

Trader characteristics and fundamental value trajectories in an asset market experiment

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Abstract

We report results from an asset market experiment, in which we investigate the relationship between traders risk aversion, loss aversion, and cognitive ability and their trading behavior and market outcomes. Before the market begins, risk aversion, loss aversion, and cognitive reflection measurement protocols are administered to traders. Greater average risk aversion on the part of traders in the market predicts lower market prices. The greater the level of loss aversion of the trader cohort, the lower the quantity traded. The greater the average cognitive reflection test score, the smaller the differences between market prices and fundamental values. The variation between groups in risk aversion, loss aversion, and CRT score, explains 45%, 18%, and 29% of the cohort-level variation in price level, mispricing, and volume of trade respectively. Different treatments enable us to study how the time path of the fundamental value trajectory affects the level of adherence to fundamentals. We compare the level of mispricing between decreasing and increasing fundamental value trajectories. In contrast to previous experiments with long-lived assets, there is a phase in which fundamental values are constant before the onset of a trend. We find evidence for closer adherence to fundamental values when the trajectory follows a decreasing, than when it has an increasing, trend.

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JEL classification: C92, G02

1. Introduction

The tendency for experimental markets for long-lived assets to price at levels that differ from intrinsic values is one of the most robust and puzzling results from research in experimental markets. This result, first established by Smith et al. (1988), has been replicated in numerous studies, though the extent and pattern of mispricing is affected by a number of factors. These include the levels of endowment of shares and cash available for transactions (Caginalp et al., 1998; 2000), the trading institutions employed (Van Boening et al., 1993; Haruvy et al., 2007; Lugovskyy et al., 2012), whether margin buying, short-selling,

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or futures trading is permitted (King et al., 1993; Haruvy and Noussair, 2006; Noussair and Tucker, 2006), the training of subjects (Lei and Vesely, 2009), and the induction of emotions (Andrade et al, 2012; Lahav and Meer, 2010). See Palan (2013) for an overview of this research.

However, while experimental work has been able to isolate the effect of each of these features with designs that compare behavior between treatment conditions, the sources of within-treatment variation have received scant attention. It is typical to have much variation between different experimental sessions within the same treatment. Because the parametric and institutional structure of the asset market is identical in all sessions within a treatment, the only possible means whereby this variation could arise is from the characteristics and propensities of the subjects participating in different sessions. In this paper, we explore some possible sources of this within-treatment variation. Our research question is the following: do the risk aversion, loss aversion, and cognitive ability level of participants, correlate with market-and individual-level behavior?

To consider this we obtain direct measures of risk aversion, loss aversion, and cognitive ability from our subjects before they participate in the market. They complete three individual choice tasks. These are described in detail in section 2.2. First, participants' loss aversion is measured with a version of the protocol used in Fehr and Goette (2007). Second, the willingness/ability to reflect about their decisions is elicited with a cognitive reflection test (CRT) as described in Frederick (2005). Third, risk aversion is measured with the procedure of Holt and Laury (2002). The data from these tasks permit us to consider the link between risk aversion, loss aversion, and cognitive ability on one hand, and market behavior and individual trading strategies on the other.

As described in section three, we advance a number of hypotheses about the relationship between loss aversion, risk aversion, cognitive reflection, and market behavior. In particular, we hypothesize that the average risk aversion of participants in a market is correlated with the average price level, with more risk aversion associated with lower prices. We also hypothesize that the average level of loss aversion of market participants is predictive of the quantity traded, with more loss aversion correlating with lower transaction volume. The last hypothesis is that greater average CRT score among the trader cohort predicts lower mispricing relative to fundamental value. As described in section four, all three of these hypotheses are supported, at least to some extent. Furthermore, we observe correlations between the responses on these measurement protocols and trading strategies. Risk-averse agents are less likely to trade based on market momentum, and loss-averse agents are less likely to speculate. Those scoring more highly on the cognitive reflection test are more likely to behave as fundamental value traders. Thus,

intuitive relationships exist between measures of individual characteristics and trader behavior in the asset market.²

The experiment is designed in a manner that also allows us to contrast behavior between two different time trajectories of fundamental values. Some authors have claimed that the declining fundamental value structure used in the classic study by Smith et al. (1988) and in follow-up work is unfamiliar to experimental subjects, who are typically used to appreciating assets outside the laboratory (Noussair et al., 2001; Kirchler et al., 2012). The claim is that the declining fundamental value serves as a source of confusion for subjects. Indeed, it does appear that subject misunderstanding plays a role in generating mispricing in such an environment (Lei et al., 2001; Lei and Vesely, 2009; Kirchler et al., 2012; Cheung et al., 2013).

There is evidence that the time path of fundamentals can affect the extent to which prices track fundamentals. Noussair et al. (2001) and Kirchler et al. (2012) compare markets in which the fundamental value is constant over time to ones in which it is decreasing. They find that the setting with constant fundamentals generates less mispricing. Giusti et al. (2012) compare settings in which fundamentals are increasing versus decreasing. In their setting, the cash held by traders earns interest, and with a sufficiently high interest rate, the fundamental value of the asset increases over time. They observe a strong pattern; fundamental value trajectories with an increasing trend are more conducive to pricing close to fundamentals than those that are decreasing. Huber et al., (2012) implement decreasing fundamental value trajectories with dividend payments, and increasing time paths by imposing taxes (in effect negative dividends), on those who hold units at the end of each period. They observe that a decreasing trend leads to overpricing and an increasing trend to underpricing, though the increasing trajectory departs from fundamental pricing to a lesser extent. Both treatments exhibit a rapid adjustment of prices in the direction of the fundamental near the end of the life of the asset.

Noussair and Powell (2010) study two treatments, called *Peak* and *Valley*. The treatments differ from each other in only one aspect. In *Peak*, the fundamental value of the asset increases for the first eight periods of the 15-period horizon, and then declines for the remaining seven. Under *Valley*, the value declines for the first eight periods and then increases for seven. There is a strong difference in the speed and extent of price discovery between the two treatments. Prices adhere to fundamentals much more

² A number of studies have considered similar relationships. Corgnet et al. (2014), Noussair et al., (2014), and Charness and Neugebauer (2014) observe a correlation between CRT scores of individual traders and earnings in asset markets with monotonically decreasing fundamentals. Huber et al (2014) correlate risk aversion with behavior in an experimental market in which the asset's fundamental follows a Brownian motion. They observe that more risk averse participants trade less and make less use of short-selling opportunities.

closely in the Peak than in the Valley treatment. When the early and late periods of the asset's time horizon are considered separately, the decreasing trajectory exhibits better price discovery when it follows a phase of increase than when it precedes it. In contrast, prices under the increasing trajectory track fundamentals more closely when it constitutes the first phase of the time path rather than the second.³

The above discussion suggests that the timing of the onset of a fundamental trend and the time path of intrinsic value preceding the beginning of the trend might be a crucial factor influencing price discovery. A phase of trading before the onset of a trend, allows a redistribution of units and cash among traders, as well as the accumulation of experience. Thus, the trend in fundamentals begins under different conditions than it would if were to set in immediately. In this paper, we study the relationship between the time path of fundamental value and the price discovery process under such conditions. The experiment has two treatments. In the *Bullmarket* treatment, the time path is constant for the first half of the life of the asset, after which there is an increasing trend in fundamental value for the remainder of the life of the asset. In the *Bearmarket* treatment, the phase of constant fundamentals is instead followed by a decreasing trend in the second half of the asset's life. While Giusti et al (2012) and Huber et al. (2012) observe that price discovery is better for increasing trends, the results of Noussair and Powell suggest that the Bearmarket treatment would adhere more closely to fundamentals, provided that the initial phase of constant fundamentals operates in a similar manner as the early periods of their markets. We find that the Bearmarket treatment exhibits closer adherence to fundamental value than the Bullmarket treatment.

2. The Experiment

2.1. General structure

The experiment consisted of sixteen experimental sessions. Twelve of these sessions were conducted at the CentER laboratory at Tilburg University, the Netherlands. The other four took place at the Laboratorio de Economía Experimental (LEE) facility at the University Jaume I, Castellon, Spain. The sessions at Tilburg were conducted in English and those in Castellon were in Spanish. The English version of the instructions can be found in the Appendix. All participants were students enrolled at one of the two universities. Between 7 and 9 individuals participated in each session. Each session consisted of four parts and took on average approximately two hours. Average earnings were 22.64 Euro.

³ It is important to note that in all of the previous experimental studies mentioned in this introduction, subjects know what the fundamental value of the asset would be at each time period in the future. Thus, fundamental value trends are always accurately anticipated. In the study we conduct here, we continue with this practice.

2.2. Risk Aversion, Loss Aversion, and Cognitive Reflection Measures

Each session consisted of four parts. The first part was the administration of a protocol to measure loss aversion. We employed a version of the elicitation procedure used by Fehr and Goette (2007), which is a series of six choices, presented in a price list format. Subjects completed the task using a pen and paper. The choices were presented on one sheet of paper. This meant that subjects could revise their earlier decisions in light of their choices in subsequent ones.

Each task required the person to indicate whether she would like to play a gamble which yielded a gain of 4.5 Euro with probability .5 or a loss of an amount x with probability .5. Depending on the decision task, x took on values of {.5, 1.5, 2.5, 3.5, 4.5, and 5.5 Euros}. Each value of x appeared in exactly one decision task that each subject completed. Subjects submitted all of their choices simultaneously when they turned in their sheet of paper to the experimenter. Only one of the decisions counted toward their earnings. The decision task this would be was determined after all decisions were turned in. A die was rolled, determining which decision would count for all participants. If a subject had chosen not to play the relevant gamble, she received a payoff of zero for part I of the experiment. If a participant chose to accept the selected gamble, a coin was flipped to determine whether she received 4.5 Euro or the negative payment specified in the gamble. A separate coin was flipped for each participant who chose to play the gamble. We used the number of gambles one was not willing to accept as a measure of her loss aversion.⁴

Parts two, three, and four of the experiment were computerized. In the second part of the experiment all subjects completed the cognitive reflection test developed by Frederick (2005). Subjects were given three minutes to answer three questions, and they received 1 Euro for each correct answer. The three questions were:

1. A bat and a ball cost a total of 1.10 Euro. The bat costs 1 Euro more than the ball. How much does the ball cost?
2. If it takes five people five minutes to make five widgets, how long does it take 100 people to make 100 widgets?
3. In the lake there is a patch of lily pads, which doubles in size every day. It takes 48 days for the patch to cover the entire lake. How many days does it take the patch to cover half of the lake?

⁴ The loss aversion measure we use does not rely on any assumptions on the curvature of the utility function. It does not necessarily correlate with the risk aversion measure that we employ in our experiment. For example, if the individual's utility function is piecewise linear with a steeper slope in the domain of losses than in the domain of gains the risk aversion protocol will register risk neutrality, while the loss aversion protocol will indicate loss aversion. Indeed as shown in table 2, the correlation between risk aversion and loss aversion is .1124, which is not significantly different from zero.

This test has been used extensively in experimental economics to measure the ability (or willingness, depending on the researcher's interpretation of the test) to reflect in answering a question. The questions have the feature that the first answer that typically springs to mind is an incorrect one, but that the correct answer is simple upon some reflection. We took the number of correct answers as a measure of how prepared an individual is to reflect about a decision situation.

In part three, subjects' risk aversion levels were measured using the Holt-Laury (2002) protocol. Under this procedure, subjects make a series of 10 choices between a relatively low-variance, and a relatively high-variance, lottery. The choices follow a price list format, in which the high-variance lottery takes on an ever greater expected value relative to the low-variance lottery. The probability at which the individual becomes willing to accept the riskier lottery implies a level of risk aversion. Specifically, there is a series of ten choices between two lotteries of the form $p*x_1 + (1-p)*x_2$ and $p*y_1 + (1-p)*y_2$, where $y_2 > x_2 > x_1 > y_1$, and p varies monotonically from .1 to 1 in increments of .1 in the ten different choices. In our experiment, we set $y_2 = 3.85$, $x_2 = 2.00$, $x_1 = 1.60$, and $y_1 = 0.10$, denominated in Euro. Thus, a person choosing the relatively low-variance lottery ($p*x_1 + (1-p)*x_2$) for $p \leq .4$, and the high-variance lottery ($p*y_1 + (1-p)*y_2$) for $p > .4$, was consistent with risk neutrality, the maximization of expected value. Fewer (more) than four safe choices are consistent with risk-seeking (risk-averse) preferences. The ten decisions were presented on one screen, so that individuals could revisit and revise their responses to previous questions in light of latter ones. When they were satisfied that they did not want to change any of their responses, they submitted all ten of them simultaneously. One of the 10 questions was randomly selected to count toward earnings.

2.3. The Market and the Two Treatments

The fourth phase of the experiment was the most lengthy and consisted of a sequence of two asset markets, both identical in parametric structure. Each market consisted of 15 periods, during which individuals could trade units of an asset. The asset's lifetime equaled the 15 periods during which the market was in operation. An experimental currency called ECU, converted to Euros at the end of the experiment, was used for all payments, transactions, taxes and dividend distributions. After the first 15-period market had elapsed, a second market was conducted. The second market was reinitialized to conditions identical to those prevailing at the beginning of the first market. Thus the first and second markets began under identical conditions except for the level of experience of traders.

There were two treatments, called *BearMarket* and *BullMarket*. The *BearMarket* treatment was characterized by a time path of fundamentals that was constant during the early portion of each market and decreasing during the latter portion. The decreasing trend began in period 8 of each market. The *BullMarket* treatment consisted of markets in which the fundamental value was constant in the early

periods of the market, and increasing beginning in period 8. The time path of fundamentals in the two treatments is illustrated in Figures 1a and 1b. In the figures, the horizontal axis indicates the period number. The vertical axis indicates the fundamental value, in terms of ECU, the experimental currency. Subjects knew at all times what the fundamental value would be in all future periods, and thus the change in the trend of fundamentals was anticipated⁵.

[Figures 1a and 1b: About Here]

The fundamental value of the asset arose from three sources: dividends, taxes/subsidies, and a final buyout. This final buyout was a payment for each unit of asset held at the end of the market, that is, at the end of period 15, to the unit's owner. All three components of fundamental value were in effect payments to or by the current owners of the asset on each unit they held. Because the asset is finitely lived, at any point in time the fundamental value was the sum of the expected net future financial flows from all three sources. Specifically, the fundamental value of a unit of the asset during any period was equal to the sum of the expected dividends and final buyout it would generate, minus any taxes and plus any subsidies that remained to be paid on the unit. Thus, the fundamental value of one unit of the asset at any point in time was the expected value of the stream of payments that resulted from holding the unit for the remainder of the current market. The three different sources of value were included in the design merely to induce the appropriate dynamic patterns in fundamental values. All three components were present in both treatments so that both conditions had the same level of complexity. The number and timing of future dividend draws, tax payments, and final buyouts in the current market was always common knowledge.

After every period, each unit of the asset paid a dividend to its current owner. Dividends were drawn independently for each period from a two-point distribution with equal probability of +10 or -10. In the experiment, the dividends were determined with a public coin flip. The result of the coin flip was then entered into the computer by the experimenter. The expected dividend in any period, and thus the expected future dividend stream, was equal to 0 ECU.

⁵ To make sure that this was the case, a table with explicit information about the fundamental value of the asset (indicated as the "average holding value" of the asset) at any point in time was included in the instructions. We also included three comprehension questions about the fundamental value of the asset that subjects needed to answer correctly before the market could begin. These questions were aimed at verifying that subjects had a good understanding of the fundamental value and its components and at reducing confusion about the fundamental as a possible cause of mispricing. The same questions (except for those that had to differ because of the different numerical values involved in the two treatments) were used in both treatments. Although some subjects needed further explanation and guidance, the number of correct answers was not different across treatments.

In periods 8 – 15 of each market in the BullMarket treatment, taxes were paid. After each of these periods, all subjects paid a fixed inventory tax of 10 ECU for each unit in their possession. The effect of these taxes was to create an increasing fundamental value trend during the periods that the tax was in effect. Each tax payment reduced the future tax liability on each unit by 10 ECU, and thereby increased the fundamental value by the corresponding amount.

In the BearMarket treatment, in periods 8 – 15 of each market, a subsidy of 10 ECU was paid in each period to the holder of any unit of asset. This had the effect of reducing the fundamental value in each of the last eight periods of the life of the asset. As each subsidy was received, the future flow of subsidy payments decreased by 10 ECU.

The third component of the fundamental value was the final buyout. This was a payment to the holder of each unit of asset at the end of the 15-period life of the asset. This payment was equal to 200 ECU in the BullMarket treatment and to 40 ECU in the BearMarket treatment. The values were chosen to make the fundamental value equal to an identical value of 120 over the first seven periods in both treatments. The final buyout ensured that the fundamental value of the asset was always positive.

Dividends, subsidies and final buyout payments were added to individuals' cash balances at the time they were paid out, and taxes were subtracted from cash balances at the moment they were incurred. This meant that positive dividend payments and subsidies added to the cash could be used for subsequent purchases. Negative dividends and taxes reduced the cash available for later purchases.⁶

At the beginning of period 1 in each market, agents received an initial endowment of 10 units of asset and 3600 ECU of cash that they could use for transactions. Cash balances and asset inventories were required to be positive. In other words, margin buying and short-selling were not allowed. The markets were computerized and used continuous double auction trading rules (Smith, 1962) implemented with the z-Tree computer program (Fischbacher, 2007).

In a continuous double auction, the market is open for a fixed interval of time. At any time, any agent, who has sufficient cash or units to conclude the transaction, may submit an offer to the market. An offer specifies a price at which the agent is willing to either buy or sell a share. Any trader with sufficient funds and units of asset to complete the transaction may accept any outstanding offer at any point in time. All offers are displayed to all agents on their computer screens. Upon acceptance of an offer, a trade is concluded and the asset and cash transferred between the transacting parties. Within our 15-period markets, inventories of assets and cash carried over from one period to the next so that for each

⁶ The two treatments are equally complex, with three components of value: dividends/holding costs, a final buyout value, and taxes/subsidies. While some confusion might be present, there is no obvious reason why it would be different in the two treatments. To the extent that an asset's fundamental value increasing over time in the presence of a tax may be somewhat unintuitive, we believe that having the fundamental decrease in an environment with subsidies is equally unnatural for subjects.

individual, the quantities of cash and assets held at the beginning of period $t+1$ were the same as those held at the end of period t , adjusting for any dividends and subsidies received as well as for any taxes paid. Each of the 15 periods of a market lasted two minutes.

A subject's entire earnings over a market were equal to the amount of cash he held at the end of the final period of that market, after the last dividend, tax/ subsidy, and final buyout were paid. This was equal to his initial endowment of cash, plus any earnings from dividends, plus any subsidies received, minus any taxes paid, plus proceeds from sales of shares, minus expenditures on purchases of shares, plus any final buyout received. ECU were converted to Euros at a rate of 500 ECU = 1 Euro.

3. Hypotheses

The five hypotheses we advance concern market-level activity. We readily concede that we anticipated some of the hypotheses to be more likely to be upheld in the data than others. Nevertheless, the hypotheses express what might reasonably be predicted from previous studies and from economic theory. The first three hypotheses concern the relationships between each of tasks in phases 1 - 3 and market activity in phase 4. They concern whether measurement of traders' risk aversion, loss aversion, and tendency to reflect, can predict the activity in the market in which they participate.

Hypothesis one relates to risk aversion and it is rooted in the classical theory on risk aversion and asset pricing. Because the asset traded in our markets is a risky lottery, it should be valued less by relatively risk-averse agents. Thus, we hypothesize that a greater average level of risk aversion among participants in the session, as measured in part three of the experiment, would correlate negatively with price level in part four.

Hypothesis 1: Greater risk aversion on the part of the average trader is correlated with lower prices in the asset market.

We quantify price level using a measure called *Average Bias* or *AB* (Haruvy and Noussair, 2006). This equals $AB = \sum_t (p_t - f_t)/15$ and is a measure of price level relative to fundamentals.⁷ We correlate it with the average level of safe choices in part three, using each session as the unit of observation. Furthermore, within each session, we expect that relatively risk-averse individuals would be net sellers of units to relatively risk tolerant ones, exploiting the gains from exchange that can ensue from such a

⁷ In our analysis in the next session, we also report Relative Deviation (RD), a related measure of price level that is widely-used in experimental finance. The measure was initially proposed by Stockl et al., (2010). We also report an absolute measure of mispricing, Relative Absolute Deviation (RAD), developed by the same authors.

transfer of risk. By the end of the market, relatively risk tolerant agents should hold more units of asset than more risk averse ones.

Just as we assert that risk aversion is related to the price level, we hypothesize that loss aversion is related to the quantity transacted. Consider a loss-averse agent who has purchased a unit and now wishes to sell a unit. This agent may be reluctant to sell a unit at a price lower than the last price at which he purchased. Alternatively, this reluctance could occur at another reference price, such as the average price paid in previous purchases, but a similar intuition would emerge. Similarly, consider a loss-averse agent deciding whether or not to purchase a unit. He may be reluctant to purchase the unit at a price greater than a reference price, which might be for example the one at which he concluded his last sale. This reluctance to trade may create friction, which would lower transaction volume. On the basis of this intuition, we hypothesize that the average loss aversion of a cohort measured in part 1 of the session is negatively correlated with the average quantity transacted in the markets, in which the cohort participates in later in the session.

Hypothesis 2: Greater average loss aversion is correlated with lower transaction volume in the asset market.

At the individual level, we would expect the relatively loss-averse individuals within a session to conclude fewer trades than their less loss-averse counterparts. The next hypothesis concerns the relationship between market activity and the cognitive reflection test administered in part two of the experiment. The CRT test measures the willingness to think about a decision problem, and it is plausible to conjecture that individuals who are prepared to do so are also more likely to thinking about the fundamental value of the asset when trading in the market. Thinking about the fundamental might encourage an individual to use it as a limit price. Indeed, Corgnet et al., (2014) report that subjects with higher CRT scores tend to make purchases at price below, and sales at prices above, fundamental values. It is likely that the greater the proportion of people who approach their trading decisions in this way, the greater the tendency is for prices to be close to fundamentals.

To evaluate hypothesis 3, we use a measure called the *Average Dispersion (AD)*. This is an overall measure of market mispricing relative to fundamentals over the entire lifetime of the asset. It is defined as $AD = \sum_t |p_t - f_t| / 15$, where p_t is the average price in period t and f_t is the fundamental value in period t . AD is the absolute difference between price and fundamental, averaged over the 15 period horizon. We hypothesize that Average Dispersion would be negatively correlated with the average CRT score of the traders in the market.

Hypothesis 3: Greater average CRT score is correlated with closer adherence to fundamental values.

The fourth hypothesis is that the two treatments, BullMarket and BearMarket, would exhibit equally effective price discovery. Although Giusti et al. (2012) and Huber et al. (2012) find that increasing fundamental value trajectories exhibit better price discovery than decreasing ones, both of these studies differ from ours in a number of ways. The most basic difference is, of course, that our design features a delayed onset of the fundamental value trend. Thus, we maintain the ex-ante expectation that there would be no difference in adherence to fundamentals between the two treatments. Thus, hypothesis 4 is that *AD* is not different between the Bullmarket and Bearmarket treatments.

Hypothesis 4: The Bullmarket and Bearmarket treatments track fundamentals equally closely.

The last hypothesis also originates from previous experimental studies. These have shown that as the same subjects participate in a second market under identical conditions, the prices at which they trade move closer to fundamentals (Smith et al., 1988; Dufwenberg et al., 2005; Haruvy et al., 2007). Nevertheless, it is possible that the convergence to fundamentals would occur at different rates in the two treatments. This is suggested by the results of Noussair and Powell (2010), who find that experience leads to more rapid price discovery in their Peak than in their Valley treatment. This would suggest that convergence would occur faster in the BearMarket than in the BullMarket treatment. This is because the Bullmarket treatment has an upward fundamental trend in the latter part of the session, like the Valley treatment. In contrast, Bearmarket has a downward trend like the Peak treatment. However, our view is that the analogy is too speculative to advance an ex-ante hypothesis that convergence would occur at different rates in the two treatments.

Hypothesis 5: Greater experience leads to closer adherence to fundamental values. Market 2 tracks fundamentals more closely than Market 1.

4. Results

This section is organized in the following lines. In section 4.1, we describe the price patterns in the market. In section 4.2, we turn to the principal research questions of this paper, the relationship between the risk aversion, loss aversion, and cognitive ability of traders and market behavior. In section 4.3 we consider the relationship between the measures and individual trading outcomes. In section 4.4, we

explore the connection between the measures and trading strategies. In section 4.5, we report the results of regressions that evaluate our hypotheses.

4.1. Market Price Patterns and Treatment Differences

Figure 2 below shows the time series of transaction prices for each market in the two treatments. Each individual time series corresponds to the activity of one of the 16 groups. The two panels in the upper portion of the figure correspond to the first and second markets of the BullMarket treatment. The vertical axes indicate the price, the horizontal axes mark the time period, and the fundamental value is given by the bold black line. Each time series represents the average price in each period in one of the sessions. The middle portion of the figure represents the analogous data for the BearMarket treatment for the sessions conducted at Tilburg University. The lower portion contains the data from the BearMarket sessions run at Jaume I University.

[Figure 2: About here]

Figure 2 illustrates several basic patterns. The first is that prices in the BearMarket treatment are closer to fundamental values than those in the BullMarket treatment, especially for market 2 in the sessions conducted at Tilburg. The second is that prices in the second market within each treatment are closer to fundamentals than those in the first market in some sessions but not in others. In the BearMarket treatment sessions conducted at Tilburg, pricing in market 2 is obviously closer to fundamentals than market 1. The sessions conducted at Jaume I University tend to exhibit greater deviations from fundamentals than those conducted at Tilburg. In the Bullmarket treatment, in the first eight periods, prices depart substantially from fundamental values, even in market 2.

The figure also shows that in the Bullmarket treatment, prices have some tendency to be greater than fundamentals early in the majority of the markets and then lower than fundamentals late in the life of the asset. In the Bearmarket treatment, the asset seems to have no overall tendency to be over-or under-priced early in its life, but tends to be overpriced late in the life of the asset in the sessions conducted at Jaume I. These patterns are consistent with a modest effect of the cash-to-asset ratio on price level, which is relatively low near the end of the sessions under Bullmarket, and relatively high in Bearmarket. Greater cash balances at the disposition of traders have been associated with higher prices relative to fundamentals in previous studies (Caginalp et al., 1999; Haruvy et al., 2006; Kirchler et al., 2012). In period t , the cash-to-asset ratio is given by $(C/A)_t = \frac{\sum_i c_{it}}{\sum_i q_{it} f_t}$ where $(C/A)_t$ is the cash-to-asset ratio

in period t , c_{it} is the cash available to trader i in period t , q_{it} is the quantity of units that trader i holds in period t , and f_t is the period t fundamental value.

The time profile of the cash-to-asset ratio is illustrated in figure 3. It shows that in the late periods of Bearmarket, as the subsidies increase the cash available, while lowering the fundamental value, the cash-to-asset ratio increases. In contrast, in Bullmarket, the taxes remove cash from the disposition of traders, and increase the fundamental. These effects would push the Bearmarket toward overpricing and the Bullmarket toward underpricing in the later part of the market, a pattern we observe in the data.

Statistical tests conducted using the 12 Tilburg sessions, enabling control for subject pool effects, confirm the impressions gleaned from the figures. A Mann-Whitney rank sum test fails to reject the hypothesis that the average dispersion is equal between the Bullmarket and Bearmarket treatments in market 1 ($z = 1.441$, $p = .1496$). For market 2, however, the test yields $z = 2.402$ ($p = .0163$), which is significant at conventional levels. We thus fail to support hypothesis 4, in market 2, when subjects have previously obtained experience with the market process. In market 2, the Bearmarket treatment leads to more accurate pricing. The hypothesis is supported though for market 1.

The average dispersion is lower in market 2 than in market 1 in only three of the six Bullmarket sessions. However, in all six sessions of Bearmarket conducted in Tilburg, prices exhibit lower average dispersion in market 2 than in market 1 ($z = 2.082$, $p < 0.037$). Thus, there is mixed support for hypothesis 5. It is supported in the Bearmarket treatment, but not in Bullmarket^{8,9}.

[Figure 3: About here]

4.2. The relationship between Risk Aversion, Loss Aversion, CRT score, and Market Activity

Figure 4 shows the relationship between the average risk aversion of session participants and the price level in each market. The risk aversion of each individual is weighted by her *market power* in the

⁸ We ran the same rank sum tests for Average Bias, but no significant differences were found between treatments ($z = -.217$ for market 1 and $z = -1.410$ for market 2) or between markets 1 and 2 ($z = .320$ for Bullmarket Treatment and $z = .302$ for Bearmarket Treatment)

⁹ The same analyses were conducted using Relative Absolute Deviation (RAD) and Relative Deviation (RD) as measures of mispricing. Mann-Whitney rank sum test fails to reject the hypothesis that RAD is equal between the two treatments: $z = -.961$ for market 1 and $z = 1.281$ for market 2. As for the hypothesis regarding experience leading to less mispricing, we find that RAD is lower in market 2 than in market 1 in 4 out of 6 sessions for the Bullmarket and in 5 out of 6 sessions for the Bearmarket. The correlation between average risk aversion weighted by market power for the pooled data from both treatments and RD is $-.173$ ($p = .520$) for market 1 and $-.382$ ($p = .143$) for market 2. The correlation between average CRT score weighted by market power and the RAD measure is $-.452$ ($p = .078$) for market 1 and $-.602$ ($p = .001$) for market 2.

experiment, and this new variable constitutes the horizontal axis. The market power is the average of the percentage of the shares outstanding and the percentage of the total stock of cash that an individual holds. It is used as a measure of influence in the market (see Haruvy and Noussair, 2006, or Haruvy et al., 2013). The market power of individual i , denoted as MP_i , equals $\Sigma(.5*s_{it}/\Sigma_i s_{it} + .5*m_{it}/\Sigma_i m_{it})/15$. The variable s_{it} equals the number of units of asset that i has at the beginning of period t and m_{it} is the amount of cash that individual i has at the beginning of the period. The weighting of risk aversion by market power is intended to reflect the fact that those individuals with greater capacity to buy and sell tend to have more influence on market activity.

In figure 4, The Average Bias in a market is indicated on the vertical axis. Each data point corresponds to one market in one session. The figure shows the relationship suggested in hypothesis 1 for the BullMarket treatment, though the relationship does not appear for BearMarket. For the pooled data from both treatments however, the correlation between average risk aversion for a trader cohort and the Average Bias in their market is $-.500$, significant at the $p = .048$ level in market 1. The correlation is $-.476$ in market two, significant at $p = .062$. Thus, we find strong support for hypothesis 1 in BullMarket and mixed support overall.

Figure 5 illustrates the relationship between average trader loss aversion by session and the volume of trade in each treatment. The loss aversion of individuals in the session, weighted by their market power, is plotted against the volume of trade by session. The figure shows that there is a negative relationship ($\rho = -.19$) in market 1 for the BearMarket treatment, which is consistent with hypothesis 2, though the correlation is not significant. The relationship is weaker in market 2 ($\rho = -.12$), suggesting that the relationship becomes yet weaker with experience. There is no relationship between these two measures in the BullMarket treatment. Overall, we find only very weak support for hypothesis 2.

Figure 6 relates the average CRT score of session participants, weighted by their market power, to the Average Dispersion in each session. The figure shows that the greater the average CRT of the group, the closer is their conformity to fundamentals. The correlation is $-.414$ and almost significant in market 1, ($p = .110$) as well as in market 2, $-.464$ ($p = .069$). Thus there is strong support for hypothesis 3 considering the number of observations.

[Figures 4, 5 and 6: About here]

4.3. Risk aversion, loss aversion, CRT score, and individual trading behavior

We have observed, in section 4.2, that greater average risk aversion among market participants is negatively correlated with price level. We now consider whether relatively risk-averse individuals tend to sell to those who are less risk averse. This pattern would be reflected in a relationship between an

individual's risk aversion, as measured in part 1 of the sessions, and how many units of the asset she holds at the end of the last period of the market. Figure 7 shows the relationship between an individual subject's risk aversion and her final asset holding at the end of markets 1 and 2. The vertical axis is the measured level of risk aversion in part 3 of the session, with 10 corresponding to the greatest, and 0 to the lowest, possible risk aversion level (highly risk seeking). Each data point in figure 7 is the average quantity held at the end of a session by individuals of a given risk aversion level. Larger circles indicate a larger number of individuals with the corresponding risk aversion level. The Appendix contains histograms of the risk aversion, loss aversion and cognitive reflection measures for our sample of participants.

The figure illustrates the tendency of individuals who are relatively risk averse to sell to those who are less risk averse. This intuitive relationship exploits potential gains from trade as risk is transferred to those who have a lower cost of bearing it. The correlation between the final inventory of an individual and her risk aversion in the BearMarket treatment is $\rho = -.197$, significant at $p = .073$. However, the correlation is insignificant under BullMarket ($\rho = -.035$, $p = .802$).¹⁰

At first glance this last result seems inconsistent with the fact that the overall correlation between average risk aversion of a cohort and price level is greater in BullMarket than in BearMarket. However, the latter, a between-session correlation, is perfectly compatible with the stronger within-session relationship in BearMarket between individuals' risk aversion and their holdings. Figure 8 documents the relationship between loss aversion and individual trading behavior. The vertical axis shows the value of the loss aversion measure in part 1 of the experiment. Higher values indicate greater loss aversion. Loss aversion is plotted against the total number of units the individual trades, that is, the sum of her purchases and sales, over a 15-period market. Each data point is the average number of units individuals with a given loss aversion level trade over the course of their 15-period market.

The figure shows, in the BearMarket treatment, a relationship between an individual's loss aversion and how much trade he engages in, with relatively loss-averse individuals involved in fewer trades. The correlation is $-.180$ ($p = .035$) in Market 1 and $-.094$ ($p = .275$) in Market 2. While this relationship does not appear significantly at the market level, in that a more loss averse group trades less than a relatively less loss averse group, it is clear that within a session, it is the less loss averse people who trade more. It seems that the relatively low number of observations at the market level and the greater presence of within- rather than between-group heterogeneity likely accounts for the lack of a significant relationship at the market level.

¹⁰ We recognize that the observations within a session are not totally independent. Nevertheless, with nine subjects per market, the impact of one given trader upon another can be presumed to be small on average.

Figure 9 plots the CRT score of an individual minus the average for her session on the horizontal axis, and her earnings on the vertical. Each data point represents an individual participant. The figure shows that higher CRT scores are related to higher earnings. The correlations are highly significant for the Bullmarket treatment .291 ($p = .000$) and for Bearmarket treatment .285 ($p = .009$). In markets with a dispersion of CRT scores, those with lower scores earn less, indicating that they make unprofitable trades. In markets in which the average score is high, few traders make poor decisions, and prices stay relatively close to fundamentals.

[Figures 7, 8, and 9, About Here]

4.4. Risk aversion, loss aversion, CRT score, and trader strategies

We now consider how the risk aversion, loss aversion, and cognitive reflection measures we have elicited correlate with trading strategies. To classify traders according to the strategies they tend to employ, we use the framework of Haruvy and Noussair (2006) and Haruvy et al. (2014). They classify traders into three types, called *Fundamental Value* Traders, *Momentum* Traders, and *Rational Speculators*. We classify each of the traders participating in our experiment as one of the three types, according to the following criteria.

We define an individual's behavior as consistent with the *Fundamental Value* Trader type in period t if either one of two conditions holds. The first condition is that, if $p_t > f_t$, then $s_{it} < s_{i,t-1}$, where p_t is the average price in period t , f_t is the fundamental value in period t , and s_{it} is the number of units of asset that individual i holds in period t . This means that if prices are above fundamentals, trader i is a net seller of units in period t . The second condition is that if $p_t < f_t$, then $s_{it} > s_{i,t-1}$. If prices are below fundamentals, trader i is a net buyer in period t . The fundamental value trader, then, acts as if she is using the fundamental value as a limit price.

A trader's behavior is consistent with the *Momentum* Trader type if either of two conditions holds. The first is that, if $p_{t-1} < p_{t-2}$, then $s_{it} < s_{i,t-1}$. The second is that, if $p_{t-1} > p_{t-2}$, then $s_{it} > s_{i,t-1}$. The momentum traders is a net purchaser in period t if there has been an increasing price trend in the last two periods, and sells off units if there has been a decreasing trend.

A trader's behavior is consistent with the *Rational Speculator* Trader type if her behavior in period t satisfies one of the following two conditions. The first is that, if $p_{t+1} < p_t$, then $s_{it} < s_{i,t-1}$, and the second is that, if $p_{t+1} > p_t$, then $s_{it} > s_{i,t-1}$. This type of agent anticipates the price in the next period in an

unbiased manner. She makes positive net purchases if the price is about to increase between the current and the next period. She makes net sales if the price is about to decrease.

To classify a subject as one of the trader types, we count the number of periods during which a person is consistent with each type, and then classify him as the type with which he is consistent for the greatest number of periods. If there is a tie between two types, we classify the trader as belonging to each type with proportion .5. If there is a tie between all three types, he is assigned each type with proportion .33.

Table 1 shows the percentage of traders of each type in each treatment and market. It shows several interesting patterns. Despite the fact that the BearMarket treatment tracks fundamentals more closely than the Bullmarket treatment, the percentage of individuals classified as each type is very similar. Furthermore, the proportion of players of each type in market 1 is very similar to the two previous studies in which a similar classification was made for subjects with no prior experience in the same experiment (Haruvy and Noussair 2006, and Haruvy et al., 2013)¹¹. The fraction of players that are Momentum traders decreases between markets 1 and 2 while the proportions that are of the Fundamental Value and Rational Speculator types increase. This change in distribution suggests that positive reinforcement is occurring, since momentum trading is irrational, resulting in relatively low earnings, while the other two types describe trading behaviors that reflect different notions of rationality.

[Tables 1 and 2: About Here]

Table 2 shows the correlations between risk aversion level, loss aversion level, CRT score, and each of the three types. Each individual trader constitutes one observation. The table reveals the following patterns. Risk aversion, loss aversion and CRT scores are not significantly correlated with each other. Cognitive reflection test scores exhibit a significant correlation with being a fundamental value type in market 1. This is consistent with previous results reported by Corgnat et al., (2014). CRT score is negatively correlated with momentum trading. These are intuitive relationships since momentum trading is an irrational strategy, while fundamental value trading requires the trader to interpret the future streams of dividends, final buyout value, taxes and subsidies as a limit price.

¹¹ Both Haruvy and Noussair (2006) and Haruvy et al. (2013) classified 33.1% of their traders as Fundamental Value Traders, 25.4% as Rational Speculators, and 36.5% as Momentum Traders. Haruvy et al. (2014) categorized 40.1% of their participants as Fundamental Value Traders, 23.8% as Rational Speculators, and 36.1% as Momentum Traders.

In market two, other intuitive relationships appear, perhaps because traders have had some time and experience so that they are able to formulate trading strategies that more accurately reflect their preferences. In market 2, there is a significant positive correlation between risk aversion and fundamental value trading. This relationship reflects risk-averse agents selling their units in large quantities when prices are greater than fundamentals. Loss averse agents are also less likely to be rational speculators in market 2, likely reflecting their desire to avoid the potential losses that one risks when speculating. There is no significant relationship between risk aversion, loss aversion, and CRT score, suggesting that they are largely orthogonal characteristics.

4.5. Regression analysis

[Table 3: About Here]

Table 3 illustrates how much between-session variation in market prices that risk aversion, loss aversion and CRT score can explain. The dependent variables in the estimations reported in the table are the Average Dispersion, Average Bias, and the total quantity traded (Q), which has been associated with bubbles by previous authors (see for example Van Boening et al, 1993) . Model 1 includes the experience level of the subjects (whether the data comes from market 1 or market 2), the treatment in effect, and the location in which the session was conducted. These variables explain 24% of the variance in AD, 1% for AB, and 23% for Q. When the average risk aversion, loss aversion, and CRT score are added to the specification in model 2 (location is dropped because the different subject pools differ in the average level of the three characteristics), the explanatory power of the model increases substantially, to 42% for AD, 46% for AB and 52% for Q. Thus, knowing the average risk aversion, loss aversion, and CRT score of a group of traders allows much more market variation to be explained than when these measures are unavailable.

[Table 4: About Here]

Table 4 reports a similar analysis at the individual level. The dependent variables are final earnings, the number of trades, and final asset holdings. The results show effects that are in the same direction as the correlations documented in section 4.3. The regressions in the first two columns indicate that CRT score is a significant predictor of final earnings, even if loss aversion, risk aversion and subject pool are taken into account. The other regressions suggest that loss averse individuals make fewer trades and risk averse traders have lower final holdings. However, in these two cases, although the estimated effects are quite substantial (an increase in the loss aversion measure by one question corresponds to 5.7 fewer trades

over the course of a session, and an increase in the risk aversion measure by one question corresponds to 0.556 fewer units held at the end of the session), they are not significant. There appear to be many unobserved factors affecting trade and holdings. Furthermore, including subject characteristics explains at best a small amount of additional variation in individual outcomes beyond that explained by treatment and experience level.

5. Conclusion

Experiments have shown that market behaviour responds readily to different treatments. However, much within-treatment variation in market activity is observed. Because, at least in principal, the only difference between sessions within a treatment is the group of subjects participating, it is natural to consider whether subject characteristics are a source of this variation. In this paper, we document correlations between risk aversion, loss aversion, cognitive reflection test scores, and market outcomes. The average risk aversion of traders correlates negatively with the price level. The average CRT score correlates negatively with the distance between price and fundamentals. Risk aversion, loss aversion, and CRT score also correlate with individual asset holdings, trading intensity, and earnings in intuitive ways.

Our results show that trader characteristics are also important determinants of market behaviour. More risk-averse individuals are more likely to sell units and to trade on fundamentals. They are also less likely to trade on momentum. Loss-averse individuals trade less than their less loss-averse counterparts, and are less likely to speculate. Traders with higher CRT scores are more likely to trade on fundamentals and to achieve greater earnings. Traders with low CRT scores are more likely to be momentum traders.

The markets we have studied have the feature that a time trend in fundamentals sets in after an interval of constant value. Though the effect requires some trader experience before it sets in, prices tend to track fundamentals more closely when the trend is decreasing, in the BearMarket treatment, than when it is increasing, in the BullMarket treatment. The contrast between our results and those from previous studies indicates that the timing of the onset of a trend in fundamentals is an important feature influencing how the trend affects the price discovery process. This suggests that markets for assets which have a declining fundamental value trend from the moment of their creation, such as some bonds and options, or depreciating capital, might exhibit differences in pricing behaviour from those such as stocks and commodities that may experience episodes of declining value at later points in their lifetimes.

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Table 1: Proportion of Individuals of Each Trader Type, by Treatment and Market

	Market1		Market2	
	Flat FV	Increasing FV	Flat FV	Increasing FV
Fundamental Value	39.00%	33.33%	32.08%	34.91%
Momentum	28.61%	45.61%	28.30%	30.18%
Rational Speculator	32.39%	21.06%	39.62%	34.91%

	Market1		Market2	
	Flat FV	Decreasing FV	Flat FV	Decreasing FV
Fundamental Value	33.94%	39.97%	45.79%	44.00%
Momentum	30.92%	44.19%	20.47%	35.55%
Rational Speculator	35.14%	15.85%	33.74%	20.46%

Table 2: Correlation between trader type, risk aversion, loss aversion, and CRT score

Market 1	Fundamental Value	Momentum	Rational Speculator	Risk aversion	Loss aversion	CRT
Risk aversion	0.0228	0.0047	-0.0771	1		
Loss aversion	0.0775	-0.0902	-0.0337	0.1124	1	
CRT	0.2373***	-0.1934**	-0.0248	-0.0394	0.0990	1

*** correlation sig. at $p < .01$

** correlation sig. at $p < .05$

Market 2	Fundamental Value	Momentum	Rational Speculator	Risk aversion	Loss aversion	CRT
Risk aversion	0.1647**	-0.1446*	0.0259	1		
Loss aversion	0.1470*	0.0056	-0.1593*	0.1124	1	
CRT	0.1336	-0.2371***	0.0696	-0.0394	0.0990	1

*** correlation sig. at $p < .01$

** correlation sig. at $p < .05$

* correlation sig. at $p < .1$

Table 3: Determinants of Average Dispersion, Average Bias and Quantity traded with and without Risk Aversion, Loss Aversion, and CRT as Explanatory Variables

	AD	AD	AB	AB	Q	Q
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Treatment	-24.04**	-29.52**	9.64	30.78**	.565	.441
Experience	-6.39	-6.39	4.73	4.734	-.647**	-.647**
Subject pool	31.66***		-10.88		.440	
Risk Aversion		14.75***		-33.09***		-.381*
CRT Score		-23.28***		21.84**		-.742**
Loss Aversion		4.79		-2.41		-.438
	R ² = 0.2464	R ² = 0.4207	R ² = 0.0184	R ² = 0.4604	R ² = 0.2308	R ² = 0.5227

Table 4: Determinants of Earnings, Number of Trades and Asset Holdings with and without Risk Aversion, Loss Aversion, and CRT as Explanatory Variables

	Final earnings	Final earnings	Number of trades	Number of trades	Final holdings	Final holdings
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Treatment	289.85	623.68	15.890***	8.040	2.35e-16	-.897
Experience	-214.70	-214.70*	-12.411***	-12.411***	2.50e-33	2.29e-17
Subject pool	-272.5	-211.59	8.133	1.770	-3.63e-16	.131
Risk Aversion		167.53		-2.167		-.556
CRT Score		408.32***		2.960		1.273
Loss Aversion		31.58		-5.764		.216
	R ² = 0.0095	R ² = 0.0901	R ² = 0.1172	R ² = 0.1541	R ² = 0.0000	R ² = 0.0199

Figure 1a: Fundamental Value Time Path in BullMarket Treatment

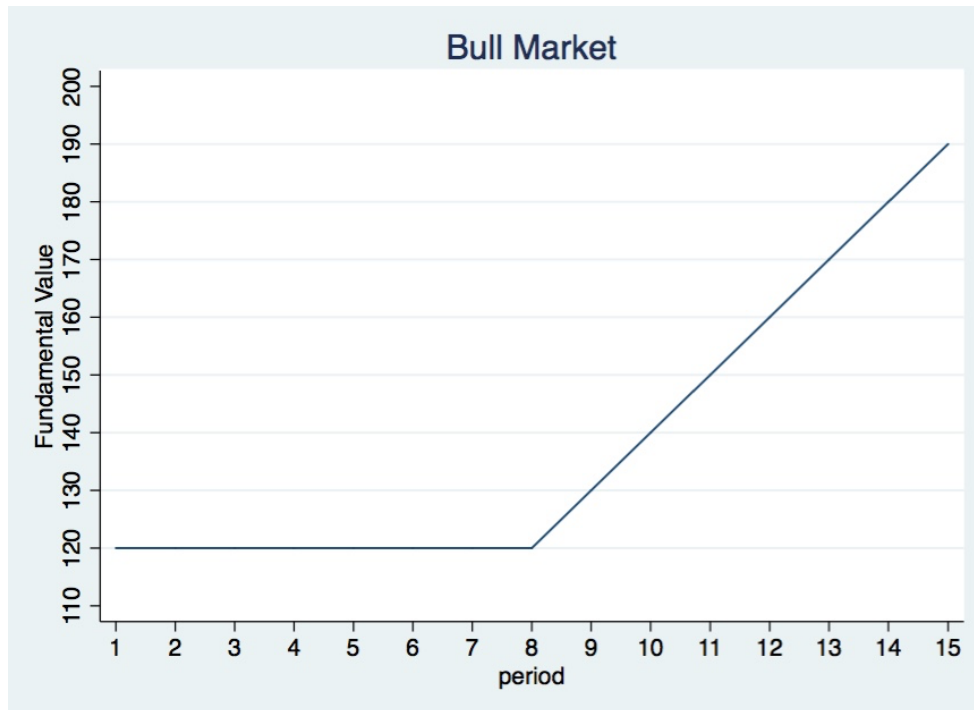


Figure 1b: Fundamental Value Time Path in BearMarket Treatment

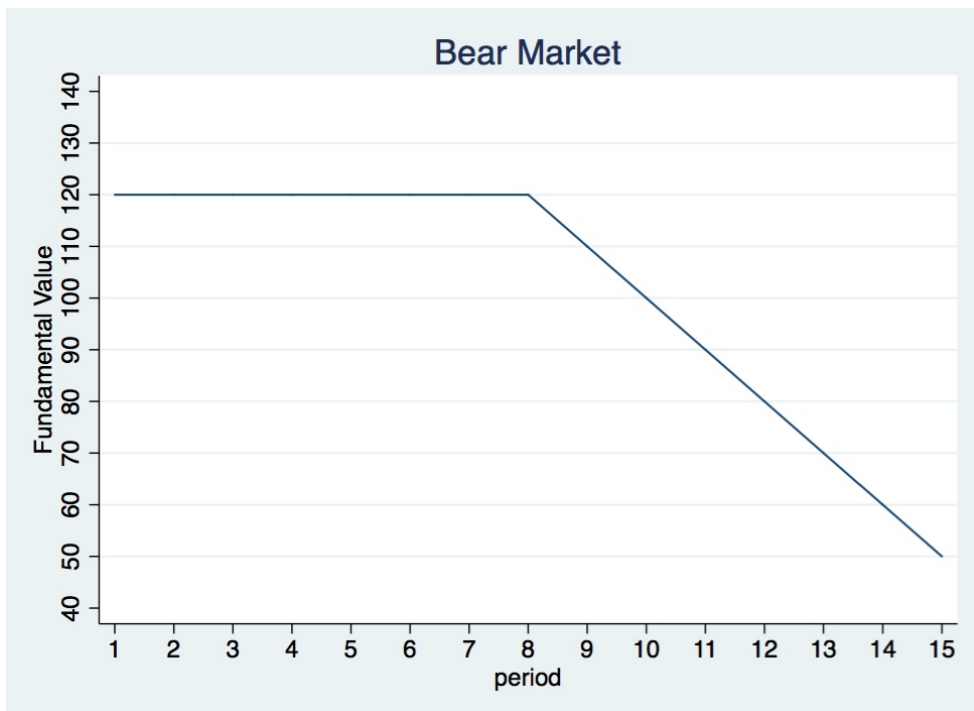
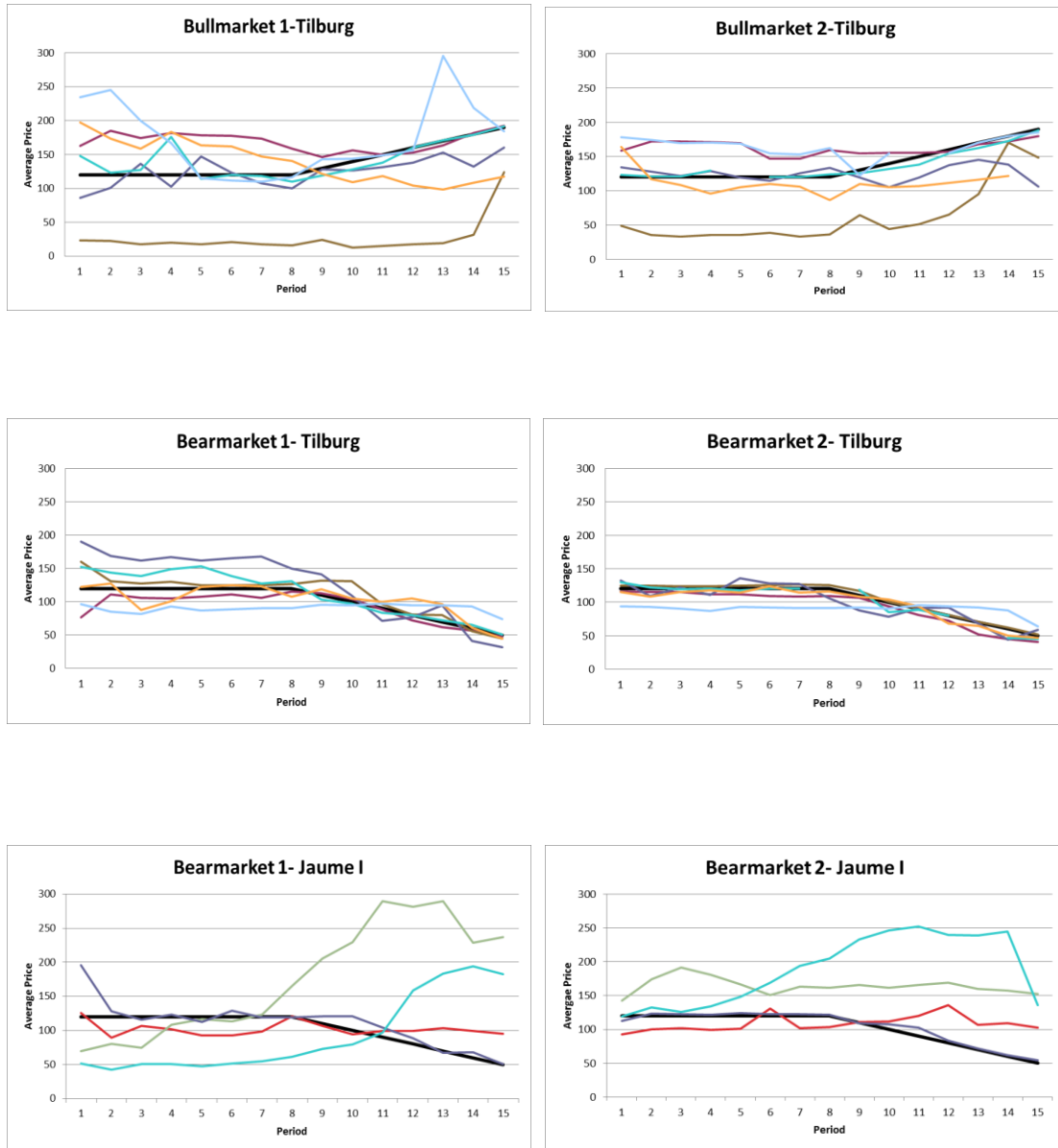


Figure 2: Average Market Prices, All Markets



Left Panels: Market 1; Right Panels: Market 2

The data are the average transaction price in a period. Each time series is a separate session. The Fundamental Value Time Trajectory is given by the bold black line.

Figure 3: Cash and cash/asset ratio in the Bullmarket and Bearmarket Treatments

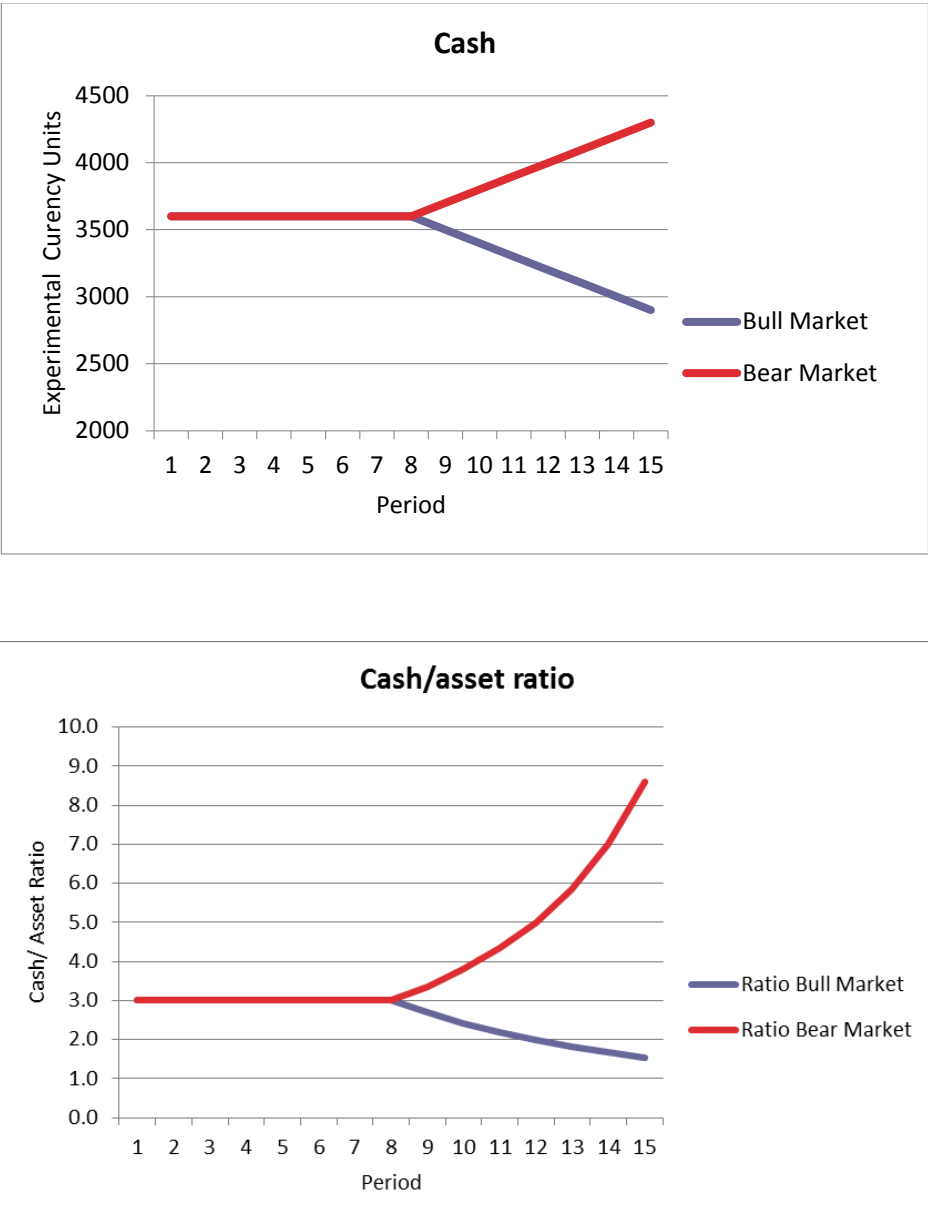
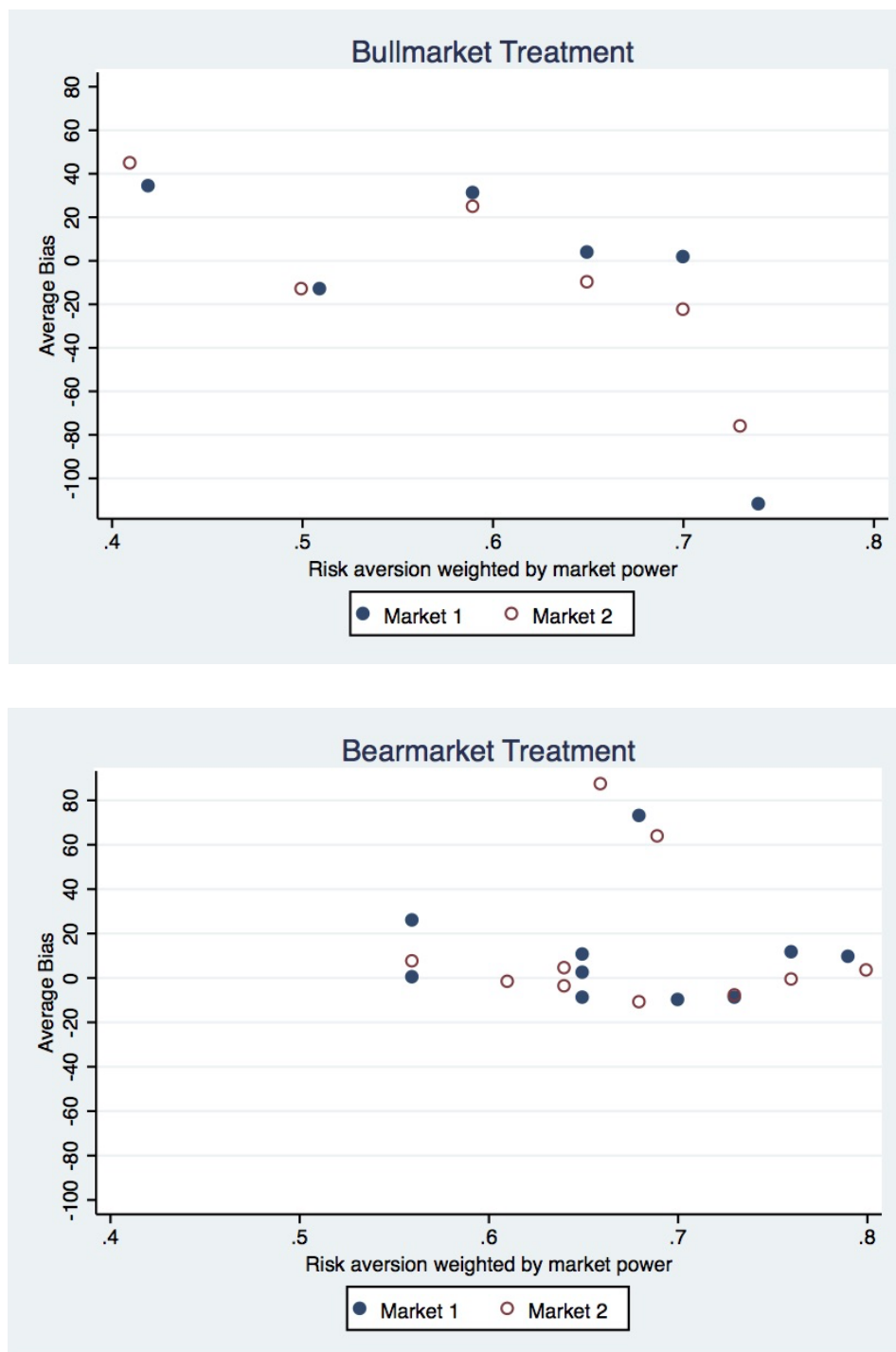
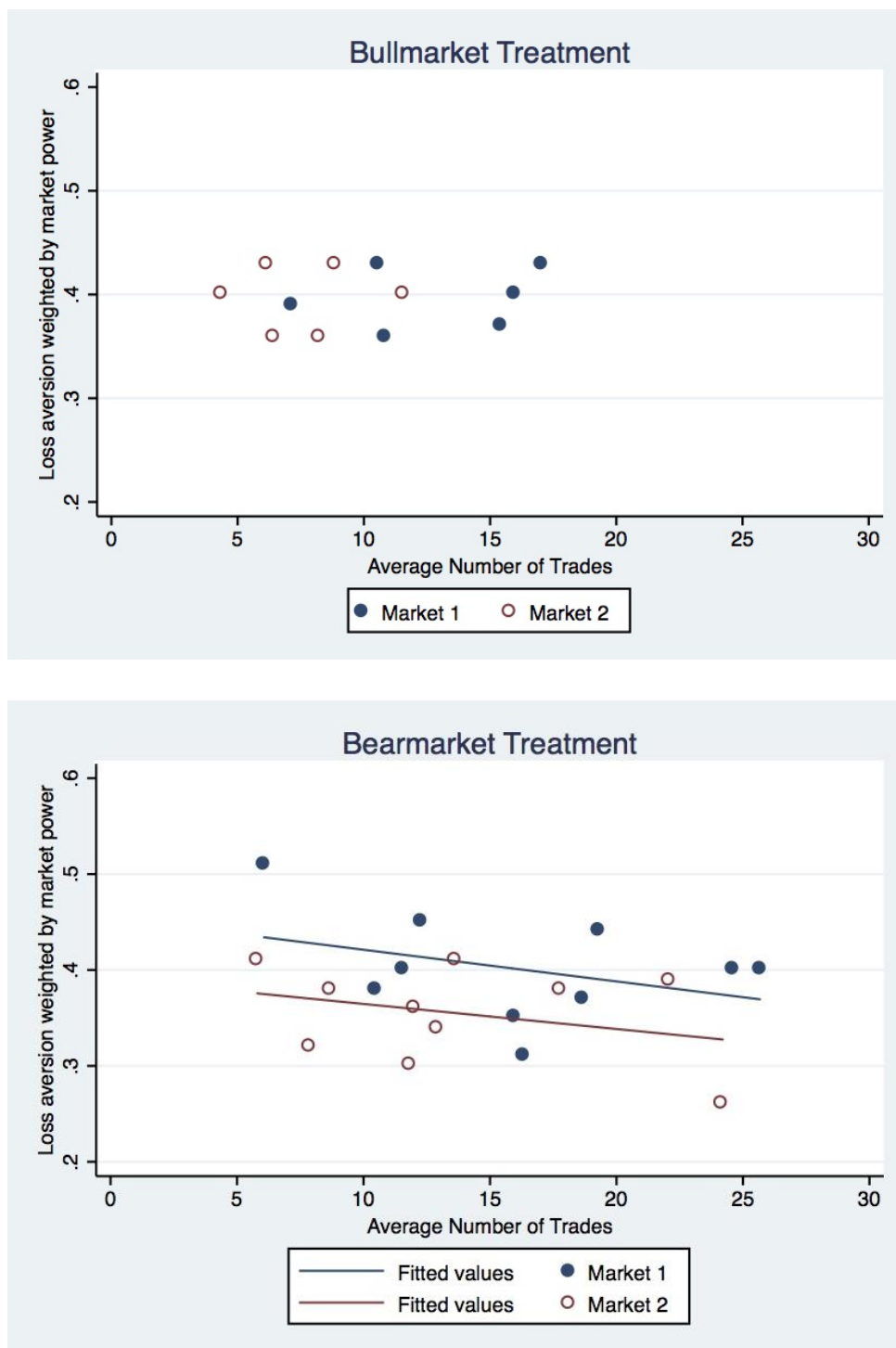


Figure 4: Correlation between risk aversion weighted by market power and average price level in each market, both treatments



Risk aversion weighted by market power equals $[(\text{Number of safe choices in part 3 by individual } i) \times (i\text{'s average market power over the 15 period market})]$, averaged over all traders in the market

Figure 5: Relationship between loss aversion and number of transactions in a market, both treatments



Loss aversion weighted by market power equals $[(\text{Number of safe choices in part 1 by individual } i) \times (i\text{'s average market power over the 15 period market})]$, averaged over all traders in the market.

Figure 6: Cognitive Reflection Test Score and Average Dispersion, All Markets.

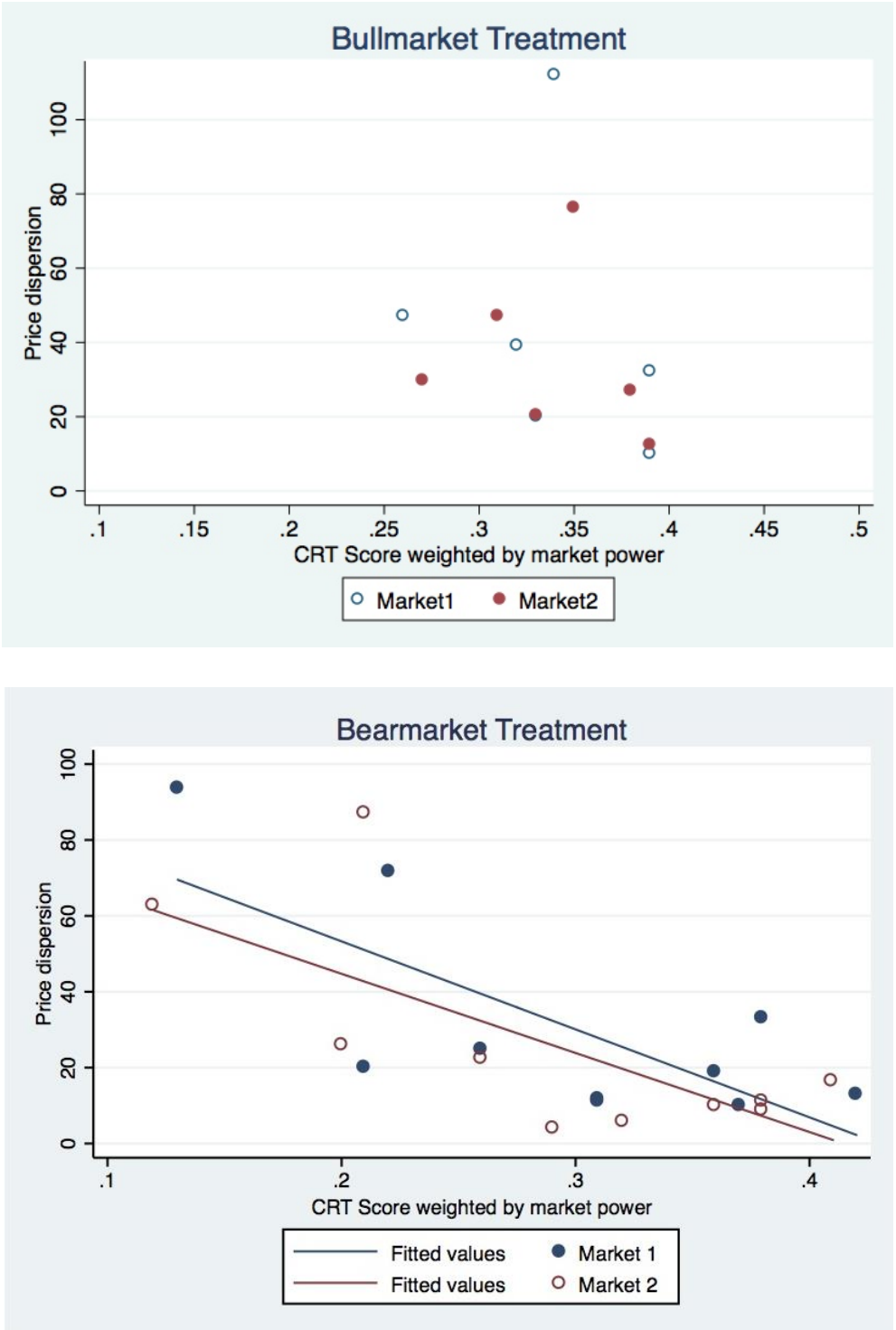


Figure 7: Final Individual Asset Holdings and Risk Aversion

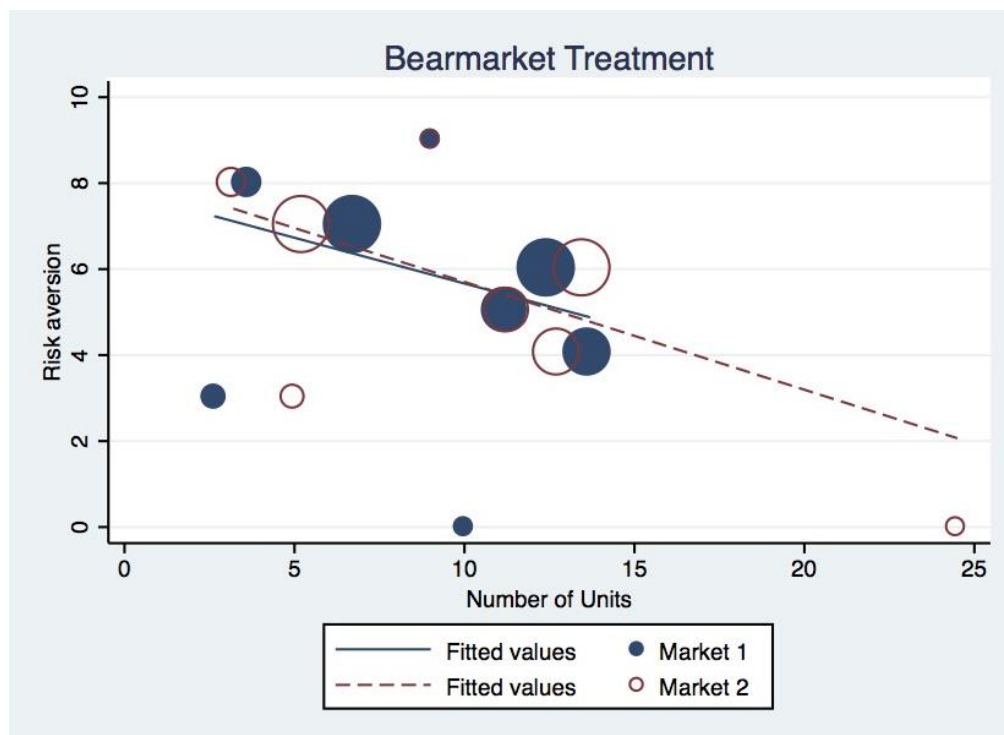
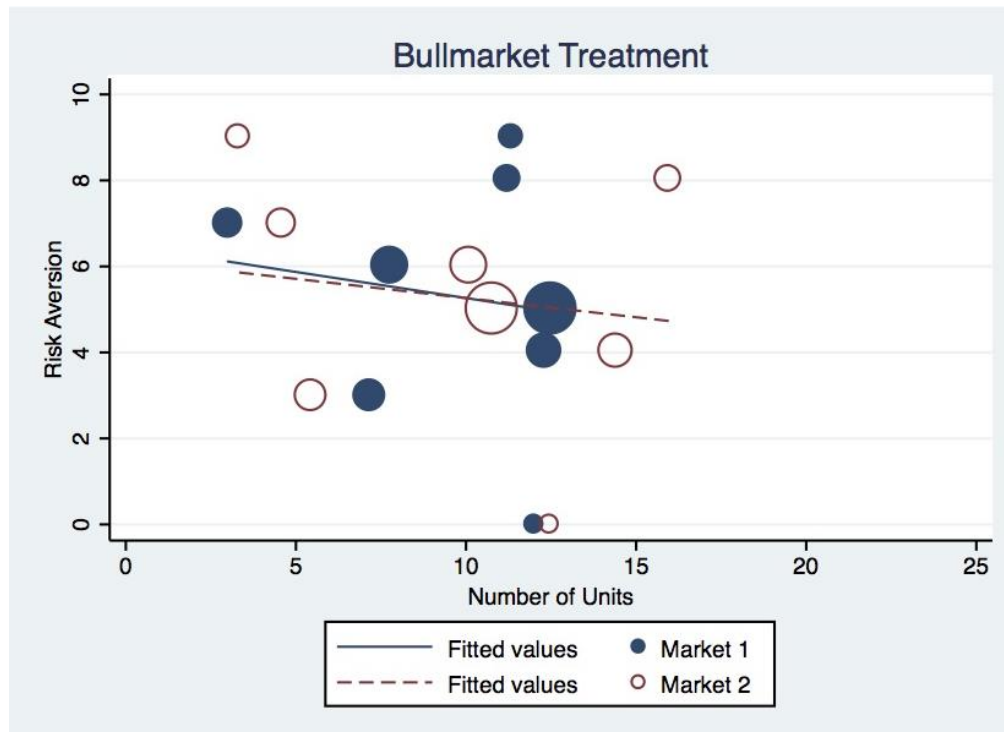


Figure 8: Total number of trades individuals conclude and their loss aversion level

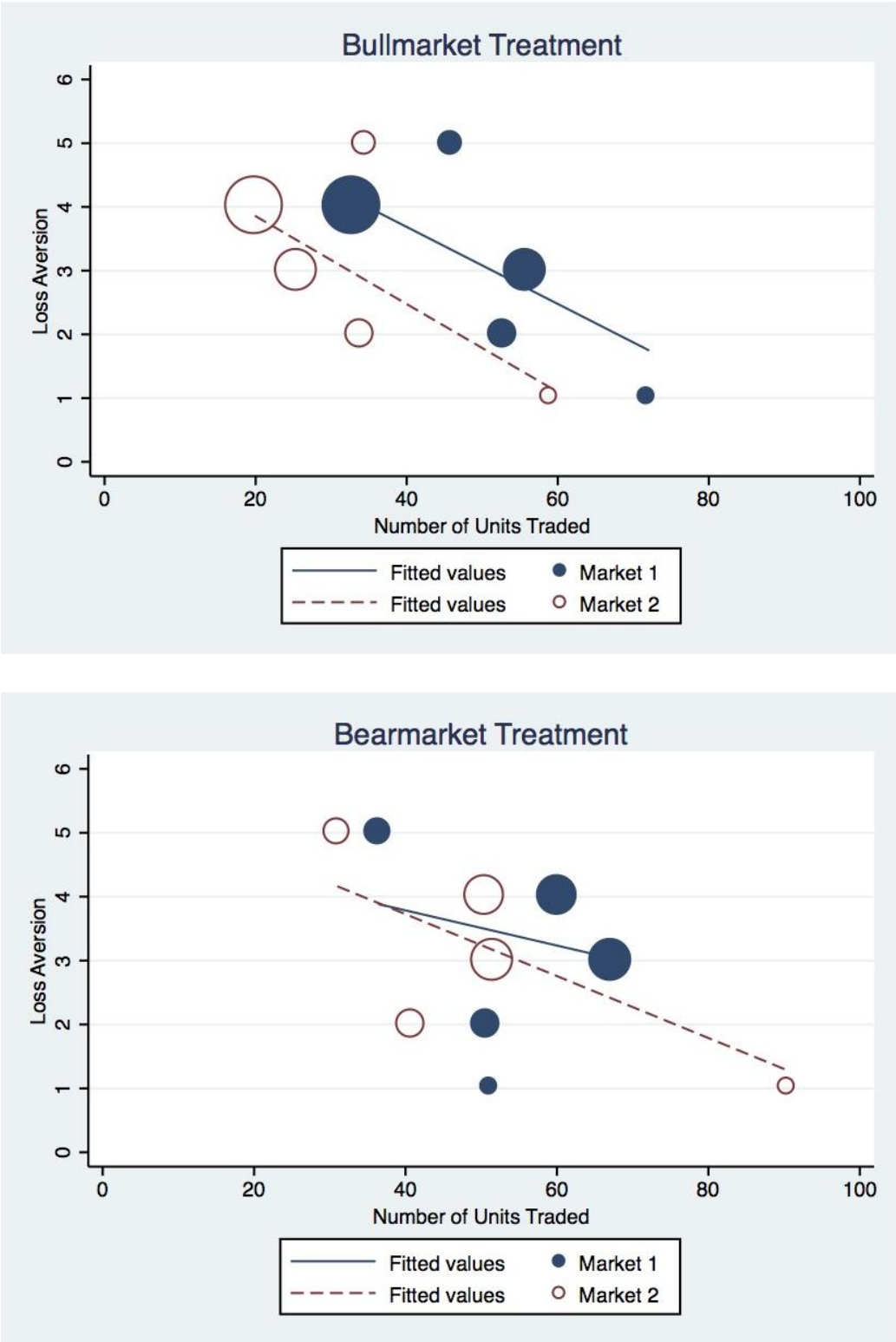
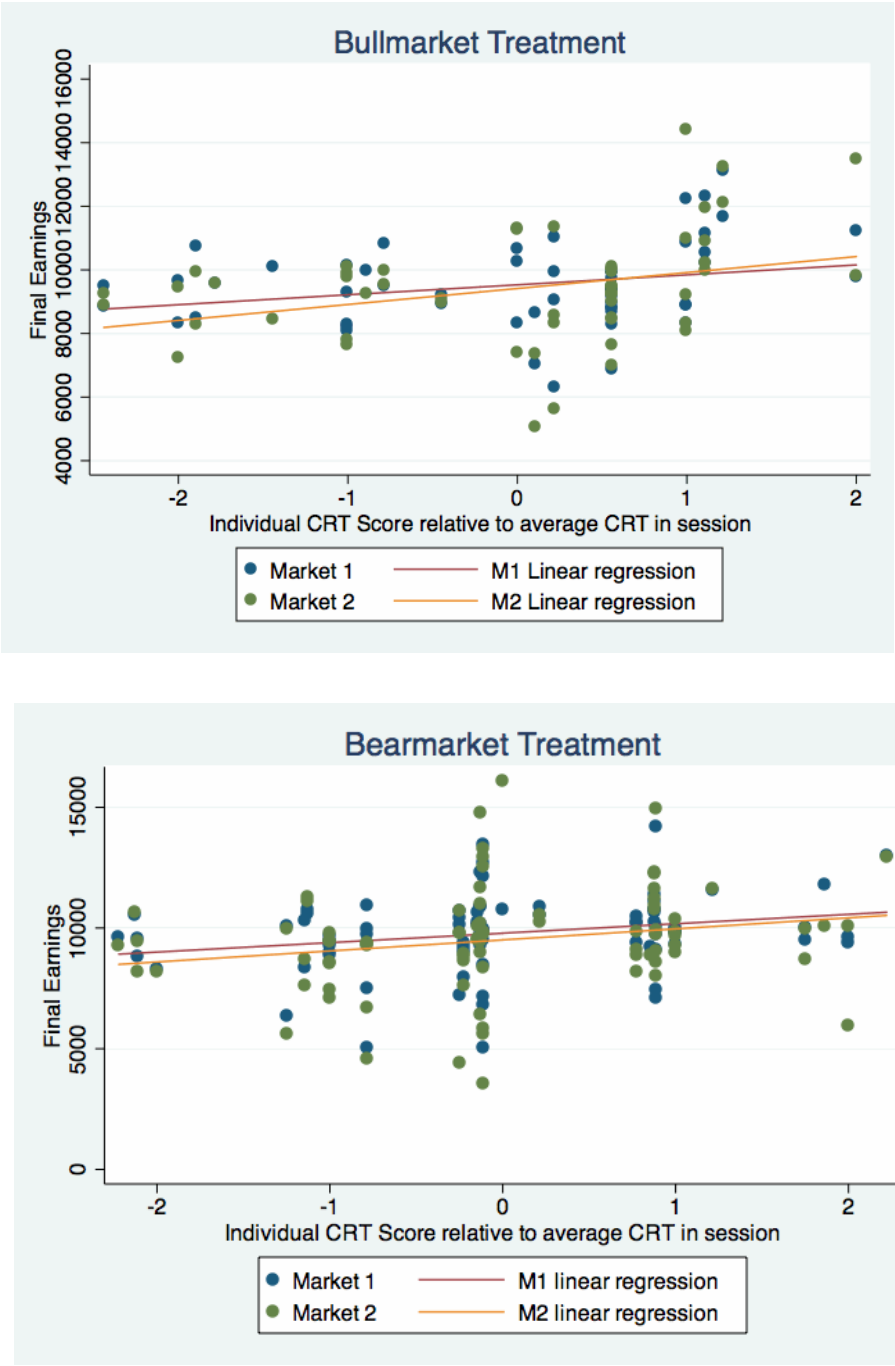
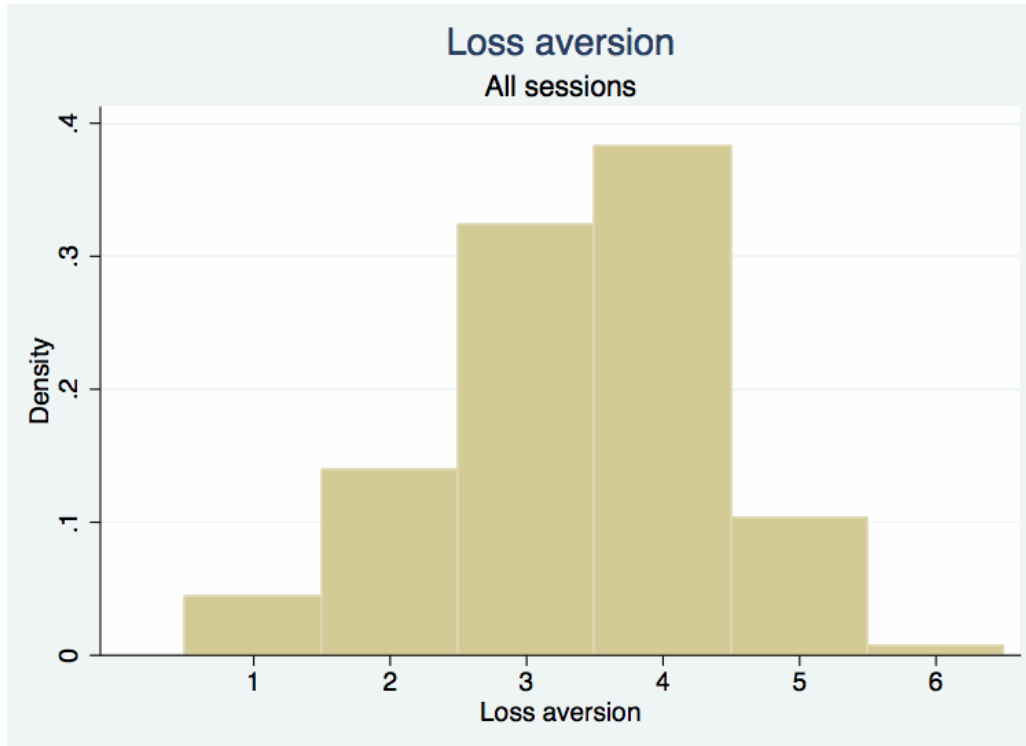
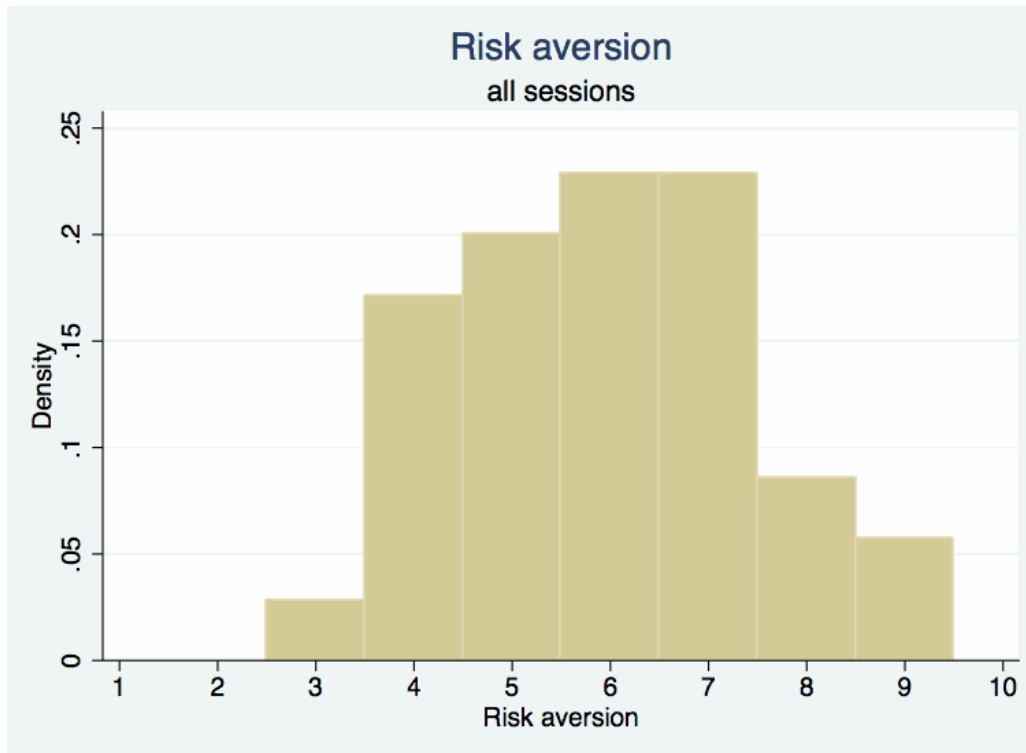


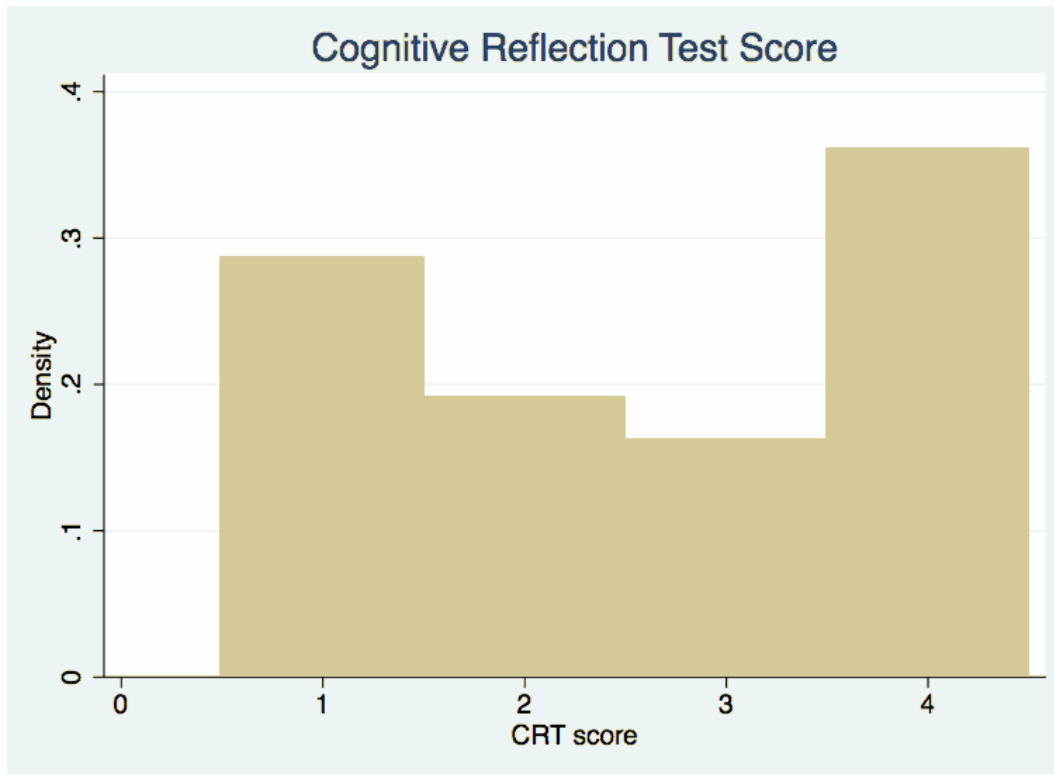
Figure 9: CRT Score and final earnings at the individual level



Appendix I: This appendix contains histograms of the distributions of Loss Aversion, Risk Aversion and Cognitive Reflection Test Scores among our subjects.







Appendix II: Instructions Bearmarket Treatment

Name _____

Computer number _____

General Instructions

Welcome to this experiment. The instructions are simple and if you follow them carefully and make good decisions, you might earn a considerable amount of money, which will be paid to you by bank transfer later today after the experiment ends.

The session will be divided into four parts and you will have the opportunity to earn money in each of them.

Part I

In the first part of the experiment six bets will be presented to you. Each bet gives you a 50-50 chance of winning some money or losing some money. The six bets are indicated at the bottom of this page.

You must decide if you want to play each bet or not, although only one randomly chosen decision will count toward your earnings. You indicate whether you accept to play the bet by selecting Yes or No in the row corresponding to the bet.

After all participants have made their decisions for each of the six bets, the experimenter will roll a six-sided die. The outcome of the roll will determine the one single bet that will count to determine your earnings. If the die reads 1, you will be paid for your decision in the first lottery. If the die reads 2, you will be paid for your decision in the second lottery, and so on. Exactly one of the six bets will count.

If you decided not to play the bet chosen by the die roll, your earnings will be 0 euros for this part of the experiment.

If you decided to play that bet chosen by the die roll, there will be a 50-50 chance for you to win or lose the amount of money indicated in the bet. To determine whether you win or lose, the experimenter will toss a coin. If the coin comes up heads you lose and if the coin comes up tails you win the amount of money specified in the lottery.

Lottery (50-50 chance)

Lose 0.5€ or win 4.5€

Lose 1.5€ or win 4.5€

Lose 2.5€ or win 4.5€

Lose 3.5€ or win 4.5€

Lose 4.5€ or win 4.5€

Lose 5.5€ or win 4.5€

Accept to play?

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

Part II

In this part of the experiment, you will have to answer three questions. You will have exactly 3 minutes to answer the questions. Each correct answer will earn you 1 euro. That is, if you give one correct answer, you get 1 euro; if you give two correct answers you get 2 euros and if you give three correct answers you get 3 euros in this part of the experiment. There is no penalty for wrong answers.

Part III

In this part of the experiment you will be making choices between two lotteries, such as those represented as "Option A" and "Option B" below. The money prizes are determined by the computer equivalent of throwing a ten-sided die. Each outcome, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, is equally likely. If you choose Option A in the decision shown below, you will have a 1 in 10 chance of earning 2.00€ and a 9 in 10 chance of earning 1.60€. Similarly, Option B offers a 1 in 10 chance of earning 3.85€ and a 9 in 10 chance of earning 0.10€.

Decision 1 :

Option A: 2.00€ if the die is 1 and 1.60€ if the die is 2 - 10

Option B: 3.85€ if the die is 1 and 0.10€ if the die is 2 – 10

Each box of the decision table contains a pair of choices between Option A and Option B. You make your choice by clicking on the "A" or "B" buttons on the bottom. Only one option in each box can be selected, and you may change your decision as you wish before you submit it.

Even though you will make ten decisions, only one of these will end up being used. The selection of the one to be used depends on the "throw of the die" that is determined by the computer's random number generator. No decision is any more likely to be used than any other, and you will not know in advance which one will be selected, so please think about each one carefully.

For example, suppose that you make all ten decisions and the roll of the die is 9, then your choice, A or B, for decision 9 would be used and the other decisions would not be used.

After the random die throw determines the decision box that will be used, a second random number is drawn that determines the earnings for the option you chose for that box. In Decision 9 below, for example, a throw of 1, 2, 3, 4, 5, 6, 7, 8, or 9 will result in the higher payoff for the option you chose, and a throw of 10 will result in the lower payoff.

Decision 9:

Option A: 2.00€ if the die is 1-9 and 1.60€ if the die is 10

Option B: 3.85€ if the die is 1-9 and 0.10€ if the die is 10

For decision 10, the random die throw will not be needed, since the choice is between amounts of money that are fixed: 2.00€ for Option A and 3.85€ for Option B.

Your earnings in this part of the experiment will be added to your final payoff.

Part IV

In this part of the experiment you will make decisions in a market. There will be a sequence of trading periods in which you will have the opportunity to buy and sell shares in a market. The currency used in this market is ECU. All trading will be in terms of ECU. The cash payment to you at the end of the experiment will be in Euros. The conversion rate is 500 ECU to 1 Euro.

1. How to use the computerized market

On the top right corner of the screen you see how much time is left in the current period. The goods that can be bought and sold in the market are called Shares. On the left side of your screen you see the current period, the number of Shares you currently have and the amount of Money, in ECU, you have available to buy Shares.

If you would like to offer to sell a share, use the text area entitled “Enter offer to sell.” in the second column. In that text area you can enter the price at which you are offering to sell a Share, and then select “Submit Offer To Sell”. Please do so now. Type in a number in the appropriate space, and then click on the field labelled “Submit Offer To Sell”. You will notice that nine numbers, one submitted by each participant, now appear in the second column on the left, entitled “Offers To Sell”. Your offer is listed in blue. Submitting a second offer will replace your previous offer.

If you select “Buy”, the button at the bottom of this column, you will buy one share for the currently selected sell price, which is indicated by a blue background. The lowest offer-to-sell price will always be on the top of that list and will, by default, be selected. You can select a different offer by clicking on it. It will then be highlighted. If an offer is selected and the offer gets changed, it will become deselected if the offer became worse for you. If the offer gets better, it will remain selected.

Please purchase a share now by selecting the “Buy” button.

When you buy a share, your Money decreases by the price of the purchase. When you sell a share, your Money increases by the price of the sale.

You may make an offer to buy a unit by selecting “Submit offer to buy”. Please do so now. Type a number in the text area “Enter offer to buy”, then press the red button labelled “Submit Offer to buy”. You can replace your offer-to-buy by submitting a new offer. Please make an offer to buy now.

You can accept any of the offers-to-buy by selecting the offer and then clicking on the “Sell” button. If you do so, you sell one of your units at the price of the offer. Please sell a unit now.

In the middle column, labelled “Transaction Prices”, you can see the prices at which Shares have been bought and sold in this period.

You will now have 5 minutes to buy and sell shares. This is a practice period. Your actions in the practice period do not count toward your earnings and do not influence your position later in the experiment. The only goal of the practice period is to master the use of the interface. Please be sure that you have successfully submitted offers to buy and offers to sell. Also be sure that you have accepted to buy and sell others. You are free to ask questions during the practice period by raising your hand.

2. Specific Instructions for this experiment

The experiment will consist of 15 trading periods. In each period, there will be a market open for 2 minutes, during which you are permitted to buy and sell shares. Shares have life of 15 periods. Your inventory of shares carries over from one period to the next. For example, if you have 5 shares at the end of period 1, you will have 5 shares at the beginning of period 2.

You start period 1 with 10 shares in your inventory and 3600 ECU of Money, which you can use in the market.

Dividends:

You may receive dividends for each share in your inventory at the end of each of the 15 trading periods. At the end of each trading period, including period 15, the experimenter will flip a coin, which will determine the dividend for that period.

Each period, each share you hold at the end of the period earns you a dividend of:

10 ECU if the coin comes up heads

-10 ECU if the coin comes up tails

Both sides of the coin are equally likely, which means that the average dividend is 0. We arrive at 0 by averaging the two equally likely dividends: 10, -10. That is, we calculate $(10-10)/2=0$.

If the dividend of the period is 10, you earn 10 ECU for each share you own, and that money will be automatically added to your Money balance at the end of the period. If the dividend of the period is -10, for each share you own there will be 10 ECU subtracted from your Money balance at the end of the period.

Subsidies: At the end of each of the last eight periods, you will obtain a payment of 10 ECU for each share in your inventory. This payment is called a subsidy. The subsidy is paid to you at the end of period 8, period 9, ..., and period 15. No subsidy is paid at the end of the first seven periods: period 1, period 2,..., and period 7.

The subsidies that you receive are automatically added to your money balance at the end of each of the last eight periods.

Final Buyout: At the end of period 15, after the dividends and subsidies have been paid out for the period, the experimenter will purchase back all the shares in the market for 40 ECU each from their current owners. This buyout value will be added to any dividends and subsidies received in period 15.

3. Average Holding Value Table

You can use the AVERAGE HOLDING VALUE TABLE (attached at the end of this document) to help you make decisions. It calculates the average amount of dividends and holding taxes you will receive and pay if you keep a share until the end of the experiment. It also describes how to calculate how much in future dividends and holding taxes you give up on average when you sell a share at any time. The columns in the table contain the following information:

1. Column (1), Current Period: the period during which the average holding is being calculated. For example, in period 1, the numbers in the row corresponding to “Current Period 1” are in effect.
2. Column (2) Number of Remaining Dividends: the number of times that a dividend can be received from the current period until the final period. This is the remaining number of times the experimenter will toss the coin. It is calculated by taking the total number of periods, 15, subtracting the current period number, and adding 1, because the dividend is also paid in the current period.
3. Column (3) Average Dividend: the average amount of each dividend. As we indicated earlier, the average dividend in each period is 0 per share in each period.
4. Column (4) Final Buyout Value: The payment you receive for each share you hold at the end of period 15, in addition to any dividend and subsidy in that period.
5. Column (5): Number of Remaining Subsidy Payments: the number of times that a subsidy will be paid on a share from the current period until the end of the experiment. It is calculated by taking the total number of periods remaining in which a subsidy will be paid, 8, and subtracting the number of subsidy payment periods that have already passed.
6. Column (6): Subsidy Amount in Current Period: the amount that the subsidy payment per share will be in the current period. As indicated earlier, there is no subsidy in the first 7 periods, while the subsidy amount is 10 ECU per share in the last 8 periods.
7. Column (7): Total Remaining Subsidies: the total value of the subsidies remaining to be paid on a share from now until the end of the experiment. That is, for each unit you hold in your inventory for the remainder of the experiment, you will be paid the amount listed in column 7 in subsidies. It is calculated by multiplying Number of Remaining Subsidies Payments by Subsidy Amount in Current Period (column (5)*Column (6)).
8. Average Holding Value: the average value of holding a share for the remainder of the experiment. That is, for each unit you hold in your inventory for the remainder of the experiment, the net value of the dividends you earn, the subsidies you will be paid and the buyout value you receive will on average be the amount listed here. It is calculated by summing up Total Remaining Subsidies + (Average Remaining Dividends)*(Number of Remaining Dividends) + Final Buyout Value.

4. Your Earnings

Your earnings in this part of the experiment will equal the total amount of money that you have at the end of period 15. More specifically, your earnings will be:

YOUR EARNINGS = the money you begin with
 +any dividends you receive
 +any subsidies you receive
 +any money you receive from sales of shares
 -any money you spend on purchases of shares
 + the final buyout value for the units you have at the end of period 15

Please have a look at the Average Holding Value table now and make sure you understand it. Feel free to raise your hand if you have a question. When you feel comfortable with it, please go on and answer the following practice quiz:

PRACTICE QUIZ

1. Suppose it is period 10. How much will you get paid in total in subsidies on a share if you hold it for the remainder of the experiment?

ANSWER:

2. Suppose it is period 10. How much do you expect to receive in dividends on a share if you hold it for the remainder of the experiment?

ANSWER:

3. Suppose it is period 10. What is the average value of holding a share for the remainder of the experiment?

ANSWER:

Beginning the experiment. From now on your decisions will count toward your earnings, so please think carefully before making them.

Current Period	Number of Remaining Dividends	Average Dividend	Final Buyout Value	Number of Remaining Subsidy payments	Subsidy Amount in Current Period	Remaining Subsidies	Average Holding Value
1	15	0	40	8	0	80	120
2	14	0	40	8	0	80	120
3	13	0	40	8	0	80	120
4	12	0	40	8	0	80	120
5	11	0	40	8	0	80	120
6	10	0	40	8	0	80	120
7	9	0	40	8	0	80	120
8	8	0	40	8	10	80	120
9	7	0	40	7	10	70	110
10	6	0	40	6	10	60	100
11	5	0	40	5	10	50	90
12	4	0	40	4	10	40	80
13	3	0	40	3	10	30	70
14	2	0	40	2	10	20	60
15	1	0	40	1	10	10	50