Hold on to it?

An Experimental Analysis of the Disposition Effect

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Abstract

We experimentally investigate a well-known anomaly in portfolio management, i.e. the fact paper losses are realized less than paper gains (disposition effect). We document the existence of the disposition effect in a simple risk task and show that the anomaly is most likely due to an higher degree of risk aversion of those experiencing a loss in a prior investment relative to those experiencing a gain. However, we also show that when an "emotionally colder" choice protocol is adopted, a reverse disposition effect is observed. Our results may help design trading rules to overcome the pitfalls of the disposition effect.

Keywords: Disposition Effect, Decision Making under Uncertainty, Behavioral Finance, Experiments, Prospect Theory.

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1 Introduction

Active portfolio management requires to revise investment choices whenever new information is available. On markets in which information is efficiently incorporated into prices, portfolio adjustments should depend only upon the impact that the new information has on the discounted cash flow associated to assets in the portfolio (Fama, 1970). However, several deviations from this strict forward-looking approach have been documented in the literature (Shefrin and Statman, 2000) and the efficiency of financial markets has been questioned by several empirical tests (e.g., Shiller, 1981).

Behavioral finance investigates market inefficiencies that originate from cognitive biases and limited rationality of agents in financial markets (Shleifer, 2000). Here we focus on the so-called "disposition effect", a well-known bias in portfolio management. According to the disposition effect, individuals who experienced a loss in an investment are more likely to hold on to it than individuals who experienced a gain. Shefrin and Statman (1984) introduced the term disposition effect and pointed out the sub-optimality of such a behavior in terms of optimal taxation strategy.[1]

Two main behavioral explanations for the disposition effect have been identified in the literature, one rooted in beliefs about future price dynamics and the other in non-standard risk preferences. On the one hand, beliefs in mean-reverting trends can support the liquidation asymmetry typical of the disposition effect. An investor believing in reversion of price trends will deem optimal to sell (hold) an asset after a rise (decrease) in value (on reverting trends, see De Bondt and Thaler, 1984). On the other hand, an asymmetry in risk propensity among those who experienced a gain or a loss may justify different propensities to hold on to the investment. We exploit the advantages of a laboratory experiment to discriminate between the belief-based explanation and the preference-based explanation of the disposition effect.

Participants in our experiment face a series of choices over simple risky prospects. To assess the existence of a disposition effect, we compare the decision to take part in a risky investment of those who had experienced a loss and those who had experienced a gain in a prior risky choice. Furthermore, we compare two choice protocols that are likely to appeal to the affective-instinctive system (System 1) and to the cognitive-deliberative system (System 2), in a different way (e.g., Kahneman, 2003). In the emotionally "cold" choice protocol (*Strategy*), participants define a contingency plan for dealing with a loss or a win before knowing the actual outcome of the toss of the die. In the emotionally

[1] "We will develop a positive theory of capital gain and loss realization in which investors tend to sell winners too early and ride losers too long. [...] We shall refer to this tendency as the disposition effect." [p.778].

"hot" choice protocol (*Direct*), participants choose just after having known the outcome of the first toss of the die.[2]

We document the existence of a disposition effect when choices are taken sequentially and show that the effect is not due to the different wealth levels of those who faced a loss and those who faced a win. However, when choices are taken in an emotionally colder setting, a reverse disposition effect is observed, with losers less likely to hold on to their investment than winners. Generally speaking, the behavior of losers is more affected by previous events and by elicitation methods than that of winners. Furthermore, liquidation patterns emerging in the experiment are likely to originate in asymmetric risk preferences of winners and losers and not in idiosyncratic beliefs about future value trends.

1.1 Literature Review

The term disposition effect has been introduced by Shefrin and Statman (1984) who pointed out the inefficiency of liquidation asymmetry in terms of optimal taxation strategies. Since then, several studies have confirmed the existence of the Disposition Effect in empirical data. Odean (1998) investigates trading behavior of a large sample of US investors. The proportion of losses (gains) realized is obtained as a ratio of losses (gains) realized and total outstanding losses (gains), computed as deviations from the average purchase price. The study shows that the proportion of gains realized is significantly higher than the proportion of losses, providing support to the existence of the disposition effect. Concerning the determinants of the effect, the study cannot directly control for beliefs of the trader and thus, cannot discriminate between a belief-based and a preference-based explanation. However, the author notices that the belief-based explanation is not ex-post rational, as sold investments tend to perform better than those not sold, over the next year. Chen et al. (2007) replicate the analysis of Odean (1998) on Chinese investors and find evidence in support of the disposition effect.

The empirical literature on the disposition effect has mainly focused on financial markets. However, liquidation asymmetries compatible with the disposition effect have been observed also among professional traders of the Chicago Board of Trade (Coval and Shumway, 2005), among homeowners (Genesove and Mayer, 2001) and among employees of publicly traded corporations (Heath et al., 1999). Moreover, a few individual characteristics that interact with the disposition effect have been identified. Dhar and Zhu (2006) identify a sustained heterogeneity in terms of disposition effect when considering individual-level data from a

[2]To identify the "emotional content" of the two treatments we adopt here the same jargon (hot vs. cold) adopted by, among other, Brandts and Charness (2000).

large discount brokerage firm. Moreover, individuals that presumably have a better financial education display less disposition effect than individuals with less education. Cheng et al. (2013) empirically estimate a stronger disposition effect among females and among older investors. Goulart et al. (2013) highlight a correlation between some psychophysiological measures and the disposition effect.

While several tests of the disposition effect rely on field happenstance data, very few attempts have been made to investigate the phenomenon with the support of experimental data. In a pioneering contribution, Weber and Camerer (1998) study behavior in a laboratory experiment replicating a portfolio management situation. Participants can buy and sell stocks over a series of rounds and need to infer the stochastic process underlying each artificial stock. The authors find that selling is more frequent when a stock rises in price the when it falls, in line with the disposition effect. Unfortunately, like it happens in field happenstance, the study cannot fully discriminate between the belief-based and the preference-based explanation, as participants display wrong beliefs in mean-reverting trends. However, less disposition effect is observed when an exogenous liquidation rule is imposed, a pattern not compatible with the belief-based explanation. Recently, Fischbacher et al. (2013) experimentally study the adoption of trading rules in a artificial markets and show that a simple stop-loss rule is effective in reducing the disposition effect.

A combination of Prospect Theory (Tversky and Kahneman, 2000) and of mental accounting (Thaler, 1999) provides the leading explanation for the emergence of the disposition effect (for an early account, see Shefrin and Statman, 1984). This explanation of the disposition effect is further elaborated below, but the intuition behind its working is quite straightforward. Individuals do not evaluate the performance of an investment in terms of its utility consequences, but assess the performance in terms of deviation from a given reference point (e.g., the purchase price). Moreover, individuals are risk seeker for negative deviations from the reference point (losses) and are risk averse for positive deviations (gains). It follows that those who experience a gain are less likely to hold on to the risky investment than those who experienced a loss.

Grinblatt and Han (2005) present a theoretical model with heterogeneous agents in which a fraction of agents behaves as predicted by the disposition effect. This produces persistent deviations from the rational benchmark and an under-reaction to news that results in post-announcement price drifts. An empirical estimation of the model provides support to the combination of mental accounting and prospect theory as a determinant of the drift in prices. This explanation better fits the data than the alternative explanation based on beliefs about reversion of price trends. In a similar vein, Frazzini (2006) shows that

price predictability is higher when the disposition effect predicts more underreaction to corporate news.

Barberis and Xiong (2009) critically discusses the link between the Prospect Theory and the Disposition Effect in a partial equilibrium model. Two alternatives conceptualizations of prospect theory are considered. When prospective valuations are applied to annual trading profits, the disposition effect is unlikely to emerge, and actually a reverse disposition effect is often observed. The intuition for this is that when an investment is deemed attractive in first instance, the moderate risk aversion induced by a positive outcome does not prevent an investor from taking a large bet on the same investment. In contrast, when prospective valuations are applied to realized gains and losses, the disposition effect is likely to emerge. Because of the diminishing sensitivity of Prospect Theory, an investor improves her welfare when splitting gains, but not when splitting losses. This foster the disposition effect when valuations are made on realized gains rather than on overall gains in a reference period.

Li and Yang (2013) move from the partial analysis of previous works to a general equilibrium model. The Main finding of the analysis is that the link between the disposition effect and the reflection effect of prospect theory is critically affected by the nature of the dividend process, via loss aversion. In particular, negatively skewed dividends promote the disposition effect, while other skewness configurations may generate a reverse disposition effect is predicted. Finally, Henderson (2012) consider a model in which agents adopt prospect theory which generates predictions compatible with the disposition effect. The model innovates on previous works by delivering an optimal stopping rule that forces those experiencing a loss to sell their investment when the relative returns of the risky investment are too moderate.

2 Method

2.1 Choice Task

The experiment is made of two distinct phases, Phase 1 and Phase 2, and in each phase participants face five risky prospects, labeled Prospect 1–5. All prospects are simple win/lose gambles with the same probability assigned to the good and to the bad outcomes. The bad outcome is always equal to a loss of 40 Experimental Currency Units (ECU), while the good outcome is manipulated across prospects and can assume the following gain values: 20, 30, 40, 50, and 60 ECU. Prospects 1 and 2 have a negative expected value, Prospects 3 is a fair prospect, and Prospects 4 and 5 have a positive expected value.

In Phase 1 and Phase 2, participants make choices involving risky prospects,

but the way choices are expressed differs in the two phases. In Phase 1, participants are given an endowment E and must choose whether to invest it in a good X or in a good Y. The participants are aware that X warrants a positive return if the outcome of a fair die toss is lower than 4, otherwise the return from the toss is negative. The opposite holds for Y: when the outcome is greater than 3 returns are positive and when the outcome is lower than 4 returns are negative.[3] As an example, consider the prospect yielding 50 ECU in case of a win: if the participant chooses X and the outcome of the toss is 2, the participant is going to earn $E + 50$ ECU. After becoming aware of the outcome of the die, each participant chooses whether she wants to hold on to the investment or to sell it. When holding on, a second toss of the die is performed and earnings computed like in the first toss. When selling, the outcomes of the first toss are paid to participants and the round ends. As an example, consider the prospect yielding 50 ECU when the outcome is favorable: if the outcome of the first toss is a win and the outcome of the second toss is a loss, earnings in the round are equal to $E + 50 - 40$. In Phase 1, the five risky prospects are implemented as independent investment choices over five distinct rounds.[4]

The investment choices of Phase 2 are also based on the five risky prospects, but involve only one toss of a fair die. Similarly to Phase 1, participants will choose whether to invest in X or in Y. Differently than in Phase 1, participants could choose whether to hold on to the investment or to sell it before the toss of the fair die. In Phase 2, participants choose twice for each prospect over 10 distinct rounds, with initial endowments differing in each round. The values of initial endowments are defined to replicate the earnings of participants after the first toss of the die in Phase 1. To elaborate, five initial endowments are given by E-40, while the other five are given by the sum of E and the five possible earnings in case of a win (see Table 1 for a summary of implemented prospects).

In our study, a measure of disposition is obtained by comparing choices of those winning and those losing in their investment choices. The presence of Phase 2 allows us to control for the role of wealth effects in affecting the choices of winners and losers. Aim of Phase 2 is to "take" participants to the same economic condition faced after a win or a loss, but to avoid the experience of the success/failure of the investment. When differences between losers and winner are motivated only by differences in accumulated wealth, the same pattern of behavior should be observed in Phase 1 and Phase 2.

The experimental method presents some clear advantages over standard empirical methods in terms of identification of the disposition effect and of its main

[3] We asked participants to actively choose between two goods, that a priori are equally attractive, to improve involvement in the investment task and the accountability of the process.

[4] To control for potential order effects, the order of the prospects is randomized at the individual level, both in Phase 1 and in Phase 2.

determinants. First, the difference in holding rates of winners and losers provides us with a direct and unambiguous measure of disposition effect. Second, we provide participants with a salient reference point given by the investment entry price. Third, we adopt an experimental setting aimed at minimizing wrong beliefs about the stochastic process underlying the investment activity.

2.2 Treatments

In our experiment, we implement two between-subject treatments. The first treatment refers to the size of the endowment E given in Phase 1, that can be either large or small. Specifically, in the condition *High Endowment* the initial endowment is equal to 100 ECU, while in the condition *Low Endowment* it is equal to 60 ECU. Table 1 presents a summary of the prospects obtained in the two endowment conditions.

Table 1 about here

In condition *High Endowment* two consecutive losses still generate positive outcomes. This does not hold in the *Low Endowment*, in which two consecutive losses produce a negative outcome.

The other between-subjects treatment refers to the procedure adopted to collect choices in Phase 1. In condition *Sequential*, participant are choosing whether to hold or sell their investment, after knowing the outcome of the first toss of the coin. In condition *Planned*, participants are choosing adopting the so-called strategy method. To elaborate, participants choose before the first toss of the coin whether they want to hold on to or sell the investment, conditional upon obtaining a good outcome in the first toss and upon obtaining a bad outcome in the first toss. This contingent-plan is bounding and cannot be renegotiated after becoming aware of the outcome of the first toss. In other terms, participants are asked to define a simple portfolio strategy with the opportunity to implement a stop-loss/gain rule.

Under standard rationality assumption, no differences in behavior should be observed between the two methods. However, previous studies argued that the emotional involvement of the strategy method is lower than that of the direct-response method and this may affect behavior (e.g., Figner et al., 2009). Specifically, the "hot" direct-response method, more emotionally-laden, is likely to foster instinctive and heuristic behavior, while the "cold" strategy method should promote deliberate and reflective behavior.

2.3 Behavioral Predictions

The decision to hold or sell an investment should depend only on the matching between own risk preferences and risk characteristics of the investment. Under standard assumption of utility maximization and of constant absolute risk aversion, the same tendency to hold on to the investment should be observed among those who registered a loss in the first toss of the die (losers) and those who registered a win (winners), overall. The attractiveness of prospects is the same for the two subsets of participants and, because of random allocation to the two subsets, no systematic difference in risk preferences should be observed in the two groups. Our benchmark prediction is, thus, that holding rates of losers and winners will not substantially differ in the experiment. In our analysis, we are going to assess behavior in the experiment against this prediction.

Under standard utility maximization, no disposition effect should be observed in our experiment. However, an asymmetry in holding behavior in Phase 1 may be explained by a different way of evaluating risky prospects, conditional upon prior experience in a similar task. In the same spirit of Weber and Camerer (1998), we refer to Prospect Theory (Kahneman and Tversky, 1979), to obtain predictions compatible with the disposition effect.[5] One of the main features of Prospect Theory, is the asymmetry of risk propensities for positive and negative deviations from a reference point (i.e., reflection effect). In particular, those experiencing a gain relative to a reference point are risk-averse, while those experiencing a loss are risk-seeker. To obtain a testable prediction, we assume that participants who face a loss in the first toss of the die move to the loss domain and participants who face a win to the gain domain. When this is the case, the choice to hold or sell the investment is different for a seller and a loser. As an example, for the fair Prospect #3 a loser faces a choice between a sure loss of 40 when selling and a lottery giving a loss of 2×40 with probability p=.5 and no loss with p=.5, when holding. For any level of risk-seekingness, the uncertain loss of 40 in expected value is always preferred to the sure loss of 40. In contrast, a winner will always choose to sell the fair prospect rather than hold on to it, because of risk aversion.[6]

[5] Here we refer to Prospect Theory in its cumulative version (Tversky and Kahneman, 1992). For simple two-outcome prospects like those in our experiment, the value of a prospect is given by $V(x_1, x_2; p_1, p_2) = w(p_2)v(x_2) + [1 - w(p_2)]v(x_1)$, where x_2 and x_1 are the outcomes of the risky prospects, measured as deviations from a reference point, with the highest outcome in absolute value being x_2, and p_1 and p_2 being the probabilities of the two outcomes. The weighting function $w(p)$ maps probabilities into decision weights and Tversky and Kahneman (1992) suggest the following functional form for $w(p)$: $w(p) = p^\gamma / [p^\gamma + (1-p)^\gamma]^{(1/\gamma)}$ (for an alternative specification, see also Prelec, 1998). Concerning the value function $v(x)$, Tversky and Kahneman propose the following: $v(x) = x^\alpha$ for gains ($x > 0$) and $v(x) = -\lambda(-x^\alpha)$ for losses ($x < 0$). The parameter λ captures loss aversions and here we adopt the value estimated by Tversky and Kahneman, $\lambda = 2.25$. The parameter α measures the curvature of the value function and for $\alpha < 1$ the reflection effect is obtained.

[6] For illustrative purposes, we do not explicitly consider probability weighting here. Previ-

Predictions based on Prospect Theory are quite straightforward for the fair lottery, but some more parametric assumptions are needed for other prospects. When adopting the value function of Tversky and Kahneman (1992), it can be shown that for a curvature coefficient $\alpha \leq 0.52$ an asymmetry in behavior compatible with the disposition effect should be observed in all prospects.[7] The only exception is given by Prospect #1, that should induce both losers and winner to sell the investment, irrespective of the curvature of their value function. A

An important implication of the application of Prospect Theory to our decisions is that we predict asymmetries in behavior to emerge only in Phase 1 . As illustrated above, it is of crucial importance for the predictions obtained under Prospect Theory that individuals actually experience a deviation from a reference point. This does not happen in Phase 2 of the experiment, when individuals choose "as if" they had lost or won and thus do not experience any deviation from the reference point. Thus, Phase 2 provides us with an important control to assess the nature of the disposition effect. If asymmetries in behavior are merely due to changes in wealth of winners and losers (wealth effects), the same pattern of behavior should be observed in prospects of Phase 1 and in the corresponding prospects of Phase 2.

The experimental manipulations that we perform allow us to better understand the nature of the disposition effect. In one of our experimental treatments we manipulate the way in which investment decisions are collected. In a pure consequentialistic logic framework, the two methods should deliver the same results in terms of disposition. However, we assume that when emotions have a higher stake in the decision process, stronger disposition effect is observed. Accordingly, we predict that a larger asymmetry in behavior of losers and sellers is observed in the *Direct* than in the *Strategy* condition.

In the other experimental manipulation we perform, participants are either endowed with an high or a low endowment, but face the same set of lotteries. In the *High Endowment* condition, initial endowment is always large enough to cover losses in the experiment. In contrast, in the *Low Endowment* condition the initial endowment is lower than the maximum loss. This implies that in the *Low Endowment* condition losses from holding the investment are framed as real losses, even though they are covered by the show-up fee. As shown by several studies (e.g., Tversky and Kahneman, 1986), the framing of alternatives may have substantial effects in terms of choices. We expect that the framing of

ous studies have shown that individuals tend to slightly underweight p=.5. As an example, Wu and Gonzalez (1996) estimate a $\gamma = 0.74$, which results in g(.50)=.47. Furthermore, Barberis and Xiong (2009) notices that probability weighting does not play a central role in linking prospect theory and the disposition effect.

[7] Among works that provide an estimation of α, Wu and Gonzalez (1996) reports $\alpha = 0.52$, Camerer and Ho (1994) (as computed by Wu and Gonzalez, 1996) reports $\alpha = 0.37$, and Tversky and Kahneman (1992) reports $\alpha = 0.88$.

losses will induce losers to be more cautions when choosing to hold on to their investment in *Low Endowment* than in *High Endowment*.

2.4 Participants and Procedures

The computerized experiment was programmed and conducted using the z-Tree software (Fischbacher, 2007) at the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento. A total of 159 participants took part in the experiments, mainly undergraduate students of the University of Trento. Participants received a fee of €2.50 for showing up in time and average earnings of those who participated in the experiment amounted to €11.60. The experiment was conducted with virtual money (UMS) that was converted at the end of the experiment in euros at a conversion rate of UMS 20 : €1.

The experiment was divided into two independent phases, Phase 1 and Phase 2. Choices in Phase 1 were made over 5 independent rounds, while 10 independent rounds were implemented in Phase 2. In each round a different prospect was implemented (see Table 1), with the order of presentation randomized at individual level to control for potential order effects. Participants were informed about the existence of two phases at the beginning of the experiment, but received instructions of Phase 2 only at the end of Phase 1. Before each phase, participants received written instructions and were given a few minutes for private reading. Then, instructions were read aloud by a member of the staff.

In each round, some random draws were performed to define whether the investment undertaken produced a win or a loss. To improve the accountability of the random process, a six-sided die was tossed by one of the participants randomly picked. The outcome of the toss was then announced to other participants, under the scrutiny of the participant who tossed the die.

Participants were aware that only one of the five choices made in Phase 1 and one of the ten choices made in Phase 2 would be randomly chosen for payment at the end of the experiment. A randomly picked participant was asked to select the relevant round in Phase 1 (2) by drawing a ball from an urn containing 5 (10) balls numbered from 1 to 5 (10).

After having made their choices in the two phases of the experiment, participants were asked to answer a non-incentivized questionnaire. In a first set of questions, participants were asked to report their year of birth, gender, and field of study, In addition they were asked to self-asses their financial competence on a 5-points scale that goes from poor to excellent. In a second set of questions, subjects were asked to answer 6 questions aimed at checking their level of financial education.[8]

[8]The questions are excerpted from a wider set of questions reported in van Rooij et al.

3 Results

3.1 Description of Choices

3.1.1 Sequential Choice Protocol

Table 2 displays the percentage (%) of participants who choose to hold on to their investments after the first die roll, distinguishing between Phase 1 and Phase 2, Prospects, and outcome of the first toss of the die (Winners/Losers).

Tabe 2 about here

In Phase 1 the % of losers holding on to their investment is always larger than the % of winners holding on to it, both with an high and a low endowment. In contrast, in Phase 2 the holding rates are quite similar among losers and winners and the pattern of holding rates is more faceted.

Figure 1 complements the information contained in Table 2 by presenting average holding rates across alternative prospects.

Figure 1 about here

As shown by the figure, the average holding rate is always higher among losers than among winners. However, the difference is much higher in Phase 1 than in Phase 2 and in the High Endowment condition than in the Low Endowment condition. To elaborate, in High Endowment the percentage difference in holding rates of losers and winners is 18.7% in Phase 1, but the same difference is only 2.4% in Phase 2. In Low Endowment, the differences in overall holding rates are 13.6% and 5%, respectively. According to Wilcoxon rank sum tests (WSRT),[9] the differences in holding rates between losers and winners are statistically significant in Phase 1 when the endowment is high (p-value=0.002) and, although only marginally, when the endowment is low (p-value=0.084). In Phase 2, no significant differences are detected (all p-values ≥ 0.515). Thus, we

(2011). Specifically, the following items were taken into account: 1) Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? (i) More than h102–(ii) Exactly €102; –(iii)–Less than €102–(iv) Do not know; 2) Suppose you had €100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total? (i) More than €200–(ii) Exactly €200–(iii) Less than €200–(iv) Do not know; 3) Which of the following statements is correct? If somebody buys the stock of firm B in the stock market: (i) He owns a part of firm B–(ii) He has lent money to firm B–(iii) He is liable for firm Bs debts–(iv) None of the above–(v) Do not know; 4) Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return? (i) Savings accounts–(ii) Bonds–(iii) Stocks–(iv) Do not know; 5) Stocks are normally riskier than bonds. (i) True–(ii) False–(iii) Do not know; 6) If the interest rate falls, what should happen to bond prices? (i) Rise–(ii) Fall–(iii) Stay the same–(iv) None of the above–(v) Do not know.

[9] The tests rely on a pairwise comparison of individual-level holding rates in the winning and in the losing condition.

observe a significant difference in liquidation propensity between winners and losers that is compatible with the disposition effect and cannot be ascribed to wealth effects.

To understand whether the liquidation asymmetry is mainly driven by the behavior of losers or by that of winners, we compare holding rates of losers and winners in Phase 1 and in Phase 2.[10] The overall holding rates of losers are higher in Phase 1 than in Phase 2, both for the High Endowment and the Low Endowment condition, but the difference is statistically significant only in the former (WSRT; p-value=0.024 and p-value=0.220). Concerning winners's behavior in the two phases, a small negative difference is observed for both endowment conditions, however the differences are never statistically significant (WSRT, p-values$\geq$ 0.241). From this we can infer that the asymmetry in behavior observed in Phase 1 originates mainly in the hostility of losers to liquidate their investments, and not in the urge of winners to cash-in paper gains.

3.1.2 Planned Choice Protocol

Table 3 replicates the descriptive analysis of Table 2, for the *Planned* condition.

Table 3 about here

The Table shows that in Phase 1 holding rates are always higher among winners than among losers. This is at odds with the disposition effect documented in the *Sequential* condition. In line with results of *Sequential*, differences in holding rates between winners and losers are smaller in Phase 2 than in Phase 1.

Figure 2 shows the holding rates of winners and losers when pooling data together, regardless of the prospect in which choices were taken.

Figure 2 about here

The differences in overall holding rates of winners and losers are statistically significant in Phase 1 but not in Phase 2 (WSRT: p-value$<$ 0.001 and p-value= 0.149, respectively).[9] Thus, when decisions are taken before risky outcomes are actually revealed, a reverse disposition effect is observed, with losers being less likely to hold on to their investment than winners.

Similarly to what done in *Sequential*, we compare holding rates of losers and winners in Phase 1 and Phase 2. The overall holding rates of losers are smaller in Phase 1 than in Phase 2, while the opposite holds for winners. However, non-parametric tests show that the difference between the two phases is statistically significant only for losers (WSRT: p-value=0.019 and p-value=0.467,

[10] Of course, in Phase 2 there are no proper winners and losers. However, individuals are classified in these categories according to their initial endowment.

respectively).[10] Thus, the asymmetry in behavior observed, that runs against disposition effect, seems to originate in the behavior of losers that after an anticipated, but not yet experienced, loss are discouraged about further investing in the losing enterprise.

A comparison of holding rates across the two elicitation mechanism shows that the differences in terms of disposition effect observed across the two mechanisms originate in the behavior of those registering a loss. In phase 1, holding rates of losers are statistically different (WRST, $p-value < 0.001$), while holding rates of winners do not significantly differ (WSRT, $p - value = 0.268$). Thus, the alternative elicitation mechanism manly impact on behavior of losers, inducing a significantly higher propensity to hold on to the investment among losers in the emotionally hot condition than in the emotionally cold one.

3.2 Regression Analysis

The regression outputs of Table 4 provides us with insights about the determinants of the decision to hold on to the investment in the two elicitation modes, separately.[11] The dependent variable $Hold$ captures the decision to hold ($Hold = 1$) or sell ($Hold = 0$) the investment. The variable $Loss$ is equal to 1 when the subject obtained a loss from the first toss of the die, and equal to 0 when a win was registered. The variable $Phase.1$ is equal to 1 when choices are made in the first phase of the experiment, when the actual loss is either anticipated or experienced, and equal to 0 if choices are taken in the second phase. Variable $LowEndow$ captures the level of the endowment, either low ($LowEndow = 1$) or high ($LowEndow = 0$). Possible interactions among these three main explanatory variables are also taken into account (denoted by a $\times$ term). Of particular interest for our analysis are the interactions involving $Loss$ and $Phase1$.

A few control variables are taken into account. Variables $P1$, $P2$, $P4$, and $P5$ control for the attractiveness of the prospect in terms of expected values, with labels matching those of Table 1. In addition, we also control for self reported expertise in finance ($Expertise$), gender ($Female$), performance in the financial education questionnaire administered ($FinancialEdu$), whether their major of study is economics/business administration or not ($Econ$), and age (Age).

Table 4 about here

In the *Sequential* condition, a positive and significant coefficient is observed for the interaction $Loss \times Phase.1$. Thus, in line with the disposition effect, those

[11] This specification was chosen to improve the ease of the results. Similar results were obtained in an estimation jointly considering data from the two elicitation modes.

actually experiencing a loss are more likely to hold on to their investment than those experiencing a win. In addition, the coefficient of *Loss* is not statistically significant and this provides further support to the fact that the asymmetry in behavior of losers and winners is not due to a change in wealth, following the outcome of the previous stage. In the low endowment condition, the impact of a loss in Phase1 is qualitatively smaller, but the estimated coefficient is not statistically significant. Concerning control variables, prospect dummies (P1–P5) show that prospects with a negative expected value are significantly less likely to be held than the fair baseline prospect, while the opposite holds for positive expected value prospects.

In the *Planned* condition, the coefficient of the interaction $Loss \times Phase.1$ is negative ans statistically significant. Thus, anticipating a loss when defining a contingent investment plan makes perspective losers more likely to hold on to their investment than perspective winners. Moreover, given that the coefficient of *Loss* is not statistically significant, this asymmetry in behavior cannot be attributed to wealth differentials.

The regression analysis highlights the existence of an asymmetry in behavior compatible with the disposition effect when choices are sequentially taken and not planned in advance. The effect is driven by the fact that losers in Phase 1, actually experiencing a loss, display an higher propensity to hold on to their investment than losers in Phase 2. In contrast, the propensity of winners to hold on to their investment does not significantly differ in the two phases of the *Sequential* condition. When choices are taken in the *Planned* condition, the picture is reversed: losers in Phase 1 are less likely to hold on to their investment than in Phase 2. Thus, the elicitation mode heavily impacts on the reaction of participants to a loss and affects the nature of the disposition effect.

4 Conclusion

We rely on a laboratory experiment to investigate disposition effect in a simple investment task. Relative to previous studies employing field happenstance data, we achieve a better control on beliefs of participants and this allows us to disentangle between belief-based and preference-based explanations of the disposition effect.

Evidence collected provides strong support to the existence of a disposition effect when choices are taken sequentially. The asymmetry in behavior is mainly driven by a sustained propensity to hold on to the investment among losers. However, when choices are planned ahead, a reverse disposition effect is observed, with losers less likely to hold on to their investment than in the control condition in which no reaction to a loss must be planned. While the behavior

of winners does not significantly differ across the two elicitation mechanisms, the behavior of losers is changes substantially and this drives the reversal in the disposition effect. Given that the same stochastic process is implemented in the two elicitation methods, differences observed suggest that the disposition effect is most likely due to asymmetries in preferences between losers and winners. Thus, evidence collected provides support to the interpretation of disposition effect as a phenomenon rooted in non-standard risk preferences and not in beliefs abut mean-reverting trends.

A possible explanation for the different results obtained under alternative elicitation methods can be searched in the bracketing of choices and in the shifting of the reference point. Given that the disposition effect is mainly driven by the behavior of those experiencing a loss, it may be that when choosing sequentially the reference point is not shifted after a loss or a a win and the perspective of breaking-even drives the decision to hold the investment among those experiencing a loss (on the "break-even effect" see Thaler and Johnson, 1990). Differently, planning ahead may favor the perception of the decision to hold on to the investment in isolation, generating an implicit shift of the reference point. When taken in isolation, the decision to hold on to the investment is not deemed valuable by individuals displaying conventional levels of loss aversion.[12] Finally, the shift in the reference point may be stronger among losers than among winners because the former adopt the shift as a strategy to reduce the cognitive dissonance following a negative outcome. This interpretation of the unexpected results obtained is highly speculative and calls for further research focusing on the adjustment of reference points in sequential risky choices.

To conclude, we document the existence of disposition effect in a controlled setting and provide evidence that the phenomenon is not driven by beliefs but by an asymmetry in risk preferences of those experiencing a win or a loss in an prior investment. However, we also show that when investment choices are taken prior to losses and gains being realized, the disposition effect tends to reverse. This result deserves further attention and may help overcome the pitfalls of the disposition effect by promoting the introduction of automatic stopping rules in portfolio management.

[12] In terms of Prospect Theory, all lotteries have a negative value for a measure of loss aversion $\lambda \geq 1.5$.

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A Figures and Tables

Figure 1: Direct Response - Pooled Choices

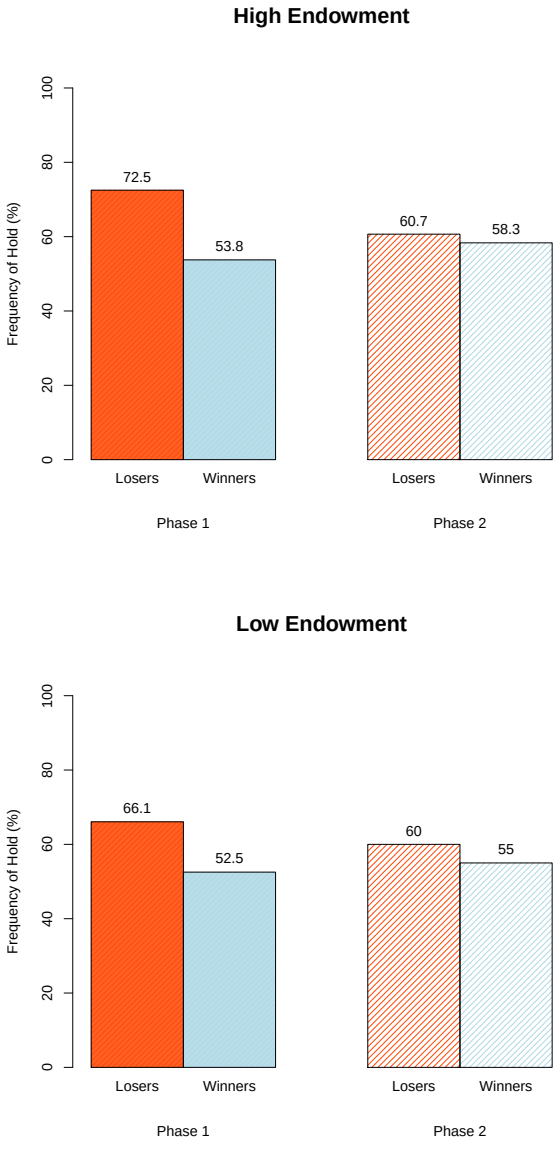

Figure 2: Strategy Method - Pooled Choices

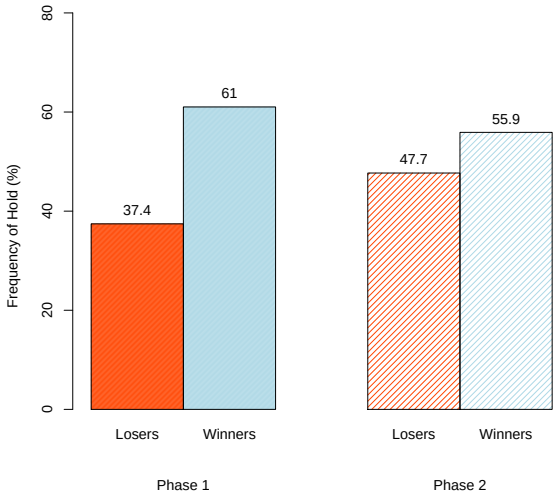

Table 1: Prospects

Phase 1				Phase 2			
Prospect	E_1	w	l	Prospect	E_2	w	l
High Endowment							
#1	100	20	-40	#1	120	20	-40
				#2	60	20	-40
#2	100	30	-40	#3	130	30	-40
				#4	60	30	-40
#3	100	40	-40	#5	140	40	-40
				#6	60	40	-40
#4	100	50	-40	#7	150	50	-40
				#8	60	50	-40
#5	100	60	-40	#9	160	60	-40
				#10	60	60	-40
Low Endowment							
#1	60	20	-40	#1	80	20	-40
				#2	20	20	-40
#2	60	30	-40	#3	90	30	-40
				#4	20	30	-40
#3	60	40	-40	#5	100	40	-40
				#6	20	40	-40
#4	60	50	-40	#7	110	50	-40
				#8	20	50	-40
#5	60	60	-40	#9	120	60	-40
				#10	20	60	-40

Table 2: Participants (%) who hold their investment (*Sequential*)

	Phase 1			Phase 2		
Prospect	Losers	Winners	Diff	Losers	Winners	Diff
High Endowment						
#1 (+20/-40)	50.0	25.0	+25.0	30.0	33.3	-3.3
#2 (+30/-40)	64.0	42.9	+21.1	46.7	45.0	+1.7
#3 (+40/-40)	70.6	53.8	+16.8	63.3	63.3	0.0
#4 (+50/-40)	95.5	63.2	+32.3	81.7	66.7	+15.0
#5 (+60/-40)	96.3	81.8	+14.5	81.7	83.3	-1.6
Low Endowment						
#1 (+20/-40)	58.8	42.3	+16.5	36.7	38.3	-1.6
#2 (+20/-40)	64.0	48.6	+15.4	51.7	45.0	+6.7
#3 (+40/-40)	65.4	58.8	+6.6	60.0	48.3	+11.7
#4 (+50/-40)	66.7	51.5	+15.2	75.0	73.3	+1.7
#5 (+60/-40)	83.3	63.3	+20.0	76.7	70.0	+6.7

Table 3: Participants (%) choosing to hold on to the investment

Prospect	Phase 1			Phase 2		
	Losers	Winners	Diff	Losers	Winners	Diff
			High Endowment			
#1 (+20/-40)	25.6	46.2	-20.6	23.1	30.8	-7.7
#2 (+30/-40)	38.5	61.5	-23.0	41.0	38.5	+2.5
#3 (+40/-40)	28.2	64.1	-35.9	53.8	53.8	+0.0
#4 (+50/-40)	46.2	66.7	-20.5	56.4	76.9	-20.5
#5 (+60/-40)	48.7	66.7	-18.0	64.1	79.5	-15.4

Table 4: Regression Analysis (Generalized linear mixed model-Logit)

	Sequential	Planned
(Intercept)	2.234 (0.818)**	1.250 (1.577)
$Loss$	0.125 (0.188)	−0.411 (0.224)
$LowEndow$	−0.043 (0.252)	
$Phase.1$	−0.237 (0.222)	0.263 (0.226)
$LOSS \times Phase.1$	1.026 (0.341)**	−0.787 (0.321)*
$LOSS \times LE \times Phase.1$	−0.394 (0.476)	
$LOSS \times LE$	0.140 (0.264)	
$LE \times Phase.1$	0.094 (0.314)	
$P1$	−1.103 (0.166)***	−0.946 (0.256)***
$P2$	−0.500 (0.162)**	−0.249 (0.247)
$P4$	0.664 (0.172)***	0.572 (0.250)*
$P5$	1.102 (0.182)***	0.739 (0.252)**
Age	−0.076 (0.033)*	0.026 (0.071)
$Expertise$	−0.106 (0.121)	−0.340 (0.228)
$Female$	−0.373 (0.205)	−0.894 (0.364)*
$Econ$	0.074 (0.239)	0.235 (0.382)
$FinancialEdu$	0.033 (0.104)	−0.141 (0.149)
AIC	2128.939	968.088
Log Likelihood	−1046.469	−470.044
Num. obs.	1800	780
Num. groups: ID	120	39

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

B Translated Instructions

Note: the label [Common] identifies instructions which are common to Sequential and Planned choice protocols; the label [HighEndow.Seq] identifies instructions which refer exclusively to the High Endowment/Sequential condition; the label [LowEndow.Seq] identifies instructions which refer exclusively to the Low Endowment/Sequential condition; the label [Planned] identifies instructions which refer exclusively to the Planned choice protocol.

General Instructions

[Common] You earned €2.50 for showing up in time. We kindly ask you to carefully read this instructions and to keep silent. It is forbidden to talk to other participants in the experiment. If you have any doubt, please raise your hand. A staff member will answer your question, privately. Any conduct interfering with the regular working of the experiment is sanctioned with the removal from the room without payment.

[Common] The experiment is made of two independent parts. You will receive instructions for the second part only at the end of the first part.

[Common] The experiment allows you to earn an amount in Euro. In the course of the experiment, you will to use experimental currency units (ECU) instead of Euro. At the end of the experiment, 20 ECU are exchanged with €1 and the amount in Euro is paid out in cash (As an example, an earning of 100 ECU will be exchanged at the end of the experiment with €5).

[Common] Your final earnings in the experiment are given by the sum of earnings in the first part and in the second part.

[LowEndow.Seq] At the end of the experiment you may also register negative earnings. Any negative amount earned is going to be deducted from the show-up fee you earned for showing up in time. As an example, if you will earn €-1 you will receive only €1.50 for showing up in time. The €2.50 you earned for showing up on time are always enough to cover potential negative earnings in the experiment and, thus, you will never be asked money to compensate negative earnings.

First Part Instructions

Note: in the original instructions the letter E is replaced by 60 in he Low Endowment/Sequential condition and by 100 in the other conditions.

[Common] This part is made of 5 independent rounds. In each round, you are given E UMS. You must allocate the E UMS by choosing to invest in good X or good Y. Both goods have a price of E UMS. One of the two goods will yield a gain, the other will yield a loss; the magnitude of losses and gains changes every round and you are going to be informed at the beginning of each round about it.

[Common] After you have invested in one of the two goods, one of the participants randomly picked is tossing a die: when the outcome is a number equal or lower than 3, good X is selected and it yields a gain, while good Y yields a loss; when the outcome

is a number greater than 3, good Y is selected and yields a gain, while good X yields a loss.

[HighEndow.Seq, LowEndow.Seq] After the initial draw, you can choose whether to keep or sell your good.

[Planned] At the beginning of each round, you can choose whether to keep or sell your good after the first toss of the die. The choice must be taken before the toss and, thus, without knowing the outcome of the toss. To elaborate, you must choose whether to keep or sell your good, both in case you obtained a gain (scenario 1) and in case you obtained a loss (scenario 2), in the first toss of the die. The choice made in correspondence to the outcome of the first toss of the die is bounding and cannot be revised.

[Common] If you choose to sell the good, your earnings are given by the value of the good after the first draw. If you choose to keep the good, your earnings are conditional upon the toss of a die performed by one of the participants randomly picked: when the outcome is a number equal or lower than 3 (1, 2, or 3), good X is selected and it yields a gain, while good Y yields a loss; when the outcome is a number greater than 3 (4, 5, or 6), good Y is selected and yields a gain, while good X yields a loss. The magnitude of losses and gains changes every round and you are going to be informed at the beginning of each round about it.

[Common] At the end of the experiment, only one of the five rounds that belong to the first part is randomly selected for payment. You are going to know the chosen round at the end of second part.

Second Part Instructions

[Common] This part is made of 10 independent rounds. In each round, you are given an endowment in UMS. The endowment changes every round and you are going to be informed at the beginning of each round about it. You must allocate the UMS by choosing to invest in good X or good Y. Both goods have a price equal to your UMS endowment in that round.

[Common] After you have invested in one of the two goods, you can choose whether to keep or sell your good. If choose to sell the good, your earnings are given by the value of the good after the first draw. If you choose to keep the good, your earnings are conditional upon the toss of a die performed by one of the participants randomly picked: when the outcome is a number equal or lower than 3 (1, 2, or 3), good X is selected and it yields a gain, while good Y yields a loss; when the outcome is a number greater than 3 (4, 5, or 6), good Y is selected and yields a gain, while good X yields a loss. The magnitude of losses and gains changes every round and you are going to be informed at the beginning of each round about it.

[Common] At the end of the experiment, only one of the five rounds that belong to the second part is randomly selected for payment.