.613 ***		0.344 **	0.401 ***
		(3.83)	(3.93)		(2.57)	(2.75)
Gain*Reinvestment Day			-0.248			-0.212
			(-1.24)			(-1.06)
Constant	0.180	-0.188	-0.233	-0.310 ***	-0.545 ***	-0.584 ***
	(1.20)	(-1.01)	(-1.22)	(-2.77)	(-3.65)	(-3.78)
Obs	403,319	403,319	403,319	343,194	343,194	343,194
R2	0.000	0.000	0.000	0.000	0.000	0.000

	Panel B: One Year (255 trading Days) Post Sale					
	Excess Returns			Characteristic Adjusted Returns		
Reinvestment Day	-2.335 ***	-1.949 ***	-1.310 ***	-2.053 ***	-1.826 ***	-1.413 ***
	(-8.48)	(-7.10)	(-3.22)	(-7.25)	(-6.46)	(-3.36)
Gain		3.638 ***	3.924 ***		2.084 ***	2.267 ***
		(11.67)	(11.53)		(6.78)	(6.76)
Gain*Reinvestment Day			-1.073 **			-0.683
			(-2.30)			(-1.38)
Constant	0.485 *	-1.965 ***	-2.158 ***	-0.906 ***	-2.335 ***	-2.460 ***
	(1.78)	(-5.58)	(-5.91)	(-3.99)	(-7.55)	(-7.57)
Obs	403,319	403,319	403,319	336,669	336,669	336,669
R2	0.000	0.001	0.001	0.000	0.001	0.001

	Panel C: Two Years (505 trading Days) Post Sale					
	Excess Returns			Characteristic Adjusted Returns		
Reinvestment Day	-4.738 ***	-3.962 ***	-2.565 ***	-4.278 ***	-3.847 ***	-2.941 ***
	(-10.27)	(-8.56)	(-3.66)	(-9.20)	(-8.22)	(-4.26)
Gain		7.314 ***	7.940 ***		3.944 ***	4.345 ***
		(12.64)	(12.10)		(7.65)	(7.34)
Gain*Reinvestment Day			-2.346 ***			-1.494 *
			(-2.90)			(-1.80)
Constant	-2.869 ***	-7.794 ***	-8.215 ***	-4.858 ***	-7.566 ***	-7.841 ***
	(-5.38)	(-10.49)	(-10.55)	(-11.83)	(-13.63)	(-13.10)
Obs	403,319	403,319	403,319	334,120	334,120	334,120
R2	0.000	0.002	0.002	0.000	0.001	0.001

This table presents linear regressions of returns on a number of dummy variables. *Reinvestment Day* is equal to one if another position is purchased on the day of the sale and *Gain* is a dummy variable equal to one if a position is at a gain. Returns are measured from the trading day after the sell day (t) to t+65 in Panel A, t+255 in Panel B and t+505 in Panel C. Excess returns are returns after the sell date with the CRSP value weighted return index subtracted from it. Characteristic adjusted returns are the returns of the stock minus the returns of a portfolio matched on quintile of size, book to market and momentum. The top value is the coefficient, the bottom value in parentheses is the t-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 6 – Returns of Sold Positions after the Sale Controlling for Investor Effects

	Excess Returns			Characteristic Adjusted Returns		
Panel A: One Quarter (65 trading Days) Post Sale						
Reinvestment Day	-0.643 ***	-0.626 ***	-0.604 ***	-0.891 ***	-0.894 ***	-0.907 ***
	(-4.71)	(-4.56)	(-3.02)	(-5.53)	(-5.53)	(-3.78)
Gain		0.254 *	0.264		-0.047	-0.053
		(1.65)	(1.57)		(-0.27)	(-0.28)
Gain*Reinvestment Day			-0.037			0.021
			(-0.16)			(0.08)
Constant	0.167	-0.002	-0.009	-0.374 ***	-0.342 **	-0.338 **
	(1.25)	(-0.01)	(-0.05)	(-3.52)	(-2.16)	(-2.02)
Obs	403,319	403,319	403,319	342,426	342,426	342,426
R2	0.150	0.150	0.150	0.167	0.167	0.167
Account FE	X	X	X	X	X	X
Panel B: One Year (255 trading Days) Post Sale						
	Excess Returns			**Characteristic Adjusted Returns**		
Reinvestment Day	-1.180 ***	-1.024 ***	-0.561	-1.253 ***	-1.209 ***	-0.938 *
	(-3.98)	(-3.45)	(-1.26)	(-3.82)	(-3.69)	(-1.86)
Gain		2.303 ***	2.525 ***		0.640 *	0.768 **
		(7.25)	(7.12)		(1.89)	(2.03)
Gain*Reinvestment Day			-0.777			-0.448
			(-1.49)			(-0.77)
Constant	0.201	-1.328 ***	-1.477 ***	-1.101 ***	-1.534 ***	-1.622 ***
	(0.98)	(-4.54)	(-4.76)	(-6.47)	(-5.44)	(-5.31)
Obs	403,319	403,319	403,319	336,669	336,669	336,669
R2	0.164	0.164	0.164	0.179	0.179	0.179
Account FE	X	X	X	X	X	X
Panel C: Two Years (505 trading Days) Post Sale						
	Excess Returns			**Characteristic Adjusted Returns**		
Reinvestment Day	-1.828 ***	-1.513 ***	-0.759	-1.789 ***	-1.751 ***	-1.480 *
	(-3.90)	(-3.22)	(-1.04)	(-3.43)	(-3.35)	(-1.87)
Gain		4.654 ***	5.015 ***		0.557	0.686
		(8.37)	(7.92)		(1.01)	(1.07)
Gain*Reinvestment Day			-1.266			-0.447
			(-1.46)			(-0.47)
Constant	-3.584 ***	-6.674 ***	-6.917 ***	-5.466 ***	-5.843 ***	-5.931 ***
	(-10.22)	(-11.79)	(-11.43)	(-19.84)	(-12.57)	(-11.41)
Obs	403,319	403,319	403,319	334,120	334,120	334,120
R2	0.184	0.184	0.184	0.199	0.199	0.199
Account FE	X	X	X	X	X	X

This table presents linear regressions of returns on a number of dummy variables. *Reinvestment Day* is equal to one if another position is purchased on the day of the sale and *Gain* is a dummy variable equal to one if a position is at a gain. Returns are measured from the trading day after the sell day (t) to t+65 in Panel A, t+255 in Panel B and t+505 in Panel C. Excess returns are returns after the sell date with the CRSP value weighted return index subtracted from it. Characteristic adjusted returns are the returns of the stock minus the returns of a portfolio matched on quintile of size, book to market and momentum. All regressions include an account fixed effect. The top value is the coefficient, the bottom value in parentheses is the t-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 7 – Returns of Sold Positions Compared to Positions Retained in the Portfolio

	One Quarter (65 trading Days) Post Sale		One Year (255 trading Days) Post Sale		Two Years (505 trading Days) Post Sale	
	Excess Returns	Characteristic Adjusted Returns	Excess Returns	Characteristic Adjusted Returns	Excess Returns	Characteristic Adjusted Returns
Sell* Reinvestment Day	-0.294 **	-0.201	-1.174 ***	-0.901 **	-1.964 ***	-1.516 **
	(-2.20)	(-1.34)	(-3.56)	(-2.36)	(-3.49)	(-2.41)
Sell*Liquidation Day	0.026	0.057	-0.012	-0.062	-0.279	-0.528
	(0.26)	(0.55)	(-0.05)	(-0.24)	(-0.74)	(-1.25)
Constant	-0.109 ***	-0.479 ***	-0.787 ***	-1.698 ***	-6.005 ***	-6.706 ***
	(-12.29)	(-49.59)	(-36.91)	(-67.05)	(-159.34)	(-154.69)
FE: Account x Date	X	X	X	X	X	X
Obs	1,899,281	1,595,464	1,899,282	1,571,773	1,899,282	1,561,483
R2	0.254	0.243	0.230	0.240	0.245	0.256

This table presents linear regressions of returns on a number on *Sell*Reinvestment Day* which equals to one if a position is sold on a day that another position is purchased and *Sell*Liquidation day* which is equal to one if a position is sold on a day that another position is not purchased. The omitted category is thus stocks that were not sold on the day that a sale occurred. Returns are measured from the trading day after the sell day (*t*) to *t*+65 in the first two columns, *t*+255 in columns 3 and 4 and *t*+505 in columns 5 and 6. Excess returns are the return with the CRSP value weighted return index subtracted from it. Characteristic adjusted returns are the returns with the portfolio matched on quintile of size, book to market and momentum subtracted. All positions that could have been sold on sell days are included in the regression. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 8 – Experimental Results

Panel A: Disposition Effect in Treatment and Control

	Control	Treatment	Difference
Disposition Effect	0.045 *	-0.019	-0.064 *
	(1.76)	(-0.70)	(-1.71)
PGR	0.196	0.203	0.007
			(0.23)
PLR	0.151	0.222	0.071 **
			(2.44)
Observations	7,110	6,367	13,477

Panel B: Rolling of Gains versus Losses

Prob. Of Roll | Gain Sold	0.374
Prob. Of Roll | Loss Sold	0.542
Difference	-0.168 ***
	(-3.37)
Observations	1,345

This table presents results from the laboratory experiment described in Section 5. In Panel A PGR is the #Gains Sold/(#Gains Sold+#Gains Not Sold) and PLR is the #Losses Sold/(# Losses Sold+# Losses Not Sold). Disposition Effect is defined by PGR-PLR, and the *t*-statistic (clustered by account) for the test that this difference is zero is given underneath. Control and treatment columns indicate the experimental condition the data is generated from. The difference column is a test whether the measures are statistically different across conditions with a *t*-statistic (clustered by account) for the test that this difference is zero underneath. Panel B shows the proportion of sold gains and losses reinvested into the negative NPV gamble. The difference is reported underneath with a *t*-statistic (clustered by account) for the test that this difference is zero. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 9 – Mutual Fund Selling by Flow Amount

	(1)		(2)		(3)		(4)	
Gain*(Pos Flow)	-0.040	***	-0.030	***	-0.026	***	-0.021	***
	(-4.59)		(-4.45)		(-5.30)		(-4.97)	
Gain	0.019	**	0.015	***	0.009	**	0.006	*
	(2.10)		(2.90)		(2.42)		(1.70)	
Pos Flow	-0.096		-0.108	***	-0.047	***	-0.049	***
	(-7.90)		(-10.99)		(-7.38)		(-7.88)	
Constant	0.457		0.505	***	0.351	***		
	(32.82)		(59.16)		(67.66)			
Observations	15,081,746		15,081,713		15,081,713		15,081,713	
R2	0.014		0.022		0.139		0.143	
Other Controls			X		X		X	
Fund FE					X		X	
Date FE							X	

This table presents coefficients from linear regressions of a dummy variable, *Sale*, equal to 1 if a stock is sold on a dummy variable equal to one if the position is at a gain and *Pos Flow* which is equal to one if the fund experienced positive flows from month *m*-16 to *m*-4 where month *m* is the report month. Flow is calculated as $Flow_t = [TNA_t - TNA_{t-1} \times (1+Return_t)] / TNA_{t-1}$. Additional controls are *Gain*, *Return* Gain, Return* Loss, Return*√Holding Days*Gain, Return*√Holding Days*Loss, Variance *Gain, Variance *Loss,* and *√Holding Days*. Mutual fund data are from January 1990 to June 2010 where dates examined are report dates. A fund must hold at least 20 CRSP merged securities to be included in the analysis. The top number is the coefficient, and the lower number in parenthesis is the *t*-statistic. Standard errors are clustered by date and fund.

Table 10 – Disposition Effect by Amount Purchased Relative to Amount Sold

Panel A: All Observations

	All Buy	$Buy>$Sell	$Buy≈$Sell	$Buy<$Sell
PGR	0.157	0.122	0.196	0.179
PLR	0.164	0.164	0.229	0.165
Difference	-0.008	-0.042 ***	-0.033 ***	0.014 **
	(-1.36)	(-7.28)	(-4.58)	(2.29)
Observations	631,259	242,164	72,354	389,265

Panel B: 5 or more stocks

	All Buy	$Buy>$Sell	$Buy≈$Sell	$Buy<$Sell
PGR	0.104	0.079	0.108	0.120
PLR	0.106	0.105	0.131	0.107
Difference	-0.002	-0.026 ***	-0.024 ***	0.013 **
	(-0.42)	(-5.38)	(-4.02)	(2.53)
Observations	531,973	206,859	54,311	325,261

Panel C: 4 or Fewer stocks

	All Buy	$Buy>$Sell	$Buy≈$Sell	$Buy<$Sell
PGR	0.452	0.394	0.471	0.482
PLR	0.461	0.476	0.511	0.452
Difference	-0.009 *	-0.082 ***	-0.040 ***	0.030 ***
	(-1.72)	(-11.78)	(-4.15)	(5.32)
Observations	99,286	35,305	18,043	64,004

This table presents measures of the disposition effect on reinvestment days according to the relative amounts purchased and sold. PGR is the #Gains Sold/(#Gains Sold+#Gains Not Sold) and PLR is the #Losses Sold/(# Losses Sold+# Losses Not Sold). Difference is PGR-PLR with a *t*-statistic (clustered by date and account) for the test that this difference is zero underneath. All Buy includes all observations when another position is purchased. $Buy>$Sell includes days where the total amount purchased is greater than the total amount sold by at least 5%, $Buy≈$Sell include all days where the amount purchased is within 5% of the amount sold and $Buy<$Sell where the amount purchased is less than 95% of the amount sold. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 11 – Disposition Effect by Days from Most Recent Purchase

Gain*(Time to Buy)	0.007	***	Gain*(1 Week to Buy)	0.072	***
	(11.35)			(15.65)	
Gain	0.021	***	Gain*(2 Week to Buy)	0.085	***
	(3.87)			(15.03)	
Loss*Time to Buy	0.001	**	Gain*(3 Week to Buy)	0.094	***
	(2.42)			(14.26)	
Constant	0.149	***	Gain*(4 Week to Buy)	0.099	***
	(24.82)			(14.19)	
Observations	1,638,614		Gain	-0.007	
R2	0.008			(-1.23)	
			Constant	0.165	***
				(21.65)	
			Week Dummies	X	
			Observations	1,638,614	
			R2	0.009	

This table presents regressions of a dummy variable equal to one if a position is sold on *Gain*, a dummy variable equal to one if a position is at a gain, and variables indicating the number of days between a sell day and the most recent buy day. The first column includes a linear variable *Time to Buy* which is the number of days between a sell day and the nearest buy day. The second column includes dummy variables for each week (5 trading days) to the nearest buy day, with the omitted category being where the buy and the sell are on the same day. The main effects of the four week dummies not interacted with *Gain* are included in the regression, but not reported. We consider only observations where a buy and sell day occur within one month of each other (where *Time to Buy* is between 0 and 20 trading days). The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively

Table 12 – Investor Heterogeneity

Panel A: Within Investor Difference in Disposition Effect between Reinvestment and Liquidation Days

All Observations	0.077 ***
	(18.77)
4 or Fewer Stocks	0.108 ***
	(12.79)
5 or More Stocks	0.048 ***
	(12.53)

Panel B: Disposition Effect on Reinvestment and Liquidation Days by Taxable Status

	Deferred Tax Accounts		Taxable Accounts	
	Liquidation Day	**Reinvestment Day**	**Liquidation Day**	**Reinvestment Day**
PGR	0.311	0.199	0.241	0.150
PLR	0.200	0.214	0.171	0.157
Difference	0.111 ***	-0.016	0.071 ***	-0.007
	(18.20)	(-1.04)	(15.15)	(-1.05)
Observations	315,730	143,226	1,078,251	473,540

Panel A presents measures of the disposition effect and rank effect calculated for each investor separately for liquidation days and reinvestment days. Only investors with at least five of each type of day are included. The mean difference is shown with a *t*-statistic (clustered by date and account) for the test that this difference between the two disposition effect measures is zero underneath. Panel B presents measures of the disposition effect separately for reinvestment and liquidation days by tax status of the account. Deferred tax accounts are those categorized as IRA or Keogh in the data. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.

Table 13 – Rank Effect by Reinvestment and Liquidation Days

	All	Liquidation Day	Reinvestment Day
Best	0.246	0.271	0.188
Worst	0.177	0.169	0.197
Difference	0.069 ***	0.102 ***	-0.009
	(14.39)	(19.60)	(-1.52)
2nd Best	0.196	0.207	0.170
2nd Worst	0.145	0.136	0.166
Difference	0.051 ***	0.071 ***	0.004
	(14.66)	(20.71)	(0.66)

This table presents measures of the tendency of investors to sell extreme ranked positions, according to whether or not a purchase was also made on the same day. Best is the #Best Sold/(#Best Sold+#Best Not Sold) where best is the position with the highest return since purchase, worst is the lowest return and 2nd best (worst) is the 2nd highest (lowest) return. Difference is Best-Worst in the third row and 2nd Best-2nd Worst in the seventh row with a t-statistic (clustered by date and account) for the test that this difference is zero underneath. "Liquidation Day" means the sale occurred without any purchase that day, and "Reinvestment Day" includes days where any position is purchased. The top value is the coefficient, the bottom value in parentheses is the *t*-statistic, and standard errors are clustered by acount and date. *, **, and *** indicate statistical significance at the 10%, 5%, and 1%, level respectively.