Optimistic and Stubborn:
An Experimental Analysis of the Disposition Effect*

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Abstract

The disposition effect (DE) is a common bias by which investors tend to sell profitable assets too soon and hold losing assets too long. We investigate individual and institutional determinants of the DE in a standard experimental environment and find that the DE is robust to transaction costs and competitive payments. The most significant psychological predictors of the DE and of the reluctance to sell losers are *optimism* and *stubbornness* (difficulty recognizing one's errors).
Our results provide novel evidence about investors' distorted beliefs as a likely source of the DE. In two novel treatments, called *Allocate* and *Choose*, we elicit price expectations after subjects are either randomly allocated, or forced to choose some assets, respectively. Subjects are more optimistic about assets that they own than about other assets, especially in the *Choose* treatment. Here, subjects remain stubbornly optimistic even after poor performance of their chosen assets.

KEYWORDS: Behavioral Finance, Transaction Costs, Competition, Psychological Characteristics, Cognitive Dissonance, Gender, Beliefs.
JEL CLASSIFICATION: C91, D70, D81, D91

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1 Introduction

Originally coined by Shefrin and Statman (1985), the disposition effect (DE) is the tendency to sell winning assets too early and hold losing assets too long. Such a tendency has been persistently documented in empirical studies of investor behavior and is among the most established findings in Behavioral Finance.[1]

Experimental studies, starting with the work of Weber and Camerer (1998), have confirmed the prevalence of the DE in controlled environments, where such a tendency is unambiguously suboptimal. However, few studies have investigated the role of individual heterogeneity, or that of institutional factors, as determinants of the DE. This paper reports the empirical findings of two complementary studies that contribute to the literature on the DE in three main directions.

1. Firstly, we examine the impact of specific psychological factors that have been proposed as potential determinants of the DE, such as optimism, difficulty recognizing errors (or stubbornness, for short), enjoyment of winning, competitiveness or self-control, as well as financial literacy. We also look at the so-called Big Five personality traits (John and Srivastava, 1999) and other demographic characteristics such as gender. In line with previous results, we find that females sell significantly fewer losing assets, although this effect is not large enough to create a gender difference in the DE. Novelly, our results show that optimism and stubbornness are the only psychological factors strongly correlated with the DE and that this effect operates via a reduction in the propensity to sell losing assets. These results are established using the widely used experimental framework of Weber and Camerer (1998) in combination with questionnaire data.
2. We build upon the benchmark experimental design to investigate a beliefs-based explanation of our evidence regarding optimism and stubbornness. In two novel treatments, subjects are either randomly allocated some assets or have to choose a given number of assets which they have to hold on to. We find that subjects are indeed optimistic in their beliefs: in both treatments, subjects are significantly more likely to guess that an asset will appreciate when they own it, and this effect is much stronger when the asset has been chosen by the subject. Finally, whereas beliefs over randomly allocated assets tend to update in the right direction, subjects are stubbornly optimistic about assets that they have chosen themselves: they tend to expect that the asset will appreciate with a high probability and do not update their beliefs downwards when the asset is performing poorly. Consistently, we observe a positive DE in the treatment involving choice and no DE in the treatment with randomly allocated assets. Together, our results suggest that distorted beliefs aimed at maintaining a positive perception about one's investment ability could be a key determinant of the DE. To the best of our

[1] See, for example, Shefrin and Statman (1985), Odean (1998), Grinblatt and Keloharju (2001), Shapira and Venezia (2001), Dhar and Zhu (2006), Brown *et al.* (2006), Barber *et al.* (2007), Duxbury (2015).

knowledge, our paper is the first to systematically investigate beliefs as a possible driver of the DE. This is the second contribution of our paper.

3. Finally, we also check for the robustness of the DE to important institutional features of financial trading environments outside the laboratory, namely, transaction costs and competitive payment schemes. We find that the DE is robust to transaction costs, even when these involve a 50% rebate on realized losses. Similarly, a competitive payment scheme has no effect on the DE.

The remainder of the paper is arranged as follows. Section 2 reviews the literature on the DE, individual heterogeneity, beliefs, and institutional factors. Sections 3 and 4 describe the results of experiments 1 and 2, respectively. Section 5 concludes. Additional results and a translation of the experimental instructions can be found in the appendix.

2 Related literature

2.1 Disposition effect

Several empirical studies have documented the existence of the DE. Odean (1998) finds that individual investors have a strong preference for selling winners and holding losers, except in December when tax motivated selling prevails. Using a comprehensive data set of stock market investors in Finland, Grinblatt and Keloharju (2000, 2001) find that investors are about twice as likely to sell a stock at a moderate gain as at a moderate loss. Shapira and Venezia (2001) confirm the prevalence of the DE among independent investors and professional brokers in Israel. Dhar and Zhu (2006), Brown *et al.* (2006) and Barber *et al.* (2007) document similar findings among investors in the United States, Australia and Taiwan, respectively.

There are also several experimental studies of the DE starting with Weber and Camerer's (1998) seminal contribution. Weber and Camerer (1998) design an experiment in which individuals have the opportunity to buy and sell units of six risky assets with constant, but unknown, probabilities of changing prices. Their main finding is that subjects in this environment exhibit a significant DE. Weber and Welfens (2007), Da Costa *et al.* (2008, 2013) and Rau (2014, 2015) replicate these results employing similar designs. Magnani (2015) confirms the existence of the DE in an experiment involving the exercise of a put option. Here subjects take too long to exercise their option when the share price is falling and cash the value of the asset too early when its price is raising. Frydman *et al*. (2014) conduct an experiment based on Weber and Camerer (1998) using functional magnetic resonance imaging (fMRI) and also find a strong DE. Interestingly, they find that subjects' neural activity is consistent with the "realization utility" theory of the DE. This theory posits that investors derive positive (negative) utility directly from the act of realizing gains (losses) (Barberis and Xiong, 2009, 2012; Ingersoll and Jin, 2013).

Various alternative behavioral theories of the DE have been put forward. One prominent explanation draws on Prospect Theory (PT, Kahneman and Tversky, 1979). According to PT

investors are risk averse in the gain domain and risk loving in the loss domain, leading them to sell winners earlier than losers. Other explanations include irrational beliefs in mean-reversion, loss aversion, regret aversion, self-control or cognitive dissonance, among others. In a review of the various theories and their relative merits, Kaustia (2010b) argues that the evidence favors an explanation based on cognitive dissonance rather than one based on preferences (PT) or mean reversion beliefs.

According to *cognitive dissonance theory* (Festinger, 1957), individuals tend to hold consistent beliefs, attitudes and actions. Events that upset this consistency are psychologically costly and are therefore often avoided. Applied to financial decisions, selling a losing asset carries an additional psychological cost to investors, since it involves the acceptance that their prior beliefs and actions were wrong. On the other hand, selling a winning asset pleases an investor since it confirms her previous beliefs and actions. This general theory can encompass other mechanisms suggested in the literature, such as self-justification, realization utility, or feelings of regret/rejoicing. Summers and Duxbury (2012) manipulate subjects' feelings of regret/rejoicing and disappointment/elation by varying the degree of control over their investment decisions and find that higher feelings of regret (rejoicing) are accompanied by a lower (higher) tendency to sell losing (winning) assets. Similar experimental evidence is reported by Rau (2015), who finds that two-person teams of investors exhibit higher feelings of regret and rejoice and a higher DE than individual investors. Finally, Frydman *et al*. (2014) and Frydman and Camerer (2016) identify neural signals of realization utility and of regret, respectively, and relate them to the DE.

2.2 Individual heterogeneity

Little is known, however, about the sources of individual heterogeneity in the DE beyond differences in expertise (Feng and Seasholes, 2005; Dhar and Zhu, 2007; Weber and Welfens, 2007). For instance, despite the vast literature on gender and financial risk taking, to our knowledge only two studies focus specifically on gender differences in the DE. Da Costa *et al.* (2008) find suggestive experimental evidence that males exhibit, on average, a larger DE, although their results depend on their specific definition of DE (see Section 3.2.2). In contrast with this evidence, Rau (2014) finds a significant DE for females and not for males. Interestingly, he finds that the DE is entirely driven by females' reluctance to sell losers.

Weber and Welfens (2007) test empirically and experimentally for differences, stability and learning in individual DE. They find that learning and experience reduce the DE. In addition, their field data reveal no evidence of gender differences, although this could be simply driven by the low frequency of females in their sample (4.84%).

Feng and Seasholes (2005) find an overall positive DE among Chinese investors, which is moderated by experience. Similarly to Rau (2014), they also find that female investors are more reluctant to sell losing stocks. Dhar and Zhu (2006) analyze the trading records of a major discount

brokerage house and find that the DE is weaker for older, wealthier and more experienced investors.

An interesting and scarcely researched source of heterogeneity is that of *psychological characteristics*. Chui (2001) finds that subjects with an *internal* locus of control (a tendency to feel that events are under their own control) have a higher DE than those with an *external* locus of control. To the best of our knowledge, there are no other published studies that relate individual psychological characteristics to the DE. This is particularly surprising since the DE has been often linked to easily measurable psychological traits such as overconfidence (Odean, 1999) or poor self-control (Shefrin and Statman, 1985). One of our objectives is, indeed, to fill this gap in the literature.

2.3 Beliefs

There are several examples of behavioral models based on investors' beliefs that try to explain some features of financial markets, such as momentum, long-term reversals, etc.[2] One of the behavioral models proposed to explain the DE is based on mean-reversion beliefs (Odean, 1998): investors sell winners because they expect lower future returns and keep losers because they expect higher future returns.[3] Another possibility is that of excessive optimism: optimistic individuals may irrationally believe that their stocks are more likely to appreciate simply because they own them. Ciccone (2011) suggests that renewed optimism after the new year may explain, at least partially, the so called "January effect", i.e., the fact that the stock market performs particularly well in January. Antoniou *et al* (2013, 2015) find strong momentum in optimistic periods, where optimism is measured using the Consumer Confidence Index. According to the authors' interpretation, small investors who are in an optimistic mood fail to incorporate bad news, or do so very slowly.

According to cognitive dissonance theory, individuals may often change their beliefs rather than their actions when the two are in conflict (Wilkinson and Klaes, 2012, p.135). For example, in their sunk cost study Arkes and Hutzel (2000) find that individuals believe that the probability of success of a hypothetical investment is higher when an initial investment of money, effort or time has been made. The authors claim than the inflated probability estimates are a "post-hoc" rationalization of the prior decision to invest. With respect to the DE, this bias could be particularly relevant to the reluctance to sell losing assets.

Surprisingly, there seems to be no experimental studies focusing on beliefs in the context of the DE. This is undertaken in Experiment 2 of the present study.

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[2] Barberis *et al.* (1998), Daniel *et al.* (1998), Hong and Stein (1999). See Kaustia (2010b) for a review.
[3] However, Weber and Camerer (1998), using an experimental set-up, find no support for beliefs in mean-reversion as a driver of the DE. See also Kaustia (2010a) and Lehenkari (2012).

2.4 Institutional factors

Another interesting avenue of research looks at the specific institutional factors that may affect the DE. Weber and Camerer (1998) find that the DE is greatly reduced when assets are automatically sold after each period. That is, subjects are not as likely to repurchase losing assets once these have been sold after each period. Another important finding is that the DE seems to be less prominent, or to disappear altogether, for mutual fund investments (Calvet *et al.*, 2009; Ivković and Weisbenner, 2009; Chang *et al.*, 2016). Along similar lines, Jin and Scherbina (2010) find that mutual fund managers are more likely to sell losing stocks when they are inherited from previous managers. A possible reason for this is that, as it happens with automatic selling, investors feel less responsible for their past decisions when they invest in mutual funds, rather than in regular stocks. To the extent that poor investment decisions can be blamed on an outside source (like the fund management), individuals might be less compelled to hold onto losing stocks. By the same token, Lehenkari (2012) finds that private investors are more likely to sell losing stocks when they are received as a gift. Summers and Duxbury (2012) and Chang *et al.* (2016) obtain similar experimental results by manipulating the degree of control over the investment decision or the salience of the delegation, respectively.

Another yet unexplored institutional factor is related to the degree of competitiveness of the trading environment. Competitive payment schemes are very common among professional traders and have been shown to affect portfolio choices, improving stock selection ability (Elton *et al.* 2003), but also affecting portfolio volatility (Brown *et al.*, 1996; Dijk *et al.*, 2014). Goulart *et al.* (2015) conduct an experiment in which profits are made public and find that this increases the DE by inducing a higher rate of realized winners. However, "competition" here is only for prestige and does not affect actual earnings.

Transaction costs may also affect the DE. Barber and Odean (2000) analyze the investments of nearly 70,000 households and find that the average cost of a round-trip trade over $1,000 was around 4%. Transactions costs are, therefore, typically large and difficult to avoid. As Barber and Odean (2000) put it, *"trading is hazardous to your wealth"*: because of transaction costs, households' net returns are significantly below the market weighted average return. Barber and Odean (2000) and other authors conclude that the primary reason why investors trade too much is *overconfidence*.[4] Investors trading in a market with large transaction costs must be confident in their ability to select the right stocks. It is possible that such highly confident investors might bear a higher psychological cost when selling losing stocks and, hence, be particularly vulnerable to the DE.

On a related theme, Summers and Summers (1984) defend a tax on financial transactions,

[4] See, for instance, Barber and Odean (2001), Bhandari and Deaves (2006), and Grinblatt and Keloharju (2009).

much in the spirit of the so-called "Tobin Tax", arguing that it may help to reduce volatility by disincentivizing the activity of noisy traders. However, this prediction is not supported by the available empirical evidence. Colliard and Hoffmann (2017) find no effect on volatility in France after the introduction of a tax in 2012, and Cappelletti *et al.* (2016) find that volatility actually increased in Italy after the introduction of the 2013 tax. Finally, transaction costs or taxes need not be applied symmetrically to gains and losses. In most countries taxpayers can deduct net losses in investments from their taxable income capital losses (tax loss offset). This entails an asymmetry between taxes on gains and losses that could potentially reverse the DE. Indeed, Odean (1998) finds evidence suggesting that tax-motivated selling tends to eliminate the DE towards the end of the calendar year. We investigate the effect of asymmetric transaction costs on the DE in one treatment of Experiment 2.

3 Experiment 1

3.1 Design

We recruited 192 subjects, 97 female and 95 male, to participate in this study. Experiments were conducted in 8 sessions of 24 subjects each. All subjects were recruited from the undergraduate population of the University of Alicante. The experiment was programmed in z-Tree (Fischbacher, 2007). Subjects were recruited using ORSEE (Greiner, 2004) and earned around 19€ on average for an experiment that lasted, on average, two hours.

We borrow the baseline design from Weber and Camerer (1998) and Weber and Welfens (2007), with some modifications. In our baseline treatment, subjects can buy and sell six risky assets (A, B, C, D, E, and F) over 9 periods using experimental currency. Each asset follows a different stochastic price path, independent of subjects' actions. We introduce two variations of the baseline treatment: *i)* a trading tax and *ii)* a competitive payment scheme. All subjects go through the baseline treatment, the tax treatment, the competitive treatment, and the competitive & tax treatment. The treatment order is counterbalanced.[5] Individuals are endowed with 5,000 pesetas in each treatment to trade in the market.[6]

3.1.1 Prices

Subjects are assigned randomly into groups of two males and two females. They know that they are in a group of four but are not told the identity, or gender, of their group mates.[7] Subjects

[5] Sessions 1 and 2: baseline, competitive, tax, competitive & tax; sessions 3 and 4: tax, competitive & tax, baseline, competitive; sessions 5 and 6: competitive, baseline, competitive & tax, tax; sessions 7 and 8: competitive & tax, tax, competitive, baseline. Subjects played a short trial period before each treatment.

[6] We call the experimental currency "pesetas." Exchange rate: 1,000 pesetas = 1€.

[7] To ensure that subjects perceive a similar gender-balanced environment in every session, their positions in the laboratory are always male, female, male, female… This is done by asking male and female subjects to randomly draw a number from different boxes: one box contains odd numbers and the other contains even numbers. Subjects are then seated on the cubicle corresponding to their drawn number.

are also told that each group of four faces the same price path of the six assets. The history of each market begins in period -3, with the same initial price of 100 pesetas for all assets. From period -2 onwards, prices can go up by 6% or down by 5%. Subjects are told that each asset has a different probability of a price increase, but are not told the actual probabilities. However, they are informed that, for each asset, the probability of a price increase is constant over the whole treatment and that price changes are independent of previous prices and subjects' actions. In particular, we assign randomly to each asset a probability of a price increase that is chosen without replacement from the set {0.6, 0.55, 0.5, 0.5, 0.45, 0.4}. This implements a market in which there are always two "good" assets (those with a price increasing probability of 0.6 and 0.55), two "neutral" assets (0.5), and two "bad" assets (0.45 and 0.4).

Since the probability of a price increase for each asset is unknown and constant, a rational subject should infer that appreciating assets are more likely to continue appreciating than depreciating assets. This implies that rational subjects should be more likely to sell losing assets than winning assets. Therefore, a positive DE clearly constitutes a costly decision-making bias in this environment.

Individuals observe prices from period -3 to 10, but can only trade from period 1 to 9. Prices at period 10 are only used to liquidate portfolios. To elicit subjects' beliefs about the asset types, in periods 1, 6, and 10 we ask them to guess which asset has the highest, second highest, lowest and second lowest probability of a price increase, respectively. The task is incentivized by paying subjects 100 pesetas each time they guess all asset types correctly.

3.1.2 Treatments

We employ a within-subject design, in that all subjects participate in the four treatments. In the *baseline* treatment, they earn the value of the portfolio upon liquidation (period 10) plus their remaining cash. In the *competitive* treatment, only the "winner" –i.e. the investor whose liquidated portfolio plus remaining cash is the largest in each group of four- earns the value of her portfolio plus the remaining cash, multiplied by two. The remaining three members of the group do not receive the value of their portfolios, nor their remaining cash. In the *tax* treatment, subjects have to pay a fee for each transaction. The fee is a fixed rate, chosen from the set {1%, 4%, 7%} so that a third of the groups in each session face each fee. All individuals in a given group face the same fee throughout the treatment. The fee is the same for purchases and sales. Finally, in the *competitive & tax* treatment, we combine the features of treatments 2 and 3. To elicit subjects' self-confidence, we ask them to guess, at the beginning and at the end of each treatment, their own ranking in terms of earnings within their group. They receive another 100 pesetas every time they guess their position right.

3.1.3 Individual measures

At the end of the experiment subjects complete a survey including the Financial Literacy Test (FLT, Lusardi and Mitchell, 2011) and other socio-demographic questions. We also use some self-assessed psychological measures gathered using a Likert-type scale including a reduced version of the Big Five Test,[8] questions regarding indecisiveness (Germeijs and De Boeck, 2002), self-control (Tangney *et al.*, 2004), difficulty recognizing errors, optimism, willingness to take risks, confidence, competitiveness and enjoyment of winning (see Appendix C for the exact wording of these questions). All these questions aim to capture different traits that have been associated to the DE or to closely related phenomena. For instance:

1. Indecisiveness may be correlated with regret aversion, which has been proposed as a possible source of the DE (Shefrin and Statman, 1985; Frydman and Camerer, 2016).
2. Self-control has also been related to the DE (Shefrin and Statman, 1985). Under the view that the DE is partly caused by "realization utility" (Shefrin and Statman, 1985; Barberis and Xiong, 2012; Ingersoll and Jin, 2013), one might also expect self-control, competitiveness and enjoyment of winning to be correlated with the DE.
3. Optimism and confidence feature prominently as explanations of overtrading, momentum, and the January effect (Odean, 1999; Ciccone, 2011; Antoniou *et al*, 2013).
4. Difficulty recognizing one's errors has been proposed as a contributing factor for the reluctance to sell losers (Gross, 1982; Shefrin and Statman, 1985). By the same token, cognitive dissonance theory suggests that individuals who are optimistic and who have difficulty recognizing their errors might hold on to losers and therefore be vulnerable to the DE.

Before the beginning of the trading period, we elicit risk preferences using a Multiple Price List protocol (Holt and Laury, 2002) in which subjects go through a sequence of 21 binary decisions between a lottery and a safe option. The lottery is always the same: 5,000 or 0 pesetas with equal probability. The safe option ranges from 0 to 5,000 pesetas, increasing by a constant step of 250 pesetas along the sequence.

3.2 Results

To calculate the DE, we follow Odean (1998) by computing the number of units sold at a price above the reference price ("Realized Gains"), the number of units sold at a price below the reference price ("Realized Losses"), the number of units not sold and whose price exceeds the reference price ("Paper Gains"), and the number of units not sold and whose price is below the reference price ("Paper Losses"). The DE is defined as DE = PGR – PLR, where:

[8] We use a Spanish translation of the reduced form of the Big 5 test (Benet-Martinez and John, 1998; John and Srivastava, 1999).

$$\text{Proportion of Gains Realized, PGR} = \frac{\text{Realized Gains}}{\text{Realized Gains+Paper Gains}}, \text{ and}$$

$$\text{Proportion of Losses Realized, PLR} = \frac{\text{Realized Losses}}{\text{Realized Losses+Paper Losses}}.$$

PGR and PLR are between 0 and 1, so DE is between -1 and 1.

An alternative measure of the DE introduced by Weber and Camerer (1998) and often used in the experimental literature is the so-called "alpha" coefficient, defined as $alpha = \frac{S^+ - S^-}{S^+ + S^-}$, where S^+ (S^-) are the number of sales of stocks whose price has gone up (down) in the last period.

The first issue when calculating PGR and PLR, is defining a *reference price* from which gains and losses are computed. As Odean (1998, p. 1782) puts it: "*Any test of the DE is a joint test of the hypothesis that people sell gains more readily than losses and of the specification of the reference point from which gains and losses are determined*."

A number of different reference prices have been used in the literature, such as the *weighted average* price, the *first period* price, the *last period* price, the *first-in-first-out* rule (FIFO) or the *last-in-first-out* rule (LIFO). Most empirical studies follow Odean (1998) in employing the weighted average price.[9] However, experimental studies are more varied: Weber and Camerer (1998) use FIFO and LIFO; Weber and Welfens (2007) use the weighted average price; Da Costa *et al.* (2008) use LIFO and last price; Rau (2014) uses only LIFO; Frydman *et al.* (2014) use the *purchase price* in an experiment in which FIFO, LIFO and the weighted average price coincide.

We use the weighted average reference price for most of our analysis, unless otherwise stated.[10] However, our results are robust to other reference prices and the alternative alpha measure. We also show that the weighted average price is regarded by our subjects as the most reasonable reference price, according to their questionnaire responses (see Appendix C).

The average DE in our baseline treatment is 0.069 and is significantly different from zero ($p = 0.002$, Wilcoxon signed-rank test). In this respect, our findings are comparable to those obtained in related works. For instance, Odean (1998, Table 1) also uses the average reference price and finds that 14.8 percent of the gains available for realization are actually realized, while only 9.8 percent of the losses are realized, which yields a DE of 0.05.

3.2.1 Treatment effects

Figure 1 displays average DE, PGR and PLR in each treatment. Considering the four treatments together, the DE is 0.078 (± 0.011 SE). Individuals, therefore, clearly display some

[9] This is also how capital gains are usually computed for tax purposes.

[10] Suppose an individual holds 10 units of asset A in period 6. She bought 3 units in period 2 and 7 units in period 5. The weighted average reference price for asset A in period 6 is the price in period 2 multiplied by (3/10) plus the price in period 5 multiplied by (7/10).

degree of DE in all treatments. The DE is 0.069 (± 0.023 SE) in the baseline treatment, 0.070 (± 0.024 SE) in the competitive treatment, 0.105 (± 0.019 SE) in the tax treatment, and 0.068 (± 0.020 SE) in the competitive & tax treatment. For each treatment, Wilcoxon tests reject the null hypothesis that DE = 0 ($p < 0.01$).

Although the DE is higher in the tax treatment than in the baseline treatment, this difference is not significant (Wilcoxon test, $p = 0.391$). Using the Skillings-Mack (SM) test (a generalization of the Friedman test that allows for missing observations), we also find no significant differences in DE across treatments ($p = 0.363$).

By contrast, PGR and PLR are significantly affected by our treatment conditions (SM tests, $p = 0.003$ and $p < 0.001$, respectively). In particular, in the tax and in the competitive & tax treatment both PGR and PLR decrease significantly with respect to the baseline (Wilcoxon tests, $p < 0.01$). Finally, we find no differences in PGR or PLR between the baseline and the competitive treatment.

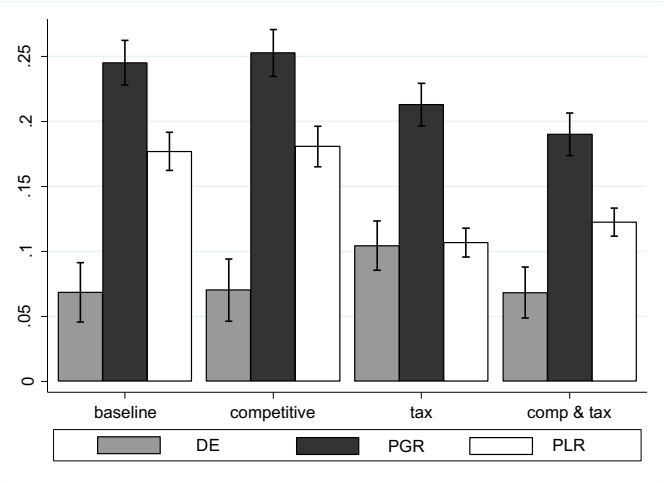

Figure 1. Mean DE, PGR and PLR (± SE bars) by treatment. Weighted average reference price

Table B2 (in Appendix B) reports the results corresponding to the four other reference prices and alpha. To summarize, we find that the DE is significantly different from zero for most treatments and reference prices. The DE tends to be higher in the tax treatment although, as before, this difference is not significant.

As shown in Table 1, within-subjects correlations of the DE across treatments are all high and very significant ($p<0.001$), suggesting that individuals' DE is fairly stable across treatments.

Table 1. Correlation matrix of DE across treatments

	Baseline	Competitive	Tax
Competitive	0.5964		
Tax	0.3092	0.2832	
Comp & Tax	0.4978	0.4488	0.5022

3.2.2 Gender effects

As we explained earlier, participants in each session were divided into groups of 4 subjects, two men and two women, facing the same price histories. To test for gender differences we calculate, for each group, the mean values of the relevant measures (DE, PGR, PLR) by gender, together with their differences (42 in total, one for each group).

We test whether these differences are significantly different from zero using a Wilcoxon signed-rank test. We find that the average value of the DE is lower for males (0.049) than for females (0.088) in the baseline treatment. However, this difference is not statistically significant ($p = 0.358$). We get very similar values for the PGR of males (0.255) and females (0.235) in the baseline treatment, again with no significant difference ($p = 0.553$). In contrast, we get clear gender differences in the PLR ($p = 0.005$), with females having significantly lower PLR (0.145) than males (0.209).

We now investigate gender differences in each treatment, controlling for various individual characteristics. Table 2 presents the marginal effect of the variable *female* for each treatment. These are calculated after estimating three regressions in which the dependent variables are DE, PGR and PLR, respectively. The full set of covariates is displayed in Table 3.[11]

The first line of Table 2 reports the overall marginal effect. In lines 2-5 we report the marginal effects computed for each treatment. The estimated marginal effects confirm our previous results: although females have a higher DE than males, the difference is not statistically significant in any treatment. On the other hand, females exhibit a significantly lower PLR in the baseline and competitive treatments, but this difference disappears in the presence of transaction costs.[12]

[11] We have to compute these marginal effects because our model has the dummy variable *female* interacted with the treatment dummies. Suppose we estimate a model with interactions in which there are only two treatments (treatment 1 and treatment 2). The estimated model is: $Y = b_0+b_1F+b_2T_2+b_3FT_2$, where F and T_2 are dummy variables that take value 1 for females and treatment 2, respectively. The marginal effect of the dummy F in treatment 1 is b_1, and it is b_1+b_3 in treatment 2. Finally, the overall effect of F is just a weighted average of b_1 and b_1+b_3.

[12] In Appendix B, we rerun the analysis using the alternative reference price specifications to compute the DE, as well as using the alpha measure. Our results are robust to these various measures, with the exception of LIFO (where no significant gender differences in PLR are found).

Table 2. Marginal effects of gender from random effects regressions with robust standard errors clustered by group and session (see Table 3).

VARIABLES	DE	PGR	PLR
(overall) female = 1	0.0216	-0.00424	-0.0262
	(0.0347)	(0.0282)	(0.0199)
(baseline) female = 1	0.00666	-0.0459	-0.0557**
	(0.0391)	(0.0315)	(0.0223)
(competitive) female = 1	0.0233	-0.0257	-0.0478*
	(0.0433)	(0.0346)	(0.0270)
(tax) female = 1	0.0333	0.0139	-0.00951
	(0.0434)	(0.0344)	(0.0260)
(comp & tax) female = 1	0.0219	0.0350	0.00562
	(0.0476)	(0.0364)	(0.0278)
Observations	706	720	710

We run three regressions in which the dependent variables are DE, PGR and PLR, respectively. The first line shows the overall marginal effect of female, pooled across the four treatments. The remaining lines show the marginal effect of female, disaggregated by treatment. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Our findings differ from previous results in the literature. In particular, Da Costa *et al.* (2008) find that only men fall into the DE when using alpha as the measure of the DE. On the other hand, Rau (2014) reports values of the DE using the LIFO rule and finds significant gender differences. In particular, he finds a negative average DE for males and a positive one for females. There are a number of differences between our experimental set-up and that of Da Costa *et al.* (2008) and Rau (2014), which might explain the discrepancy of our results. First, in these studies all participants face the same market, which corresponds exactly to the price path in Weber and Camerer (1998). In our experiment, instead, each group faces a different market, with randomly generated price paths. Second, our sample is substantially larger. We have 192 subjects, roughly half for each gender. Rau's sample is composed of 55 subjects, of which 28 are female; Da Costa *et al.* (2008) have 96 subjects, of which 52 are female.[13] Finally, our experiment is incentivized, whereas Da Costa *et al.* (2008) use hypothetical payoffs.

On the other hand, our finding that the PLR is significantly lower in females is in line with the experimental results reported by Rau (2014) and with empirical evidence obtained by Feng and Seasholes (2005) on Chinese investors.

3.2.3 Individual heterogeneity

The questionnaire administered at the end of the experiment allows us to carry out a more in-depth analysis of individual heterogeneity. Summary statistics of the individual measures can be found in Table B1 in the Appendix. We estimate three regression models with DE, PLR and PGR

[13] This refers to the deliberate selling treatment, which is the case comparable to ours.

as dependent variables, using as covariates measures gathered from the questionnaire. A similar analysis with the alternative reference prices is left to the Appendix (Tables B3-B5).

To ease the interpretation of the quantitative effect associated with each coefficient, we create dummy variables which take a positive value whenever the associated measure (an integer between 1 and 7) is above the median. We do this for the eight variables that measure optimism, risk, confidence, difficulty recognizing errors, competitiveness, enjoyment of winning, decisiveness, and self-control, respectively. Following common practice in the literature, Big Five personality traits are standardized. The variables *experience2* to *experience4* are dummies capturing the order of treatments within a session.[14] We also include four dummy variables measuring ability and confidence: *high financial literacy*, *high grades, >1 switches* and *high confidence before*.[15] Finally, since our experimental subjects are students from all fields (Social Sciences, Art and Literature, Health, Sciences, and Engineering), we control for the field of studies with four dummy variables, with students from Social Sciences selected as baseline group.[16]

Table 3 reports the estimated coefficients. They confirm our previous findings and offer additional evidence:

1. Although the PLR is significantly reduced in the tax and the competitive & tax treatment, the effect on the DE is not significant. This is because the drop in PLR provoked by the tax is partly offset by a drop in PGR.
2. The variable *experience4* has a negative and significant effect on the DE. This provides further support to previous evidence that trading frequency and experience help to mitigate the DE (Feng and Seasholes, 2005; Dhar and Zhu, 2006; Weber and Welfens, 2007; Da Costa *et al.*, 2013).
3. Among the Big Five personality traits, we only find a moderate effect of *openness*. However, this result is not robust to all reference prices (see Table B3).
4. Students from Engineering exhibit lower DE and PGR for all reference prices. One possible

[14] For example, in the first session, the treatment order was baseline, competitive, tax, competitive & tax. The variables experience2, 3 and 4 would then take value 0 in the baseline, experience2 = 1 in the competitive treatment, experience3 = 1 in the tax treatment, and experience4 = 1 in the competitive & tax treatment. On the other hand, in the eighth session, the treatment order was competitive & tax, tax, competitive, baseline. So here experience2 would take value 1 in the tax treatment and so on.

[15] *High financial literacy* = 1 if a subject answers the three questions of the Financial Literacy Test (Lusardi and Mitchell, 2011, 2014) correctly; *high grade* = 1 if a subject reports an average grade of 7 or higher (out of 10) in their studies; *>1 switches* = 1 if a subject switches more than once in a Holt and Laury (2002) type lottery task, reflecting inconsistent behavior; *high confidence before* = 1 if a subject guesses that she will be the best in her group of 4 before a given treatment. To avoid reducing the sample size significantly, we do not include the measure of risk aversion gathered in the lottery task, since we would have to exclude 42 subjects who switched more than once. This variable was nevertheless insignificant when included in the regression.

[16] These are the five official categories of fields of studies in Spanish universities. Our sample was distributed as follows: 10% Art and Literature, 30% Social Sciences, 32% Health, 10% Science, 18% Engineering.

interpretation is that Engineering students are better able to understand the price process in the experiment, which discourages them from selling winners too early. This result fits well with the field evidence that sophisticated investors tend to exhibit a lower DE (Odean, 1998, Grinblatt and Keloharju, 2001; Shapira and Venezia, 2001; Dhar and Zhu, 2006, Brown *et al.*, 2006).

5. Among individual characteristics, the most significant are *optimism* and *difficulty recognizing errors*. The variable *optimism* is measured by asking subjects "are you an optimistic or a pessimistic person? (1 = extremely pessimistic; 7 = extremely optimistic)". The variable *difficulty recognizing errors* is measured by asking subjects the extent to which they agree with the statement "I find it hard to recognize my errors (1 = completely disagree; 7 = completely agree)". We investigate these two factors in more detail in the following section.[17]

3.3.4 Optimism and difficulty recognizing errors

Optimism is considered a common investment bias, which has been suggested to have a significant impact on stock prices (Diether *et al.*, 2002; Ciccone, 2011; Antoniou *et al.*, 2013) and venture performance (Hmieleski and Baron, 2009). In particular, Antoniou *et al.* (2013) use the Consumer Confidence Index to partition the last 40 years of stock market data into "optimistic" and "pessimistic" periods and find that in optimistic periods small investors are slower to sell losers than in pessimistic periods. The authors argue that, due to cognitive dissonance, unsophisticated optimistic investors are slow to incorporate bad news.

The regressions of Table 3 show that *optimism* has a significant positive effect on the DE via a decrease in the PLR, while having no effect on the PGR. This result seems intuitive: some subjects hold onto losing assets too long because they optimistically believe that these assets will appreciate in the future. This result is robust to all reference price specifications except LIFO (see tables B3-B5, Appendix B). Our results bring further direct support for the role of optimism on the reluctance to sell losing assets.

Difficulty recognizing errors also has a significant positive effect on the DE. Like *optimism*, it reduces the PLR, while having no effect on the PGR. Again, this result is robust to all reference price specifications except LIFO (see tables B3-B5, Appendix B). This finding confirms the hypothesis of Shefrin and Statman (1985) regarding one possible cause of the DE. Namely, that investors find selling losing assets difficult because they are reluctant to admit their own past mistakes. Earlier studies point towards this interpretation of the DE, for instance, by showing that the DE disappears when losing stocks are "inherited" rather than purchased directly by the investor (Jin and Scherbina, 2010; Lehenkari, 2012; Summers and Duxbury, 2012; Chang *et al.*,

[17] As robustness checks, we reestimate the model with: (i) bootstrapped standard errors and (ii) removing 10% of the subjects with the most extreme values of DE. All the results are maintained.

2015). However, the significant and robust negative correlation between PLR and the degree to which subjects agree with the statement "*I find it hard to recognize my errors*" presented here constitutes the first direct evidence in support of this view.

4 Experiment 2

Although *optimism* and *difficulty recognizing errors* have very similar effects, they constitute two distinct mechanisms. For instance, the raw variables are uncorrelated ($\rho = -0.086$, $p = 0.236$). Our interpretation is that the main channel through which optimism and difficulty recognizing errors reduce the willingness to realize losses is via their impact on beliefs. In this respect, optimism can be understood as an upward bias on the beliefs about future price changes of an individual's assets *regardless* of the involvement of the individual in the original investment decision. On the other hand, difficulty recognizing errors would entail an upward bias on the beliefs only for those assets that were personally purchased by the investor. Two of the treatments in Experiment 2 have been specifically designed around this working hypothesis, the other two aim to assess whether asymmetric transaction costs can mitigate the DE.[18]

4.1 Design

For Experiment 2 we recruited 96 subjects, 52 males and 44 females. Subjects were again undergraduates of the University of Alicante, although participants in Experiment 1 were excluded from the the subject pool of Experiment 2. We conducted a total of 4 sessions with 24 subjects in each session. As before, the experiment was programmed in z-Tree (Fischbacher, 2007) and recruitment was carried out using ORSEE (Greiner, 2004). Average payment was 19€ for an experiment lasting, on average two hours.[19]

As before, there were 4 treatments and all subjects participated in all of them. Subjects were matched randomly into groups of 4 as in Experiment 1. The Baseline treatment was identical to that of Experiment 1. The Tax Rebates treatment was also identical to the tax treatment in Experiment 1 with the exception that subjects received a 50% tax rebate on realized losses at the end of the treatment.[20] Our aim here was to assess whether this policy might mitigate the DE. The remaining two treatments, which we will call Allocate Treatment (AT) and Choose Treatment (CT), were primarily designed to study subjects' beliefs. The order was counterbalanced from session to session.[21]

[18] We thank the Editor and two anonymous referees for encouraging us to run these additional treatments.
[19] We adjusted the exchange rate downwards to 1,500 pesetas = 1€ to keep average payoffs similar to Experiment 1.
[20] These were calculated according the weighted average rule. A simple explanation relying on examples was given in the Instructions (see Appendix).
[21] Session 1: Baseline, Tax Rebates, Allocate, Choose. Session 2: Tax Rebates, Baseline, Choose, Allocate. Session 3: Allocate, Choose, Baseline, Tax Rebates. Session 4: Choose, Allocate, Tax Rebates, Baseline.

As always, subjects in AT and CT could see the price paths of 6 risky assets, which behaved in the same way as in Experiment 1. In these two treatments, however, subjects could not buy or sell any assets, and were instead asked simply to guess whether each asset would go up or down in price. Each correct guess was rewarded with 100 pesetas. At the end of period 5, 10 units of each of 3 randomly selected assets were given to each subject in AT.[22] In CT, subjects were asked to choose 3 assets and to purchase 10 units of each at the end of period 5. In both treatments, the cost of these assets was deducted from their initial cash endowment of 5,000 pesetas. From period 6 to 9, subjects continued making price guesses as before. However, in both treatments they would now own 10 units of each of 3 different assets. Finally, after making price guesses in period 9, subjects could freely sell as many units of each owned asset as they wished. Profits were then calculated as the sum of their cash endowment plus the value of their remaining assets at period 10 prices.

4.2 Results

4.2.1 Baseline and Tax Rebates treatments

Mean values for DE, PGR and PLR for the first two treatments are displayed in Table 4. Our results suggest that tax rebates were not effective at reducing the DE (Wilcoxon test, p = 0.767). Although the effects are in the same direction as in Experiment 1, we find no significant effect of tax rebates on PGR (p = 0.217), and a borderline significant negative effect on PLR (p = 0.100). As expected, the DE was not significantly different in Experiment 2 than in Experiment 1 in the *Baseline* treatment (Mann-Whitney test, p = 0.329). DE in the *Tax* treatment (Experiment 1) and in the Tax Rebates treatment were also not significantly different from each other (Mann-Whitney test, p = 0.514), again suggesting that tax rebates were not effective at reducing the DE.

Table 4. Mean DE, PGR and PLR in the Baseline and Tax Rebates treatments.

	Average Price Reference		
	DE	**PGR**	**PLR**
Baseline	0.107***	0.238	0.131
	(0.024)	(0.018)	(0.014)
N	96	96	96
Tax Rebates	0.109***	0.223	0.113
	(0.025)	(0.021)	(0.014)
N	96	96	96
p-value	0.767	0.217	0.100

Standard errors in parentheses. p-values from Wilcoxon signed-rank tests of treatment effects. ***DE is significantly different from 0 in both treatments (p<0.001, Wilcoxon signed-rank test)

[22] Subjects in the same group saw identical prices. In AT, members of the same group also received the same assets.

4.2.2 Choose and Allocate treatments

A natural interpretation of the evidence from Experiment 1 regarding *optimism* and *stubbornness* is that investors are reluctant to realize losses because they tend to have overly optimistic beliefs about the stocks they own, particularly when believing otherwise would contradict their original investment decision. The purpose of these last two treatments is to study price expectations in order to further test this hypothesis.

The first part of this hypothesis is that subjects have an optimistic element which may bias their beliefs about stocks that they own, regardless of whether they were personally chosen by them or randomly allocated to them by the experimenter. The second part of the hypothesis is in line with cognitive dissonance theory. In our experiment, cognitive dissonance would arise in a situation in which subjects must form beliefs about a purchased asset which is performing poorly. If that asset was personally chosen by the subject, she might bias her beliefs upwards and ignore negative information in order to reduce the discomfort arising from cognitive dissonance. This bias should be present in CT but not in AT, since it is only in CT that subjects make active investment decisions.

We derive three distinct testable predictions from this hypothesis:

- *Optimism:* In both AT and CT, and controlling for prices, subjects believe that stocks that they own are more likely to appreciate than stocks that they do not own.
- *Stubbornness 1:* The above effect is larger in CT than in AT.
- *Stubbornness 2:* Beliefs are less sensitive to prices in CT than in AT for assets owned by the subjects.

To test these hypotheses, we estimate logit regressions in which the dependent variable (*guessup*) takes value 1 (0) if a subject guessed that a specific asset at a given period would go up (down) in price. Since our variables of interest are whether the individual owns the stock and whether the stock is allocated or chosen by the subject, we limit our attention to the last 5 periods of each treatment, since up until period 5, subjects own nothing but cash. To control for the price path of assets, we include 3 different measures: current price, price at period 5 (purchase price), and the dummy variable *price100,* which equals 1 if the current price is above 100.[23]

Estimation results are presented in Table 5 and the relevant marginal effects are shown in Table 6. We include OLS estimates alongside the logit estimates as a robustness check. Models (2) and (4) include some additional interactions as regressors. The estimation results support our hypotheses in that owning an asset significantly increases the likelihood that subjects guess its price will go up, and this effect is much stronger in CT. The left panel of Table 6 displays the

[23] Alternatively, we can include frequencies of price increases instead of prices. In this way, current price would be replaced by the current proportion of price increases, and *price100* would be replaced by a dummy variable = 1 if the current proportion of prices increases is higher or equal to 0.5. Results are essentially the same if we follow this approach.

effect of owning an asset for each treatment. The estimated effects are 0.070 (p=0.017) in AT and 0.198 (p<0.001) in CT, which correspond to increases in the probability of an upward guess of 7 and 19.8 percentage points, respectively. The difference between these two effects is statistically significant (Chi-squared test, p=0.0017).

Model (2) in Table 5 estimates the different impact of *price100* on guesses about assets in each treatment. The right panel of Table 6 displays the effect of *price100* separated by treatment and by whether the asset is owned or not by the subject. Whereas *price100* has a significant positive effect on beliefs in AT, particularly for owned assets (0.0977, p=0.017), it has no effect in CT. Focusing on owned assets, the difference in these partial effects is marginally significant (Chi-squared test, p=0.0934). In sum, all three predictions are supported by the data.

An additional result worth mentioning is the consistently high significance of the purchase price (price at t = 5, see Table 5). This result is reminiscent of the findings of Baucells *et al*. (2011), who find that the initial purchase price has a large impact on subjects' reference prices. In their study, reference prices are elicited by asking subjects "at what selling price would you feel neutral about the sale of the stock, i.e., be neither happy nor unhappy about the sale." Both their result and ours support the notion that prices at the time of purchase are indeed important anchors affecting both preferences and beliefs.

We now focus on beliefs in period 9. These are particularly interesting since subjects had the opportunity to sell any of their assets at the end of this period. Therefore, beliefs in period 9 are most likely to affect selling behavior and the DE. For this purpose, we first consider beliefs over assets that have appreciated or depreciated since period 5. Figure 2 displays mean price guesses and standard errors. Visual inspection reveals that the effects observed in the previous estimations are clearly present in period 9. In particular:

1. Beliefs are on average more optimistic about owned assets in both treatments (AT: Wilcoxon signed-rank test, p=0.056; CT: p=0.001).
2. Past performance of the asset (gain vs loss) has an effect on beliefs in AT (Wilcoxon signed-rank test, p=0.012) but not in CT (p=0.952). In CT, subjects remain highly optimistic even about losing assets (See Fig. 2 for further statistical comparisons).

Turning to selling behavior, Table 7 presents mean DE, PGR and PLR in AT and CT.[24] Given that subjects only owned 3 assets and could only sell at a single period, our sample size is relatively small due to missing observations, particularly when carrying out paired tests. This is because, in order to measure the DE, a subject must own at least one winning asset and one losing asset in period 9. This is the case for only 52 subjects in AT, 54 in CT, and only 28 subjects have

[24] Note that since all assets are bought in period 5, all criteria for computing the reference prices coincide in these treatments. Since subjects always own either 10 or 0 units of each asset in period 9, the PGR and the PLR are simply a tenth of the average sales of winning and losing stocks, respectively. Similarly, the DE is a tenth of the difference between these two numbers.

a defined DE in both treatments simultaneously. Unsurprisingly, this yields non-significant results in Wilcoxon signed-rank tests of the effect of treatment on the DE (p=0.327, N=28) and the PGR (p=0.606, N=78), although we still find a borderline significant effect on the PLR (AT mean = 0.482 ± 0.059 SE, CT mean = 0.360 ± 0.051 SE, N=38, paired t-test p=0.050, Wilcoxon signed-rank test p=0.104).[25] Notwithstanding sample size limitations, our results suggest that the DE indeed tends to disappear in AT, and that it remains positive and of similar magnitude to the baseline in CT.

These findings are closely related to experimental results by Summers and Duxbury (2012), who also find no DE in a treatment in which stocks are exogenously given to subjects. They also offer further support to field evidence showing no DE in stocks inherited from previous fund managers (Jin and Scherbina, 2010) or received as a gift (Lehenkari, 2012).

Table 5. Logit and OLS regressions. Dependent variable is guessup=1 (=0) if a subject guesses that the price of a stock go up (down).

	Logit		OLS	
VARIABLES	(1)	(2)	(3)	(4)
CT	-0.504**	-0.437**	-0.117**	-0.104**
	(0.206)	(0.207)	(0.0471)	(0.0479)
Owned	0.298**	0.209	0.0671**	0.0476
	(0.126)	(0.152)	(0.0290)	(0.0362)
CT*Owned	0.570***	0.668***	0.127***	0.156***
	(0.179)	(0.226)	(0.0404)	(0.0519)
price100	0.217*	0.256*	0.0503*	0.0607*
	(0.121)	(0.146)	(0.0272)	(0.0340)
CT*(price100)		-0.197		-0.0399
		(0.180)		(0.0421)
Owned*(price100)		0.168		0.0353
		(0.182)		(0.0422)
CT*Owned*(price100)		-0.126		-0.0382
		(0.266)		(0.0596)
price (t=5)	0.0192***	0.0191***	0.00421***	0.00417***
	(0.00569)	(0.00576)	(0.00123)	(0.00124)
price	-0.00501	-0.00473	-0.00111	-0.00104
	(0.00438)	(0.00436)	(0.000980)	(0.000975)
Observations	5,640	5,640	5,760	5,760
R-squared			0.074	0.074

Each regression includes subject and group fixed effects. Each group of four individuals face the same asset prices. Standard errors are clustered by the interaction of subject and asset. Robust standard errors in parentheses;
*** p<0.01, ** p<0.05, * p<0.1

[25] Note that these numbers do not match those of Table 7 because the Table reports average values of all non-missing observations whereas the paired tests only rely on the subsample of subjects with no missing values of the relevant variable in both treatments.

Table 6. Marginal effects (probabilities) from regressions in Table 5.

	Effect of Owned			Effect of price100	
	Logit	OLS		Logit	OLS
CT=0	0.0698**	0.0671**	CT=0 & Owned=0	0.0615*	0.0607*
	(0.0294)	(0.029)		(0.0349)	(0.034)
CT=1	0.198***	0.194***	CT=0 & Owned=1	0.0977**	0.0960**
	(0.0277)	(0.0273)		(0.0411)	(0.0406)
			CT=1 & Owned=0	0.0143	0.0208
				(0.0416)	(0.0401)
			CT=1 & Owned=1	0.0205	0.0179
				(0.0403)	(0.0416)
Observations	5640	5760		5640	5760

Left panel: effect of Owned on guessup disaggregated by treatment; 1st and 2nd columns are obtained from models (1) and (3) of Table 5, respectively. Right panel: effect of price100 on guessup disaggregated by treatment and Owned; 3rd and 4th columns are obtained from models (2) and (4) of Table 5, respectively. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

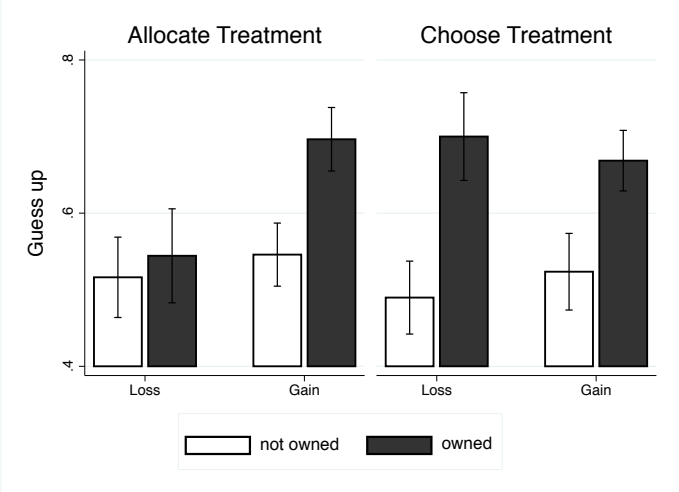

Fig. 2. Mean proportion of upward guesses in period 9. Loss (Gain) denotes assets with a price at period 9 lower (higher) than at period 5. A Skillings-Mack test rejects no difference between the eight groups (p=0.002). Wilcoxon signed-rank tests: Loss, AT (owned vs not owned, p=0.585); Gain, AT (owned vs not owned, p=0.003); Loss, CT (owned vs not owned, p=0.009); Gain, CT (owned vs not owned, p=0.041). AT, owned (Gain vs Loss, p=0.012); CT, owned (Gain vs Loss, p=0.952). Wilcoxon signed-rank tests cannot reject guessup=0.5 in any case in which stock is not owned. If stock is owned, it rejects guessup=0.5 in all conditions except Loss, AT.

Finally, we check whether beliefs do indeed influence selling decisions. Figure 3 displays histograms of sales. We separate sales according to whether subjects guessed that the price would go up or down in the last period. These histograms show overall ("raw") data, which allows us to see the clear spikes at 0, 10, and somewhat at 5. To check for the effect of beliefs on selling decisions, we restrict our analysis to subjects who displayed variation in beliefs at period 9 over the stocks that they owned (N=82). We compare their average sales following an expected price increase and an expected price decrease using a Wilcoxon signed-rank test which yields a significant difference in the expected direction (p=0.005). On average, subjects increase their sales by 33% when expecting a price decrease (3.98 vs 5.29 units sold).

Table 7. Mean DE, PGR and PLR in the Allocate and Choose treatments.

	DE	**PGR**	**PLR**
Allocate	0.002	0.468	0.491
	(0.080)	(0.037)	(0.047)
N	52	84	64
Choose	0.090[+]	0.493	0.465
	(0.056)	(0.034)	(0.046)
N	54	90	60
p-value	0.327	0.606	0.104

[+]Wilcoxon signed-rank test of DE=0 in CT, p=0.147; in AT, p=0.729. Standard errors in parentheses. p-values from Wilcoxon signed-rank tests of treatment effects.

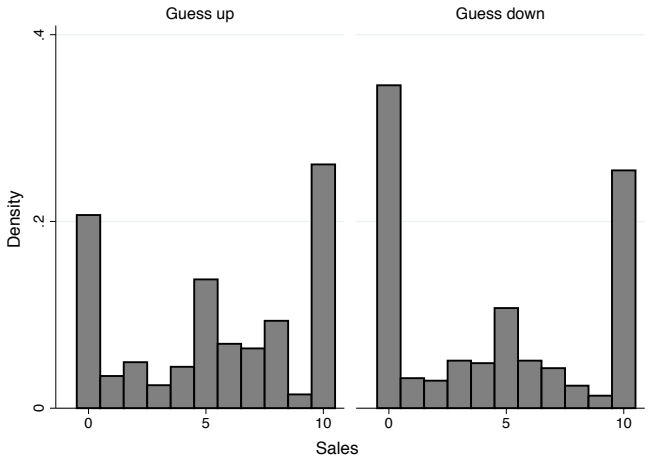

Fig. 3. Histograms of sales separated by beliefs about price change in period 9.

5 Conclusion

This paper studies the DE under various experimental conditions. Our results show that the DE is robust to an environment with transaction costs, to competitive payment schemes and to tax rebates on realized losses.

To gain further insight into the possible psychological causes of the DE, we included a debriefing questionnaire covering various psychological measures such as self-control, decisiveness, optimism, difficulty recognizing errors, as well as financial literacy and a reduced version of the Big Five personality questionnaire. Here, *optimism* and *difficulty recognizing errors* turn out to be the only strong psychological predictors of subjects' PLR and DE. In particular, our findings suggest that both factors increase the DE by making individuals more reluctant to sell losing assets, while having no effect on the PGR.

With regards to *optimism*, our results have an intuitive interpretation: subjects postpone the sale of losing assets under the optimistic belief that they will eventually rise in value. With regards to *difficulty recognizing errors*, the fact that it increases the DE by reducing the PLR provides the first direct evidence that *"investors are also reluctant to accept and realize losses because the very act of doing so proves that their first judgment was wrong"* (Gross, 1982, p. 150).

In a follow-up experiment, we further test the implications of these findings by systematically measuring beliefs while tightly controlling the investment decision. In AT, 3 out of the 6 available assets were randomly selected and 10 units of each of these assets were purchased on behalf of the subjects halfway into the task. In CT these 3 assets had to be chosen by the subjects themselves. Throughout these two treatments, subjects were not allowed to make any other purchases or sales and simply had to state whether they thought each asset would go up or down in price in each period. Finally, in period 9 they had the opportunity to sell as many units as they wanted.

Supporting the intuitions of Experiment 1, we observe that subjects are more optimistic about assets that they owned than about other assets in AT. Yet, beliefs in AT about owned assets are still responsive to prices in a way compatible with Bayesian updating. In contrast, beliefs in CT are far more optimistic about owned assets than about other assets. Furthermore, beliefs about chosen assets in CT are unresponsive to prices, resulting in equally optimistic predictions regardless of the past performance of an asset. Consistently with these belief data, we find that the DE vanishes in AT, whereas it remains positive and of similar magnitude to earlier treatments in CT.

The idea of optimistic and stubborn beliefs can help to explain several striking results in the literature. For instance, it illustrates why small investors are slower to sell losers during optimistic periods than during pessimistic periods (Antoniou *et al.* 2013). It also explains why investors tend to find it much easier to sell losers when doing so does not reflect badly on their own initial judgment, such as when the assets are initially purchased by the experimenter (Summers and

Duxbury, 2012), when they are received as gifts (Lehenkari, 2012), when they are inherited from a previous fund manager (Jin and Scherbina, 2010), or when an external manager can be blamed (Calvet *et al.* 2009; Ivković and Weisbenner, 2009; Chang *et al.* 2016). Our experiments add further support to the cognitive dissonance interpretation of the DE suggested by these studies and identify the crucial role played by psychological factors and beliefs.

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Table 3. DE, PGR and PLR with average reference price. Random effects regression.

		Average Price	
VARIABLES	**DE**	**PGR**	**PLR**
Female	0.00666	-0.0459	-0.0557**
	(0.0391)	(0.0315)	(0.0223)
Competitive	0.000574	0.00172	-0.00147
	(0.0318)	(0.0245)	(0.0201)
Tax	0.0207	-0.0584**	-0.0903***
	(0.0427)	(0.0296)	(0.0235)
Competitive & Tax	-0.00234	-0.0916***	-0.0878***
	(0.0352)	(0.0262)	(0.0208)
Female*Competitive	0.0166	0.0203	0.00794
	(0.0366)	(0.0288)	(0.0291)
Female*Tax	0.0267	0.0598*	0.0462*
	(0.0481)	(0.0350)	(0.0250)
Female*(Comp & Tax)	0.0152	0.0809***	0.0614***
	(0.0346)	(0.0294)	(0.0197)
Experience2	-0.0369	-0.0193	0.0175
	(0.0239)	(0.0196)	(0.0111)
Experience3	-0.0377	-0.0198	0.00804
	(0.0275)	(0.0199)	(0.0195)
Experience4	-0.0680***	-0.0507***	0.0172
	(0.0249)	(0.0157)	(0.0154)
Optimism	0.0713**	0.00993	-0.0614**
	(0.0341)	(0.0350)	(0.0268)
Risk	-0.0240	-0.0213	0.00758
	(0.0325)	(0.0311)	(0.0189)
Confidence	-0.0554	-0.00764	0.0440
	(0.0343)	(0.0346)	(0.0269)
Difficulty recognizing errors	0.0878***	0.0344	-0.0569***
	(0.0295)	(0.0300)	(0.0167)
Competitiveness	0.0448	0.0141	-0.0286
	(0.0392)	(0.0290)	(0.0235)
Enjoys Winning	-0.0481	-0.0396	0.00958
	(0.0298)	(0.0258)	(0.0223)
Decisiveness	-0.0153	-0.0274	-0.0144
	(0.0355)	(0.0358)	(0.0184)
Self-control	0.0593	0.0575*	-0.00518
	(0.0410)	(0.0307)	(0.0251)
High Confidence	-0.00963	-0.0142	-0.00366
	(0.0222)	(0.0193)	(0.0135)
High Financial Literacy	-0.0331	-0.0193	0.0120
	(0.0385)	(0.0333)	(0.0237)
High Grades	-0.00124	-0.00268	-0.00247
	(0.0365)	(0.0322)	(0.0212)
>1 Switches	0.0108	0.00885	-0.00364
	(0.0384)	(0.0291)	(0.0219)
Neuroticism	0.0145	0.0189	0.00313
	(0.0174)	(0.0180)	(0.0122)

Extraversion	0.0163	0.0149	-0.00238
	(0.0139)	(0.0153)	(0.0114)
Agreeableness	-0.0144	-0.0193	-0.000641
	(0.0178)	(0.0160)	(0.00950)
Openness	0.0236*	0.0207	-0.00445
	(0.0139)	(0.0132)	(0.00887)
Conscientiousness	-0.00417	-0.00800	-0.00412
	(0.0196)	(0.0167)	(0.0116)
Art	-0.0150	-0.0538	-0.0385
	(0.0460)	(0.0462)	(0.0293)
Health	0.0313	-0.0210	-0.0534**
	(0.0448)	(0.0387)	(0.0222)
Science	0.0256	-0.0503	-0.0778**
	(0.0494)	(0.0386)	(0.0307)
Engineering	-0.0984**	-0.106***	-0.00988
	(0.0477)	(0.0351)	(0.0374)
Constant	0.0514	0.331***	0.288***
	(0.0846)	(0.0724)	(0.0363)
Observations	706	720	710
Number of id	192	192	192

Note: We show the coefficients of three different regressions in which the dependent variables are DE, PGR, and PLR, respectively. The set of regressors is the same in the three regressions. All variables except Female, Treatment and Experience standardized to zero mean and unit standard deviation. Robust standard errors clustered by group and session in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix A. Reference prices

In this appendix we discuss alternative reference price specifications in relation to our findings. The various alternatives to the weighted average price are the initial price, the last price, FIFO and LIFO. Lastly, we also consider alpha as an alternative measure of the DE.

To see how each of these reference prices is computed, suppose that an individual has 10 units of asset A in period 7. She bought 3 units in period 2 and 7 units in period 5. The initial price is the stock's price at period 1 (always 100 in our experiment). The last price reference would take the price of the asset in the previous period, i.e. period 6. FIFO and LIFO take the price at which that asset was purchased, according to a "first-in first-out" principle or a "last-in first-out" principle, respectively. In the example above, reference prices according to FIFO and LIFO are the price in period 2 and the price in period 5, respectively.

Table A1 presents mean values of the DE, PGR and PLR for our baseline treatment, using each of the five reference prices mentioned above.

Table A1. DE, PGR, and PLR in the baseline treatment for different reference prices

		Reference prices				
		Average	**Initial**	**FIFO**	**LIFO**	**Last**
DE	**Mean**	0.0685***	0.0177*	0.1205***	0.0243**	0.0994***
	St. Error	(0.0228)	(0.0244)	(0.0193)	(0.0171)	(0.0176)
	Obs.	163	154	164	145	165
	p-value	0.0021	0.0685	0.0000	0.0294	0.0000
PGR	**Mean**	0.2452	0.2222	0.2402	0.0901	0.2124
	St. Error	(0.0170)	(0.0151)	(0.0163)	(0.0115)	(0.0148)
	Obs.	164	164	164	145	165
PLR	**Mean**	0.1771	0.2109	0.1183	0.0608	0.1123
	St. Error	(0.0147)	(0.0192)	(0.0108)	(0.0106)	(0.0101)
	Obs.	164	155	166	157	166

Note: Standard errors in parentheses. From a total of 192 individuals, each reference price generated some missing observations. The line Obs. refers to the number of individuals used in each calculation. The p-values correspond to a Wilcoxon signed-rank test in which the null is that the corresponding DE is zero. We do not report p-values for PGR and PLR since all of them are below 0.0001. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The values we get for the DE range from 0.0177 (initial price) to 0.1205 (FIFO). The weighted average yields the median value of the DE among the five reference prices. With respect to the PGR, all reference prices but LIFO yield similar results. We get more variation with the PLR, where again the lowest value corresponds to LIFO. We also calculate alpha, which is equal to 0.198 (± 0.0513 SE).

Results in Table A1 are average values. It is interesting to see how individual DE measures computed according to different reference prices are correlated with each other. As Table A2

shows, all five measures are highly and positively correlated. However, while the measures of the DE calculated using the average price, the initial price, FIFO, and the last price exhibit correlation coefficients well above 0.5 (the smallest one is 0.6411), the correlation between the DE using LIFO and the other four measures is always below 0.5.[26] Pairwise Kolmogorov-Smirnov tests confirm that the LIFO rule results in a significantly different distribution of the DE than any other accounting rule ($p<0.001$). The correlation table includes alpha, which again shows a lower correlation with LIFO than with all other DE measures.

Table A2. Correlation matrix of DE in the baseline treatment using different reference prices.

	Average	**Initial**	**FIFO**	**LIFO**	**Last**
Initial	0.7069				
FIFO	0.9396	0.6846			
LIFO	0.4579	0.3779	0.4569		
Last	0.8327	0.6411	0.8585	0.4295	
Alpha	0.657	0.5713	0.64	0.4139	0.731

Note: p-values of all pairwise correlations < 0.0001

The results in Table A2 highlight that the choice of a reference price may lead to substantially different measures of the DE. In particular, because of the low correlation of the measure of DE using LIFO with the other measures, results using this last measure can differ substantially from results using alternative measures (see Tables B3 – B5 in Appendix B).

To assess the adequacy of the different reference prices, we follow an approach similar to that of Kohsaka *et al.* (2013). At the end of the experiment we present subjects with a hypothetical price path and transaction history and ask them to rate the degree to which they agree with various ways of computing gains or losses associated with the last sale in the example (subjects are presented with two scenarios, one involving gains and one involving losses, see Appendix C).

The results of this survey are presented in Table A3. Consistently with Kohsaka *et al.* (2013), the *weighted average* reference price received the highest average rating. The results are similar for the loss and gain scenarios and across genders.

[26] We find the same result with the other three treatments, and also if we compute correlation coefficients separately by gender.

Table A3. Subjective evaluation of reference prices.

	Mean score Loss domain	Mean score Gains domain
Initial Price	3.8021	4.0729
	(2.4306)	(2.4804)
FIFO	3.5208	3.875
	(1.9411)	(2.0378)
Average Price	4.1458	4.2708
	(1.9357)	(1.9867)
LIFO	3.5938	3.5521
	(2.1155)	(2.0358)
Last Price	3.3021	3.1563
	(2.1281)	(2.1586)
Observations	96	96

Note: Each column corresponds to the mean score received by each reference price in the questionnaire for the loss domain and the gain domain respectively (from *completely disagree* = 1 to *completely agree* = 7). Standard errors in parentheses. The number of observations is only 96 because we ask this question only in half of the sessions.

In Table A4 we present gender differences in baseline DE using all reference prices. We do so in order to compare our results to the previous experimental literature on gender and the DE.

Table A4. Gender differences in DE, PGR, PLR and alpha in the baseline treatment.

		Reference Prices Average	Initial	FIFO	LIFO	Last	Alpha	N
DE	**diff**	0.0544	0.0476	0.0502	0.0106	0.0355	0.0007	42
		(0.0455)	(0.0523)	(0.0414)	(0.0387)	(0.0361)	(0.0916)	
	p-value	0.3581	0.2883	0.3516	0.6374	0.5610	0.9751	
PGR	**diff**	-0.0092	0.0013	-0.0062	0.0263	-0.0162		42
		(0.0345)	(0.0317)	(0.0335)	(0.0340)	(0.0301)		
	p-value	0.5526	0.7977	0.7029	0.9711	0.4645		
PLR	**diff**	-0.0678	-0.0528	-0.0580	0.0079	-0.0535		42
		(0.0236)	(0.0316)	(0.0184)	(0.0209)	(0.0172)		
	p-value	**0.0054**	**0.0903**	**0.0012**	0.4491	**0.0026**		

Note: Subjects were allocated to groups of 4 participants (2 women, 2 men) who experienced identical prices. We averaged each measure for each group and gender so that $\sum_n(mean(DE_n^{fem}) - mean(DE_n^{male}))/N$, where N is the number of groups (N = 42). Standard errors in parentheses, p-values from Wilcoxon signed-rank tests, where the null hypothesis is diff = 0.

We find that the average value of the DE is lower for men than for women for all reference prices. However, these differences are never statistically significant and very close to zero in the case of alpha.

We get very similar values for the PGR of men and women, with no significant differences in

any measure. In contrast, we get clear gender differences in the PLR, with women having significantly lower PLR than men under all reference prices except LIFO. In sum, our main results in Section 4 appear to be robust to alternative specifications of the DE. Our evidence strongly suggests that women are more reluctant to sell losing assets than men, but does not reveal any difference in the sale of winning assets.

Appendix B. Additional tables.

Table B1. Summary statistics of the individual measures

VARIABLES	Mean	Std. Dev.	Min	Max	Obs	Cronbach's α
DE	0.0797	0.2228	-0.6282	0.7134	192	
PGR	0.2279	0.1884	0	0.8472	192	
PLR	0.1470	0.1349	0	0.7843	192	
Female	0.5052	0.5013	0	1	192	
Optimism	4.8229	1.3420	1	7	192	
Risk	4.6615	1.5536	1	7	192	
Confidence	4.7604	1.5195	1	7	192	
Not Recognize Errors	3.9479	1.6681	1	7	192	
Competitiveness	4.9740	1.5933	1	7	192	
Enjoys Winning	5.9010	1.3047	2	7	192	
Decisiveness	3.2708	1.7183	1	7	192	
Self-control	42.1719	9.3443	20	67	192	0.7061
Optimism dummy	0.6302	0.4840	0	1	192	
Risk dummy	0.5729	0.4959	0	1	192	
Confidence dummy	0.6146	0.4880	0	1	192	
Not Recognize Errors dummy	0.5833	0.4943	0	1	192	
Competitiveness dummy	0.6458	0.4795	0	1	192	
Enjoys Winning dummy	0.6875	0.4647	0	1	192	
Decisiveness dummy	0.5990	0.4914	0	1	192	
Self-control dummy	0.5365	0.5000	0	1	192	
High Confidence	0.3372	0.3204	0	1	192	
High Financial Literacy	0.3802	0.4867	0	1	192	
High Grades	0.6198	0.4867	0	1	192	
>1 Switches	0.2188	0.4145	0	1	192	
Neuroticism	4.1128	1.1998	1.5	7	192	0.7758
Extraversion	4.3896	1.3874	1	7	192	0.8392
Agreeableness	4.7969	0.7378	2.4	7	192	0.3043
Openness	5.2314	0.9016	2.8571	7	192	0.6882
Conscientiousness	5.0490	0.9537	2.4	7	192	0.6633
Art	0.1042	0.3063	0	1	192	
Health	0.3177	0.4668	0	1	192	
Science	0.0990	0.2994	0	1	192	
Engineering	0.1771	0.3827	0	1	192	
Social Sciences	0.3021	0.4604	0	1	192	

Note: DE, PGR, and PLR are calculated with weighted average reference price. Cronbach's α, a measure of internal consistency, is only relevant for measures involving multiple items. For the Big 5 and Self-control measures, we find α levels very close to those of the original studies, with the exception of Agreeableness. This trait, however, was originally found to display the lowest internal consistency out of the five traits (Benet-Martinez and John, 1998).

Table B2. DE for all treatments with different reference prices

		Reference prices					
Treatment		**Average**	**Initial**	**FIFO**	**LIFO**	**Last**	**Alpha**
Baseline	**Mean**	0.0685***	0.0177*	0.1205***	0.0243**	0.0994***	0.1984***
	St. Error	(0.0228)	(0.0244)	(0.0193)	(0.0171)	(0.0176)	(0.0513)
	Obs.	163	154	164	145	165	162
	p-value	0.0021	0.0685	0.0000	0.0294	0.0000	0.0002
Competitive	**Mean**	0.0703***	-0.0099	0.1031***	0.0275***	0.0678***	0.1605***
	St. Error	(0.0228)	(0.0228)	(0.0196)	(0.0097)	(0.0180)	(0.0498)
	Obs.	182	172	182	166	183	181
	p-value	0.0017	0.4125	0.0000	0.0003	0.0001	0.0020
Tax	**Mean**	0.1045***	0.0321***	0.1422***	0.0950***	0.0865***	0.2168***
	St. Error	(0.0189)	(0.0196)	(0.0163)	(0.0135)	(0.0140)	(0.0577)
	Obs.	179	171	186	153	188	171
	p-value	0.0000	0.0076	0.0000	0.0000	0.0000	0.0005
Comp. & tax	**Mean**	0.0684***	0.0127	0.0968***	0.0459***	0.0585***	0.1506**
	St. Error	(0.0195)	(0.0225)	(0.0167)	(0.0122)	(0.0136)	(0.0542)
	Obs.	182	171	187	148	187	173
	p-value	0.0011	0.2482	0.0000	0.001	0.0007	0.0130

Note: Standard errors in parentheses. From a total of 192 individuals, each reference price generated some missing observations. The line Obs. refers to the number of individuals used in each calculation. The p-values correspond to a Wilcoxon signed-rank test in which the null is that the corresponding DE is zero. We do not report p-values for PGR and PLR since all of them are below 0.0001. *** p<0.01, ** p<0.05, * p<0.1.

Table B3. Disposition Effect according to each reference price

VARIABLES	Average Price	Initial Price	FIFO	LIFO	Last Price	Alpha
Female	0.00666	0.0525	0.0102	-0.00477	0.00773	0.00257
	(0.0391)	(0.0508)	(0.0363)	(0.0291)	(0.0324)	(0.0982)
Competitive	0.000574	-0.0318	-0.0217	0.00794	-0.0380	-0.0724
	(0.0318)	(0.0389)	(0.0274)	(0.0264)	(0.0318)	(0.0778)
Tax	0.0207	0.00587	0.0264	0.0535*	-0.0159	-0.0339
	(0.0427)	(0.0425)	(0.0357)	(0.0293)	(0.0312)	(0.0846)
Competitive & Tax	-0.00234	-0.00741	-0.0245	0.00249	-0.0540*	-0.0841
	(0.0352)	(0.0510)	(0.0314)	(0.0339)	(0.0281)	(0.0779)
Female*Competitive	0.0166	0.0263	0.0209	-0.00394	0.0244	0.0880
	(0.0366)	(0.0550)	(0.0324)	(0.0319)	(0.0371)	(0.0999)
Female*Tax	0.0267	0.0265	-0.00181	0.0302	0.0218	0.121
	(0.0481)	(0.0525)	(0.0399)	(0.0344)	(0.0325)	(0.106)
Female*(Comp & Tax)	0.0152	0.0231	0.0155	0.0340	0.0400	0.0976
	(0.0346)	(0.0554)	(0.0329)	(0.0411)	(0.0288)	(0.110)
Experience2	-0.0369	-0.0310	-0.0314	-0.0373*	-0.0451**	-0.0944*
	(0.0239)	(0.0235)	(0.0213)	(0.0199)	(0.0190)	(0.0515)
Experience3	-0.0377	-0.0564*	-0.0338	-0.0117	-0.0604***	-0.110
	(0.0275)	(0.0303)	(0.0214)	(0.0214)	(0.0219)	(0.0709)
Experience4	-0.0680***	-0.0649**	-0.0629***	-0.0523**	-0.0863***	-0.241***
	(0.0249)	(0.0263)	(0.0219)	(0.0205)	(0.0210)	(0.0630)
Optimism	0.0713**	0.0861***	0.0574**	0.00687	0.0501**	0.228***
	(0.0341)	(0.0334)	(0.0284)	(0.0180)	(0.0232)	(0.0851)
Risk	-0.0240	-0.0334	-0.0171	-0.00850	-0.0227	-0.0643
	(0.0325)	(0.0339)	(0.0285)	(0.0183)	(0.0263)	(0.0926)
Confidence	-0.0554	-0.0507	-0.0446	0.00673	-0.0439*	-0.0837
	(0.0343)	(0.0354)	(0.0289)	(0.0197)	(0.0234)	(0.0976)
Difficulty recognizing errors	0.0878***	0.0790***	0.0705***	0.0381**	0.0538***	0.169**
	(0.0295)	(0.0294)	(0.0270)	(0.0152)	(0.0205)	(0.0711)
Competitiveness	0.0448	0.0443	0.0382	-0.00289	0.0328	0.135
	(0.0392)	(0.0399)	(0.0335)	(0.0194)	(0.0276)	(0.108)
Enjoys Winning	-0.0481	-0.0635*	-0.0361	-0.0139	-0.0480**	-0.145*
	(0.0298)	(0.0353)	(0.0263)	(0.0153)	(0.0211)	(0.0865)
Decisiveness	-0.0153	0.00198	-0.0162	-0.0142	-0.0332	-0.0666
	(0.0355)	(0.0361)	(0.0320)	(0.0167)	(0.0263)	(0.0851)
Self-control	0.0593	0.0430	-0.0506	-0.0221	0.0509	0.108
	(0.0410)	(0.0354)	(0.0387)	(0.0226)	(0.0315)	(0.109)
High Confidence	-0.00963	0.0138	-0.00754	-0.00178	0.00842	0.0437
	(0.0222)	(0.0243)	(0.0214)	(0.0160)	(0.0190)	(0.0542)
High Financial Literacy	-0.0331	-0.0343	-0.0263	0.0113	-0.0155	-0.0415
	(0.0385)	(0.0327)	(0.0327)	(0.0213)	(0.0240)	(0.0728)
High Grades	-0.00124	0.0288	-0.00559	-0.0110	-0.00813	-0.00627
	(0.0365)	(0.0361)	(0.0331)	(0.0189)	(0.0260)	(0.0881)
>1 Switches	0.0108	0.0141	0.00223	0.0166	0.0154	-0.0342
	(0.0384)	(0.0348)	(0.0322)	(0.0179)	(0.0298)	(0.107)

Neuroticism	0.0145	0.0205	0.0182	0.00143	0.0176	0.0573
	(0.0174)	(0.0184)	(0.0169)	(0.00981)	(0.0133)	(0.0476)
Extraversion	0.0163	-0.000608	0.0194	0.0111	0.0173	0.00396
	(0.0139)	(0.0137)	(0.0124)	(0.00819)	(0.0110)	(0.0461)
Agreeableness	-0.0144	-0.0162	-0.0189	-0.0115	-0.00905	0.00542
	(0.0178)	(0.0181)	(0.0151)	(0.00737)	(0.0126)	(0.0389)
Openness	0.0236*	0.0301**	0.0210*	0.00169	0.0115	0.0403
	(0.0139)	(0.0140)	(0.0122)	(0.00727)	(0.0100)	(0.0315)
Conscientiousness	-0.00417	0.00333	-0.00436	-0.00469	-0.00644	-0.0261
	(0.0196)	(0.0155)	(0.0177)	(0.00810)	(0.0138)	(0.0451)
Art	-0.0150	0.0402	-0.0144	-0.0119	-0.0105	-0.0532
	(0.0460)	(0.0435)	(0.0405)	(0.0215)	(0.0400)	(0.111)
Health	0.0313	-0.000513	0.0148	-0.0192	0.00622	0.0602
	(0.0448)	(0.0395)	(0.0388)	(0.0240)	(0.0303)	(0.104)
Science	0.0256	-0.00936	0.0130	-0.0294*	0.00594	0.117
	(0.0494)	(0.0461)	(0.0438)	(0.0173)	(0.0382)	(0.144)
Engineering	-0.0984**	-0.103**	-0.0803***	-0.0314	-0.0671**	-0.146
	(0.0477)	(0.0424)	(0.0307)	(0.0239)	(0.0293)	(0.130)
Constant	0.0514	-0.0407	0.162**	0.0686*	0.134**	0.152
	(0.0846)	(0.0772)	(0.0768)	(0.0370)	(0.0638)	(0.214)
Observations	706	668	719	612	723	687
Number of id	192	192	192	191	192	192

Note: We show the coefficients of six different regressions in which the dependent variables is DE. We use a different definition of reference price in each case. The set of regressors is the same in the six regressions. All variables except Female, Treatment and Experience standardized to zero mean and unit standard deviation. Robust standard errors clustered by group and session in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table B4. Proportion of Gains Realized (PGR) according to each reference price

VARIABLES	Average Price	Initial Price	FIFO	LIFO	Last Price
Female	-0.0459	-0.0254	-0.0378	0.00757	-0.0414
	(0.0315)	(0.0321)	(0.0313)	(0.0231)	(0.0296)
Competitive	0.00172	-0.0230	-0.0111	0.0177	-0.0176
	(0.0245)	(0.0213)	(0.0234)	(0.0179)	(0.0232)
Tax	-0.0584**	-0.0636***	-0.0506*	0.0163	-0.0775***
	(0.0296)	(0.0227)	(0.0293)	(0.0231)	(0.0234)
Competitive & Tax	-0.0916***	-0.0708***	-0.0878***	-0.0148	-0.0985***
	(0.0262)	(0.0225)	(0.0256)	(0.0228)	(0.0209)
Female*Competitive	0.0203	0.0260	0.0330	-0.0294	0.0282
	(0.0288)	(0.0290)	(0.0264)	(0.0236)	(0.0278)
Female*Tax	0.0598*	0.0557*	0.0528	0.0253	0.0691**
	(0.0350)	(0.0290)	(0.0337)	(0.0271)	(0.0280)
Female*(Comp & Tax)	0.0809***	0.0504	0.0790***	0.0117	0.0837***
	(0.0294)	(0.0308)	(0.0285)	(0.0300)	(0.0264)
Experience2	-0.0193	-0.0129	-0.0181	-0.0297**	-0.0234
	(0.0196)	(0.0141)	(0.0193)	(0.0138)	(0.0160)
Experience3	-0.0198	-0.0176	-0.0199	-0.00249	-0.0379**
	(0.0199)	(0.0135)	(0.0193)	(0.0167)	(0.0175)
Experience4	-0.0507***	-0.0356***	-0.0508***	-0.0349**	-0.0631***
	(0.0157)	(0.0134)	(0.0161)	(0.0166)	(0.0140)
Optimism	0.00993	0.00687	0.0135	-0.00102	0.00473
	(0.0350)	(0.0327)	(0.0339)	(0.0163)	(0.0274)
Risk	-0.0213	-0.0193	-0.0177	0.00903	-0.0162
	(0.0311)	(0.0298)	(0.0298)	(0.0153)	(0.0267)
Confidence	-0.00764	0.00687	-0.00381	0.0166	-0.00208
	(0.0346)	(0.0332)	(0.0343)	(0.0184)	(0.0293)
Difficulty recognizing errors	0.0344	0.0226	0.0303	0.0247**	0.0143
	(0.0300)	(0.0275)	(0.0298)	(0.0124)	(0.0239)
Competitiveness	0.0141	-0.00819	0.0109	-0.0156	0.00632
	(0.0290)	(0.0261)	(0.0291)	(0.0142)	(0.0232)
Enjoys Winning	-0.0396	-0.0329	-0.0364	-0.0237**	-0.0417**
	(0.0258)	(0.0257)	(0.0272)	(0.0118)	(0.0196)
Decisiveness	-0.0274	-0.00560	-0.0247	-0.0174	-0.0319
	(0.0358)	(0.0349)	(0.0359)	(0.0149)	(0.0302)
Self-control	0.0575*	0.0485*	-0.0358	-0.00314	0.0390
	(0.0307)	(0.0254)	(0.0345)	(0.0193)	(0.0249)
High Confidence	-0.0142	0.0126	-0.00737	-0.0105	-0.00885
	(0.0193)	(0.0154)	(0.0186)	(0.0136)	(0.0147)
High Financial Literacy	-0.0193	-0.0293	-0.0235	0.0114	-0.0209
	(0.0333)	(0.0258)	(0.0320)	(0.0173)	(0.0243)
High Grades	-0.00268	0.00982	-0.00240	-0.0133	-0.00742
	(0.0322)	(0.0277)	(0.0326)	(0.0175)	(0.0251)
>1 Switches	0.00885	0.0142	0.00359	0.0101	0.0129
	(0.0291)	(0.0246)	(0.0284)	(0.0154)	(0.0248)

Neuroticism	0.0189	0.0196	0.0174	0.000643	0.0167
	(0.0180)	(0.0172)	(0.0178)	(0.00835)	(0.0144)
Extraversion	0.0149	0.00319	0.0154	-0.00189	0.0111
	(0.0153)	(0.0137)	(0.0145)	(0.00672)	(0.0130)
Agreeableness	-0.0193	-0.0123	-0.0208	-0.00519	-0.0112
	(0.0160)	(0.0151)	(0.0162)	(0.00659)	(0.0131)
Openness	0.0207	0.0191	0.0177	0.00266	0.0135
	(0.0132)	(0.0119)	(0.0126)	(0.00521)	(0.0117)
Conscientiousness	-0.00800	-0.00488	-0.00425	-0.00260	-0.00596
	(0.0167)	(0.0125)	(0.0165)	(0.00802)	(0.0129)
Art	-0.0538	-0.0339	-0.0576	-0.0275	-0.0540
	(0.0462)	(0.0359)	(0.0462)	(0.0195)	(0.0380)
Health	-0.0210	-0.0157	-0.0269	-0.0201	-0.0400
	(0.0387)	(0.0295)	(0.0383)	(0.0196)	(0.0291)
Science	-0.0503	-0.0527	-0.0545	-0.0537***	-0.0612*
	(0.0386)	(0.0329)	(0.0403)	(0.0150)	(0.0324)
Engineering	-0.106***	-0.0887**	-0.101***	-0.0327**	-0.0935***
	(0.0351)	(0.0373)	(0.0338)	(0.0160)	(0.0312)
Constant	0.331***	0.273***	0.366***	0.136***	0.336***
	(0.0724)	(0.0564)	(0.0720)	(0.0280)	(0.0604)
Observations	720	719	720	612	727
Number of id	192	192	192	191	192

Note: We show the coefficients of six different regressions in which the dependent variables is PGR. We use a different definition of reference price in each case. The set of regressors is the same in the six regressions. All variables except Female, Treatment and Experience standardized to zero mean and unit standard deviation. Robust standard errors clustered by group and session in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table B5. Proportion of Losses Realized (PLR) according to each reference price

VARIABLES	Average Price	Initial Price	FIFO	LIFO	Last Price
Female	-0.0557**	-0.0800**	-0.0534***	0.0103	-0.0536***
	(0.0223)	(0.0315)	(0.0191)	(0.0195)	(0.0186)
Competitive	-0.00147	0.00277	0.00846	0.0116	0.0178
	(0.0201)	(0.0344)	(0.0187)	(0.0166)	(0.0183)
Tax	-0.0903***	-0.0792**	-0.0805***	-0.0337**	-0.0649***
	(0.0235)	(0.0358)	(0.0198)	(0.0145)	(0.0189)
Competitive & Tax	-0.0878***	-0.0630	-0.0650***	-0.0190	-0.0446**
	(0.0208)	(0.0413)	(0.0175)	(0.0178)	(0.0175)
Female*Competitive	0.00794	0.00290	0.0163	-0.0205	0.0138
	(0.0291)	(0.0412)	(0.0271)	(0.0245)	(0.0278)
Female*Tax	0.0462*	0.0376	0.0595***	-0.00639	0.0524**
	(0.0250)	(0.0368)	(0.0215)	(0.0227)	(0.0206)
Female*(Comp & Tax)	0.0614***	0.0287	0.0636***	-0.0153	0.0410*
	(0.0197)	(0.0437)	(0.0220)	(0.0265)	(0.0224)
Experience2	0.0175	0.0168	0.0106	0.00825	0.0215***
	(0.0111)	(0.0193)	(0.00803)	(0.0109)	(0.00826)
Experience3	0.00804	0.0336	0.00844	0.00927	0.0165
	(0.0195)	(0.0311)	(0.0124)	(0.0102)	(0.0141)
Experience4	0.0172	0.0284	0.00471	0.0122	0.0166
	(0.0154)	(0.0236)	(0.0116)	(0.00785)	(0.0130)
Optimism	-0.0614**	-0.0819***	-0.0359**	-0.00870	-0.0363*
	(0.0268)	(0.0284)	(0.0174)	(0.00935)	(0.0186)
Risk	0.00758	0.0219	-0.00447	0.0136	-0.000174
	(0.0189)	(0.0233)	(0.0132)	(0.00993)	(0.0130)
Confidence	0.0440	0.0572*	0.0344*	0.00528	0.0332*
	(0.0269)	(0.0311)	(0.0189)	(0.0110)	(0.0190)
Difficulty recognizing errors	-0.0569***	-0.0573***	-0.0425***	-0.0116	-0.0399***
	(0.0167)	(0.0213)	(0.0123)	(0.0103)	(0.0123)
Competitiveness	-0.0286	-0.0558*	-0.0259	-0.0121	-0.0247
	(0.0235)	(0.0306)	(0.0164)	(0.0105)	(0.0158)
Enjoys Winning	0.00958	0.0309	0.00346	-0.00663	0.0102
	(0.0223)	(0.0292)	(0.0154)	(0.00948)	(0.0164)
Decisiveness	-0.0144	-0.0175	-0.00711	-0.00276	0.00767
	(0.0184)	(0.0207)	(0.0140)	(0.00865)	(0.0131)
Self-control	-0.00518	0.00397	0.0175	0.0169	-0.0152
	(0.0251)	(0.0282)	(0.0182)	(0.0118)	(0.0174)
High Confidence	-0.00366	0.000361	0.00426	-0.00911	-0.00749
	(0.0135)	(0.0225)	(0.00999)	(0.00863)	(0.0110)
High Financial Literacy	0.0120	0.00353	0.00275	0.00131	-0.00638
	(0.0237)	(0.0268)	(0.0149)	(0.0113)	(0.0142)
High Grades	-0.00247	-0.0223	0.00106	-0.00224	-0.00139
	(0.0212)	(0.0240)	(0.0153)	(0.00820)	(0.0154)
>1 Switches	-0.00364	-0.00456	0.00647	-0.00209	0.00133
	(0.0219)	(0.0235)	(0.0142)	(0.00813)	(0.0144)

Neuroticism	0.00313	-0.00150	6.54e-05	-0.00276	-0.000140
	(0.0122)	(0.0147)	(0.00836)	(0.00434)	(0.00834)
Extraversion	-0.00238	0.00222	-0.00457	-0.0108**	-0.00672
	(0.0114)	(0.0133)	(0.00818)	(0.00452)	(0.00781)
Agreeableness	-0.000641	0.00321	0.00120	0.00590	0.00104
	(0.00950)	(0.0139)	(0.00682)	(0.00435)	(0.00746)
Openness	-0.00445	-0.0118	-0.00317	0.00145	0.00140
	(0.00887)	(0.0117)	(0.00643)	(0.00417)	(0.00612)
Conscientiousness	-0.00412	-0.00818	5.25e-05	0.00110	-0.000251
	(0.0116)	(0.00977)	(0.00723)	(0.00320)	(0.00813)
Art	-0.0385	-0.0722**	-0.0399**	-0.0152	-0.0391*
	(0.0293)	(0.0343)	(0.0193)	(0.0121)	(0.0212)
Health	-0.0534**	-0.0141	-0.0404**	-0.00451	-0.0405**
	(0.0222)	(0.0286)	(0.0171)	(0.0107)	(0.0166)
Science	-0.0778**	-0.0422	-0.0671***	-0.0273***	-0.0668***
	(0.0307)	(0.0299)	(0.0199)	(0.0105)	(0.0230)
Engineering	-0.00988	0.0115	-0.0274	-0.00470	-0.0344
	(0.0374)	(0.0406)	(0.0212)	(0.0159)	(0.0218)
Constant	0.288***	0.330***	0.204***	0.0671***	0.200***
	(0.0363)	(0.0492)	(0.0306)	(0.0230)	(0.0286)
Observations	710	673	732	660	729
Number of id	192	192	192	191	192

Note: We show the coefficients of six different regressions in which the dependent variables is PLR. We use a different definition of reference price in each case. The set of regressors is the same in the six regressions. All variables except Female, Treatment and Experience standardized to zero mean and unit standard deviation.
Robust standard errors clustered by group and session in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix C. Experiment instructions (FOR ONLINE PUBLICATION)

Questionnaire (translated from Spanish)

- Are you an optimistic or a pessimistic person?
- Are you a person willing to take risks or do you try to avoid risks?
- Are you a confident person?
- I find it hard to recognize my errors
- I am a very competitive person
- I enjoy very much winning in a game
- After making a decision, I do not worry about it or regret it

Reference prices question (translated from Spanish)

1. In the following table, we present the hypothetical evolution of the price of an asset, your transactions and your portfolio:

	Period 1	Period 2	Period 3	Period 4	Period 5
Price	100	80	60	40	20
Buy/Sell	+1	+1	+2	-1	
Portfolio	1	2	4	3	

Imagine that in period 5 you decide to sell one unit of the asset. Express your degree of agreement or disagreement with the following ways to account for your losses in this transaction:

A. I lose 80 in this transaction, because the initial price of the asset was 100 (20 – 100 = -80).
B. I lose 60 in this transaction, because the first unit I bought (at 100) I sold it in period 4, and this unit I bought it at 80 in period 2 (20 – 80 = -60).
C. I lose 55 in this transaction, because the average purchase price is (100+80+60x2)/4 = 75. (20 – 75 = -55)
D. I lose 40 in this transaction, because the price of the last unit I bought is 60 (20 – 60 = -40).
E. I lose 20 in this transaction, because the last price of the asset is 40 (20 – 40 = -20).

Seven possible answers form 1 = “completely disagree” to 7 = “completely agree.”

2. In the following table, we present the hypothetical evolution of the price of an asset, your transactions and your portfolio:

	Period 1	Period 2	Period 3	Period 4	Period 5
Price	100	120	140	160	180
Buy/Sell	+1	+1	+2	-1	
Portfolio	1	2	4	3	

Imagine that in period 5 you decide to sell one unit of the asset. Express your degree of agreement or disagreement with the following ways to account for your gains in this transaction:

A. I gain 80 in this transaction, because the initial price of the asset was 100 (180 – 100 = 80).
B. I gain 60 in this transaction, because the first unit I bought (at 100) I sold it in period 4, and this unit I bought it at 120 in period 2 (180 – 120 = 60).
C. I gain 55 in this transaction, because the average purchase price is (100+120+140x2)/4 = 125. (180 – 125 = 55)
D. I gain 40 in this transaction, because the price of the last unit I bought is 140 (180 – 140 = 40).
E. I gain 20 in this transaction, because the last price of the asset is 160 (180 – 160 = 20).

Experiment 1 Instructions

Welcome to the experiment. This is an experiment to study how individuals take decisions. We are only interested in what individuals do on average. Do not think that any particular behavior is expected from you.

Please read these instructions carefully. Throughout the experiment you will be able to buy and sell assets using experimental money. To simplify the presentation, we will use *pesetas* as experimental money. The amount of pesetas you can earn depends on the decisions you make and, in some cases, the decisions made by other participants. At the end of the experiment you will be asked to fill in a short questionnaire.

Once you finish the experiment you will be paid privately and in cash the earnings you have obtained in the experiment.

The exchange rate is 1000 pesetas = 1 €

Please, it is important that you take all decisions privately. So do not talk to other participants during the experiment. You cannot use mobile phones during the experiment. If you need help, raise your hand and remain silent. We will answer your question as soon as possible.

The experiment lasts approximately 2 hours and consists of four rounds and a warm-up round. Each round consists of 14 periods (from -3 to 10). In periods -3 to 0 you will receive information on the prices of 6 assets (A, B, C, D, E and F), although you will not be able to buy or sell. In period 1 of each round you will receive an endowment of 5000 pesetas that you can use to buy and sell units of the 6 assets for the next 9 periods (period 1 to 9).

LOTTERY ROUND
You have 21 decisions between a fixed payment and a lottery. The lottery is always the same: there is a 50 % chance of winning 5000 pesetas and a 50 % chance of winning nothing. At the end of the experiment we will randomly select one of the 21 decisions. If in that decision you chose the safe payment, you will be paid that amount. If you chose the lottery, the computer will “flip a coin”: if heads you will get 5000 pesetas and if tails you will get nothing.
ANY QUESTIONS?

FIRST ROUND

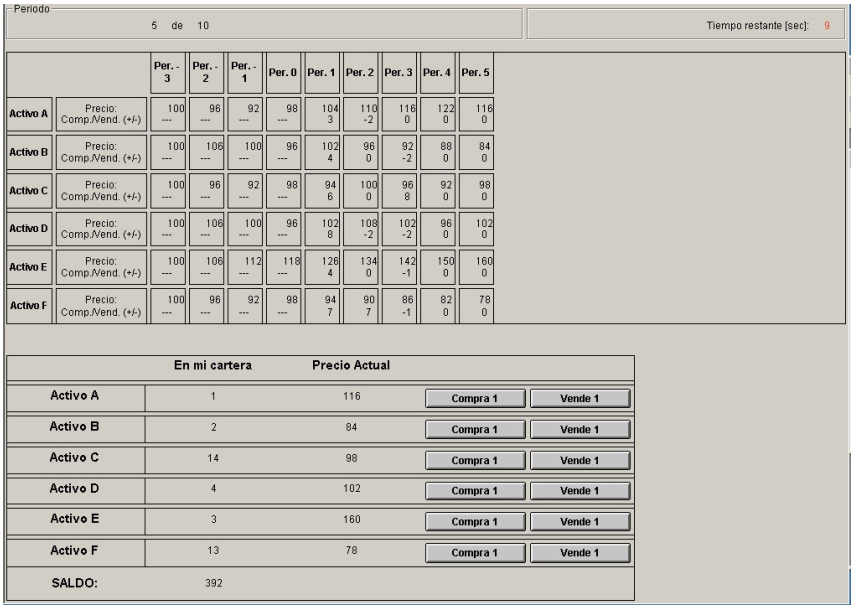
In this round, you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. The 4 members in the group participate in a small financial market consisting of 6 assets. All assets have the same initial price (in period -3) of 100 pesetas. From there, the price of each asset will change: it will raise a 6% or it will decrease a 5%. The probability of a price increase may be different for each asset but is constant for the same asset over each round. At the beginning of each round, the computer randomly chooses new probabilities of up or down for each asset, which will remain constant for that round. That means that the same asset can have a very high probability of rising in a round, and very low in another.

Suppose, for example, that an asset has a probability of price increase of 0.55 (i.e. 55%). This means that in each period, the current price can go up a 6% with a probability of 55%, or down a 5% with a probability of 45% (= 100% -55%).

This means that, if in a given period the price of an asset is 113.9 pesetas, its price in the next period will rise by 6% to 120.7 pesetas (= 113.9 × (1 +0.06)) with probability 0.55 or will fall 5% to 108.2 pesetas (= 113.9 × (1-0,05)) with probability 1-.55 = 0.45 .

These probabilities will be unknown for you. However, remember that they will not change within each round. In addition, price changes are independent of each other and independent of your trading decisions. They are also independent of the decisions of others.

In each of the periods from period 1 to period 9 you can buy or sell assets. In the figure below you can see the computer screen. At the top you can see the prices of assets A-F throughout the round. In this case we only show prices up to period 5.



The top of the screen shows the evolution of the prices of the six assets A-F from period -3, and all the transactions you have already made.[27] As in periods -3, -2 , -1 and 0 you cannot buy or sell, the number of transactions for these periods is always 0. Purchases from period 1 onwards are represented by positive numbers and sales by negative numbers.
The bottom of the screen contains your transactions. Here you can decide whether to buy or sell one or more units of assets A-F. The column "En mi cartera" indicates the number of units of each asset you own. The column "Precio actual" means the price you pay for each additional unit you want to buy and also the price you receive for each unit you want to sell. You can also see how much pesetas you still have available under "SALDO".
If you want to buy an asset you have to pay for each unit the current price of the asset. You can never spend more money than you have available (your "SALDO"). To purchase an asset, you have to click the "Compra 1" button. If you want to buy more than one unit, you simply have to click as many times as you want to buy units.

Example: As in the figure above, suppose we are in period 5 and Asset A has a price of 116 pesetas. If you decide to buy 3 units of A, you will have to click three times on the "Compra 1" button. In this operation you are going to spend 3×116 = 348 pesetas. This amount is subtracted from your SALDO.

If you own units of an asset, then you have the option to sell those units. For each unit you sell you will receive the current price of the asset. The number of units you sell cannot exceed the number of units you own.

Example: As in the figure above, suppose we are in period 5 and Asset C has a price of 98 pesetas. You have 14 units of C and you want to sell 3 of them. To do this you have to click 3 times on the "Vende 1" button. You will receive 3×98 = 294 pesetas that will be added to your SALDO.

In each period you have a limited time to take your purchase decisions. This time will be one minute. You will see the remaining time in red on the top right of the screen.
The round ends in period 10. In period 10 you will not be able to buy or sell assets. The prices of period 10 will determine the final value of your portfolio. The value of the portfolio will be added automatically to your "SALDO" and will be part of your earnings.
At the beginning and end of the round we will ask you to tell us what position you believe you will be in terms of profits within the group of 4 people to which you belong. Every time you guess

[27] Due to a small programming error, prices were rounded to the nearest even number, rather than to the nearest integer. No subject seemed to notice this otherwise inconsequential fact.

correctly, you will be paid 100 pesetas.
Also, before periods 1, 6 and 10 we will ask you to guess, which one of the 6 assets is the best (i.e., the one whose probability of price increase is highest), which one is the second best, which one is the worst (the one whose probability of price increase is the lowest) and which one is the second worst. In each of the three times, if you guess correctly the four, you will receive an additional 100 pesetas. For these two decisions there is no time limit. However, we ask you not to take too much time because until you do not take your decision the round cannot continue.

In short, your gains in this first round are:

Your SALDO
+ The value of the assets in your portfolio
+ What you have earned guessing your position
+ What you have earned guessing the assets

To get you familiar with the mechanics of the experiment, we will start with a small trial practice.
ANY QUESTION?

SECOND ROUND

This second round is similar to the first, with a variation. As in the first round you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate. The difference with the previous round has to do with the profits you can get. Specifically, your earnings in this round are:

If you are the winner in your group of 4 (i.e., if at the end of the round the value of your assets plus your "SALDO" is greater than those of the other 3 members of your group), you will receive:

(The value of the assets in your portfolio + your "SALDO") × 2
+ What you have earned guessing your position
+ What you have earned guessing the assets

If you are not the winner in your group of 4, then you will receive:

+ What you have earned guessing your position
+ What you have earned guessing the assets

ANY QUESTION?

THIRD ROUND

This third round is similar to the first round, with a variation. As in the first round you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate. The difference is that each time you buy or sell an asset, you will have to pay a fee that is a percentage of the value of the asset. The fee is the same for all members of each group, although it can vary across groups. At the bottom of the screen you will see the amount of the fee.

Example: We are in period 3 and asset A has a price of 130 pesetas. The fee applied to transactions is 1%. If you want to buy 4 units of A you have to pay 4×130 = 520 pesetas plus 4×130×0.01 = 5.2 pesetas in fees. In total this operation has a cost of 520 +5.2 = 525.2 pesetas. This amount is subtracted from your "SALDO".

Example: We are in period 8 and asset E has a price of 90 pesetas. The fee is 4%. Suppose you own 5 units of E and you decide to sell 3 of them. By selling those 3 units you receive 3×90 = 270 pesetas, but you have to pay fees of 3×90×0.04 = 10.8 pesetas, so your net revenue will be 270 - 10.8 = 259.2 pesetas that will be added to your "SALDO".

IMPORTANT: The fee will be charged automatically each time you press the "Compra 1" or "Vende 1" button. You must be careful because if you buy a unit of an asset and sell it within the same period, you pay the fee twice.

Your earnings in this round are:

Your SALDO
+ The value of the assets in your portfolio
+ What you have earned guessing your position
+ What you have earned guessing the assets

ANY QUESTION?

FOURTH ROUND

This fourth and final round is similar to the second round, but also as in the third round each time you buy or sell an asset, you will have to pay a fee that is a percentage of the value of the asset. The fee is the same for all members of each group, although it can vary across groups. At the bottom of the screen you will see the amount of the fee. As in previous rounds you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate.

Your earnings in this round are:

If you are the winner in your group of 4 (i.e., if at the end of the round the value of your assets plus your "SALDO" is greater than those of the other 3 members of your group), you will receive:

(The value of the assets in your portfolio + your "SALDO") × 2
+ What you have earned guessing your position
+ What you have earned guessing the assets

If you are not the winner in your group of 4, then you will receive:

+ What you have earned guessing your position
+ What you have earned guessing the assets

Once you finish the four rounds, your total earnings will be the sum of the earnings of the four rounds plus the result of the lottery round.

ANY QUESTION?
To finish we ask you to answer a short questionnaire. Once you finish you can leave the room and wait outside. Do not forget to pick up your number. We will call you to come in to collect your earnings.

Thank you all!

Experiment 2 Instructions

LOTTERY AND FIRST ROUND

Exactly as in the first experiment.

SECOND ROUND

This second round is similar to the first, with a variation. As in the first round you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate. The difference with the first round is that each time you buy or sell an asset, you will have to pay a fee that is a percentage of the value of the asset. The fee is the same for all members of each group, although it can vary across groups. At the bottom of the screen you will see the amount of the fee. Nevertheless, at the end of the round we will refund you 50% of the fees corresponding to sales of losing assets

Example: We are in period 3 and asset A has a price of 130 pesetas. The fee applied to transactions is 1%. If you want to buy 4 units of A you have to pay $4\times130 = 520$ pesetas plus $4\times130\times0.01 = 5.2$ pesetas in fees. In total this operation has a cost of $520 + 5.2 = 525.2$ pesetas. This amount is subtracted from your "SALDO".

Example: We are in period 8 and asset E has a price of 90 pesetas. The fee is 4%. Suppose you own 5 units of E and you decide to sell 3 of them. By selling those 3 units you receive $3\times90 = 270$ pesetas, but you have to pay fees of $3\times90\times0.04 = 10.8$ pesetas, so your net revenue will be $270 - 10.8 = 259.2$ pesetas that will be added to your "SALDO". As we sad above, if this is a sale with losses (imagine you paid 100 pesetas for each of the three units), at the end we will refund you 50% of the fees you paid. In this case there is a refund of 5.4 pesetas.

IMPORTANT: The fee will be charged automatically each time you press the "Compra 1" or "Vende 1" button. You must be careful because if you buy a unit of an asset and sell it within the same period, you pay the fee twice.

Your earnings in this round are:
Your SALDO
+ The value of the assets in your portfolio
+ What you have earned guessing your position
+ What you have earned guessing the assets
+ 50% of the fees corresponding to sales of losing assets
ANY QUESTION?

THIRD ROUND

This third round is different from the previous rounds. As in the previous rounds you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate.
In this round you have to take two types of decisions:

1) During periods 1 to 9 you should try to guess, for each of the six assets, if in the next period the price of the asset will go UP or DOWN. You simply have to press the corresponding button (UP or DOWN) that you will see next to each asset. Remember that you have to make a prediction for each of the six assets. Each time you guess correctly you will receive 100 pesetas. In each period you have a time of one minute to make this decision. Please try not to exceed this time, since the other participants will have to wait for you. The remaining time will be shown in red at the top right of the screen.

2) In period 5 we will randomly choose 3 assets and we will buy you 10 units of each one of them. These assets will be the same for all members in your group. In the screen you will see the assets that you own in green. The purchase value will be deducted from your SALDO. Only in period 9 you will have the opportunity to sell these assets. You can sell all your assets, part of them or even sell nothing. To do this you simply have to press the "Sell 1" button of the corresponding asset as many times as you want. You can always correct your decision by pressing the "Cancel 1" button. In this round you will not have to pay any fees when selling your assets. You have one minute to make this decision. Please try not to exceed this time, since the other participants will have to wait for you. The remaining time will be shown in red at the top right of the screen.

Your earnings in this round are:

Your SALDO
+ The value of the assets that you have not solved (at period 10 prices)
+ What you have earned guessing if prices go UP or DOWN
+ What you have earned guessing your position

ANY QUESTION?

FOURTH ROUND

This fourth and last round is similar to the third round with one modification. As in the previous rounds you will be in a group of 4 randomly selected participants. You will never know who is in your group, and no one will know if you are in his/her group, neither during nor after the experiment. Again you will have an initial endowment of 5000 pesetas to participate.
In this round you have to take three types of decisions:

1) Exactly the same as in Round 3.

2) In period 5 you will have to choose 3 assets from which you will have to buy exactly 10 units of each. To do it, you will have to press the button "Buy 10" next to the three assets you have chosen. You can always correct your decision by pressing the "Cancel" button. Once you have taken your decision you have to press the button "OK". The purchase value will be deducted from your SALDO. In the screen you will see in green color the three assets you have chosen. You have one minute to make this decision. Please try not to exceed this time, since the other participants will have to wait for you. The remaining time will be shown in red at the top right of the screen.

3) Only in period 9 you will have the opportunity to sell these assets. You can sell all your assets, part of them or even sell nothing. To do this you simply have to press the "Sell 1" button of the corresponding asset as many times as you want. You can always correct your decision by pressing the "Cancel 1" button. In this round you will not have to pay any fees when selling your assets. You have one minute to make this decision. Please try not to exceed this time, since the other participants will have to wait for you. The remaining time will be shown in red at the top right of the screen.

Your earnings in this round are:

Your SALDO
+ The value of the assets that you have not solved (at period 10 prices)
+ What you have earned guessing if prices go UP or DOWN
+ What you have earned guessing your position

Once you finish the four rounds, your total earnings will be the sum of the earnings of the four rounds plus the result of the lottery round.

ANY QUESTION?