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**EVALUATION PERIODS AND ASSET PRICES IN A  
MARKET EXPERIMENT**

By Uri Gneezy, Arie Kapteyn and Jan Potters

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**Discussion paper**

# Evaluation Periods and Asset Prices in a Market Experiment\*

Uri Gneezy

Faculty of Industrial Engineering & Management, Technion.

Email: Gneezy@ie.technion.ac.il

Arie Kapteyn

CentER, Tilburg University.

Email: kapteyn@kub.nl

Jan Potters

Department of Economics and CentER, Tilburg University.

Email: J.J.M.Potters@kub.nl

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## Abstract

We test whether the frequency of feedback information about the performance of an investment portfolio and the flexibility with which the investor can change it influence her risk attitude in markets. In line with the prediction of Myopic Loss Aversion (Benartzi and Thaler, 1995), we find that more information and more flexibility result in less risk taking. Market prices of risky assets are significantly higher if feedback frequency and decision flexibility are reduced. This result supports the findings from individual decision making, and shows that markets do not eliminate such behavior.

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# 1 Introduction

In February 1999 Bank Hapoalim, Israel's largest mutual funds manager, announced that it intends to change its information policy towards its client-investors. The basic idea was that the Bank would send information about the performance of its funds not every month as it used to, but rather only once every three months. The clients will still be able to check the performance every day if they wish, but if they do not, they will get the information less frequently than before. The bank expected investors to be more willing to hold assets in the mutual fund when they are less frequently informed about the evolution of fund prices. The bank's intuition is that "investors should not be scared by the occasional drop in prices".<sup>1</sup>

The bank's intuition corresponds closely to the concept of myopic loss aversion (MLA) advanced by Benartzi and Thaler (1995). MLA rests on the combination of two behavioral concepts. The first concept is loss aversion (Kahneman and Tversky, 1979), which refers to the tendency of individuals to weigh losses more heavily than gains. The second concept is mental accounting (Kahneman and Tversky, 1984), which refers to the (myopic) methods people employ to code and evaluate financial outcomes.

A well known example, due to Samuelson (1963), can best illustrate the effect of combining the two concepts. Samuelson asked a colleague whether he would be willing to accept a gamble in which there are equal chances to win \$200 and to lose \$100. The colleague declined this single gamble, but at the same time expressed a willingness to accept multiple plays of the gamble. Although such a preference may have much intuitive appeal, Samuelson proved a theorem, stating that if the single gamble is rejected at every relevant wealth position, then accepting the multiple gamble is inconsistent with expected utility maximization (see Tversky and Bar-Hillel, 1983, for further discussion).

On the other hand, Benartzi and Thaler show that such preferences may be consistent with MLA. To illustrate, suppose that the individual is loss averse and has a utility function  $u(z) = z$  for  $z > 0$  and  $u(z) = 2.5z$  for  $z \leq 0$ , where  $z$  is the change in wealth due to the gamble. Then, the expected utility of one gamble is negative:  $\frac{1}{2}(200) + \frac{1}{2}(-250) < 0$ . Hence, the individual will reject one gamble, and also two gambles if each one is evaluated separately. The same individual, however, accepts two gambles if (s)he evaluates

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<sup>1</sup>See e.g. Yediot Hachronot, February 16, 1999 (in Hebrew).

them in combination:  $\frac{1}{4}(400) + \frac{1}{2}(100) + \frac{1}{4}(-500) > 0$ . Hence, rejecting a single gamble while accepting two gambles is quite easily explained by the combined hypotheses of individuals being more sensitive to losses than to gains and evaluating the outcomes of the sequence of gambles in combination.

This combined hypothesis would also be consistent with the intuition of the Israeli bank. In the longer run the return on the mutual fund is likely to be larger than that on bonds or savings accounts. Occasionally, however, the return will be negative. When investors myopically evaluate their portfolio with each new piece of price information, they will be more likely to evaluate the mutual fund positively when the information arrives less frequently. The return on the investment is more likely to be positive - and larger than that on bonds - when the returns are based on a longer period and calculated in a more aggregate way.

Benartzi and Thaler (1995) do not advance MLA as a marketing tool to fund managers though, but as a potential explanation for the famous equity premium puzzle. This puzzle refers to the fact that, over the last century, the average real return of stocks in the United States has been about six percentage points per year higher than that of bonds (Mehra and Prescott, 1985). By considering the stochastic process that corresponds to the historical pattern of stocks and bond returns and choosing parameter values for the utility function and loss aversion parameter based on experimental evidence, Benartzi and Thaler found that the equity premium puzzle can be resolved if it is assumed that investors evaluate their portfolio about annually. Hence, apart from being useful to a fund manager, myopic loss aversion would seem to be a behavioral concept with the potential of explaining one of the most important puzzles in the finance literature.

Benartzi and Thaler's analysis is a purely theoretical one, but recently some experimental evidence in support of MLA has become available. For example, in Thaler et al. (1997), subjects allocate their investments to two funds, one with a relatively high mean and variance of returns (stocks) and one with a relatively low mean and variance (bonds). The experiment manipulates the evaluation period of the subjects. In a 'monthly' treatment, subjects make 200 investment decisions, each binding for one period, and are updated on returns after each period. In a 'yearly' treatment, subjects make 25 investment decisions, each binding for 8 periods, and are updated on (aggregated) returns after each 8 periods. In line with MLA, Thaler et al. find that subjects

in the yearly treatment hold significantly more assets in the risky fund than subjects in the monthly treatment. Barron and Erev (2000) and Gneezy and Potters (1997) obtain similar experimental results.

Although these experimental results provide some direct evidence for MLA, they are concerned with individual decision-making rather than market interaction. Each participant makes her own independent decisions but these have no effect on the decisions of other participants or *vice versa*. Stocks and bonds, however, are traded in markets. An essential feature of markets is that prices are determined by the marginal traders. As a consequence, individual violations of the standard expected utility theory (EUT) do not necessarily imply that market outcomes will violate EUT.<sup>2</sup> A small number of rational agents may be enough to make market outcomes rational. Another important issue is that market interaction will affect individuals' experience and information feedback. The learning process in repeated individual decision tasks will be different from the learning process in repeated market interaction. Traders can learn from observing the choices of other traders and from the information contained in prices. Hence, there are a number of reasons to question whether phenomena that are observed in individual decision making will carry over to market interaction.

The current paper aims to test whether the effects of MLA will also show up in a competitive environment. In particular, we set up markets in which traders adjust their portfolio by buying and selling a risky financial asset. In the 'high frequency' treatment, traders commit their investment for one period, and are informed about the assets' return after each period. In the 'low frequency' treatment, they commit their investment for three periods, and are informed about the assets' return only after three periods.

We find that prices of the risky asset in the low frequency treatment are significantly higher than in the high frequency treatment. These results are in line with the results of the individual choice experiments. Investors are more willing to invest in risky assets if they evaluate the consequences in a more aggregated way. In our market experiment this shows up in a positive effect on prices.

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<sup>2</sup>Enke (1951) provides the classic argument for why the assumption of rationality may be a good approximation of behavior of agents in markets, but not necessarily of the description of individual behavior. See Camerer (1992) for a more comprehensive discussion of the potential of markets to correct anomalous individual behavior in experiments.

## 2 Experimental design and procedure

We set up a market in which 8 participants can trade units of a risky asset in a sequence of 15 trading periods. Each unit of the asset is a lottery ticket which, at the end of a trading period, pays 150 cents with probability  $\frac{1}{3}$ , and 0 cents with probability  $\frac{2}{3}$ . At the beginning of each period, a trader is endowed with a cash balance of 200 cents and 3 units of the asset. If a trader buys a unit, the price is subtracted from her cash balance, and one unit of the asset is added to her portfolio. If a trader sells a unit, the price is added to her cash balance and a unit is subtracted from her portfolio.

At the end of the period, the asset expires and its value is revealed through a lottery. Traders' earnings for the period are then equal to:  $200 + [\text{prices received from units sold}] - [\text{prices paid for units bought}] + [\text{number of units in portfolio at the end of the period}] \times [\text{value of the asset (0 or 150) as determined by the lottery}]$ . These earnings are then transferred to the traders' accumulated earnings, and the next period starts with each trader again having a portfolio consisting of 200 cents in cash and 3 units of the asset. Traders cannot use accumulated earnings from earlier rounds to buy assets.

The crucial feature of our design is that we have two different treatments. In the 'high frequency' (*H*) treatment, the market opens in each of the 15 periods of the experiment, and in each period traders can adjust their portfolio by buying and selling units, as described above. At the end of each period, traders are informed about the realized value of the asset for that period, and then the next period starts. In the 'low frequency' (*L*) treatment, the market opens for trading only in the first period of a block of three periods, that is, trading takes place only in periods 1, 4, 7, 10, and 13. In each of these trading periods, units are traded in blocks of three. That is, if a unit is bought (sold) at a particular price in period  $t$ , then also a unit is bought (sold) at that same price in periods  $t+1$  and  $t+2$ . Hence, traders fix their asset holdings for three periods. After trading period  $t$  is over (with  $t = 1, 4, 7, 10$  or  $13$ ), three independent draws determine the values of the units in periods  $t, t + 1$  and  $t + 2$ , respectively. Traders are informed about the three realized values simultaneously. For example, they may learn that the values of the asset in the three periods are 0, 0 and 150, but these three values are not explicitly assigned to a particular period.

The basic idea behind the two treatments is to manipulate the period over which par-

ticipants evaluate outcomes, in almost exactly the same way as in the individual choice experiments of Thaler et al. (1997) and Gneezy and Potters (1997). Since the frequency of portfolio adjustment and information feedback is lower in treatment  $L$ , the participants in this treatment can be expected to evaluate the financial consequences of holding units in a more aggregated way than the participants in treatment  $H$ , who are induced to evaluate and adjust their asset holdings every period. If agents are myopic, the horizon in treatment  $L$  may be three periods, whereas in treatment  $H$  it will be one period. As we will argue next, such myopia induces loss averse traders to be less willing to hold assets, and leads to lower prices of the risky asset in treatment  $H$  than in treatment  $L$ .

To simplify matters, suppose for a moment there are only three periods, and in each period one asset can be bought. At the end of a period, the asset expires and pays 0 with probability  $\frac{2}{3}$  and 150 with probability  $\frac{1}{3}$ . Suppose a trader is characterized by a utility function  $u(z) = z$  for  $z > 0$  and  $u(z) = \lambda z$  for  $z \leq 0$ , where  $z$  is the change in wealth. We assume that  $\lambda > 1$ . Assume that the asset trades at a price  $p$ , with  $0 < p \leq 50$ . If the trader evaluates the purchase decision for each period separately, then with  $0 < p \leq 50$  she will be indifferent between buying and not buying an asset in a period if  $\frac{1}{3}(150 - p) + \frac{2}{3}\lambda(-p) = 0$ , that is, if  $p_H = \frac{150}{1+2\lambda}$ . Now assume the trader evaluates the investment in the asset over the three periods in combination, that is, she considers to buy an asset either in all three periods or in none of the periods. Then, with  $0 < p \leq 50$ , (s)he will be indifferent between buying and not buying an asset in each period if  $\frac{1}{27}(450 - 3p) + \frac{6}{27}(300 - 3p) + \frac{12}{27}(150 - 3p) + \frac{8}{27}\lambda(-3p) = 0$ , that is, if  $p_L = \frac{1350}{19+8\lambda}$ . Figure 1 shows  $p_H$  and  $p_L$  as functions of  $\lambda$ .

The steepest curve is the graph of  $p_H$ . Note that  $p_L > p_H$  if and only if  $\lambda > 1$ . The basic reason for this effect is that the probability that a loss will be experienced is larger when the investments are considered in isolation ( $\frac{2}{3}$ ) than when they are considered in combination ( $\frac{8}{27}$ ). Thus, loss averse traders are more willing to buy the risky asset if they evaluate the financial consequences in a more aggregated way. This will have an upward effect on the demand for the asset, and, as a consequence, the asset's price will be higher. Hence, to the extent that our two treatments are successful in manipulating the 'mental accounting' of the traders, MLA would predict higher prices in treatment  $L$  than in treatment  $H$ . It is this basic prediction of MLA that we set out to test in our market experiment.

It is of interest to compare this with the predictions of standard expected utility theory. Intuitively, one would expect more flexibility to lead to more risk taking. For the present context, a proposition proved by Gollier, Lindsey, and Zeckhauser (1997) is relevant. Specialized to the present context, the proposition implies that whenever an investor who is restricted to fix his portfolio for several periods prefers to buy the risky asset in the first period, then surely the investor will buy the risky asset in the first period (at the same price) if he has the flexibility to adjust his portfolio over time. Hence, according to expected utility theory we should expect the market price of the asset in the first period to be at least as high in treatment  $H$  as in treatment  $L$  ( $p_H \geq p_L$ ).

Ten experimental sessions were run, five for each treatment. The experiment was conducted using the computerized labs of Tilburg University (two sessions in each treatment) and the University of Amsterdam (three sessions in each treatment). Eight subjects participated in each session, except for one session in which we had 7 traders. No subject participated more than once. Undergraduate students were recruited as subjects through announcements in class and in the university newspaper.

Upon entering the lab, a short standard type introduction was read by the experimenter to the subjects. Then, by drawing table numbers the subjects were randomly seated behind computer terminals, separated by partitions. Instructions (see appendix) were then distributed and read aloud. After that, subjects could examine the instructions more carefully and privately ask questions. During the experiment, all amounts were denoted in cents (with 100 cents equal to 1 Dutch guilder).

Trading took place according to standard double auction rules. Traders could submit bids to buy and asks to sell. All traders were instantaneously informed about all bids and asks submitted to the market. At any time during a trading period traders could decide to buy at the lowest ask or to sell at the highest bid. When a unit was traded, the accepted offer was withdrawn from the market and all traders were informed that a trade had occurred at that price. Units traded one by one, that is, all price offers were for one unit only. Traders could submit as many offers to the market as they liked, and sell and buy as many units as they liked. However, traders could not sell when they had no units in their portfolio, and they could not buy when their cash balance was insufficient. Also an individual offer improvement rule was enforced, requiring a new



ask (bid) price to be lower (higher) than that trader's standing ask (bid).

A trial period in which participants could practice with the market rules was held before the 15 periods of the experiment were started. A trading period lasted three minutes in the  $H$  treatment and four minutes in the  $L$  treatment<sup>3</sup>. At the end of each trading period a lottery was conducted. To determine whether the asset paid 0 cents or 150 cents in a period, we used a box containing three disks: two blacks and one white. The outcome of the lottery was determined by drawing one disk out of the box. If the disk drawn was black, the value of all units for that period was 0, and if it was white the value was 150 cents. The disk drawn was shown to the participants and the value was entered in the computer. In treatment  $L$  the value of the asset must be determined for three consecutive periods. For that we used three boxes, each containing two black disks and one white disk. One disk was drawn from each of the boxes, and these three disks determined the values of the units in the three periods. Participants were informed about the realization of the three lotteries simultaneously and without indicating which draw corresponded to which period. After the value of the units was determined, subjects' earnings for the previous period (previous three periods) were determined. Then the next trading period started. At the end of period 15, subjects were privately paid their total earnings. Earnings averaged 65 Dutch guilders, which at the time of the experiment (May-June 1997) was about \$35.

### 3 Results

Figure 2 gives a complete picture of the transaction prices in each of the 10 sessions of our experiment. Remember that, by design, trading in treatment  $L$  takes place for blocks of three rounds 1 – 3, 4 – 6, 7 – 9, 10 – 12 and 13 – 15. It can be seen that the prices fluctuate rather wildly in the early rounds of some of the sessions. See in particular session 4 (treatment  $L$ ) and session 9 (treatment  $H$ ). Furthermore, some extreme prices can be observed. In the early rounds, prices range from a low of 20 to a high of 150. Clearly, some subjects have to learn the (expected) value of holding assets. As a result,

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<sup>3</sup>Treatment  $L$  had 5 trading periods, whereas treatment  $H$  had 15. We extended the trading time in the  $L$  treatment by one minute in order to make the total time for a session in the two treatments more similar. It is clear from the data that three minutes was more than enough for all the intended trades to be completed without any time pressure.

they may initially buy at too high a price or sell too low. In most of the sessions prices stabilize fairly quickly though.

Testing the basic hypothesis (MLA:  $p_H < p_L$ ) is a straightforward exercise. We simply compare the transaction prices of the asset for the two treatments. Figure 3 gives the evolution of average prices over the rounds for each of the treatments. Note that by the design of treatment  $L$ , prices are constant within blocks of three rounds. Table 1 contains the relevant data and statistical tests. For each block of three rounds, average prices are presented for treatment  $H$  and treatment  $L$ , respectively. The final row presents the average transaction price across all rounds.

Table 1: Average Price per Block of Three Rounds<sup>a</sup>

rounds	Treatment $H$	Treatment $L$	Mann-Whitney $p^b$
1-3	49.7 (9.4)	60.4 (16.6)	0.06
4-6	48.6 (5.8)	57.6 (10.3)	0.06
7-9	48.9 (3.7)	56.8 (5.4)	0.01
10-12	49.3 (2.4)	57.6 (3.0)	0.03
13-15	50.1 (2.2)	59.6 (3.4)	0.01
all rounds	49.3 (4.7)	58.4 (7.7)	0.01

<sup>a</sup> Standard deviations in parentheses. Averages and standard deviations are calculated first over the transaction prices within a round and then averaged over the rounds and sessions.

<sup>b</sup> Two-tailed significance levels with the 10 session data as units of observations.

The results display a clear treatment effect in the direction predicted by MLA. In all rounds, average transaction prices are lower in treatment  $H$  than in treatment  $L$ . Across all rounds the asset's average price is 49.3 in treatment  $H$  and 58.4 in treatment  $L$ . This difference is significant at  $p = 0.02$  with a nonparametric two-tailed Mann-Whitney U-test, taking the 10 session averages as units of observation. The table also shows that the average standard deviation of prices is smaller in treatment  $H$  (4.7) than in treatment  $L$  (7.7). This difference is not significant though ( $p = 0.33$ ) due to substantial differences in the variability of prices across sessions (see Figure 2).

Apart from the difference in average prices, the aggregate data are very similar across the two treatments. Table 2 presents some further statistics. The first row displays the average realized value of the asset. On average the traders in treatment  $H$  were a bit more lucky with an average asset value of 58.0 compared to Treatment  $L$  where the average asset value was 48.0. The difference is not statistically significant though. The second row indicates that the average number of assets traded per round per trader is almost identical for the two treatments. Hence, our manipulation only affected the price level and not the average willingness to trade. Also the post-trade distribution of assets across traders is very similar for the two treatments. For example, for each session we computed the standard deviation of the asset holdings across traders. The third row of table 2 indicates that these standard deviations are almost identical for the sessions in Treatment  $H$  and those in Treatment  $L$ . Also the average range of final allocations is similar across the two treatments. Typically, in each session there is at least one trader that sells all three of his or her initial assets, and a trader that buys as many assets as he or she can afford, giving a range of allocations of about 6.. The range is somewhat larger in Treatment  $H$  since the assets are somewhat cheaper here. Some traders manage to buy four additional assets with their initial money endowment of 200 cents.

Table 2: Asset value, Number of traders, and Allocations

	Treatment $H$	Treatment $L$	Mann-Whitney $p^a$
Asset value	58.0	48.0	0.55
Trades per round per trader	2.23	2.18	1.00
Standard deviation of allocations	2.54	2.31	0.22
Range of allocations	6.33	5.88	0.10

*a* Two-tailed significance levels with the 10 session data as units of observation.

In conclusion, the results support the hypothesis ( $p_H < p_L$ ) advanced by myopic loss aversion. Prices of the risky asset are significantly higher when the market induces traders to evaluate the financial consequences in a more aggregated way, i.e. over a longer period of time.

## 4 Discussion

There is one empirical fact in our data that seems incongruous with myopic loss aversion, namely that the average price of the asset in treatment  $L$  is above its expected value of

50. This suggests that subjects are risk seeking, whereas loss aversion, at least in the simple representation that we advanced above, implies risk aversion. An observation of asset prices above their expected value is quite common in experimental markets, however. For example, Knez et al. (1985) find an average price of about 1.40 for a one-period asset with an expected value of 1.25. Similar degrees of "over-pricing" are reported in Rietz (1998), Sarin and Weber (1993), and Weber et al. (2000). Generally, the simple explanation that subjects are risk-seeking fails on a number of other accounts. Therefore, several other explanations have been advanced. One possibility is the presence of an endowment effect, which makes traders more reluctant to sell than they would be on the basis of a strict evaluation of financial gains and losses. As noted by Weber et al. (2000) predictions will much depend on whether cash endowments and asset endowments are coded jointly or separately and on the location of the reference point(s). Another possibility is that traders attach some value to the excitement of owning an asset (see Conlisk, 1993). Such a "utility of gambling" would also have an upward effect on prices. Yet another related possibility is that some traders are overconfident in predicting the asset's realization, and put too much weight on the probability that the asset will give a positive value (see Barber and Odean, 2000). In this paper we cannot and do not wish to argue for or against any of these factors. They simply underline that we do not have a generally accepted or parsimonious behavioral theory of financial decisionmaking.

The important question of our investigation is whether and in what direction asset prices are affected by a manipulation of the information feedback and the flexibility of portfolio adjustment. Our results provide strong evidence that more information feedback and more flexibility **reduce** the price of a risky asset. These results are in line with the findings from individual decision making experiments. They illustrate that intertemporal framing effects matter, not just for individual decisionmaking, but also in market settings.

Expected Utility Theory predicts that traders will generally like an asset better if they can adjust their holdings in it more flexibly (Gollier et al. 1997). Myopic Loss Aversion, on the other hand, predicts that traders will like an asset better if they evaluate its return in a more aggregated way (Benartzi and Thaler, 1995). The direction of the price effect we find is in line with the prediction from MLA, and opposite to the one from EUT. At the same time, it is clear that MLA can only be a first step toward a behavioral theory of (intertemporal) framing issues in financial decisionmaking. For example, it is not trivial to explain the overpricing that we and others observed. Furthermore, Langer and

Weber (2000) outline conditions under which a longer evaluation period leads to less risk taking. Yet, we believe that the importance of this ongoing debate is strengthened by our finding that these framing issues do not simply disappear in a competitive environment. Clearly, there remains room for further research into the mechanism and the conditions which trigger an increase in risk taking if feedback or flexibility is reduced. The economic significance of the phenomenon should be evident, however. The equity premium puzzle or the communication strategy of funds managers (like Bank Hapoalim, mentioned in the introduction) are only two out of a myriad of examples where risk taking, flexibility and information provision interact. Other examples would include the trade-off between flexibility and interest paid on bank deposits, the risk profile of individual portfolios, or the choice of investment projects. The fact that the nature of the interaction between risk taking, flexibility and information provision is different from what received economic theory would predict affects both economic analysis and financial advice based on these models.

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## Appendix: Instructions

(Translation from Dutch with text for treatment L in square brackets.)

### Preliminary

This is an experimental study of market decision making. The instructions are simple and if you follow them carefully, you may earn a considerable amount of money. The money you earn will be paid to you, privately and in cash, immediately after the experiment. We will first go through the instructions together. After that, you will get the opportunity to study the instructions at your own pace, and to ask questions. Then we will have a practice round, before we start the experiment.

### The market

In a few moments you will be a trader in a market. The market will consist of 15 successive rounds. In the market there will be trading in so-called **units** (of a virtual security). These units all have the same value. This value, however, will be determined and announced only at the end of the round, after the trading has stopped. With a chance of  $\frac{1}{3}$  (33%) the value of each unit will be Dfl. 1.50 (150 cents), and with a chance of  $\frac{2}{3}$  (67%) this value will be equal to Dfl. 0.00 (0 cents). How this value is determined, will be explained later.

At the beginning of each round you will start with a certain **starting-portfolio**, which consists of a number of units and a money balance. Every participant knows her or his own starting-portfolio, but not that of the other participants. Your starting-portfolio may be identical to that of other participants, but it may also be different. However, your starting-portfolio will be identical in each of the 15 rounds.

As soon as a round has started you can try to **sell** units, or you can try to use your money balance to **buy** units. If you sell a unit, the price you receive will be added to the money balance in your portfolio and the number of units in your portfolio is reduced by one. If you buy a unit, the price you pay is deducted from the money balance in your portfolio and one unit is added to your portfolio.

Your resulting earnings in a round are equal to:



the money balance in your starting portfolio  
 + the prices you receive for units sold  
 – the prices paid for units bought  
 + number of units in your portfolio at end of round x value per unit (0 or 1.50)

## Buying and selling

Buying and selling of units on the market will be processed by means of the computer. All relevant information will be available on your computer screen. You can now see what this screen will look like.

In the top left you can see what your total earnings are up to that moment. Also you can see the number of the round we are in and the time left for trading in that round. In each round the total time for trading is 3 minutes [4 minutes].

In the middle part of the screen you will see two columns with the current asks- and bids. Each ask price in the column indicates that someone is prepared to sell one unit at that price. Each bid price in the column indicates that someone is prepared to buy one unit at that price. Both ask- and bid prices will be ordered from high to low. Your own ask and bid prices are indicated with an asterisk.

If you want to buy a unit you can do two things. (1) You can press *P* (purchase). You then buy one unit at the lowest ask price that is in the column at that moment. (2) You can press *B* (bid) and enter a bid price at which you are prepared to buy a unit. If your bid price is the lowest in the column, then you have a chance that someone is prepared to sell at that price and will accept your bid price.

Also if you want to sell a unit you can do two things. (1) You can press *S* (sell). You then sell one of your units at the highest bid price that is in the queue at that moment. (2) You can press *A* (ask) and enter an ask price at which you are prepared to sell one unit. If your ask price is the lowest in the column, then you have a chance that someone is prepared to buy at that price and will accept your ask price.

At the bottom of the screen you see a row in which the prices of all the traded units will be indicated. So everyone can see how many units have been traded up to that moment

and at which prices. However, you cannot see which participants have bought or sold units.

The box on the right of your screen displays information about your portfolio. At the top your starting-portfolio is indicated, consisting of a certain money balance and a number of units. Then you see a list of the units that you have bought or sold and at what price. At the bottom of the box you can see what your current portfolio looks like. Each time you sell a unit, the price is added to your money balance and one unit is deducted from your portfolio. Each time you buy a unit, the price is deducted from your money balance and one unit is added to your portfolio.

### Restrictions

You can buy and sell as many units as you want. There are a number of restrictions, however.

- (1) You cannot sell a unit if your portfolio does no longer contain any units.
- (2) You cannot buy a unit if your money balance does not suffice to pay the price.
- (3) When buying units you cannot use money that you have earned in previous rounds.
- (4) You cannot withdraw ask and bid prices once they are entered!
- (5) If you want to enter a bid price, then it must be higher than your previous bid price. If you want to enter a new ask price, then it must be lower than your previous ask price.

[Finally, there is the following important restriction. Although the experiment consists of 15 rounds, there will be trading in rounds 1, 4, 7, 10 and 12 only. By buying and selling units in a round with trading, you determine your portfolio for that round, but also for the subsequent two rounds. In other words, you always fix your portfolio for three rounds. This means that your portfolio at the end of round 1 (consisting of a money balance and a number of units) will be identical to your portfolio at the end of round 2 and round 3. In rounds 2 and 3 there will be no trading. This means that if you buy (or sell) a unit at a certain price in round 1, you also buy (or sell) a unit at that same price in rounds 2 and 3. Thereafter, your trading in round 4 determines your portfolio in rounds 4, 5 and 6. And the same will happen for rounds 7-8-9, 10-11-12, and 13-14-15. Yet, the value of the units (0 or 1.50) will be determined separately for each round, also within each block of three rounds. ]

## The value of the units

At the end of a round each unit has the same value. After the time for trading is over, this value will be determined as follows. The assistant has a can with three disks. Two of the disks are black; one is white. At the end of the round the assistant will first fill the can with the three disks, and then randomly draw one disk. If the disk drawn is black (chance  $\frac{2}{3}$ ), then the value of all units in that round is 0; if the disk drawn is white (chance  $\frac{1}{3}$ ), then the value of all units in that round is 1.50. Your earnings in a round will thus be equal to the money balance in your portfolio at the end of the round plus the total value of the units in your portfolio.

[ As explained, in a trading round you fix your portfolio for the next three rounds. Therefore, at the end of the trading round, three times the assistant will draw a disk from a can containing two black and one white disk. The colors of the three disks drawn determine the values of the units in the ensuing three rounds. Each white disk drawn implies that in one of the three rounds the value of the units is 1.50; each black disk drawn implies that in one of the three rounds the value of the units is 0. ]

## Summary

The experiment consists of 15 rounds. In each round you start with a portfolio consisting of a certain number of units and a certain money balance. You can alter your portfolio by buying and selling units. You can try to buy units by entering a bid price (press *B*) and sell units by entering an ask price (press *A*). Also you can buy by accepting the lowest ask price (press *P*) and you can sell by accepting the highest bid price (press *S*).

[ The market is open for trading only in rounds 1, 4, 7, 10 and 12. If you buy or sell a unit in one these five rounds, then you also buy or sell a unit in the subsequent two rounds. Hence, you always fix your portfolio for three consecutive rounds. ]

All units have the same value in a round. With a chance of  $\frac{1}{3}$  (33%) this value is equal to 1.50 and with a chance of  $\frac{2}{3}$  (67%) this value is equal to 0. This value is determined at the end of the round when the assistant draws one disk from a can containing one white and two black disks.

The total value of the units in your portfolio is added to the money balance in your portfolio and determines how much you earn in that round. At the end of the experiment, your earnings per round are added and determine how much you earn for your participation.

#### Final remarks

At the end of today's meeting, you will be called by your table number to collect your earnings one by one, privately and in cash. Your earnings are your own business; you do not have to discuss them with anyone.

It is not allowed to talk or communicate with other participants in any way during the experiment. If you have a question, please raise your hand, and I will come to your table to answer your question. If you have any remarks about the experiment or about your decisions, please use the form labelled "REMARKS" that is on your table.

$B$  = enter a Bid price       $P$  = Purchase at lowest ask price  
 $A$  = enter a Ask price       $S$  = Sell at highest bid price

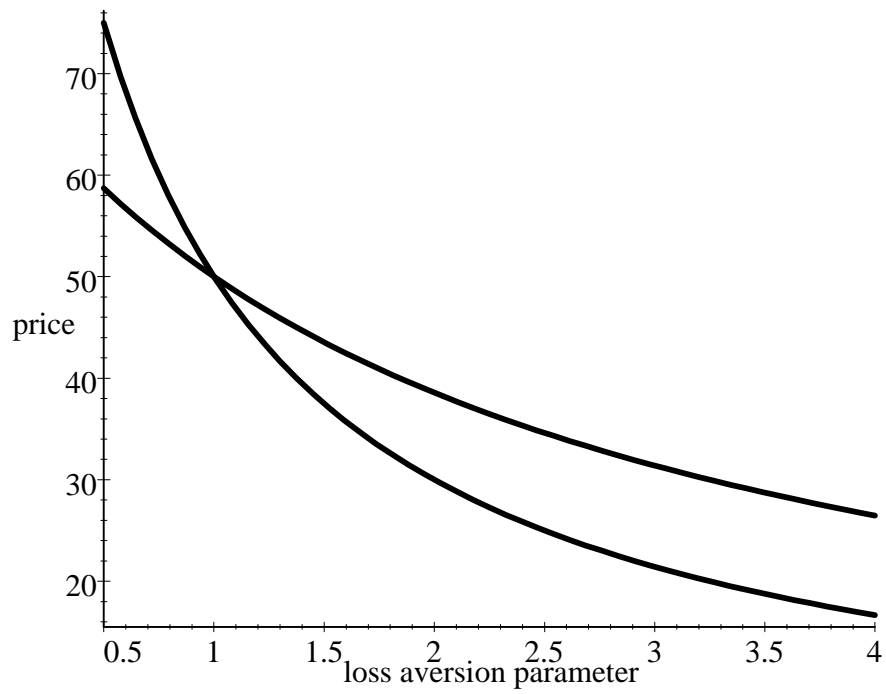


Figure 1: Equilibrium prices as a function of the loss aversion parameter

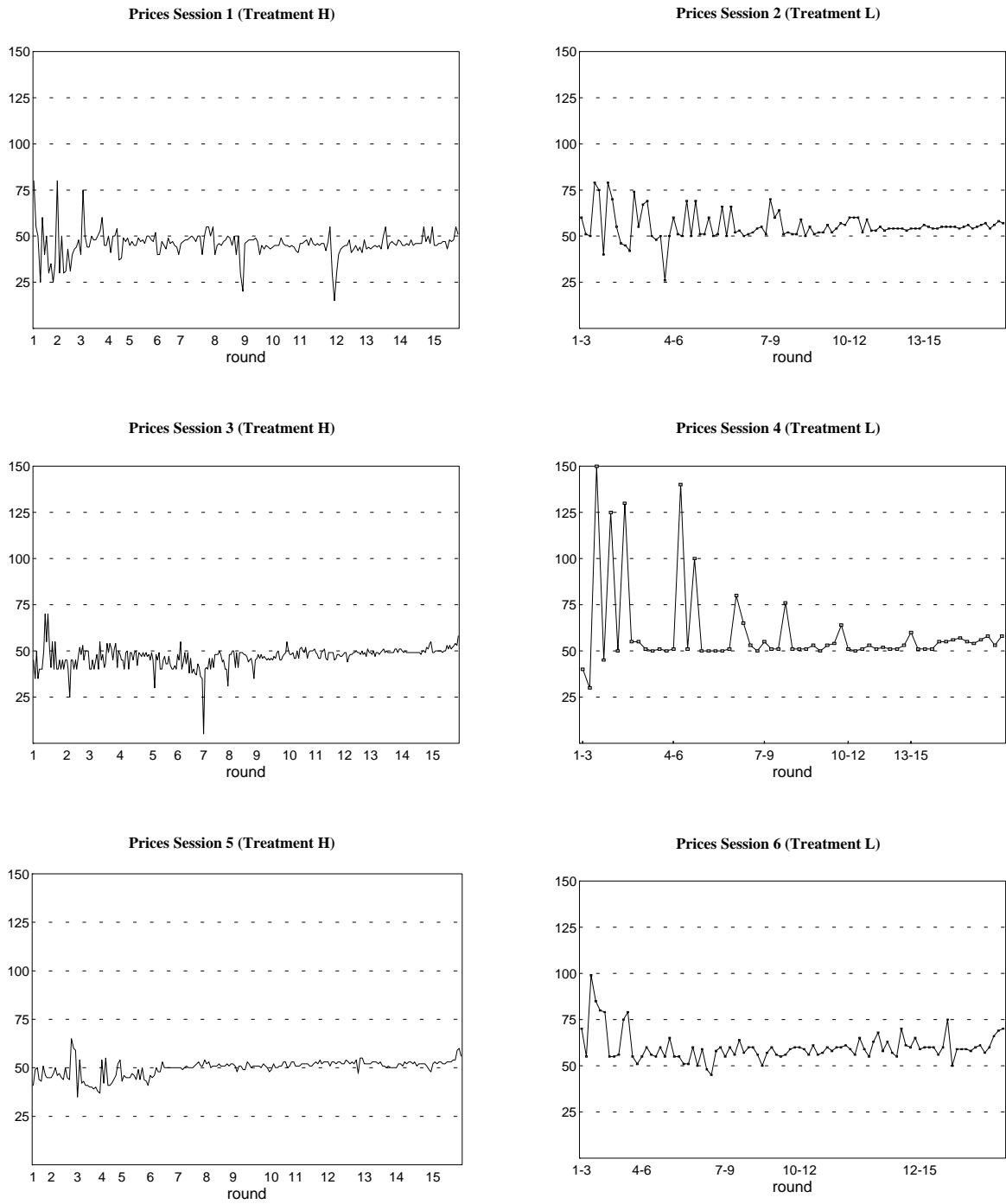


Figure 2 Transaction prices in each of the sessions

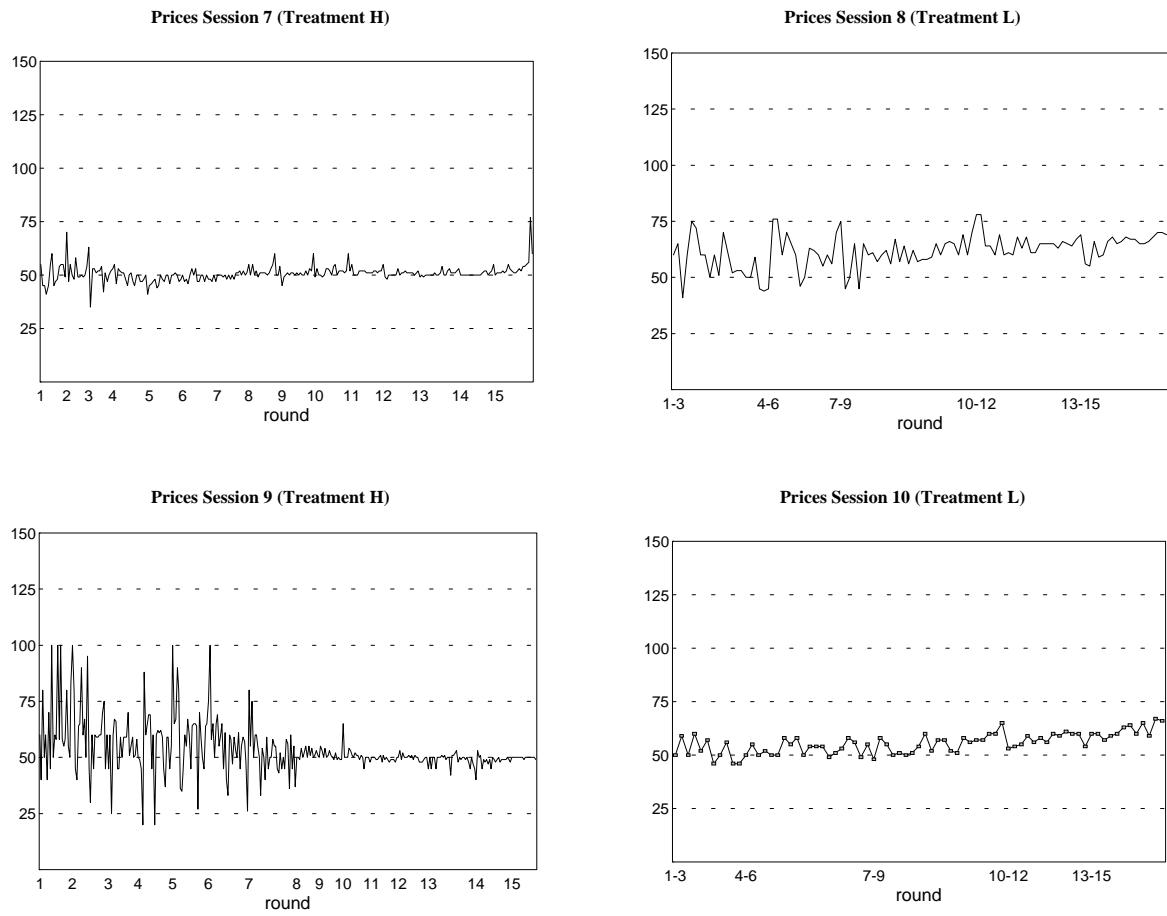


Figure 2 (cont'd). Transaction prices in each of the sessions

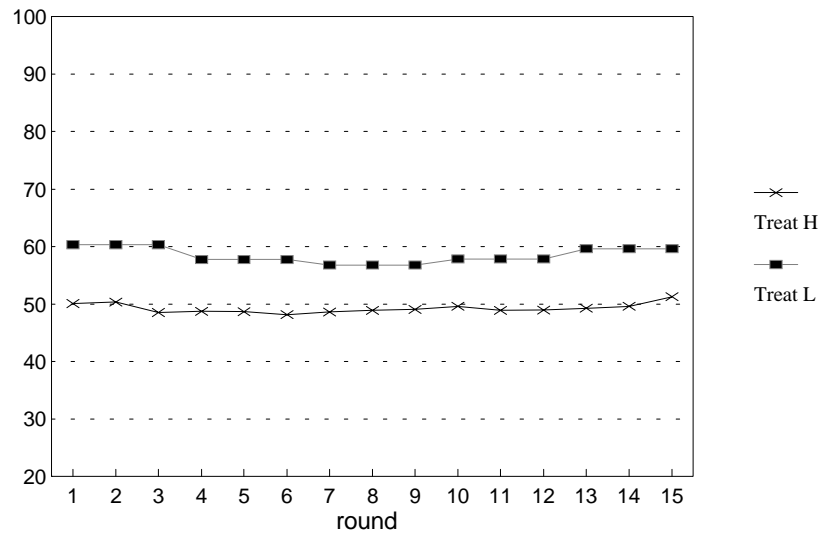


Figure 3. Average prices per round for each treatment