The impact of endowment framing on market prices — an experimental analysis

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Abstract

Framing effects are well known in individual decision making. Using experimental markets we investigated whether similar effects could be found in a market environment. Two series of experiments showed that negative framing can give different market prices than a positively framed endowment. We also found that volume may be affected by the framing of the endowment. ©2000 Elsevier Science B.V. All rights reserved.

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In individual decision making it is widely believed that risk attitude in the domain of losses may differ from that in the domain of gains: put in a short position (loss frame) people tend to be risk seeking; put in a long position (gain frame) people tend to be risk averse (Kahneman and Tversky, 1979) 1 . Using prospect theory 2 the observed choices can be explained by loss aversion. This difference in behavior implies that people’s choices are sensitive to the framing of decision problems. This paper will experimentally investigate if these framing effects found in individual decisions are reflected in market prices for risky assets and, in addition, if these effects influence trading volume.

Recently, there have been several experimental studies investigating how individuals’ deviations from expected utility theory might impact upon other economic settings. These experimental studies have included behavior in games and in the face of public good problems. In relation to experimental markets, Camerer (1987); Camerer et al. (1989) and Sarin 3

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1 Tversky and Kahneman (1986) present various additional examples; see also Hershey and Schoemaker (1980) and Johnson et al. (1993).


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and Weber (1993) found effects of certain biases on those markets, while Kahneman et al. (1991); Franciosi et al. (1996); Myagkov and Plott (1997) and Borges and Knetsch (1998) investigated the endowment effect. The present paper focuses particularly on the effects on market behavior of the different ways in which endowments may be framed.

To address this question, we ran two experiments (described in more detail in subsequent sections) where subjects traded simple risky assets. In Experiment I, we varied the framing of the initial endowment, while keeping the value of that endowment constant in terms of final wealth. In one condition, subjects’ endowments were framed as losses; in the other condition, they were framed as gains. We observed the effect of the different frames on market prices for the risky assets. In Experiment II, we endowed subjects with different initial positions. We put subjects in long, riskless and short positions which were identical in expected value. Here, we looked for any effects of endowment on risk attitudes, as reflected in market prices.

Besides examining effects on behavior in these markets, we believe our study has more general implications for experimental methodology. In quite a number of market experiments, subjects are endowed with a certain number of assets and cash. Whether the nature of this endowment, or the way the endowment is framed, affects the results is often not considered: instead, it seems to be taken for granted that the market price will operate as if there are no such effects — or at least, as if they play no significant role. As will be seen below, our results raise serious doubts about any such assumptions.

The paper is organised as follows. In Section 1 we present our hypotheses and the experimental design of Experiment I. The results are presented in Section 2. Hypotheses and design for Experiment II are presented in Section 3 and the results are given in Section 4.

1. Hypothesis and design of Experiment I

1.1. Experimental asset markets

Our experiment was run as a double auction computer market using the software system MUDA. In a standard double auction, at the beginning of each trading round subjects are given some amount of cash and/or some assets to be traded in the market. During trading, subjects can announce bids or asks, subject to the requirement that a subsequent bid (ask) has to be larger (smaller) than the bid (ask) before. If a bid is equal to an ask, or if a trader accepts someone’s bid or ask, a transaction takes place at that price, and the whole procedure starts over again. Notice that each trader can buy and/or sell assets.

In general, there are two different types of market experiments. In one type, asset values are induced by the experimenter. Such studies are often used to establish the properties of the market institution under consideration. In the other type of market experiment, traders have

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1 See, for example, Camerer (1987); Camerer et al. (1989) and Sarin and Weber (1993). For an overview see Camerer (1992).
2 We thank Charles Plott for providing us with the MUDA program. For a description of MUDA see Plott and Gray (1990).
3 See Smith (1982) and Davis and Holt (1993), chapter 3.
to decide upon their own value(s) for the asset(s) being traded, and then trade on differences in information and/or differences in preferences. Studies on bubbles, information mirages or insider detection fall into this category. The experiments reported in this paper also belong to this category.

1.2. Hypothesis

In our study, subjects traded simple state contingent claims (lotteries). We consider two mutually exclusive states $S_1$ and $S_2$. Simple two state lotteries are defined where each lottery pays a given sum of money if the one state occurs and nothing if the other state occurs. The lottery $L_1$ which pays DM $x$ in state $S_1$ and nothing in state $S_2$ is denoted by $(p(S_1), \text{DM } x; p(S_2), \text{DM 0})$, and the lottery $L_2$ which pays nothing in state $S_1$ and DM $x$ in state $S_2$ is denoted $(p(S_1), \text{DM 0; } p(S_2), \text{DM } x)$. As $S_1$ and $S_2$ are defined on complementary states, owning both lotteries $L_1$ and $L_2$ is identical to having DM $x$ for sure. Therefore, the market price for the sum of both lotteries has to be equal to DM $x$. It follows immediately that the equilibrium price of each lottery has to be equal to its expected value, i.e. the ratio of prices should be equal to the ratio of probabilities of the states.

Up to this point we have not considered the initial amount of cash and risky assets with which subjects were endowed at the beginning of each trading round. In one condition, our traders received some amount of cash plus some amount of positively valued risky assets, i.e. they were put in a long position (also called a positive frame). In the other condition, they began with a larger cash sum together with some state contingent liabilities, i.e. they were put in a short position (also called a negative frame). In both conditions, initial endowments were identical in terms of final wealth, differing only in the way in which they were framed. This type of framing is well known in individual decision making under risk. Recall the following two problems in Tversky and Kahneman (Tversky and Kahneman, 1986, p. S258), which are identical in terms of final wealth and show strong framing effects.

“Assume yourself richer by US$ 300 than you are today. You have to choose between:
A sure gain of US$ 100 (72%) and
50% chance to gain US$ 200 and 50% chance to gain nothing (28%)”.

“Assume yourself richer by US$ 500 than you are today. You have to choose between:
A sure loss of US$ 100 (36%) and
50% chance to lose nothing and 50% chance to lose US$ 200 (64%)”.

Individual decision experiments such as the one above suggest that framing matters in risky choice. The question is whether analogous behavior occurs in valuation and trading tasks undertaken in market contexts. Rietz (1993) provided some indications when he reported a market experiment using a double oral auction to trade lotteries, where he observed

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7 At the time of the experiment the exchange rate was about DM 1.60 to US$ 1.
8 See Rietz (1993) for a proof of this statement. Note, that the aggregate endowment needs to be fixed for these relations to be true.
9 Kühberger (1997) provides a meta-analysis on framing effects using a data pool of 136 empirical papers.
prices that were slightly above the expected value, so that the sum of prices for a pair of complementary claims added up to more than DM \( x \). We will refer to this phenomenon as *overpricing*. The Rietz experiment involved markets where initial endowments were all positively framed. We shall see whether his result replicates in our positively framed markets, but more importantly we will investigate whether overpricing increases for negative frames. Larger overpricing means that assets have to be traded more above their expected value, thus implying a shift towards greater risk seeking behavior, which is the kind of shift observed in many choice experiments. This leads to our first hypothesis:

**Hypothesis 1.** The sum of prices of lotteries \( L_1 \) and \( L_2 \) will be larger than DM \( x \) in both frames. Overpricing will be stronger for endowments which are negatively framed than for those which are positively framed.

### 1.3. Design

In Experiment I the following two types of assets were traded:

- **Yellow:** the asset pays 100 units if a yellow ball is drawn from a specific urn and nothing otherwise.
- **White:** the asset pays 100 units if a white ball is drawn from a specific urn and nothing otherwise.

Both lotteries were resolved by drawing one ball out of an urn which was known to contain 15 yellow and five white balls. Yellow assets with an expected value equal to 75 units were traded in Market 1, and white assets with an expected value equal to 25 units were traded in Market 2.

In order to test Hypothesis 1, we ran two series of sessions. In one series of six identical sessions, denoted by \( I^+ \), all subjects’ endowments were positively framed; in the second series of six identical sessions, denoted by \( I^- \), all endowments were negatively framed. Experiments of Type \( I^+ \) and \( I^- \) only differed in the framing of the endowment, as follows.\(^{10}\)

At the beginning of each round, subjects in Experiment \( I^+ \) were endowed with a certain amount of cash and a positive number of assets. We had two different types of traders labelled Type A and Type B. Subjects were randomly assigned to each type so that half of the traders were of each Type. The endowments of each type can be seen in Table 1.

The six sessions \( I^- \) only differed from \( I^+ \) in the framing of the endowment. Table 2 gives the endowments for Experiment \( I^- \). The endowment of Type A, for example, consisted of 700 units in cash and three assets of Yellow and a short position of three assets in White thus

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\(^{10}\) Experiment \( I^+ \) and Experiment \( I^- \) can be regarded as two treatments within Experiment I.
being equivalent to a position of 400 units in cash and six assets in Yellow (= endowment of Type A in Experiment I+).

Subjects understood that if they had a short position of, for example, two White assets, they could reduce or enlarge the (short) position by buying or selling White assets. If at the end of the round a subject had a short position of, say, −2 Whites and a white ball was drawn, the subject would have to pay 200 units to the experimenter.

All sessions in Experiment I consisted of two trial rounds and eight rounds of trading for real. Each session was run with eight subjects. No-one was allowed to participate in more than one session. Our subjects were students of business and economics at the University of Kiel, Germany. Subjects who participated in the experiment were trained in using the MUDA program a couple of days before the experiment. Each trader could trade in Market 1 and 2. No shortselling restrictions applied. Assuming risk aversion, Type A traders should sell Yellow assets and buy White assets, while Type B should sell White and buy Yellow. Fig. 1 presents the endowments of Types A (---- line) and B (-----) in an Edgeworth box.

For risk averse subjects, we expected them to trade towards the certainty line. At the end of each 8 min trading round, the cash on hand and the number of assets were noted and a new round started with the relevant endowment as shown in Tables 1 and 2. After half of the real trading rounds, those subjects of Type A became Type B and vice versa. Subjects were paid according to the results of one round selected at random. Therefore, after all real rounds had been completed, an eight-sided die was rolled to determine which round provided the basis for payment. Subjects earned on average DM 18, and the whole session took about 2 h. There was no difference in average earnings in Experiment I+ and I−.

2. Results of Experiment I

Fig. 2 shows the average prices and standard deviations for each round in Experiment I+ and Experiment I− for assets traded in Markets 1 and 2. As can be seen, the average prices were larger than the expected value. In addition, we found that overpricing was greater for negatively framed endowments than for positively framed endowments, thus confirming Hypothesis 1. Averaging over all eight rounds we get price\textsubscript{Yellow} = 82 and price\textsubscript{White} = 33 (Experiment I+), and price\textsubscript{Yellow} = 85 and price\textsubscript{White} = 47 (Experiment I−). The degree

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11 Two sessions of Type I− had to be run with six subjects. However, the results from these sessions did not differ from the results from the sessions run with eight subjects.

12 The signs ‘●’ and ‘▵’ indicate the final holdings averaging over traders, sessions and rounds 1–4 (5–8). The holdings will be discussed in more detail in Section 2.

13 We averaged over the six sessions in Experiment I+ and I−.
Fig. 1. Edgeworth box for endowments of Experiments I.
Fig. 2. Average prices and standard deviations of prices in Markets 1 and 2 for positive and negative frames.
of overpricing for the positive frame is similar to the one in Rietz (1993)\(^{14}\). Standard deviations shown as lines indicate that prices are not very volatile. Prices bars across Fig. 2 are predicted prices for Market 1 and Market 2.

Although the degree of overpricing seems to vary over time, there is no common trend in the four series of prices: in particular, the degree of overpricing does not diminish systematically with experience. Considering each session separately, overpricing is significantly reduced in five sessions, while in five sessions overpricing increases over time, and in two sessions no trend can be found.

In Fig. 2 we have presented data for Experiment I+ and Experiment I− averaged over all rounds. We now want to investigate overpricing for each session averaging over all rounds in the session. Table 3 presents these results. Table 3 shows that there is a high variation in the degree of overpricing within each type of session. A \(t\)-test shows that, on average, prices in Experiment I+ were 114.8\% of expected values noticeably lower than the overpricing in Experiment I− where prices averaged 131.8\% of expected values, \((t = 1.61, p < 0.10,\) taking each session as one observation). Thus, overpricing is a persistent phenomenon.

Taking each round in each session (95 rounds\(^{15}\)) only the first three rounds in one session showed no overpricing.

So, why is there a difference between positive and negative framing? To gain some insight we wanted to know if the difference in overpricing is also reflected in the individual willingness-to-pay and individual willingness-to-accept measures. Using a straightforward questionnaire (without reference to any endowment and without giving financial incentives to reveal ‘true’ preferences), we asked subjects at the end of the sessions to state the maximal buying price (WTP), the minimal selling price (WTA), and the certainty equivalent for one White asset and one Yellow asset.

Table 4 shows a small buying–selling price gap\(^{16}\) where the certainty equivalent is within the range of WTP–WTA (except for White assets in Experiment I−). The sum of certainty equivalents reflects no overpricing. The certainty equivalents for positive and negative frames were not different for Yellow assets \((p > 0.10)\) but they were different for White assets \((t = 2.74, p < 0.01)\). Of course, there should be no difference as subjects in Experiment I+ and I− were given exactly the same questions and no endowment was involved. Trading in a market with negatively framed endowments led subjects to evaluate White assets significantly higher than subjects from Experiment I+.

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\(^{14}\) In Rietz (1993) complementary claims with \(p = 0.70\) and \(p = 0.30\) were traded. Reading from his Fig. 2, conditions OPI 1–3 and OPIS 1–3, his degree of overpricing is about 120\%.

\(^{15}\) The data from the last round of one session was lost due to a computer problem.

\(^{16}\) The ratio WTA/WTP is considerably smaller than in other studies where no trading was undertaken beforehand. For example, Eisenberger and Weber (1995), report an average ratio of about 1.50. It seems as if the experience of trading — in this study, at least — makes the ratio shrink.
Table 4
Willingness-to-pay and willingness-to-accept for one Yellow and one White asset

<table>
<thead>
<tr>
<th></th>
<th>WTP</th>
<th>WTA</th>
<th>Certainty equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment I+</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>69.2</td>
<td>75.2</td>
<td>71.0</td>
</tr>
<tr>
<td>White</td>
<td>22.8</td>
<td>27.1</td>
<td>26.4</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td>92.0</td>
<td>102.3</td>
<td>97.4</td>
</tr>
<tr>
<td><strong>Experiment I−</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>66.0</td>
<td>76.6</td>
<td>68.6</td>
</tr>
<tr>
<td>White</td>
<td>21.7</td>
<td>31.6</td>
<td>34.1</td>
</tr>
<tr>
<td><strong>Σ</strong></td>
<td>87.7</td>
<td>108.2</td>
<td>102.7</td>
</tr>
</tbody>
</table>

Table 5
Average number of trades in Experiment I+ and I− per round and per session

<table>
<thead>
<tr>
<th>Session</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment I+</strong></td>
<td>68</td>
<td>24</td>
<td>42</td>
<td>49</td>
<td>79</td>
<td>59</td>
<td>54</td>
</tr>
<tr>
<td><strong>Experiment I−</strong></td>
<td>50</td>
<td>60</td>
<td>25</td>
<td>34</td>
<td>39</td>
<td>96</td>
<td>51</td>
</tr>
<tr>
<td><strong>Round</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><strong>Experiment I+</strong></td>
<td>38</td>
<td>44</td>
<td>47</td>
<td>47</td>
<td>53</td>
<td>63</td>
<td>71</td>
</tr>
<tr>
<td><strong>Experiment I−</strong></td>
<td>45</td>
<td>40</td>
<td>50</td>
<td>49</td>
<td>49</td>
<td>53</td>
<td>60</td>
</tr>
</tbody>
</table>

Why do we get such strong overpricing? Is no one taking advantage of the prices and getting rich through simultaneously selling both claims, i.e. through arbitrage? The answer to this question should also help us to understand the effect of different endowments on overpricing.

However, before looking at individual strategies, let us consider aggregate trading patterns. Table 5 shows the average number of trades for each session and for each round. The numbers show that subjects traded actively (overall, about 52 trades every 8 min), that the number of trades was not significantly different for positive and negative framing, that the number of trades varied considerably from one session to another, and that there was greater trading activity in rounds 6–8. Taking sessions as the unit of analysis, regressing average overpricing against average number of trades suggests that a higher intensity of trading tends to result in less overpricing: for our data, 27% of the variance of overpricing can be explained by the number of trades.

The average final allocations for all sessions (given in Fig. 3) show that subjects on average traded toward the certainty line and that final holdings were quite diverse. Each sign ‘r’ denotes the holding in a session averaging over rounds 1–4, each sign ‘Δ’ gives the final holding averaging over rounds 5–8 for a session. Averaging also over sessions (see Fig. 1), we find that subjects trade towards the certainty line. However, it is only in Experiment I+ that on average they reach the certainty line in the second half of the sessions.

However, Fig. 3 does not offer any explanation for the general tendency to overprice. We, therefore, looked at individual trading patterns. For our analysis of the individual data we only considered the last three rounds. On a within-subject basis, we found that final holdings appeared very stable during these rounds. By contrast, between subjects, we found remarkably diverse final holdings during these rounds. However, we did not find any differences in final holdings which were correlated with differences in overpricing.
Fig. 3. Final asset allocation of Experiment I+ and Experiment I−.
We also looked to see if individuals followed an arbitrage strategy. In this experiment, and in the presence of overpricing, arbitrage means selling White and Yellow assets simultaneously. A subject was classified as following an arbitrage strategy if at the end of a round the subject had at least three White and three Yellow units less than in the initial endowment. Only two out of 94 subjects could be classified as following an arbitrage strategy in all of the last three rounds, while one followed the strategy in two of the last three rounds and three did so in just one of the last three rounds. By far the majority of active traders bought in one market and sold in the other. A similar absence of arbitrage can also be found in Rietz (1993). We also checked for a potential relation between the amount of shortselling and the degree of overpricing but found no significant relation.

The individual price patterns show that the average variance of prices is very much higher for Experiment I—(41 for Yellow and 96 for White) than for Experiment I+ (16 for Yellow and 38 for White). The variance generally decreases during the sessions. The variability of prices across replications can partly explain the overpricing: the higher the variability, the larger the overpricing ($\rho^2 = 0.31$).

3. Hypothesis and design of Experiment II

3.1. Hypothesis

The results of Experiment I showed a pattern of overpricing which was even stronger for negative framing. In Experiment I the assets traded in both markets were perfectly negatively correlated and subjects could have used arbitrage strategies. In a second experiment we endowed traders with a positive, negative and neutral position of lotteries.

Consider the ‘pure’ case of one type of lottery to be traded in a double auction experiment in one market. Take, for example, the lottery $L_{0.5} = (0.5, DM 100; 0.5, DM 0)$ and assume further that every participant in a trading round has the same endowment, i.e. subjects trade purely on their differences in risk attitude. Standard economic theory assumes that subjects are risk averse, i.e. that the price for $L_{0.5}$ should be somewhat below DM 50. And indeed, when asked for certainty equivalents, subjects’ responses tend to reflect risk aversion (e.g. Böcker, 1986; Mangelsdorff and Weber, 1994). However, there is also evidence that some subjects may show risk seeking — at least in an experimental environment (for an overview, see Conlisk, 1993).

In some market experiments the market price for simple lotteries traded in one market is equal or above the expected value. Knez et al. (1985) reported such results. Keppe and Weber (1993) had subjects trading risky and ambiguous assets using MUDA. They also did not get prices which reflected risk aversion. Sarin and Weber (1993) found prices which reflected strong risk seeking for lotteries of Type $L_{0.5}$ when ambiguous lotteries were traded.

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17 We searched unsuccessfully for other patterns of holdings to reflect a possible arbitrage. For example, the number of final holdings which have at least two short positions in both markets is only equal to 9 ($= 3\%$).
19 Pictures showing the actual price paths in Markets 1 and 2 can be obtained from the first author.
in a second market and a double oral auction was used. What these studies have in common is that subjects were put in a positive position to start with. In Experiment II we wanted to investigate whether and in what way market prices of simple lotteries such as $L_{0.5}$ depend on whether traders are initially put in a positive, negative or neutral position. To derive the hypothesis, consider a positive endowment:

Endowment II+ = cash and along position $(+6L_{0.5})$

and a negative endowment:

Endowment II− = cash' and a short position $(-6L_{0.5})$.

Taking risk aversion into account, for Endowment II+ the price of $L_{0.5}$ has to be equal to the expected value minus some risk premium. For Endowment II− the price of $L_{0.5}$ has to be equal to the expected value plus some risk premium (as buying $L_{0.5}$ covers a short position). The reverse predictions are true for risk seeking subjects. If all subjects were risk neutral, prices in both conditions should be equal to the expected value. This gives Hypothesis 2. Note, however, that we do not apply any prospect theory arguments to derive Hypothesis 2. We will come back to this point in the discussion.

**Hypothesis 2.** Assuming risk aversion, prices of assets $(p, DM x; 1-p, DM y)$ traded in a market with a positive (negative) endowment are smaller (larger) than the expected value of the asset.

To generalize Hypothesis 2 to the case of some subjects being risk seeking and some being risk averse we would have to make assumptions about the market power of risk averse or risk seeking traders. For the same reason we are not able to formally derive a hypothesis for the Endowment II0 (Endowment II0 = cash'' = cash + 6x expected value of $L_{0.5}$). Intuitively, the price under Endowment II0 should be between the price of the Endowment II+ and the Endowment II−.

We also want to consider volume predictions depending on endowment. If all subjects are risk averse or risk seeking they would trade on their differences in risk attitude. In an experiment that involved eliciting buying and selling prices for $(0.5, DM 10; 0.5, DM 0)$ lotteries (Eisenberger and Weber, 1995) the average buying and selling price interval was [4.23, 6.11] for the positive frame and it was [4.79, 7.17] for the negative frame. If traders all start from the neutral endowment II0 then purchases may be thought of as taking them into the positive frame (taking a long position) whereas selling (taking a short position) would take them into the negative frame. On the basis of the above data, the average buying and selling price interval would be [4.23, 7.17], larger than the interval in either the positive and negative frame. We therefore expect a smaller volume for Endowment II0.

**Hypothesis 3.** Trading volume is smaller for Experiment II0 than for Experiment II+ and Experiment II−.

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20 Cash' = cash + 12x expected value of $L_{0.5}$, in order to have the expected value of both positions equal.
3.2. Design

Using MUDA, we had subjects trade in two markets where in each market one lottery was traded. In Market 1 the asset was defined by the lottery \( L_{0.5} = (0.5, x_{\text{high}} \text{ units}; 0.5, x_{\text{low}} \text{ units}) \); in Market 2 the lottery \( L_{0.25} = (0.25, x_{\text{high}} \text{ units}; 0.75, x_{\text{low}} \text{ units}) \) was traded \(^{21}\). Both lotteries were resolved independently by drawing with replacement from an urn which contained balls labelled 1–20. For \( L_{0.5} \) half the subjects won, if a ball labelled 1–10 was drawn; the second half won, if a ball labelled 11–20 was drawn. \( L_{0.25} \) was resolved in a second draw where one fourth of the subjects won if a ball labelled 1–5 was drawn etc. We used this procedure to make our payments more predictable.

To test our hypotheses we ran three experiments:

- Experiment II+: subjects were endowed with 6 assets in Market 1 and 6 assets in Market 2.
- Experiment II0: subjects were endowed with 0 assets in Market 1 and 0 assets in Market 2.
- Experiment II−: subjects were endowed with −6 assets in Market 1 and −6 assets in Market 2.

The initial cash position was calculated to be lower (higher) in Experiment II+ (Experiment II−) than in Experiment II0 by six times the expected value of the asset. We replicated each type of experiment twice, thus running six sessions in Experiment II. Each session lasted 14 rounds, and each round lasted 5 min. The first two rounds were trial rounds. Here subjects traded assets which were worth some sure amounts. We had eight subjects participating in each session \(^{22}\). Again, subjects were students in business and economics at the University of Kiel who had participated in a training session prior to the experimental session. A session took on average 3 h. In experimental economics there is some discussion about whether results depend on the amount subjects are paid (Harrison, 1992). We therefore decided to have four rounds where we did not pay any money, four rounds where we paid some money and four rounds where we made large payments for one randomly selected round. Afterwards the value of the assets was determined by the procedure explained above.

In Experiment II one unit was worth 1 Pfenning (DM 0.01). In the low payment rounds \( x_{\text{high}} \) was equal to 42 units and \( x_{\text{low}} \) was equal to 2 units. For \( L_{0.5} \) the expected value was equal to DM 0.22. In the high payment rounds \( x_{\text{high}} \) was equal to 420 units and \( x_{\text{low}} \) equal to 20 units. For \( L_{0.5} \) the expected value was equal to DM 2.20. The four no-payment rounds always came first and low and high payment were varied. Three sessions (one in each condition) had the high payment before the low payment and in three sessions low payment was before high payment.

Subjects in our experiment faced a clear possibility of losses. When we advertised the experiment, we told subjects that they could lose up to DM 30. At the beginning of each session we had subjects sign a letter confirming that they would indeed be prepared to pay

\(^{21}\) As there is some evidence that subjects treat lotteries with a zero outcome as something special (see Mellers et al., 1992), our lotteries were defined with nonzero outcomes, i.e. \( x_{\text{low}} > 0 \).

\(^{22}\) In one session of Experiment II− only six subjects participated.
Table 6
Design of Experiment II

<table>
<thead>
<tr>
<th>Payment</th>
<th>None</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment II+</td>
<td>200 plus 6L₀ ᵃ and 6L₀ ₂₅</td>
<td>200 plus 6L₀ ᵃ and 6L₀ ₂₅</td>
<td>2000 plus 6L₀ ᵃ and 6L₀ ₂₅</td>
</tr>
<tr>
<td>Experiment II₀</td>
<td>404</td>
<td>404</td>
<td>404</td>
</tr>
<tr>
<td>Experiment II−</td>
<td>608 minus 6L₀ ᵃ and 6L₀ ₂₅</td>
<td>608 minus 6L₀ ᵃ and 6L₀ ₂₅</td>
<td>6080 minus 6L₀ ᵃ and 6L₀ ₂₅</td>
</tr>
<tr>
<td>Rounds</td>
<td>3–6</td>
<td>7–10 or 11–14</td>
<td>11–14 or 7–10</td>
</tr>
</tbody>
</table>

Table 7
Average market price/expected value for Experiment II (standard deviations in brackets)

<table>
<thead>
<tr>
<th>Market 1: L₀ ᵃ</th>
<th></th>
<th>Market 2: L₀ ₂₅</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>Experiment II+:</td>
<td>1.01 (0.06)</td>
<td>1.07 (0.07)</td>
<td>1.02 (0.10)</td>
</tr>
<tr>
<td>Experiment II₀:</td>
<td>1.03 (0.11)</td>
<td>1.04 (0.10)</td>
<td>1.00 (0.26)</td>
</tr>
<tr>
<td>Experiment II−:</td>
<td>1.46 (0.09)</td>
<td>1.49 (0.21)</td>
<td>2.03 (0.31)</td>
</tr>
</tbody>
</table>

up to DM 30. To restrict the loss potential, we had to restrict the final holdings. Subjects were allowed to sell assets as long as the holdings were greater or equal to −12 assets (Experiment II−), and −6 assets (Experiment II₀), and 0 assets (Experiment II+) in either market. The payment varied from DM 20 (far away from paying DM 30) to DM 127 with an average of DM 65. Such payments are towards the higher end of those reported in the literature. The variation of payment was lowest in the II₀ condition and highest for II−. We again wanted to gain some insight into each subject’s evaluation of the lotteries, so before each set of high payment rounds, we ask subjects for their buying and selling prices for L₀ ᵃ, −L₀ ᵃ, L₀ ₂₅, and −L₀ ₂₅.

The design is summarised in Table 6.

4. Results

To test Hypothesis 2, we calculated the ratio of average price to expected value for all sessions. Table 7 gives these ratios. As the average prices did not differ between no payment and low payment, the prices under low payment (column L) are averages for both payment schemes. In column H we present the ratios for the high payment condition.

The results clearly show that Hypothesis 2 has to be rejected. When subjects were put in a long position, the average market price was slightly above the expected value. These results are similar to most results described in the literature. Furthermore, there is no difference in prices for markets with positive and neutral endowment. However, we find a strong effect on prices for those sessions where subjects started out with a short position. Subjects were

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23 We were worried whether we would find subjects willing to participate in an experiment where they had to cover the losses using their own money. To our surprise students really did not care about the loss potential once they knew the gain potential. From all we can tell, we did not get any selection bias, i.e. the same students showed up as they normally showed up in other experiments.

24 Again, as in Experiment I, we excluded those trades (and therefore those market prices) where subjects obviously had mixed up Markets 1 and 2.
trading at prices which were 50\% (Market 1) or even 100\% (Market 2) above the expected value.

Thus subjects show approximate risk neutrality in Experiments II+ and II0, but apparently exhibit strong risk aversion in Experiment II−. This result is similar to what Loomes and Weber (1996) observed in a second price sealed bid auction, where strong effects were found only for negatively framed endowments. There was no difference in market prices for the low and the high payment conditions\footnote{There is also evidence that paying does not alter other economic phenomena: for example, Fehr and Tougareva (1996) found that paying did not change reciprocal fairness.}. Within each session there was only a small trend in prices. In 10 of 12 session the prices slightly increased from round 3 to 14\footnote{Besides just looking at the data, we ran 12 regressions (one for each market in each session). The market price was an increasing function of the number of rounds for 10 of these regressions.}. It is also important to note that prices throughout the sessions, and even at the end, still show a certain degree of variability\footnote{The market prices over time for Experiment II can be obtained from the first author.}. Standard deviations showed no significant difference between low and high payment conditions, but tended to decrease during the session; the average standard deviation for the last rounds of each session in Market 1 (Market 2) was 0.05 (0.15).

The selling restriction, which was created to prevent people from going bankrupt, could partly explain the results above: subjects could buy without any real restrictions but they could sell only until they reached a minimum holding. Considering the final holdings, in 16\% of all cases subjects could not have short-sold more and in 10\% of all cases could not have bought more than six assets (the maximum number their holding was allowed to be lower than the initial holding). However, the influence of the short-selling restriction cannot explain the high prices in Experiment II−, as the number of subjects who were not allowed to short-sell more is about the same as in the other sessions (Experiment II+: 18\%, Experiment II0: 12\%, Experiment II−: 14\%).

Testing Hypothesis 3, Table 8 presents the average trading volume for Markets 1 and 2. The numbers clearly show that the volume is lower for Experiment II0 than for Experiment II+ and Experiment II−\footnote{Volume in II+ was larger than in II0, for Market 1 ($t = 2.16$ and $p < 0.05$) and for Market 2 ($t = 2.65$ and $p < 0.05$). Volume in II− was larger than in II0, for Market 1 ($t = 2.05$ and $p < 0.05$) and for Market 2 ($t = 1.82$ and $p < 0.1$).}. The average willingness-to-pay and willingness-to-accept which subjects gave before the high price rounds are shown in Table 9. The column ‘to EV’ gives the ratio of the midvalue between WTP and WTA and the expected value. Table 9 shows that all average willingness-to-pay and willingness-to-accept values for Market 1 and Market 2 are larger than the expected values (220 for Market 1 and 120 for Market 2). Relative to the expected

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|}
\hline
& Market 1 & Market 2 \\
\hline
Experiment II+ & 20.7 & 21.4 \\
Experiment II0 & 17.1 & 15.8 \\
Experiment II− & 20.6 & 19.4 \\
\hline
\end{tabular}
\caption{Average trading volume per round in Experiment II}
\end{table}
value, the WTP and WTA values in Experiment II are slightly higher than the ones found in Experiment I (see Table 3) and in Eisenberger and Weber (1995). Lotteries traded in a negative frame have higher prices than lotteries traded in a positive frame. However, in all the other sessions as well in the literature, the WTP+ value always reflects risk aversion. In some way either trading in (experimental) markets seems to make people ‘forget’ their risk aversion, i.e. subjects might adopt a wheeler-dealer mentality (thus ignoring their risk attitude) or they might respond differently in the context (frame) of markets.

5. Discussion

Taking both experiments together, the evidence indicates that experimental markets are liable to be strongly affected by the framing of the endowment, suggesting that reference points may matter even in simple market settings. We also found that subjects do not like short positions: when subjects were confronted with what was presented as a potential loss they were willing to pay substantially higher prices to buy assets to cover this loss. Prices showed no difference whether traders had a risk free endowment or a (positive) risky endowment. The overpricing was not reduced during the experiment. Subjects did not learn to use arbitrage to take advantage of the high prices. Subjects’ discomfort with negative framing is also reflected in the higher variance of prices for this frame.

What does this tell us in terms of subjects’ risk attitude and in terms of implications from individual decision making (described by prospect theory) for markets? Risk attitude does not help much to explain what was going on. In Experiment I, the average final holdings (closer to the certainty line than the endowment) imply that subjects on average were risk averse. However, the same subjects were willing to pay more than the expected value for a lottery — which appears to be consistent with risk seeking. In Experiment II, two conditions (II+, III0) imply risk neutrality, whereas the third condition (II−) implies strong risk aversion.

Setting aside ‘risk attitude’ for a moment, our key finding really is that people dislike short positions and are willing to pay a lot to avoid them. Prospect theory does not offer immediate help to explain this finding, as it was designed as a theory of individual choice and not as a theory of transactions. One has to make additional assumptions about how subjects encode the decision problems while trading29. The predictions of prospect theory in a transaction setting very much depend on whether the cash endowment and the asset endowment are coded jointly or separately and where the reference point is set.

We suggest one possible way of coding which might be tested in future research. Assume that a subject’s current wealth is taken as a reference point and assets and cash are

\[\text{Table 9} \]

Willingness-to-pay and willingness-to-accept for Markets 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>WTP+</th>
<th>WTA+</th>
<th>To EV</th>
<th>WTP−</th>
<th>WTA−</th>
<th>To EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market 1</td>
<td>235</td>
<td>262</td>
<td>1.13</td>
<td>249</td>
<td>286</td>
<td>1.22</td>
</tr>
<tr>
<td>Market 2</td>
<td>131</td>
<td>149</td>
<td>1.17</td>
<td>145</td>
<td>173</td>
<td>1.33</td>
</tr>
</tbody>
</table>

---

coded in two different (mental) accounts\(^{30}\). Assume also, for the sake of simplicity, a linear probability weighting function, and an endowment of one lottery \((0.5, \text{DM } -100; 0.5 \text{ DM } 0)\) and DM 1000 in cash. The value of the lottery is \(0.5v(\text{DM } -100)\), and paying DM \(x\) for a lottery would be reflected in the difference \(v(\text{DM } 1000) - v(\text{DM } 1000 - \text{DM } x)\). A loss averse subject should pay more for the lottery than the expected value: that is to say, \(|0.5v(\text{DM } -100)| > |v(\text{DM } 1000) - v(\text{DM } 1000 - \text{DM } 50)|\), which would explain the prices in both experiments. The subject ‘hates’ the short position of one lottery (the potential loss) in the lottery account and does not mind so much reducing DM 1000 (the sure gain) in his money account. Note the difference to standard prospect theory reasoning, which would predict that the lottery \((0.5, \text{DM } -100; 0.5 \text{ DM } 0)\) is preferred to a sure loss of DM 50.

For future research it will also be interesting to study why subjects take so little advantage of arbitrage opportunities. Making subjects more familiar with short positions might be a factor which influences overpricing. Subjects in day to day life are used to buying and selling. However, having a potential obligation or even short-selling a risky asset is normally not done on a regular basis. It may be that such behavior would develop with further experience, but there was little evidence of any such tendency within the duration of our experimental sessions (which certainly lasted as long as most experimental markets do). However, this is something we hope to investigate further in future work. Meanwhile our results indicate that even double auction markets, which traditionally exhibit rapid convergence to the competitive equilibrium, do not readily dispel endowment framing effects — a point which needs to be borne in mind (and controlled for) by researchers making use of such markets in future experiments.

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References


\(^{30}\) Thaler (1985) examines the concept of mental accounting in greater detail.


