Published paper, please cite as:
Duxbury, D., Hudson, R., Keasey, K., Yang, Z., and Yao, S. (2015). Do the Disposition and House Money Effects Coexist? A Reconciliation of Two Behavioral Biases using Individual Investor-Level Data. *Journal of International Financial Markets, Institutions and Money*, **34**, 55-68.
DOI: http://dx.doi.org/doi:10.1016/j.intfin.2014.11.004

Do the Disposition and House Money Effects Coexist? A Reconciliation of Two Behavioral Biases using Individual Investor-Level Data

by

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Abstract

This paper uses investor-level data to examine jointly the tendency of investors to succumb to the disposition effect and the house money effect; two behavioral biases premised on seemingly contradictory responses to prior gains/losses. We document three novel findings. First, the two effects can contemporaneously coexist in a single stock market and the majority of investors (53.5%) simultaneously succumb to both effects. Second, we demonstrate the importance of distinguishing prior outcomes across two dimensions; *unrealized/realized* and *stock/portfolio level*. Third, we find that the house money effect moderates the disposition effect, suggesting that cognitive biases need not always have negative consequences.

Keywords: behavioral biases; disposition effect; gains and losses; house money effect; investor behavior; mental accounting; prior outcomes.

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1. Introduction

Contrary to principles of rational economic behavior, prior outcomes have been shown to influence individuals' decisions. Shefrin and Statman (1985) coined the phrase the "disposition effect" to refer to the tendency of investors to sell winning shares while continuing to hold losing ones. The disposition effect is a robust behavioral anomaly, with widespread evidence in a variety of financial markets; including the U.S. (Odean, 1998), Finland (Grinblatt and Keloharju, 2001), China (Feng and Seasholes, 2005; Chen et al. 2007), experimental markets (Weber and Camerer, 1998; Oehler et al.2003; Summers and Duxbury, 2012) and across a range of different trader types, including day traders (Jordan and Diltz, 2004) and professionally managed accounts (Shapira and Venezia, 2001).[1] Such behavior has largely been explained in terms of the S-shape value function in prospect theory (Kahneman and Tversky, 1979), which depicts risk aversion in the gain domain (winning shares) and risk seeking in the loss domain (losing shares). Thaler and Johnson (1990), in contrast, coined the term house money effect to reflect evidence in the context of financial gambles that individuals tend to be more risk taking following prior gains (i.e. when gambling with the casino's money rather than their own), while being more risk averse following prior losses. While there are fewer studies of the house money effect (see Locke and Mann, 2003; for an early study) than the disposition effect, there is growing evidence of the presence of the former effect in financial markets; including Sweden (Massa and Simonov, 2005), Taiwan (Liu et al., 2010), Australia (Frino et al., 2008) and experimental markets (Gneezy et al., 2003; Ackert et al., 2006).

On first consideration, the two effects seem at odds with one another, with the disposition effect

[1] See Barber and Odean (2011) for a discussion of the range of evidence in relation to individual investors.

reflecting risk aversion following prior gains and risk seeking following prior losses, while the house money effect is premised on the reverse behavior of risk seeking/aversion following prior gains/losses. The primary purpose of this paper is to test whether the disposition and house money effects contemporaneously coexist in a single financial market, whether single investors simultaneously exhibit behavior consistent with both effects and whether the two effects potentially interact with one another. While separate studies document the existence of the two biases individually, the use of disparate datasets across studies, render them unable to comment, either individually or collectively, on the coexistence of the two biases or the extent to which they may be driven by investors' differing reactions to realized and unrealized gains/losses at the stock or portfolio level. Furthermore, the simultaneous examination of the disposition and house money effects reported here uniquely informs not only if and how such disparate behavior might coexist, but also allows potential interactions to be explored.

Using investor-level account data from a brokerage in China,[2] which records all the trading data, static position data, and personal information of each investor registered with the brokerage, we find that the disposition and house money effects coexist contemporaneously in a single financial market; nearly all investors in our sample (95.1%) are subject to one effect or the other, while the majority (53.5%) simultaneously succumb to both. Our results show that it is important to distinguish between prior outcomes across two dimensions: whether they relate to unrealized or realized outcomes and whether they have been assessed at the individual stock level or the aggregate portfolio level. We demonstrate that the disposition effect is related to prior unrealized outcomes at the individual stock level, while the house money effect is related to prior realized outcomes at the

[2] The Chinese stock market has been the subject of much academic interest in recent years, with studies examining the efficiency of the market (Fong, 2009), the profitability of trading strategies (Schuppli and Bohl, 2010) and the extent of integration with other international stock markets (Wang and Firth, 2004; Wang and Iorio, 2007; Li, 2013), along with a range of behavioral issues, including the disposition effect (Chen et al, 2007; Feng and Seasholes, 2008).

individual stock level and to both prior unrealized and realized outcomes at the aggregate portfolio level. This latter result extends the findings in other studies of the house money effect in financial markets (e.g. Liu et al., 2010; and Massa and Simonov, 2005), that show the effect is present in aggregate portfolio level data, to document the presence of the effect in individual stock level data. It seems that how investors mentally account for gains and losses is an important determinant of how they react to prior outcomes.

We provide unique insight into a hitherto unrecognized interaction between the two effects, documenting the moderating impact of the house money effect on the disposition effect. After controlling for a number of individual investor characteristics (age, gender, wealth, diversification and turnover), we find that those investors with a higher tendency to succumb to the house money effect have a lower tendency to display the disposition effect. While the disposition effect may damage investors' returns, with winning stocks sold earning on average a 3.92% higher return than losing stocks held, we find that the house money effect reduces the cost to investors succumbing to the tendency to sell winning stocks, but increases the cost to investors succumbing to the tendency to hold losing stocks. The cost reduction for winning stocks, however, is over four times the cost increase for losing stocks, hence the analysis supports the view that the house money effect moderates the disposition effect and that the impact is of economic significance. While cognitive biases have conventionally been viewed as detrimental to decision making, this latter finding suggests this need not always be the case, particularly when multiple cognitive biases may be at play.

2. Evaluation of prior gains and losses: literature and hypotheses

On first consideration, the disposition and house money effects seem at odds with one another, with the former reflecting risk aversion following prior gains and risk seeking following prior losses, while the latter is premised on the reverse behavior of risk seeking/aversion following prior

gains/losses. Two important factors follow from Shefrin and Statman's (1985) conceptualization of the disposition effect based on capital gain and loss realization. First, the gains and losses that drive such behavior must be unrealized, because the decision is to sell or hold stocks already owned. Second, investors must evaluate, or mentally account, for such gains and losses at the level of the individual stock rather than their portfolio as a whole (narrow as opposed to broad framing in the terminology of Barberis and Huang, 2001). In contrast, following Thaler and Johnson's (1990) discussion of integration and segregation in the context of the house money effect, it is not clear whether such behavior need be premised on an evaluation of realized gains and losses at the individual stock or aggregate portfolio level It is interesting to note that the existing evidence in support of the disposition effect in financial markets is based on a comparative analysis of decision-making, focusing on sell and hold decisions for winning or losing stocks (e.g. Shefrin and Statman, 1985; Odean, 1998; and Grinblatt and Han, 2005), while evidence to date in support of the house money effect is provided at the aggregate portfolio level (e.g. Liu et al., 2010; and Massa and Simonov, 2005). In the following, we draw briefly on prior literature to motivate further our interest in the impact of individuals adopting a narrow or broad frame when evaluating their investments and the distinction between realized and unrealized prior outcomes, and to develop our hypotheses.

Individuals have been shown to compartmentalize money into distinct mental accounts in their minds; with money posted in distinct accounts treated differently in terms of the propensity to spend and individuals reluctant to aggregate gains and losses across different accounts (Thaler, 1999). In the context of examining the impact of prior outcomes on trading behavior, evidence from the mental accounting literature suggests that decision makers can evaluate prior outcomes in a "narrow frame" or in a "broad frame" (Thaler, 1999). In the former the effect of prior outcomes for a given stock would only be observed in the relevant investment account for that stock, whereas in the latter the effect would spread to the whole portfolio and so impact upon other stocks held.

Barberis and Huang (2001) propose that investors may use both "individual stock accounting" (narrow framing) and "portfolio accounting" (broad framing) when making decisions. Investors may make different decisions when adopting different "frames" and, therefore, disparate behavioral effects could be observed when we examine investors' trading behavior from the different perspectives of "individual stock accounting" and "portfolio accounting". We consider whether the disposition effect and the house money effect are jointly or separately observed at the portfolio-level and/or the stock-level. In doing so, we examine how behavior is influenced by prior outcomes in terms of "individual stock accounting" (narrow frame) and "portfolio accounting" (broad frame).

It is conceivable that investors may bracket realized and unrealized outcomes into different mental accounts and hence treat them differently (Shefrin and Statman, 1985). Moreover, anticipated regret theory would also imply that realized and unrealized prior outcomes may impact risk attitudes, and so behavior, in different ways (Loomes and Sugden, 1982; Zeenlenberg, 1999). Zeelenberg (1999) argues that anticipated regret plays an important role in an individual's response to unrealized outcomes, an aspect acknowledged by Shefrin and Statman (1985) in the context of the disposition effect. A tendency to sell winners rather than hold them might arise because investors anticipate the regret they would experience were they to continue to hold the winning stock only for it to subsequently fall in value, eroding all or part of the unrealized gain. Selling, and hence realizing the gain, removes this possibility. Summers and Duxbury (2012) demonstrate experimentally that emotions have a leading role to play in the disposition effect. In their experiment they manipulate responsibility for prior gains and losses, which in turn manipulates the emotions to be experienced. Absent responsibility for the initial buy decision, prior gains/losses may lead to feelings of elation/disappointment at the outcome, while feelings of rejoicing/regret may also be experienced in the presence of responsibility. Summers and Duxbury (2012) find that regret drives the tendency for investors to hold losers, while elation is sufficient to cause investors to sell winners (rejoicing is not

required). In the absence of responsibility for the initial decision to buy the investment, they find no evidence of a disposition effect in the presence of prior gains and losses, providing direct support for recent theoretical (Barberis and Xiong, 2009) and empirical (Kaustia, 2010) challenges to the view that prospect theory provides a sole causal explanation of the disposition effect. There is good reason to believe, therefore, that realized and unrealized outcomes might play different roles in investors' decision making processes, hence we examine the extent to which prior realized and unrealized outcomes impact differentially on trading behavior.[3]

In this paper we examine empirically whether the disposition and house money effects contemporaneously coexist in a single financial market, whether single investors simultaneously exhibit behavior consistent with both effects and whether the two effects potentially interact with one another. While Massa and Simonov (2005) and Frino et al. (2008) investigate both the house money effect and loss aversion, which they see as synonymous with the disposition effect, they do not measure directly the effect as defined by Shefrin and Statman (1985) and as operationalized by Odean (1998), thus they are unable to fill the gap that this paper seeks to address. There are other important features that distinguish our work from that of these two prior studies. First, a primary concern of Massa and Simonov (2005) is to investigate how investors react to prior outcomes taking into account all wealth and income, not just financial wealth in the form of stock holdings, and they show that gains and losses in one category of wealth (e.g. real estate) can influence investors' holdings in other wealth categories (e.g. financial assets). In order to achieve this, Massa and Simonov (2005) assemble an impressive dataset combining data on individual stock holdings with data from a longitudinal panel survey of Swedish households, which includes details relating to wealth, real estate, labor and entrepreneurial income, amongst other things. This survey data is

[3] While this distinction has been largely ignored in the empirical finance literature, a few studies recognize its potential importance (for example, Locke and Mann, 2003; Frino et al., 2008). Unfortunately Frino et al. (2008) do not maintain such a distinction when investigating the impact of loss aversion, which, given the findings in this paper, might account for their failure to find evidence in support of a disposition effect.

collected once a year, hence the analysis undertaken in Massa and Simonov (2005) is based on low frequency (yearly) data. In contrast, we follow the convention in other studies (e.g. Barber and Odean, 2000; Odean, 1998) of using high frequency transaction data. Second, Massa and Simonov (2005) use measures of realized financial net gains and losses declared by investors when they file with the authorities. Setting aside the potential problems associated with self-reported measures, this approach limits Massa and Simonov (2005) to consider aggregate gains and losses and so prohibits them from undertaking detailed analyses at the individual stock level as is the case in our own work. Third, similar to Coval and Shumway (2005), but based on Australian data, Frino et al. (2008) examine how morning gains or losses influence the afternoon risk taking behavior of futures traders, while we examine the effect of prior outcomes on trading behavior in relation to stocks using predominantly individual investors.

In a recent study, Duxbury et al (2013) investigate how prior realized outcomes impact on the characteristics of stocks investors select to hold in their portfolios, hence they are concerned with an evaluation of the impact of *realized* outcomes at the *portfolio*-level on investors' *buy/hold* decisions. Following positive prior realized outcomes, Duxbury et al (2013) find that investors are more prone to invest in stocks with characteristics broadly consistent with higher risk taking (for example, higher betas and higher levels of idiosyncratic risk) than is the case following prior negative realized outcomes, though the precise characteristics differ across investor classes. In this study, we consider more widely the evaluation and impact of *realized* and *unrealized* outcomes at both the *stock*-level and *portfolio*-level on investors' *sell/hold* decisions, with the latter focus driven by our interest in the disposition effect (i.e. the tendency to sell winners too soon and hold losers too long).

Drawing on the discussion of the literature above, we develop below our hypotheses. The first step in investigating the coexistence of the disposition effect and the house money effect is to demonstrate that the former effect is present in our data. Thus, based on individual stock level

analysis and consistent with Odean (1998), we test the following hypothesis.

Hypothesis 1: The percentage of gains realized (PGR) for all observations > the percentage of losses realized (PLR) for all observations.

To investigate whether the house money effect is present for individual stocks, we examine the effect of *prior* realized gains and losses for individual stocks on the tendency for investors to realize *subsequent* gains (PGR) and losses (PLR) on the same stock (i.e. the conditional PGR and PLR).

Higher PGR means that investors are more likely to sell winners, which can be interpreted as exhibiting a higher level of risk aversion in the sense that investors sell winning stocks to lock in the gains on such stocks. Thus, if prior realized gains result in increased risk taking behavior, as per the house money effect, we would expect PGR to be *lower* than would be observed in the presence of prior realized losses (i.e. investors exhibit a greater tendency to let subsequent unrealized gains ride by continuing to hold winning stock following prior realized gains than prior realized losses). Conversely, a smaller PLR indicates a higher level of risk taking as losers are held longer. Thus, if prior realized losses result in reduced risk taking behavior we would expect PLR to be *higher* than would be observed in the presence of prior realized gains (i.e. investors exhibit a greater tendency to cut their losses by selling losing stock following prior realized losses than prior realized gains). Hence we test hypotheses 2a and 2b.

Hypothesis 2a: PGR for observations with prior realized gains (PGR-Gain) < PGR for observations with prior realized losses (PGR-Loss.)[4]

Hypothesis 2b: PLR for observations with prior realized gains (PLR-Gain) < PLR for observations with prior realized losses (PLR-Loss).

[4] PGR-Gain is the percentage of gains realized relative to all gains on which investors hold prior realized *gains*; and PGR-Loss is the percentage of gains realized relative to all gains on which investors hold prior realized *losses*. PLR-Gain and PLR-Loss are the corresponding measures for the percentage of losses realized.

Implicit in the discussion of hypotheses 1 and 2 is the assumption that a higher propensity to sell a stock implies lower risk taking. While this may be true by design in experimental studies in which there is only one risky asset and where sale implies a switch to a risk-free asset, it does not necessarily follow in stock markets where there are many risky asset alternatives and investors are free to reinvest the sale proceeds from one risky asset in other risky assets. However, hypotheses 1 and 2 relate to the individual stock level, a situation where Barberis and Huang (2001, p.1247-1248, emphasis in original) suggest "*loss aversion* and *narrow framing* play an important role in determining attitudes towards risk". If investors adopt a narrow frame (i.e. they mentally account from an individual stock level perspective), then their sell decisions are influenced, at least in part, by the desire to lock-in a sure gain by selling their winners or to avoid closing the account at a loss (Thaler, 1999) by holding losers. A decision to sell, therefore, may still be perceived as lower risk taking irrespective of what the investor subsequently chooses to do with the sale proceeds, be it reinvesting in another risky asset or holding some form of risk-free asset.

We turn our attention now to consider aggregate "portfolio accounting" (broad framing). When investigating investors' risk attitudes at the aggregate portfolio level, prior outcomes cannot be related to narrow framing thus the potential influence of loss aversion and emotions on trading behavior, and the disposition effect in particular, become unclear. In contrast, based on prior evidence in Massa and Simonov (2005) and Liu et al. (2010), we expect the house money effect to be observed at the aggregate portfolio level. We extend these prior studies to examine the effect of both unrealized and realized prior outcomes on subsequent risk taking.

Hypothesis 3: At the aggregate portfolio level, investors with unrealized and realized prior gains should have higher subsequent risk measures (i.e. expected absolute position change, relative trade size and CAPM beta) than those with unrealized and realized prior losses.

3. Data

Our data set comprises two parts. The first part is a brokerage account data set from a brokerage located in Beijing, China, which includes all the trading data, static position data, and data on personal characteristics (such as investor age and gender) of the investors who are registered with the brokerage as clients. For each transaction of an investor, we have the transaction date, quote time, transaction time, trading volume, transaction price, stock code and trading label (purchase or sale). The position data gives the stock codes and share volumes in investors' portfolios at the end of each trading day. Restrictions on the number of fund accounts an investor can have and the number of brokerages for which they can be clients, mean that the data provides full information about the trades, stock positions and portfolios of investors during the sample period. The brokerage provides the transaction data and portfolio data[5] for 3,139 individual and 49 institutional investors, though filtering to remove inactive accounts (i.e., those with no buys or sells) and those with zero holdings (i.e. zero portfolio value) reduces the number of individual investors in our sample to 2,528. There are 314,932 transactions in our data set, including 140,839 sales, and the total trade value is RMB 10,089,722,910. The second part of the data set comprises daily stock price and return data, including the daily opening price, closing price, highest price, lowest price, and adjusted return of each stock in the market. This data is collected from CCFR (China Centre for Financial Research, Tsinghua University) and the Yahoo Finance website. The data sample period is from February 27, 2001 to December 16, 2004. During this time the SHSE and the SZSE move closely together through three bull and three bear market cycles (Yan et al, 2007), thus supporting a joint analysis of the two exchanges. We restrict our attention to A shares, because they dominate the Chinese stock market in terms of the number of companies listed, daily trading values and market

[5] Similar to the findings in numerous prior studies (e.g. Barber and Odean, 2000), portfolio diversification in the sample is low (see Fuertes et al, 2012, for a discussion of behavioral factors influencing diversification). The average number of stocks in the portfolios, measured on a monthly basis during the sample period, is 2.91 and 3.10 for individual and institutional investors, respectively, and they turn over their portfolio 1.01 and 2.12 times, respectively, per month.

capitalization[6], and also because domestic trading in B shares is very thin.

4. Empirical Method

4.1 Methodology

We measure realized and unrealized prior outcomes for a given investor on a given stock, which we also use to construct aggregate portfolio data. We also capture investors' trade decisions, employ proxies to capture risk attitudes, and construct measures of the disposition and house money effects. All of the above is done at the investor-level and we also capture various investor characteristics.

4.1.1 Measuring prior outcomes

For each investor, at the end of each trading day we compute

$$\pi^{R}_{i,t,n} = \sum_{k=1}^{K} [(P^{\text{Sell}}_{i,n,k} - P^{\text{Reference}}_{i,n,k}) * V^{\text{Sell}}_{i,n,k}] \quad (1)$$

$$\pi^{U}_{i,t,n} = (P^{\text{Current}}_{i,t,n} - P^{\text{Reference}}_{i,t,n}) * V^{\text{Hold}}_{i,t,n} \quad (2)$$

where i denotes investor i, t denotes trading day t, n denotes the nth stock, K indicates the investor has made K trades over this stock in a period, k is the kth trade of the K trades over the stock, $\pi^{R}_{i,t,n}$ and $\pi^{U}_{i,t,n}$ are realized and unrealized outcomes respectively, $P^{\text{Sell}}_{i,n,k}$ is the sell price of the kth trade, $P^{\text{Current}}_{i,n,k}$ is the current price, $P^{\text{Reference}}_{i,n,k}$ is the reference price[7] of the kth trade, $P^{\text{Reference}}_{i,t,n}$ is the current reference price indicating the costs at which the investor purchases the stock currently in his portfolio, $V^{\text{Sell}}_{i,n,k}$ is the selling volume of the kth trade, and $V^{\text{Hold}}_{i,t,n}$ is the volume that the investor

[6] By the end of 2001, there were over 1,100 companies listed with A shares while there were only 110 companies listed with B shares. The market capitalization of the A share stock market was RMB 4224.6 billion and that of the B share stock market was RMB 127.7 billion.

[7] The choice of method used to determine reference prices will impact on the value of the prior outcomes computed. We employ three different methods; share-weighted value of all the historical purchasing prices, "FIFO" (First-In-First-Out) and "LIFO" (Last-In-First-Out). The analyses and results are robust to the method chosen, hence we only report the results derived using the share-weighted reference price.

holds in his portfolio. Note that the prior outcome at the aggregate portfolio level for a given investor on a given trading day is simply the sum of outcomes on all the stocks in their portfolio, computed separately for realized and unrealized outcomes.

Our approach to distinguishing between unrealized and realized outcomes is related to, but differs from, Barberis and Xiong's (2009) examination of the prospect theory explanation of the disposition effect from the perspective of annual gains/losses and realized gains/losses. In the former case investors receive utility from prior gains/losses only at the end of the year, while in the latter case they receive "a jolt of prospect theory utility right then, at the moment of sale, where the utility term depends on the size of the realized gain or loss" (Barberis and Xiong, 2009, p. 753). Thus, their distinction is not driven by whether a sale has taken place, but rather by when the utility from a sale is derived. In contrast, we use *unrealized* to refer to paper gains/losses prior to a sale being initiated, while *realized* gains/losses derive only after a sale takes place.[8]

4.1.2 Prior outcomes and decision making at the individual stock level

To measure the tendency of an investor to sell or hold a stock at the individual stock level, we employ the method of Odean (1998). Each day that an investor sells a stock, we compute PGR (Percentage of Gains Realized to all gains) and PLR (Percentage of Losses Realized to all losses).

$$\text{PGR} = \frac{\text{Number of realized gains}}{\text{Number of realized gains} + \text{Number of paper gains}} \tag{3}$$

$$\text{PLR} = \frac{\text{Number of realized losses}}{\text{Number of realized losses} + \text{Number of paper losses}} \tag{4}$$

A sale is judged to be a gain (loss) by comparing the selling price to the reference price.[9] For

[8] Barberis and Xiong (2009) compute gains and losses relative to the return on the risk free rate. In line with many prior empirical studies (e.g. Odean, 1998), we compute gains and losses relative to the reference purchase price, excluding adjustments for the risk free return.

[9] We define a sale as a realized gain/loss if an investor sells any (positive) proportion of his/her holding of a particular stock.

stocks not sold in a given day, if both the lowest and highest price are above (below) its reference price it is counted as a paper gain (loss), otherwise it is classed as neither a gain nor a loss. Since the intention is to compare the PGR and PLR ratios across stocks with prior realized gains or losses, we group stocks by their prior realized outcomes first and calculate the conditional PGR and PLR. On those days when no sales take place for a given investor, no gains or losses are counted.

4.1.3 Prior outcomes and risk attitudes at the aggregate portfolio level

To investigate the relationship between prior outcomes at the aggregate portfolio-level it is not sufficient look at the buy/sell decisions on individual stocks, instead it is necessary to construct proxies for subsequent risk attitude. To this end we measure the prior unrealized and realized outcomes at the end of each month that the investor holds a position and the risk taken in the following three months. To measure the subjective risk attitude of each investor using the transaction data we adopt the approach of Coval and Shumway (2005), employing the expected absolute position change and the relative trade size as alternative proxies, to which we add the beta of the portfolio as derived by the CAPM model to capture systematic risk.[10] We define an investor's prior outcomes and subsequent risks at the beginning of a given month as an observation. There are a total of 15,406 observations, and for each observation the prior unrealized outcomes, realized outcomes, wealth of the corresponding investor, and subsequent risks are calculated.[11]

Expected absolute position change, Relative trade size and CAPM beta

We apply Coval and Shumway's (2005) expected absolute position change measure of the subjective risk attitude of a trader. For each stock on each trading day, the expected absolute price change is estimated by an ordered logit regression on the absolute price change on each trading day

[10] For the whole sample, the correlation coefficients between relative trade size, expected absolute position change and CAPM beta are statistically insignificant, hence we conduct our analyses using all three proxies for risk attitude.
[11] For the relative trade size proxy the number of observations is slightly smaller than 15,406, because there is no value for this measure if the investor makes no trades in the three months following the prior outcome.

in the preceding five trading days and day-of-week dummy variables. On a specific trading day, the expected absolute position change of an investor is the sum of the weighted (shares of stock) product of the expected absolute price change of each stock in the investor's portfolio multiplied by the number of shares of the corresponding stock. Our risk measurement is the cumulative expected absolute position change in the three months after the observation date.[12]

As per Coval and Shumway (2005) the relative size of each trade for a given investor is calculated as the average trade size in the three months after the observation date divided by the average trade size of this investor during the entire sample period.

We also measure the risk that investors take when they trade by examining their post-trade portfolio structure. After each transaction, the investor reconstructs his/her portfolio and the risk of the portfolio changes. For each investor, we use portfolio beta estimated by the CAPM model for the three months after the observation date to proxy the risk of portfolio.

4.1.4 Measures of the disposition and house money effects for each investor

For each investor, we compute disposition effect and house money effect measures to identify whether an investor displays one or both of the behavioral biases. Our purpose is to investigate investors' reactions to prior outcomes, both realized and unrealized, thus we must be sure that investors have actually observed the prior gains and losses on stocks held in their portfolios (specifically, that they have observed the current stock price and so are cognizant of a gain or loss being present). To ensure this is the case we adopt Odean's (1998) PGR-PLR methodology, which examines investors' portfolios only on those days when investors make a sale.[13] Following Dhar and

[12] While the summation implicitly assumes that risk increases linearly with time, the intention is to undertake a cross-sectional comparison across individuals' risk attitudes for the same three month duration, not to compare an individual's risk attitude over varying time intervals.

[13] While survival analysis has the benefit of using the additional information available on days where a sale does not take place (see Feng and Seasholes, 2005), we have no way of knowing in our dataset whether investors are cognizant of the unrealized gains or losses on their stocks on such days.

Zhu (2006) we measure the disposition effect at the level of the investor, rather than in aggregate. For investor i, the measure of the disposition effect (DPE_i) is the discrepancy between the PGR and PLR during the whole sample period. A positive DPE_i indicates that an investor is more likely to realize gains than to realize losses. The higher the value of the DPE measure, the higher the tendency for the investor to exhibit the disposition effect.[14]

We construct a measure of the house money effect for the whole sample period that is analogous to the disposition effect measure above.

$$HME_i = \frac{\forall\ PRO_{i,n} > 0, \sum_{n=1}^{N} \frac{RISK_{i,n+1}}{\overline{Risk_i}}}{No.\ months\ PRO_i > 0} - \frac{\forall\ PRO_{i,n} < 0, \sum_{n=1}^{N} \frac{RISK_{i,n+1}}{\overline{Risk_i}}}{No.\ months\ PRO_i < 0} \qquad (8)$$

Where, for investor i, HME_i is the house money effect measure, $PRO_{i,n}$ is the prior realized outcomes in month n, $Risk_{i,n+1}$ is the risk measure[15] in month n+1, $\overline{Risk_i}$ is the average monthly risk measure (calculated as the monthly risk measure divided by the aggregate average monthly risk measure), and N is the total number of months in the period. A positive HME_i measure indicates that an investor is prone to the house money effect in the sense that they tend to be more risk taking after prior realized gains than losses.

5. Empirical results

5.1 Coexistence of the disposition and house money effects at the individual stock level?

Table 1 reports the number of prior realized and unrealized gains and losses, along with PGR and PLR. Consistent with Odean (1998), we find PGR=0.2825 is significantly higher than

[14] We recognize that there may be potential issues when using the PGR-PLR methodology in cross-sectional analyses of individual investor behavior (see, for example, Appendix D of Feng and Seasholes, 2005) and we employ controls and robustness checks to mitigate against such problems.

[15] Throughout we adopt the expected absolute change of the portfolio value as the risk measure.

PLR=0.1215, confirming the existence of the disposition effect in our data set (hypothesis 1). When confronted with *unrealized* gains investors exhibit a greater tendency to realize those gains than their tendency, when confronted with *unrealized* losses, to realize those losses. Next we extend the analysis to investigate the impact of prior *realized* gains and losses for a given stock on the tendency to make a subsequent decision to sell the stock (i.e. the conditional PGR and PLR).[16] In the presence of prior realized gains, the proportion of gains realized (PGR-Gain = 0.3011) is greater than the proportion of losses realized (PLR-Gain = 0.1547), while in the presence of prior realized losses, the proportion of gains realized (PGR-Loss = 0.3389) is greater than the proportion of losses realized (PLR-Loss = 0.1659). The differences are statistically significant and confirm the presence of the disposition effect (comparison across rows in Table 1) at the individual stock level both when investors hold prior realized gains or prior realized losses for the stock in question.

<Insert Table 1 about here>

We examine whether behavior consistent with the house money effect is observed by comparing PGR (PLR) in the presence of *prior realized gains* to the PGR (PLR) in the presence of *prior realized losses* (comparison across columns in Table 1). Consistent with the house money effect we expect investors to be more likely to continue to hold stocks (exhibit risk seeking behavior), whether they be currently winners or losers, for which they have a *prior realized gain* (i.e. both PGR-G and PLR-G) than stocks for which they have a *prior realized loss* (i.e. both PGR-L and PLR-L) which they are more likely to sell (exhibit risk avoiding behavior). Table 1 reports that PGR-Loss (0.3389) is indeed higher than PGR-Gain (0.3011), while PLR-Loss (0.1659) is higher than PLR-Gain (0.1547), both at a statistically significant levels. Thus, in support of hypotheses 2a and 2b, the results provides strong evidence of trading behavior consistent with the house money effect, with investors being more risk

[16] To make clear, prior refers to a previous point in time, such that a prior *realized* gain at $time_0$ requires the situation where an investor has experienced an *unrealized* gain at some point in the past (say $time_{-2}$) that they decided subsequently to realize at a point in time preceding (say $time_{-1}$) their current decision point (i.e. $time_0$).

taking following *prior realized* gains than losses, based on individual stock-level data.

By way of robustness test, we examine investors' trading decisions using a binary logit approach, similar to Grinblatt and Keloharju (2001). On each day an investor trades, the dependent variable in the model equals 1 for a sale (whole or partial holding) and 0 otherwise. The primary regressors of interest are the prior *unrealized* and *realized* outcomes (gains/losses) on a given stock. Following Grinblatt and Keloharju (2001), we include control variables to capture the effects of other factors that may influence investors' trading decisions (including past returns, market returns and investor characteristics).[17] The results, not reported here, confirm the robustness of the above findings. Consistent with the disposition effect, prior *unrealized* outcomes are generally positively related to the tendency to sell, with investors more likely to sell stocks with prior *unrealized* gains than losses. In contrast, consistent with the house money effect, prior *realized* outcomes are negatively related to the tendency to sell, with investors more likely to hold stocks with prior *realized* gains than losses.[18]

In summary, our stock level analysis reveals two important findings. First, investors in the same stock market can contemporaneously display behavior consistent with the disposition and house money effects. Second, the evidence indicates that whether prior outcomes are realized or unrealized is the key requirement for the presence of each effect. The disposition effect is observed when investors' decisions are investigated in relation to *unrealized* outcomes; specifically the proportion of those unrealized outcomes that they decide to realize. In contrast, the house money effect is observed when investors' decisions are investigated in the presence of *prior realized* outcomes, which impact upon their decision concerning the proportion of *current unrealized* outcomes that they decide to realize. While it might seem that our results are at odds with recent theoretical

[17] The control variables include past market-adjusted stock returns (computed over various time intervals), past market returns (computed over the same time intervals), along with variables to control for the potential asymmetric impact of investor characteristics (e.g. age, gender, diversification and turnover) following positive and negative prior unrealized and realized outcomes. While some control variables were significant, they are not discussed further here.

[18] Following, among others, Duxbury et al (2013), we separate investors into institutions, high, medium and low wealth individual investors. We find a positive relationship between prior *realized* outcomes and the tendency to sell for all but high wealth individuals.

work by Barberis and Xiong (2009) on the cause of the disposition effect, this is not the case. We distinguish between unrealized gains/losses prior to the initiation of a sale and realized gains/losses deriving from a past sale, while their concern is with the realization of *utility* derived from prior gains and losses during the year, which occurs either at the end of the year or at the point of sale.

5.2 Coexistence of the disposition and house money effects at the aggregate portfolio level?

Next we turn to an investigation of trading behavior at the portfolio level, by examining the link between investors' prior outcomes at the beginning of each month and their subsequent risk attitudes in the following three months. The results from the three alternative measures of subsequent risk attitude are reported in Tables 2, 3, and 4. In all tables, observations of monthly investment outcomes and subsequent risks are double sorted by the wealth of the investor (i.e. the average portfolio position value, computed as the average of the values of the monthly portfolios for that investor) and the relative prior *realized* (Panel A) or *unrealized* (Panel B) outcomes (where relative prior outcomes are the rates of prior outcomes compared to the portfolio position values).

Beginning with prior *realized* outcomes, there is strong evidence to suggest that these have an influence on the subsequent risk attitudes, with investors willing to take more risk following higher prior realized outcomes then lower ones (supported by the significant main effects in the two-way ANOVA tests for all three risk attitude measures). The impact is particularly strong for the expected absolute position change measure (see Table 2 Panel A), where those investors with higher prior realized outcomes subsequently take higher risks (see significant t-test of differences for all wealth quintiles). Although the individual wealth quintile results are not so clear-cut for the relative trade size (Table 3 Panel A) and portfolio CAPM beta (Table 4 Panel A) risk measures, for which only the low wealth groups (Quintiles 1 and/or 2) produce significant effects, the main effect of prior realized outcomes in the ANOVA model is significant for both these measures. Turning to

prior *unrealized* outcomes, the results are again strongest for the expected absolute position change measure. In Panel B of Table 2, the column t-statistics of differences in the risk attitude measure due to prior unrealized outcomes are highly significant and positive for all wealth quintiles, showing investors also tend to be more risk taking with higher prior unrealized outcomes. The results for the relative trade size measure in Panel B of Table 3 are similar, though they are not significant for Quintile 4. In contrast, however, in Panel B of Table 4, the effect is not significant for any of the wealth quintiles when risk is measured as the portfolio CAPM beta.

<Insert Tables 2, 3, and 4 about here>

There is evidence in Tables 2-4 of investors' risk attitudes differing across wealth levels. For example, the significant interaction effects in the two-way ANOVA models of Tables 2 and 3, suggest that the impact of prior outcomes on the risk attitude measures is affected by the level of wealth, such that higher wealth levels report lower effects of prior outcomes on the risk attitudes. To ensure our results relating prior outcomes to subsequent risk attitudes and behavioral biases are robust to disparate investor characteristics such as wealth, we examine the relationship between the change in prior outcomes and change in risk attitudes for each investor, thus eliminating the effect of factors such as wealth, experience, and other investor characteristics. We select those observations where an investor holds positions in the current and the previous month, thus allowing us to compute the changes in prior unrealized and realized outcomes for each two consecutive month period.[19] Next the selected observations are double sorted by the sign of the change of prior unrealized and realized outcomes, resulting in 2x2 groups based on positive/negative change and realized/unrealized. Table 5 reports how risk taking varies with the changes in prior unrealized and realized outcomes. On average, investors change their risk attitudes following a change in their prior

[19] This is to guarantee that for a given observation an investor has both prior unrealized and realized outcomes in two consecutive months.

outcomes. When the prior unrealized and realized outcomes of the current month are both higher than the previous month (i.e. change >0 for both), all three of the risk measures support significantly increased risk taking. When the prior unrealized and realized outcomes are both lower than the preceding month (i.e. change <0 for both), expected absolute position change and relative trade size measures support significantly reduced risk taking, while the CAPM beta measure is insignificant. Jointly, the results confirm the existence of the house money effect for both prior unrealized and realized outcomes at the aggregate portfolio level.

<Insert Table 5 about here>

To conclude, based on the evidence presented in Tables 2 to 5, the house money effect is present at the *portfolio* level for both prior *unrealized* and *realized* outcomes (hypothesis 3), while the disposition effect is not observed. After higher prior portfolio outcomes (including both unrealized and realized ones), investors tend to be more risk taking with their trades and portfolios than after lower prior portfolio outcomes. We demonstrate, therefore, that the unit of analysis, whether it be the individual stock or the portfolio, is key to observing the disposition effect or the house money effect. The former is only present in the case of individual stocks, while the latter is present for either individual stocks or portfolios of stocks.

5.3 Relationship between the disposition and house money effects

Having documented the contemporaneous co-existence of the disposition and house money effects in a single financial market, we turn our attention to an investigation of whether investors who are subject to one bias may also be subject to the other bias. For a given investor, for both the disposition effect and the house money effect measures, a value >0 indicates that they succumb to

the corresponding bias and a value ≤0 indicates they do not.[20] In Table 6 we categorize investors into four groups based on their scores on the two measures and report the number and proportion of investors in each category, along with the correlation coefficients between the behavioral biases. As can be seen from Panel A of Table 6, 87.6% of investors exhibit a disposition effect and 61% exhibit a house money effect, with both proportions significantly larger than the 50% expected by random chance. There are 95.1% of investors who are subject to at least one bias, while a 53.5% majority of the sample are subject to both biases simultaneously, with only 25% expected by random chance. In Panel B of Table 6 we report the correlation coefficients between the two behavioral bias measures, the dummies of the two measures, and the two measures within each of four categories, separately. The dummy for each measure is defined as "1" when the value is >0 indicating that an investor is subject to the bias, and defined as "0" otherwise. Based on the whole sample, correlations are insignificant. However, when we restrict our attention to those investors that succumb to both biases, the correlation between the disposition and house money effects is negative (-0.137) and highly significant, indicating that when an investor is subject to both effects contemporaneously, then a stronger disposition effect may be associated with a weaker house money effect, and vice versa. One interpretation might be that, for a given investor, the presence of the house money effect weakens the magnitude of the disposition effect at the individual stock level. Indeed we see evidence of this in Table 2 where prior realized gains over an individual stock make investors more risk seeking than prior realized losses when making sell versus hold decisions on the stock (PGR-G = 0.3011 < PGR-L = 0.3389 and PLR-G = 0.1547 < PLR-L = 0.1659, both difference highly significant). Overall the disposition effect measure in the presence of prior realized gains of 0.1464 is lower than that observed in the presence of prior realized losses of 0.1730. There

[20] In order to calculate the disposition effect measure investors must have realized at least one gain or loss during the period, while the house money effect measure requires that investors experience holding both positive and negative realized portfolio outcomes and that they continue to hold positions in the months following the prior realized outcomes. Collectively these two requirements reduce the number of investors in the analysis to follow to 748. However, as both measures are two-sided and thus permit behavior that is both consistent and inconsistent with the predicted behavior, the use of the reduced sample size is not expected to bias the analysis.

is evidence, therefore, that the house money effect moderates the disposition effect, such that increased risk taking behavior (in particular the decreased tendency to sell a winner) in the presence of prior gains may help to mitigate the extent of the disposition effect.

<Insert Table 6 about here>

5.4 Regression analysis

To investigate the relationship between the disposition and house money effects further, we regress the disposition effect measure (dependent variable) against the house money effect measure (explanatory variable). In light of empirical findings reported in the extant behavioral literature, we include a number of control variables to capture individual investor characteristics.[21] We employ a range of proxies for investor sophistication, experience and learning, including a dummy variable to classify whether the investor is an institution or an individual, investors' average monthly position values as a proxy measure of investors' total wealth (which is unavailable in our data), the average number of different stocks held in an investor's monthly portfolio as a measure of portfolio diversification, the average monthly turnover of an investor (calculated as the average monthly trading value divided by the average value of the portfolio of the same investor over the month). For individual investors, who comprise the vast majority of our sample, we also include a dummy variable to indicate whether the investor is male or female and the age of the investor (a continuous variable capturing the number of years from the birth year to the current year for each individual investor and updated at the beginning of each year of the sample period). We do not differentiate gender or age for the small number of institutional investors in the sample.

We report the results of the regression analysis in Table 7. To provide the broadest interpretation of the results possible, we use the full sample of investors rather than restricting our

[21] For motivation, see Odean (1999), Barber and Odean (2000, 2001), Gervais and Odean (2001), Feng and Seasholes (2005), Dhar and Zhu (2006), Chen et al (2007), Goetzmann and Kumar (2008), Nicolosi et al (2009) and Seru et al (2010), among others.

analysis to only those investors with both positive disposition effect or house money effect measures. Across this sample, and including both institutional and individual investors, we find no evidence of an interaction between the disposition effect and the house money effect, which is in line with the correlation results reported in Table 6 based on the full sample of investors. However, the dummy variable capturing investor type (individual or institutional) is significant in the model, thus we split the sample and look at individual investors only, as there are insufficient institutions in our sample. For the model including all individual investors, but excluding institutions, we now find evidence of a negative interaction between the disposition effect and the house money effect. The coefficient on the house money effect measure is negative and significant at 10% based on two-tail tests: the higher the house money effect measure, the lower the disposition effect measure.[22] The negative coefficient on the house money effect measure indicates that it moderates the disposition effect. Prior realized gains on an individual stock cause investors to be more risk seeking, thus decreasing the tendency of an investor to sell the stock in question when it is in the gain region. In contrast, prior realized losses on an individual stock cause investors to be less risk seeking, thus decreasing the tendency of an investor to hold the stock when it is in the loss region. If prospect theory, and therefore loss aversion, has a role to play in the disposition effect, this result casts doubt on the assertion in Frino et al. (2008, p.13-14, emphasis added) that loss aversion and the house money effect are "two separate and psychologically *independent* drivers of …. risk taking".[23]

<Insert Table 7 about here>

[22] We also conduct the analysis using the reduced sample of only those investors with positive disposition effect and house money effect measures. The results, not reported here, are robust to this change, which has the added effect of improving the significance of the coefficient on the house money effect measure slightly. While some control variables are significant in the models, thus attesting to the need to control for individual investor characteristics when investigating behavioral biases, we do not comment on them here for the sake of brevity.

[23] Feng and Seasholes (2005) highlight limitations associated with using the Odean (1998) methodology in cross-sectional analyses of individual investors, with PGRi-PLRi decreasing in the number of stocks in the investor's portfolio. Our results are robust to such concerns for two reasons. First, the regression models include the average number of stocks investors hold as a control variable. While the negative and significant coefficient supports Feng and Seasholes (2005), the inclusion of the control variable removes its effect on the relationship between the measures of the disposition and house money effects. Second, we also re-ran the regressions with PGRi/PLRi -1 as the dependent variable. The results, not reported, were largely unchanged (though the institutional dummy was no longer significant), with a negative and significant coefficient on the house money effect measure for the whole sample.

In analysis similar to Odean (1998), though not reported here in the interest of brevity, we compute ex post, cumulative market-adjusted returns for the winners sold and the losers held over the next 12 months. We find that the disposition effect is costly to investors, with winning stocks sold earning on average a 3.92% *higher* return than losing stocks held. Extending Odean's (1998) approach to consider the impact of the house money effect, we separate the ex post returns for winner and loser stocks into those stocks for which investors have positive and negative prior *realized* outcomes. We find that winning stocks sold after a *positive* prior realized gain earn on average a 1.99% *lower* return than winners sold after a *negative* prior realized gain, thus the house money effect *reduces* the cost to investors succumbing to the tendency to sell winning stocks. We find that losing stocks held after a *positive* prior realized gain earn on average a 0.43% *lower* return than losers held after a *negative* prior realized gains, thus the house money effect *increases* the cost to investors succumbing to the tendency to hold losing stocks. The cost reduction of 1.99% for winning stocks is over four times the size of the cost increase of 0.43% for losing stocks, hence the analysis supports the view that the house money effect moderates the disposition effect and that the impact is of economic significance. Rather than be detrimental to profit as is the conventional perception of investment biases, Frino et al. (2008, p.22) conjecture that such biases may increase profit by cancelling out or reducing the effect of opposing biases. We provide direct evidence that this can indeed be the case.

6. Conclusions

Using investor-level data from China, we test for trading behavior consistent with the disposition and house money effects. We report three new findings that clarify how prior outcomes influence trading behavior. First, the two effects coexist contemporaneously in a single financial market and, intriguingly, the majority of investors (53.5%) succumb simultaneously to both effects.

Sales after a gain (i.e. winners) are lower after prior realized gains than after prior realized losses and sales after a loss (i.e. losers) are higher after prior realized losses than after prior realized gains, thus supporting Neilson's (1998) claim that the disposition and house money effects could be reconciled by adding income to date to the S-shape value function of prospect theory.

Second, it is important to distinguish prior outcomes across two dimensions; *unrealized/realized* and *stock/portfolio level.* We find that the disposition effect is related to prior *unrealized* outcomes at the *stock* level and not observed at the *portfolio* level, while the house money effect is related to prior *realized* outcomes at the *stock* level and to prior *unrealized* and *realized* outcomes at the *portfolio* level. Thus, we extend the findings in Liu et al. (2010) and Massa and Simonov (2005), to show the house money effect is present at the *stock* level, not just the portfolio level.

Third, we report an interaction between the disposition and house money effects. Prior realized gains over an individual stock make investors more risk seeking than prior realized losses, when investors make sell versus hold decisions concerning the stock. Relative to the situation with prior realized losses, prior realized gains on an individual stock decrease the tendency of an investor to sell the stock in question when it is in the gain region and increase the tendency of an investor to hold the stock when it is in the loss region. We provide evidence that the house money effect moderates the disposition effect, making it less costly. While conventional wisdom views cognitive biases as detrimental, this need not always be the case, particularly when multiple biases may be at play.

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Table 1

PGR and PLR for trades with prior realized gains and losses

	All stocks	Stocks with prior realized gains (G)	Stocks with prior realized losses (L)	Difference between (G) and (L)	t-statistic
Number of realized gains	35,725	10,893	3,851		
Number of paper gains	90,735	25,283	7,513		
PGR	**0.2825**	**0.3011**	**0.3389**	-0.0378	*-7.474* ***
Number of realized losses	39,206	5,060	16,458		
Number of paper losses	283,370	27,644	82,753		
PLR	**0.1215**	**0.1547**	**0.1659**	-0.0112	*-4.809* ***
PGR minus PLR	0.1610	0.1464	0.1730		
t-statistic	*115.747* ***	*46.724* ***	*37.651* ***		

Note: This table reports the Percentage of Gains Realized (PGR) to the Percentage of Losses Realized (PLR) for all stocks, stocks with prior realized gains and stocks with prior realized losses (i.e. realized in the preceding one day to three months before the decision to sell or hold). The difference between G and L is the difference of PGR (or PLR) over stocks with prior realized gains and prior realized losses.

*, **, and *** denote significant difference at 10%, 5%, and 1% level, respectively, standard errors calculated as per Odean (1998, p18).

Table 2

Expected absolute position change risk proxy and prior outcomes

		Wealth of investor					
	Quintile	Q1 (low)	Q2	Q3	Q4	Q5 (high)	ΔQ5-Q1
Panel A: Observations are double sorted on wealth of investor and prior realized outcomes							
Rate of Realized Outcomes to Position Value	Q1	0.256	0.249	0.253	0.221	0.229	*3.198 ****
	Q2	0.287	0.271	0.274	0.253	0.257	*5.079 ****
	Q3	0.305	0.318	0.287	0.297	0.280	*3.010 ****
	Q4	0.329	0.318	0.311	0.310	0.321	*0.557*
	Q5	0.362	0.397	0.380	0.348	0.340	*0.958*
	ΔQ5-Q1	*12.927 ****	*5.156 ****	*11.511 ****	*17.161 ****	*4.363 ****	
				Factor		P-value	
Sig. of Two-way ANOVA test				Prior realized outcomes		0.000 ***	
				Wealth		0.000 ***	
				Interaction		0.034 **	
Panel B: Observations are double sorted on wealth of investor and prior unrealized outcomes							
Rate of Unrealized Outcomes to Position Value	Q1	0.267	0.236	0.237	0.219	0.217	*10.683 ****
	Q2	0.278	0.272	0.266	0.247	0.243	*7.354 ****
	Q3	0.290	0.292	0.284	0.274	0.268	*4.274 ****
	Q4	0.313	0.315	0.305	0.292	0.289	*4.270 ****
	Q5	0.373	0.412	0.359	0.328	0.311	*2.676 ****
	ΔQ5-Q1	*10.156 ****	*5.212 ****	*10.950 ****	*9.811 ****	*4.940 ****	
				Factor		P-value	
Sig. of Two-way ANOVA test				Prior unrealized outcomes		0.000 ***	
				Wealth		0.001 ***	
				Interaction		0.000 ***	

Note: The table reports average risk measured by the expected absolute change of the investor's position, double sorted by the wealth of investors and the rate of realized (unrealized) outcomes to position value in Panel A (Panel B). The ΔQ5-Q1 in row (column) gives the t-statistic of the difference of the risks between quintiles with highest wealth (prior outcome rate) and lowest wealth (prior outcome rate). The ANOVA test gives the significance of wealth effect, prior outcomes effect, and interaction.

*, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

Table 3

Relative trade size risk proxy and prior outcomes

		Wealth of investor					
	Quintile	Q1 (low)	Q2	Q3	Q4	Q5 (high)	ΔQ5-Q1
Panel A: Observations are double sorted on wealth of investor and prior realized outcomes							
Rate of Realized Outcomes to Position Value	Q1	0.953	0.916	0.990	0.997	1.000	*1.542*
	Q2	0.908	0.966	0.926	0.936	0.954	*1.360*
	Q3	0.911	0.915	0.949	0.866	0.881	*0.824*
	Q4	0.906	0.960	0.926	0.983	0.876	*0.859*
	Q5	1.004	1.083	1.047	1.003	0.980	*0.578*
	ΔQ5-Q1	*2.354* **	*5.070* ***	*1.659* *	*0.142*	*0.357*	
					Factor	P-value	
Sig. of Two-way ANOVA test					Prior realized outcomes	0.000 ***	
					Wealth	0.007 ***	
					Interaction	0.000 ***	
Panel B: Observations are double sorted on wealth of investor and prior unrealized outcomes							
Rate of Unrealized Outcomes to Position Value	Q1	0.922	0.919	0.884	0.944	0.862	*1.819* *
	Q2	0.915	0.914	0.922	0.890	0.832	*2.584* ***
	Q3	0.970	0.961	0.924	0.946	0.909	*1.780* *
	Q4	0.915	0.977	0.994	0.991	0.910	*0.174*
	Q5	1.007	1.084	1.107	1.010	0.926	*1.652* *
	ΔQ5-Q1	*3.433* ***	*4.688* ***	*5.877* ***	*1.531*	*3.416* ***	
					Factor	P-value	
Sig. of Two-way ANOVA test					Prior unrealized outcomes	0.000 ***	
					Wealth	0.000 ***	
					Interaction	0.053 *	

Note: The table reports average risk measured by the relative trade size, double sorted by the wealth of investors and the rate of realized (unrealized) outcomes to position value in Panel A (Panel B). The ΔQ5-Q1 difference in row (column) gives the t-statistic of the difference of the risks between quintiles with highest wealth (prior outcome rate) and lowest wealth (prior outcome rate). The ANOVA test gives the significance of wealth effect, prior outcomes effect, and interaction.

*, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

Table 4

Portfolio beta risk proxy and prior outcomes

		Wealth of investor					
	Quintile	Q1 (low)	Q2	Q3	Q4	Q5 (high)	ΔQ5-Q1
Panel A: Observations are double sorted on wealth of investor and prior realized outcomes							
Rate of Realized Outcomes to Position Value	Q1	1.052	1.083	1.078	1.037	0.996	*2.952 ******
	Q2	1.066	1.048	1.080	1.056	0.994	*4.153 ******
	Q3	1.072	1.052	1.087	1.065	1.033	*2.259 ***
	Q4	1.082	1.072	1.114	1.051	1.029	*2.845 ******
	Q5	1.098	1.088	1.075	1.052	1.005	*3.946 ******
	ΔQ5-Q1	*2.724 ******	*0.273*	*0.193*	*0.707*	*0.331*	
				Factor		P-value	
Sig. of Two-way ANOVA test				Prior realized outcomes		0.040 **	
				Wealth		0.000 ***	
				Interaction		0.127	
Panel B: Observations are double sorted on wealth of investor and prior unrealized outcomes							
Rate of Unrealized Outcomes to Position Value	Q1	1.075	1.056	1.081	1.048	1.006	*3.866 ******
	Q2	1.074	1.081	1.113	1.069	1.041	*2.168 ***
	Q3	1.063	1.073	1.093	1.066	1.030	*1.801 **
	Q4	1.072	1.059	1.074	1.041	1.002	*3.399 ******
	Q5	1.085	1.073	1.072	1.037	0.992	*4.462 ******
	ΔQ5-Q1	*0.534*	*0.785*	*0.521*	*0.573*	*0.728*	
				Factor		P-value	
Sig. of Two-way ANOVA test				Prior unrealized outcomes		0.005 ***	
				Wealth		0.000 ***	
				Interaction		0.757	

Note: The table reports average risk measured by portfolio beta, double sorted by the wealth of investors and the rate of realized (unrealized) outcomes to position value in Panel A (Panel B). The ΔQ5-Q1 in row (column) gives the t-statistic of the difference of the risks between quintiles with highest wealth (prior outcome rate) and lowest wealth (prior outcome rate). The ANOVA test gives the significance of wealth effect, prior outcomes effect, and interaction.

*, **, and *** denote significance at 10%, 5%, and 1% level, respectively

Table 5

The impact of changes in prior outcomes on changes in risk attitude

	Change of Unrealized Outcomes					
	>0			<0		
	Relative trade size	Portfolio CAPM beta	Expected absolute position change	Relative trade size	Portfolio CAPM beta	Expected absolute position change
Change of Realized Outcomes >0	0.018	0.014	0.030	-0.034	0.001	-0.010
	*2.922 ****	*1.759 **	*5.524 ****	*-4.322 ****	*0.163*	*-1.375*
Change of Realized Outcomes <0	0.016	-0.010	-0.010	-0.014	0.003	-0.032
	*2.029 ***	*-2.024 ***	*-1.515*	*-1.883 **	*0.692*	*-4.337 ****

Note: This table reports how changes in prior outcomes for two continuous months impact on changes in risk attitude. Observations are categorized into 2x2 groups by the sign of the change of unrealized outcomes and the sign of the change of realized outcomes. UO and RO are prior unrealized and realized outcomes. Risk attitudes are measured in three ways: relative trade size, portfolio beta, and expected absolute position change.

t-statistics are reported in italics and *, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

Table 6

Distribution of scores and correlations between disposition effect and house money effect measures

Panel A: Distribution of scores for the two measures

		Disposition Effect					
		≤0		>0		Sum	
		# investors	Proportion	# investors	Proportion	# investors	Proportion
House Money Effect	≤0	37	4.90%	255	34.10%	292	39.00% ***
	>0	56	7.50%	400	53.50%	456	61.00% ***
	Sum	93	12.40% ***	655	87.60% ***		

Panel B: Correlation coefficients

		Disposition Effect			
		Dummy	All Obs.	≤0	>0
House Money Effect	Dummy	-0.0002			
	All Obs.		-0.017		
	≤0			-0.038	-0.026
	>0			0.121	-0.137 ***

Note: This table reports the distributions of scores for the disposition effect and house money effect measures (Panel A) and the correlation (Panel B) between them. For a given investor, for either measure, a value >0 indicates that they succumb to the effect and a value ≤0 indicates they do not. In Panel A, the z-test is computed to examine whether the proportion is significantly different from 50%. For each effect, the dummy takes the value "1" when the measure is larger than 0. In Panel B, correlations coefficients are computed for all observations and for observations in the four (2x2) subgroups. The t-test is computed to examine whether the correlation coefficient is significantly different from 0.

*** denotes significance at 1% level.

Table 7

Multivariate relationship between the disposition effect and house money effect measures

	Dependent variable (Sample)			
	Disposition effect (Full sample, n=748)		Disposition effect (Individuals only, n=736)	
	Estimate	t-statistic	Estimate	t-statistic
Interception	0.1980	*20.78 ****	0.2018	*9.35 ****
House money effect	-0.0226	*-1.62*	-0.0243	*-1.74 **
Iinstitution	-0.0230	*-1.91 **		
Wealth	1.70E-09	*0.49*	-7.47E-09	*-0.71*
Diversification	-0.0062	*-4.07 ****	-0.0075	*-4.70 ****
Turnover	0.0050	*2.09 ***	0.0100	*1.95 **
Gender			0.0020	*0.16*
Age			0.0030	*8.35 ****

Note: This table reports the results of regressions for which the dependent variable is the disposition effect measure, with the house money effect measure included as an explanatory variable. Control variables are included to account for differences in investor characteristics. *Institution* is a dummy variable which takes the value "1" when the given investor is an institutional investor. *Wealth* is the average monthly position value of the investor. *Diversification* is the average number of different stocks in the portfolio. *Turnover* is the monthly turnover, calculated as the average monthly trading value divided by the average position value. *Gender* is a dummy taking the value "1" when the investor is male. *Age* is the investor age in years.

*, **, and *** denote two-tail significance levels at 10%, 5%, and 1%, respectively.