

# Framing Effects, Selective Information and Market Behavior - An Experimental Analysis -\*

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## Abstract

The results of an asset market experiment, in which 64 subjects trade two assets on eight markets in a computerized continuous double auction, indicate that objectively irrelevant information influences trading behavior. Moreover, positively and negatively framed information leads to a particular trading pattern, but leaves trading prices and trading volume unaffected. In addition, we provide support for the disposition effect. Participants who experience a gain sell their assets more rapidly than participants who experience a loss, and positively framed subjects generally sell their assets later than negatively framed subjects.

Keywords: financial markets, prospect theory, anchoring and adjustment, experimental economics, disposition effect

JEL-Classification: C90; D44; D80; G12

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## 1 Introduction

The communication of asset return distribution is a central issue in finance. Investment advisors are legally obliged to inform their clients about the potential risk of their investments, whereby financial risk is usually expressed by the variance or the standard deviation of the underlying distribution of the future returns on the investment. Investors are thus, at least, implicitly required to accurately perceive and interpret statistical information, irrespective of how the information is presented.

In recent years new possibilities of acquiring financial information have become available to investors. One of the main information sources is the internet, which provides investors with a vast quantity of investment data. *Yahoo!Finance*, for instance, offers free market information, business news, and personal finance plans, and *BigCharts* provides investors with the option of creating personalized interactive charts. Market data provider *eSignal* even assumes a positive relationship between information quantity and investment success by promising “You’ll make more, because you know more.”

This evidence suggests that investors generally benefit from the provision of information. Empirical studies, however, indicate that more information does not necessarily imply an increase in actual knowledge. In the psychological literature, this tendency is referred to as the illusion of knowledge and is empirically confirmed for a variety of decision domains. Park (2001), for instance, shows that even when news media recipients are socially involved with issues covered in the media, they are prone to the illusion of knowledge. This tendency will increase the more recipients use the media. In the finance domain, Barber and Odean (2001) investigate the performance of investors who switched from phone-based trading to internet trading. While those traders who opted for internet trading initially beat the market by about 3% prior to going online, their performance decreased after going online, resulting in a performance of 2% below the market. Similarly, Choi et al. (2002) report evidence of underperformance in the market-timing of online

traders in 401(k) plans. Access to vast quantities of investment data on the internet does therefore not necessarily imply better performance.

Information does not only play an important role in individual investment decisions, but also in market environments. Market efficiency, for instance, requires that neither objectively *irrelevant* information nor selectively distributed information affects aggregate market prices. If, for example, some traders receive a positive signal about the likely returns on an asset, whereas an equal number of traders receive the opposite signal, this information should be completely revealed, leaving aggregate market prices unaffected. Thus, while individual investors may be prone to biases, such as the illusion of knowledge, aggregate market prices are considered to be unbiased.

In this paper we focus on the communication and the quality of information in the context of a competitive asset market. More precisely, we investigate the impact of objectively *irrelevant* information on trading behavior by drawing upon a novel type of framing. Traders are confronted with randomly distributed selective information about performance chances of potential investments. The presented information is either provided in a positive or a negative frame and is essentially irrelevant to the decision problem at hand. Since we symmetrically distribute the additional information among traders, aggregate market behavior is expected to remain unaffected. In addition, we also investigate the robustness of the disposition effect in a competitive market environment with real time data available.

Our results indicate that objectively irrelevant information influences trading behavior. Moreover, positively and negatively framed information leads to a particular trading pattern, but leaves trading prices and trading volume unaffected. In addition, our findings support the disposition effect. Participants who experience a gain sell their assets more rapidly than participants who experience a loss. Furthermore, this effect is mediated by

framing. Positively framed market participants generally sell their assets later than negatively framed participants.

This section proceeds with a discussion of framing effects and the disposition effect. In section 2, the experimental design and the procedure are introduced. Section 3 covers the results, and finally in section 4, our main findings are discussed.

### **1.1 Framing effects**

Expected utility theory assumes, among other things, descriptive invariance, implying that different representations of the same choice problem should yield the same preference. However, several empirical studies indicate that this axiom is frequently violated in individual decision making. McNeil et al. (1982), for instance, showed that the same medical statistics, framed either in terms of mortality rates or in terms of survival rates, lead to different preferences. Framing effects were also observed in decisions involving risky lotteries and monetary payoffs (Kahneman and Tversky 1983, Tversky and Kahneman 1981). More recently, Statman (1995) as well as Kahneman and Riepe (1998) applied the concept of framing to financial decisions, such as dollar-cost averaging.

Weber et al. (2000) investigated the impact of endowment framing on market prices in an experimental asset market. Participants were either put in long position by receiving some amount of cash plus a certain amount of positively valued risky assets (positive framing) or were put in short position by receiving a larger amount of cash and certain state-contingent liabilities (negative framing). The objective value of initial endowments was identical in terms of final wealth. In line with the predictions of prospect theory, Weber et al. (2000) found that overpricing<sup>1</sup> was observed more often for negatively framed market participants than for positively framed participants.

In contrast to Weber et al. (2000) who altered participants' initial actual endowments, the present study investigates whether framing effects are also robust under weaker con-

ditions, for instance, when participants only obtain different and more importantly *irrelevant* information. Our experimental procedure differs from the way framing effects were originally studied by Tversky and Kahneman (1981). In their experiments subjects were presented with scenarios in which a hypothetical decision problem was either semantically framed in terms of “gains” or “losses.” However, the concept of framing in studies that emphasize the role of language in the representation of the decision problem lack conclusive empirical evidence. Kühberger (1995) found that a variation of missing items of information in the decision problem produced markedly different framing effects. Moreover, with fully described decision problems, no framing effects emerged at all. While the results of a meta-analysis of 136 empirical studies indicate that generally framing effects are a reliable phenomenon (Kühberger 1998), the results of a further meta-analysis, particularly focusing on Asian disease-like studies indicate that risk preference depends on the size of payoffs, the probability levels, and the type of good at stake (Kühberger et al. 1999).

In our experimental procedure, we employ a novel type of framing, which is not based on semantic variations of a decision problem. Instead, participants are informed that dividends are randomly determined and drawn from a normal distribution with a commonly known fixed  $\mu$  and a fixed  $\sigma$ , whereby we assume that  $\mu$  serves as the aspirational reference payoff. For a given probability  $p$ ,  $p \in \{0, \dots, 0.5\}$ , we let  $\underline{X}_p$  and  $\overline{X}_p$  denote the  $100p$  and  $100(1 - p)$  percentiles, respectively. For a given  $p$ , subjects are told that dividends will be less than  $\underline{X}_p$  with probability  $p$  (negative framing), or that dividends will exceed  $\overline{X}_p$  with probability  $p$  (positive framing). We distinguish between two independent markets, A and B, in which percentile information follows two different probabilities. The framed information on market A deviates more extremely from the aspirational reference payoff  $\mu$  than the framed information on market B ( $p_A < p_B$ ).

Our experimental approach is not only related to framing effects, but also to the “anchoring and adjustment” bias (Tversky and Kahneman 1974), which refers to a sequential

decision situation in which initial information serves as an anchor, from which adjustments in the decision process are only made insufficiently.<sup>2</sup> In our design, the positively and negatively deviating dividend information represents the initial information, the anchor. If subjects respond to this additional percentile information, we expect that trading behavior is influenced in a systematic way. Positive information should increase the traders' dividend expectations, whereas negative information should lower them, leading to a particular trading pattern. Positively framed buyers are expected to purchase assets from negatively rather than from positively framed sellers, whereas in turn negatively framed sellers are expected to sell their assets to positively rather than to negatively framed buyers.

If the framed information has indeed a systematic impact on the traders' dividend expectations we hypothesize a differential trading activity on the two markets, A and B. The additional irrelevant information deviates more strongly from the aspirational reference payoff  $\mu$  on market A than on market B. Thus, the more extreme information on the former should create more diverging dividend expectations on part of the traders, which is assumed to increase the likelihood that pairs of participants willing to trade will actually meet on the market. The experimental design also allows us to investigate whether framing effects vanish if the decision problem is fully described, as suggested by Kühberger (1995), based on individual decision tasks. Since in our experiment positively and negatively framed information is symmetrically distributed among traders, the market possesses complete information.

One might argue that the percentile information in our approach might serve two different roles; an *informational* and a *framing* role. Although from a normative perspective the additional percentile information is logically redundant, given knowledge of the mean and variance of the normal distribution, individuals may perceive it as useful in the decision-making process; for instance, in order to learn about the shape of the distribution.

However, since the percentile information is symmetrically distributed among subjects in the context of a competitive market environment, given that information dissemination takes place and that subjects have statistical training, the informational role is experimentally ruled out.<sup>3</sup> Observed behavioral regularities in the experiment are therefore likely to be due *only* to the framing role.

## 1.2 Disposition effect

The disposition effect is one implication of prospect theory (Kahneman and Tversky 1979, Tversky and Kahneman 1992). In contrast to the utility function implied by expected utility theory, the value function  $v$  postulated by prospect theory is defined in terms of gains and losses relative to a reference point and not on the basis of absolute levels of final wealth. Prospect theory assumes that the value function is concave for gains and convex for losses. In a financial context, one can therefore expect that winner assets will be sold more readily than loser assets in order to collect the gain and undo or “repair” the loss, respectively (Shefrin and Statman 1985).

This hypothesis has been supported empirically, for instance, for field data (Heisler 1994, Odean 1998), and in experimental asset markets (Heilmann et al. 2000, Weber and Camerer 1998). Odean (1998) analyzed trading records for 10,000 accounts at a large discount brokerage house and found that investors held losing stocks for a median of 124 days, whereas winners were only held for 104 days. Heilmann et al. (2000) showed on an experimental call market that in periods of rising trading prices with respect to the previous trading period the number of assets offered as well as the number of assets sold was higher than in periods of falling trading prices.

In contrast to Heilmann et al. (2000) who used the price of the previous trading period as the reference point, the present study focuses on individual behavior and defines the reference point in the way Weber and Camerer (1998) did, namely as the subject’s purchase

price. But unlike the experimental procedure followed by Weber and Camerer (1998) who determined the prices not on the basis of the trading actions of subjects but by a random process, our market prices are determined solely by the market participants themselves on a computerized experimental asset market. Our contribution to the existing literature is to study the disposition effect in the context of a competitive market environment with real time data available. We expect that a purchase price lower than the previous trading price implies a gain that will lead to more rapid selling, whereas a purchase price higher than the previous trading price implies a loss that will lead to less rapid selling.

## **2 The experiment**

### **2.1 Participants**

Overall, 64 participants, all students either at Vienna University or the Vienna University of Economics and Business Administration, participated in eight sessions of an experimental asset market. On average, participants earned € 19.14 with a standard deviation of € 14.94. Twenty-two females and 42 males, aged 19 to 31 ( $M = 22.52$ ,  $SD = 2.90$ ), participated in the experiment. The time required for conducting the experiment was about 2 hours and 15 minutes. Forty-nine participants were students of economics, whereas the remaining 15 participants were enrolled in other social science disciplines. All participants had attended at least introductory courses in statistics during their studies.

### **2.2 Experimental design**

The experiment was conducted in a 2 x 2 factorial design in order to study the interaction of differently framed participants within one market. The independent variables were (i) the framing of dividend information (positively versus negatively framed information) as a between-subjects factor and (ii) the probability of the framed information (low versus high probability;  $p_A = .05$  and  $p_B = .45$ ) as a within-subjects factor. Par-



ticipants were randomly assigned to one of the two framing conditions. All participants were informed that dividends would be randomly drawn from a normal distribution with  $\mu \in \{95, 135, 105\}$  and  $\sigma \in \{20, 30, 40\}$ . For the combination and the sequence of  $\mu$  and  $\sigma$  see Table 1. In order to keep subjects' attention levels high we balanced  $\mu$  and  $\sigma$  across trading periods.

[Table 1 about here.]

Prior to the trading periods participants were provided with the actual  $\mu$  and  $\sigma$  as well as with additional irrelevant percentile information,  $\underline{X}_p$  (negative framing) and  $\overline{X}_p$  (positive framing), respectively. Figure 1 exemplarily displays the available information to subjects at the beginning of the trading periods.

[Figure 1 about here.]

### 2.3 Experimental procedure

The experiment consisted of four phases. In the first phase, subjective propensity toward risk was measured experimentally by the methods of certainty equivalents and by binary lottery decisions in order to control for possible differences in individual risk attitude. In the second phase, the experimental asset market was opened and assets were traded. In the third phase, participants were asked to complete a short questionnaire, and finally in the fourth and last phase, the procedure to control for risk attitude was repeated. The exact sequence of events in the experiment is shown in Figure 2.

[Figure 2 about here.]

*Phase 1:* After brief instructions, participants were asked (i) to reveal their certainty equivalent for a lottery that offers a payoff of 100 Experimental Currency Units (ECU)<sup>4</sup> with a probability of  $p = .50$ , and zero ECU otherwise; and (ii) to make seven decisions

among risky lotteries.<sup>5</sup> The payoffs of the lotteries are listed in Table 2. As a control for position effects, the lotteries were systematically varied with respect to  $a_1$  (highest possible payoff) and  $a_2$  (lowest possible payoff) as well as to  $A$  (certain payoff), and to the sequence of  $a_1/a_2$  (risky payoff).

[Table 2 about here.]

The certainty equivalent allows the experimenter to infer participants' attitude toward risk. More precisely, it allows to discriminate between risk aversion, risk neutrality and risk seeking behavior. A certainty equivalent that is lower than the expected value of the lottery, which is 50 ECU, indicates risk aversion, whereas a certainty equivalent equal to the expected value indicates risk neutrality, and finally a certainty equivalent above the expected value indicates risk seeking behavior. Also, the seven decisions among lotteries can be used to infer risk attitude. However, since each lottery has the same expected value in each of its two components, namely the certain payoff and the risky payoff, the design only allows to distinguish between risk aversion (certain payoff) and risk neutrality (risky payoff).

One of the seven decisions was randomly selected in order to determine the individual payoff. The payoff from the lotteries was added to the total payoff from the market. Phase 1 took 15 to 20 minutes.

*Phase 2:* After receiving instructions about the experimental asset market<sup>6</sup> and a short questionnaire to check the understanding of the instructions, subjects participated in two trial periods of six minutes each in order to become familiar with the selling and buying procedures on the market. After the trial periods, the asset market was opened. Overall, eight sessions were run with eight subjects each on a computerized asset market, using the software z-Tree (Zurich Toolbox for Readymade Economic Experiments, Fischbacher (1999)).

The computer screen for the auction is displayed in Figure 3. Each market participant was entitled (i) to submit bids and asks, (ii) to accept standing bids and asks, whereas only better offers, i.e., higher bids and lower asks, were allowed, or (iii) to remain passive. Bids and asks were automatically ranked, indicating the most favorable offer. Information about the trading history, provided as a chronological list of contracts, was displayed throughout the trading periods.

[Figure 3 about here.]

The market was performed as a continuous anonymous double auction. Participants were endowed with 1,000 ECU (100 ECU equal € 0.18) plus five risky assets A and five risky assets B. The assets were traded separately on market A and market B. To ensure comparability between the sessions, the sequence of the two markets was chosen in advance and applied to all eight sessions. Dividends were randomly determined and drawn from a normal distribution (see Table 1). Participants were informed that the markets would be open for at least eight and at most twelve periods. The probability that the markets would end after the eighth, ninth, tenth, or eleventh period was 25 percent. Participants were informed that at the end of the final market period the liquidation value of the asset would be zero. Again to ensure comparability between the sessions, the last market period was randomly chosen once for all eight sessions. According to this random selection, it was determined that each market ended after the ninth period. Each trading period lasted for 180 seconds.

Before the market was opened, participants (i) were told which market (A or B) and which trading period (1 to 9) were opened and received information about the last average market price as well as the closing price of the asset traded, (ii) received either positively framed dividend information or negatively framed information, and (iii) had to predict the next average trading price of the assets. Phase 2 took about 80 to 90 minutes.

*Phase 3:* Participants were asked to fill out a computerized postexperimental questionnaire with items designed to measure how well they had understood the experiment and how much effort they had put into arriving at accurate decisions. Phase 3 took about 15 to 20 minutes.

*Phase 4:* Finally, participants again had to reveal their certainty equivalent for a lottery offering a payoff of 100 ECU with a probability of  $p = .50$  and zero ECU otherwise; and to make seven decisions among lotteries (100 ECU  $\in$  0.73). The payoffs were identical with those used in phase 1 and displayed in Table 2. Phase 4 took about 15 to 20 minutes.

### 3 Experimental results

#### 3.1 Descriptive data analysis

Over the eight sessions with two times nine trading periods each, participants submitted 6,983 offers out of which 3,168 contracts were concluded. Thus, on average participants concluded 22 contracts per period ( $SD = 9.19$ ), ranging from a minimum of four contracts to a maximum of 68 contracts. The average market price was 368.15 ECU ( $SD = 390.71$ ).

Figures 4 and 5 indicate that over the trading periods, the number of concluded contracts decreased both in market A ( $\chi^2(1) = 112.91, p < .001$ ) and market B ( $\chi^2(1) = 73.83, p < .001$ ), while the number of offers not accepted increased in market A ( $\chi^2(1) = 75.02, p < .001$ ) and market B ( $\chi^2(1) = 20.16, p < .05$ ).

[Figure 4 about here.]

[Figure 5 about here.]

One explanation as to why the number of accepted offers decreased would be that prices increased over trading periods. This conjecture was confirmed; average trading prices were statistically significantly higher in the last period of both markets, A ( $M_{A,9} =$

235.77,  $SD_{A,9} = 216.29$ ) and B ( $M_{B,9} = 354.34$ ,  $SD_{B,9} = 425.30$ ), compared to the first period ( $M_{A,1} = 150.06$ ,  $SD_{A,1} = 83.73$ ;  $F(1; 649) = 40.52$ ,  $p < .001$ ;  $M_{B,1} = 163.94$ ,  $SD_{B,1} = 82.45$ ;  $F(1; 625) = 50.74$ ,  $p < .001$ ). However, Figure 5 indicates that average trading prices on both markets sharply declined in late trading periods when uncertainty about market duration was important. Thus, uncertainty about market termination depressed average trading prices, although these were still higher in the last period than in the first. Figure 6 also indicates that in times of high uncertainty, especially in late trading periods, the variance of market prices increased.

[Figure 6 about here.]

To control for possible differences with respect to individual risk attitude, it was investigated whether individual risk attitude differs between sessions and between experimental conditions with respect to the elicitation method of certainty equivalents and with respect to the lottery decisions. The average certainty equivalent that was revealed by the subjects was 44.23 ( $SD = 31.20$ ), indicating a slight degree of risk aversion. Certainty equivalents did not differ significantly between the eight sessions ( $F(7; 56) = 0.48$ ,  $p = .84$ ). An index for risk attitude ranging from 0=risk neutrality to 7=risk aversion was computed out of the seven decisions among lotteries. Participants' average risk attitude amounted to 3.66 ( $SD = 2.15$ ). Again no statistically significant difference between the eight sessions was observed ( $F(7; 56) = 0.95$ ,  $p = .47$ ). Nor was there any statistically significant difference between positively and negatively framed subjects with respect to the certainty equivalent ( $F(1; 62) = 0.09$ ,  $p = .76$ ) and the lottery decisions ( $F(1; 62) = 0.05$ ,  $p = .82$ ). Thus, any differences in observed behavior between experimental conditions are not likely to be caused by different underlying risk attitudes.

In addition, risk attitude does not differ between the first measurement before the market was performed and the second measurement after the market, both for the certainty equivalents ( $M_I = 44.23$ ,  $SD_I = 31.20$ ;  $M_{II} = 45.58$ ,  $SD_{II} = 31.91$ ;  $F(1; 62) =$

0.15,  $p = .70$ ) and for the lottery decisions ( $M_I = 3.34, SD_I = 2.10; M_{II} = 3.67, SD_{II} = 2.44; F(1; 62) = 1.22, p = .27$ ). The results thus indicate that the market behavior did not have a recursive impact on individual risk attitude.

Questionnaire results reveal that instructions were clear and easy to understand ( $M = 7.16, SD = 2.00$ ) and confirmed that participants carefully considered their buying orders ( $M = 6.13, SD = 1.91$ ) and selling orders ( $M = 6.09, SD = 2.08$ ). Subjects also emphasized that they had tried to maximize their earnings ( $M = 6.83, SD = 1.94$ ). All questions were formulated as statements that subjects could disagree or agree with (ranging from 1=I do not agree to 9=I fully agree).

In the following, we present the results with respect to (i) framing effects, (ii) the variation of the probability of the framed information, and (iii) the disposition effect.

### 3.2 Framing effects

The results confirm our conjecture that positively framed buyers purchase assets from negatively rather than from positively framed sellers ( $\chi^2(1) = 6.61, p < .01$ ), whereas in turn negatively framed sellers sell their assets to positively framed buyers rather than to negatively framed buyers ( $\chi^2(1) = 11.26, p < .001$ ). Tables 3 and 4 show the observed and the expected trading volume between positively and negatively framed subjects.

[Table 3 about here.]

[Table 4 about here.]

Second, we expected that varying the probabilities of the framed information would shape individual price expectations. Since the framed dividend information on market A was more extreme than on market B, it was expected that the trading volume on the former would be higher than the trading volume of the latter, due to more diverging dividend expectations.

The results at least weakly support our conjecture. The total number of concluded contracts was higher on market A than on market B ( $\chi^2(1) = 3.41, p = .07$ ). More precisely, a total of 1,636 contracts was concluded on market A compared to 1,532 contracts concluded on market B. However, the total number of offers not accepted did not differ between the two markets ( $\chi^2(1) = 0.12, p = .73$ ). On market A 1,918 offers were not accepted by other market participants, whereas on market B 1,897 offers were not accepted.

However, since Figure 6 indicates that participants seemed not to distinguish between the two asset markets, the observed higher trading volume on market A may be due to the unbalanced sequence of periods of the two markets. Figure 6 indicates that prices followed an upward trend on both markets up to the sixth period of market B, and then sharply decreased in late trading periods. Note that in the beginning of the experiment, when participants were still highly inexperienced, market A was opened more often than market B, whereas in later trading periods this pattern was reversed. Thus, the higher number of concluded contracts may be a result of this particular sequence of trading periods.

We also investigated whether the observed matching of unequally informed subjects leads to different trading prices. For this analysis we distinguished between the following trading patterns: trades (i) with negatively framed sellers and buyers, (ii) with positively framed sellers and buyers, and (iii) with mixed pairs of sellers and buyers. We ran a repeated ANOVA with the trading pattern as a between-subjects factor and the market, A or B, as a within-subjects factor. The data were aggregated by replacing the nine periods of the two markets by the overall mean of each market. The results indicate that trading prices were not statistically significantly different between trading patterns ( $F(2; 21) = 0.07, p = .93$ ), but prices differed across the two markets ( $F(2; 21) = 28.71, p < .001$ ).

Our findings indicate that objectively irrelevant information influences trading behavior: Positively framed buyers purchase assets from negatively rather than from positively framed sellers, whereas in turn negatively framed sellers sell their assets to positively

framed buyers rather than to negatively framed buyers. The observed matching of unequally informed subjects, however, does not lead to different trading prices. We also find that a probability variation of the framed information impacts trading volume. We believe, however, that this result is primarily driven by the unbalanced sequence of trading periods across markets.

### 3.3 Disposition effect

Based on the predictions of prospect theory we expect that a purchase price lower than the previous market price implies a gain situation that leads to more rapid selling, whereas a purchase price higher than the previous trading price implies a loss situation that leads to less rapid selling.

To test this conjecture, two different scenarios, one describing a gain situation and another describing a loss situation, were distinguished. The gain scenario was defined as a situation in which the purchase price was below the previous market price, whereas the loss scenario was defined as a situation in which the purchase price was higher than the previous market price. The software z-Tree (Fischbacher 1999) used in the experiment enables us to calculate the exact time in seconds between a subject's buying and a subject's selling. It can be shown that market participants who experienced a gain sold their assets significantly earlier ( $M_G = 10.12$ ,  $SD_G = 23.30$ ) than market participants who experienced a loss ( $M_L = 13.66$ ,  $SD_L = 26.90$ ;  $F(2; 1, 306) = 3.01$ ,  $p < .05$ ). This effect was mediated by framing (see Figure 7). Positively framed market participants generally sold their assets later than negatively framed market participants ( $M_P = 13.90$ ,  $SD_P = 27.62$ ;  $M_N = 10.32$ ,  $SD_N = 23.72$ ;  $F(1; 1, 307) = 6.34$ ,  $p < .05$ ). Thus, it can be assumed that framing shaped individual expectations and thereby influenced market behavior. Positively framed participants seemed to be more optimistic than negatively framed participants about the likely performance and profit of the assets and were thus also more



patient, both in gain and loss situations.

[Figure 7 about here.]

#### 4 Conclusions

In this paper we investigate the impact of objectively *irrelevant* information on trading behavior. Moreover, we draw upon a novel type of framing that is not based on semantic variations of a decision problem. Participants are given complete information about a distribution, and receive additional percentile information, which either positively or negatively deviates from an aspirational reference payoff. Normative decision theories, such as the expected utility theory, require that this additional information be neglected in the decision process so that it does not influence behavior in a market environment. From a behavioral perspective, however, we expect that the additional information serves as an anchor in the decision process and thereby systematically influences individual behavior, even in market environments. We also investigate the impact of a probability variation of the framed information and the robustness of the disposition effect in a competitive market environment with real time data available.

Our results (i) indicate that objectively *irrelevant* information influences individual trading behavior. Moreover, positively and negatively framed information leads to a particular trading pattern: Positively framed buyers purchased assets from negatively rather than from positively framed sellers, whereas in turn negatively framed sellers sold their assets to positively rather than to negatively framed buyers. The observed matching of unequally informed subjects, however, does not lead to different trading prices. We find (ii) weak support for the conjecture that a probability variation of the framed information impacts trading volume. However, we believe that this effect is not due to the available information, but rather to the unbalanced sequence of trading periods of the two asset markets. Our results (iii) confirm the disposition effect. Participants sold their assets more

readily in gain situations than in loss situations. Furthermore, this effect was mediated by framing. Positively framed market participants generally sold their assets later than negatively framed participants, indicating that the framing of dividend information influenced individual expectations and thereby also market behavior.

Since objectively irrelevant information influenced market behavior, our findings violate expected utility theory and the invariance axiom. Moreover, the results are also not consistent with refinements of the expected utility theory which do not account for framing effects, such as rank-dependent utility theories (Quiggin 1982), which are similar to cumulative prospect theory (see e.g. Weber and Camerer (1987), for a more in-depth discussion). Our experimental approach starts out with how information is perceived, which is neither captured by expected utility theory nor by rank-dependent utility theories. Both theories do not capture the perception of information, but only start with the next step, its processing.

The results of our study may have important implications for financial decision making. On financial markets a huge amount of more or less reliable investment information is available to an increasing number of potential investors all around the world. Standard finance theory assumes that markets are able to filter out relevant information allowing individuals to arrive at unbiased decisions. Specifically, standard theory assumes that even if information does not add to a decision problem, it does not bring negative externalities to bear on it. Our findings cast doubt on this prediction. Additional irrelevant information does not leave the decision problem unchanged, but systematically influences trading behavior; even in competitive market environments.

## Notes

<sup>1</sup>Overpricing refers to market prices that exceed the total value of the lotteries traded (Rietz 1993).

<sup>2</sup>Tversky and Kahneman (1974) asked subjects to estimate the percentage of African countries in the United Nations after a number between 0 and 100 had been drawn by spinning a wheel of fortune. Estimates were dependent on the initially determined number. In the case of a high number having been selected, the median percentage of African countries exceeded the corresponding percentage in the case of a low number having been determined.

<sup>3</sup>There is indeed strong experimental evidence suggesting that asset markets are highly informationally efficient (for a survey on the literature see Sunder 1995).

<sup>4</sup>One hundred ECU equal € 0.73.

<sup>5</sup>Correspondence between the two measures of certainty equivalents and lottery choices is investigated, e.g. by El-Sehity et al. (2002) and by Fellner and Maciejovsky (2002).

<sup>6</sup>An English translation of the instructions is to be found in the appendix.

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## **Appendix: Instructions about the market**

Thank you for participating in our experiment. The experiment will last for about 2 hours and 15 minutes. You will trade assets on a market, whereby your payoff is contingent on your decisions.

In the following, the trading mechanism is explained in detail. You will learn how to place buying and selling offers, and how to accept offers by other market participants. After reading the instructions, there will be time to ask questions. Afterwards there will be a short test to check whether you have understood the trading rules. The experiment will not begin until all participants have correctly answered all questions in the test. Then you will participate on a trial market with two periods: You will have the opportunity to try out the buying and selling procedures without affecting your payoffs. The two trial periods will last for six minutes each. After the trial market the real asset market will be opened.

Let us now explain how the asset market works. Generally, there are two possibilities to buy assets and two possibilities to sell assets.

Let us start with the buying of assets: You can buy assets in two ways: You can either (i) submit a bid to the market, or you can (ii) accept a standing ask made by another market participant.

(i) If you want to submit a bid, you have to type your maximal buying price in the input box “your bid” and press the button “bid” (ii) If you want to accept a standing ask made by another market participant, you have to press the button “buy.” Standing asks for the assets are ranked according to prices and listed in columns. Of course, the best offer for you, and all other potential buyers, is the lowest ask. The lowest ask is listed at the bottom of the column.

Let us now explain the selling of assets: You can sell assets in two ways: You can either (i) submit an ask to the market, or you can (ii) accept a standing bid made by the other market participants.

(i) If you want to submit an ask, you have to type your minimal selling price in the input box “your ask” and press the button “ask.” (ii) If you want to accept a standing bid made by another market participant, you have to press the button “sell.” Standing bids for the assets are ranked according to prices and listed in columns. Of course, the best offer for you, and all other potential sellers, is the highest bid. The highest bid is listed at the bottom of the column.

Note that you can engage simultaneously in buying and selling activities. However, you cannot buy more assets than your cash holdings allow, and you cannot sell more assets

than you own. If you have submitted a bid to the market, then your available money for further activities is reduced by this amount. On the other hand, if you have submitted an ask to the market, then your available asset holdings are reduced by this one offer. That is, we do not grant any credit, nor do we allow short selling.

Only improving offers, i. e., higher bids and lower asks, are allowed on the market. During a trading period you can buy assets, sell assets, or remain passive. You can engage in all three possibilities at all times. In fact, you can simultaneously submit buying offers and selling offers, and accept standing offers made by other market participants.

You are also informed about the remaining trading time, the current period number, and about the previous trades and their trading prices. All trades are chronologically listed in the column “previous trades.”

You will now have the opportunity to try out the buying and selling procedures without affecting your payoffs. The trial market consists of two periods, each lasting for six minutes.

[Trial market]

Now the “real” markets will be opened. You will trade assets on two separate markets, referred to as market A and market B. At the beginning of each trading period you will be reminded whether market A or B will be opened. The sequence of the market was determined randomly. Each trading period lasts for 180 seconds.

At the beginning of the markets you will be endowed with 1,000 Experimental Currency Units (100 ECU equal €0.18) plus five assets on each of the two markets, A and B. Note that the monetary endowment is carried forward on both markets, whereas assets of type A can only be traded on market A and assets of type B only on market B, respectively.

The minimum number of trading periods for each of the two markets is 8 and the maximum number of trading periods is 12. The probability that the market ends after the 8th, 9th, 10th, and 11th period is 25 percent. This means there is a chance of 3 over 4 that the market continues after period 8. Similarly, there is an equal chance that the market continues after period 9, 10, and 11, once this period has been reached. Only when period 12 is reached, is it certain that this will be the final market period.

Dividends are randomly drawn from a normal distribution with a certain mean and variance. At the beginning of each period you will be informed about the mean as well as the variance of the distribution. At the end of the final market period, the liquidation value of the asset is zero. This means that once the final market period is reached, the assets carry no intrinsic value; they are worth zero ECU.



In this period dividends are randomly drawn from a normal distribution with a mean of 95 ECU and a variance of 20 ECU.

With a probability of 5 percent the next dividend will be larger (smaller) or equal to 134 ECU (56 ECU). This means that on average in five out of 100 cases the observed dividend will be larger (smaller) or equal to 134 ECU (56 ECU).

Note: The information provided to subjects in the negative framing condition is displayed in parantheses.

Figure 1: Available information at the beginning of the first trading period of market A for positively and negatively framed subjects

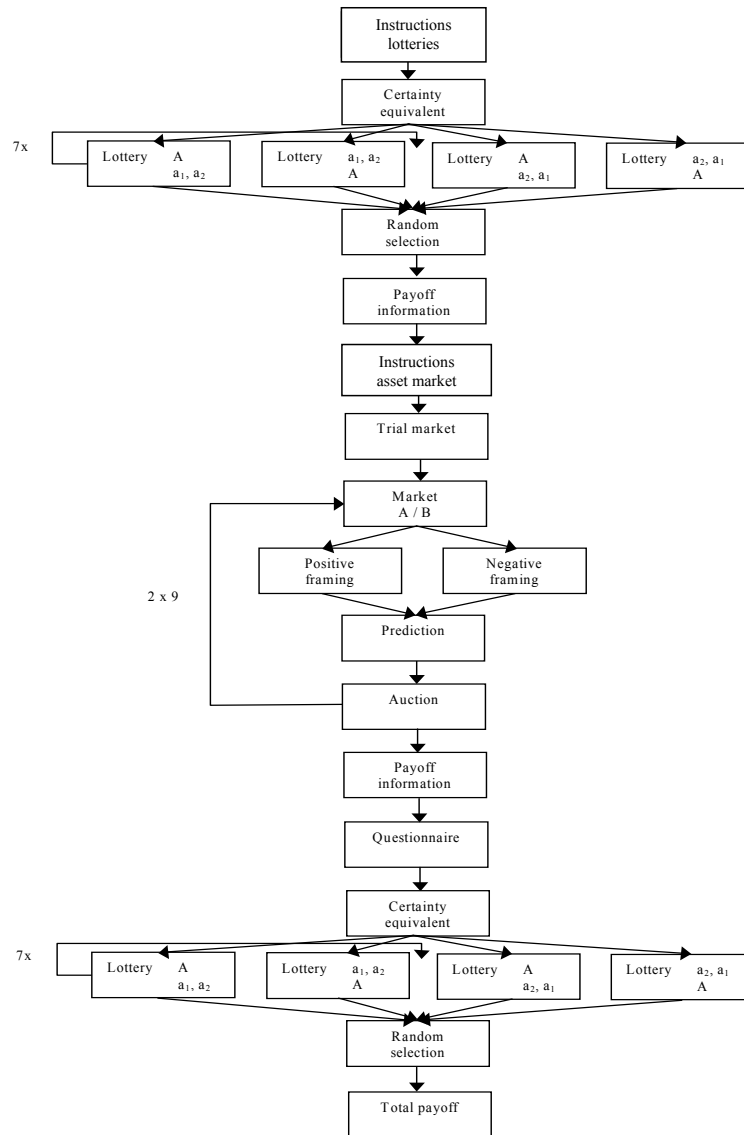


Figure 2: Sequence of events in the experiment

				Remaining Time: 12
<b>Guilders 306</b> <b>Asset B 5</b>	Your Purchasing Price 40	Current Market Price 75	Deviation + 35	<b>Asset Market</b>  <i>B</i>
Your Ask  <input type="text"/>	Asks	Market Prices	Bids	Your Bid  <input type="text" value="70"/>
	90 85 75	50 40 75	65 66	
<input type="text" value="Ask"/>	<input type="text" value="Buy"/>	<input type="text"/>	<input type="text" value="Sell"/>	<input type="text" value="Bid"/>

Figure 3: Computer screen for the auction

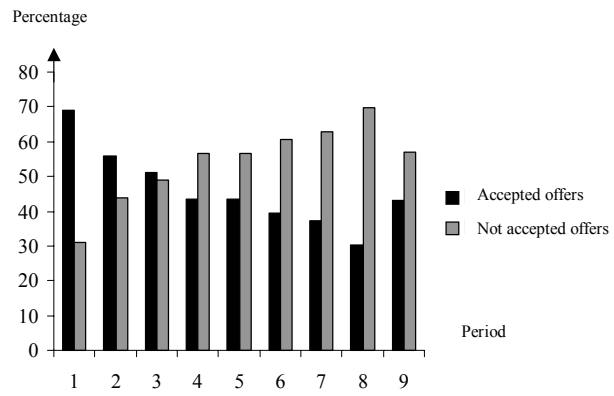


Figure 4: Percentage of accepted and not accepted offers for market A

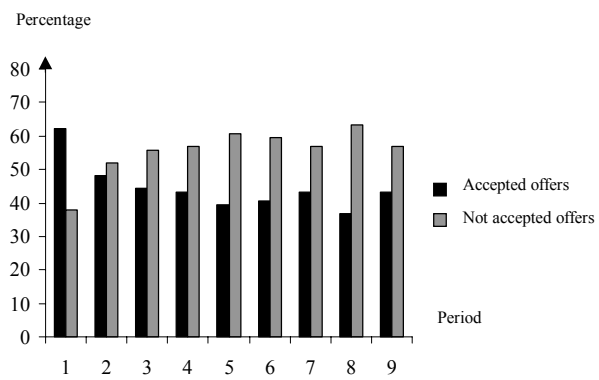


Figure 5: Percentage of accepted and not accepted offers for market B

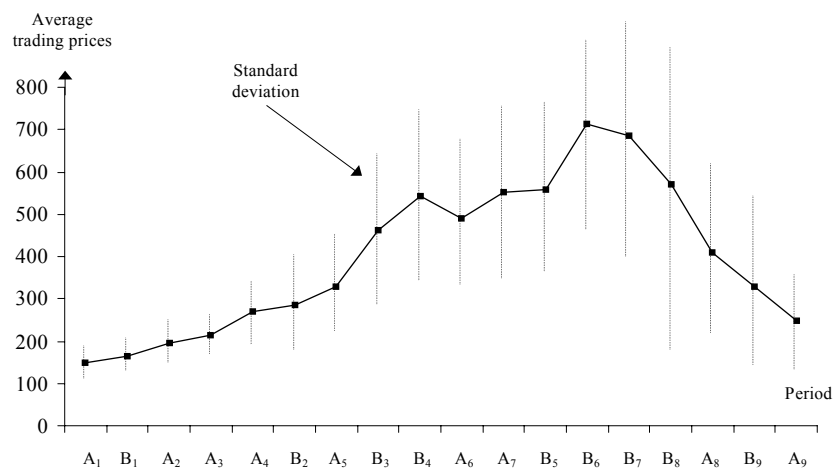


Figure 6: Average trading prices and standard deviations for market A and market B across periods

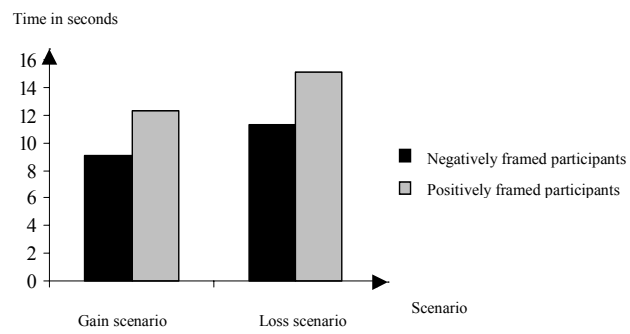


Figure 7: Average time difference between a subject's buying action and the next selling action for positively and negatively framed participants in gain and loss scenarios

Table 1: Positive and negative dividend information of markets A and B for all periods

	Market and (Period)	$\sigma_1 = 20$ $\underline{X}_p - \overline{X}_p$	Market and (Period)	$\sigma_2 = 30$ $\underline{X}_p - \overline{X}_p$	Market and (Period)	$\sigma_3 = 40$ $\underline{X}_p - \overline{X}_p$
$\mu_1 = 95$	A(1)	56 - 134	A(2)	36 - 154	A(3)	17 - 174
	B(9)	92 - 98	B(8)	91 - 99	B(7)	90 - 100
$\mu_2 = 135$	A(4)	96 - 174	A(5)	76 - 194	A(6)	57 - 214
	B(6)	132 - 138	B(5)	131 - 139	B(4)	130 - 140
$\mu_3 = 105$	A(7)	66 - 144	A(8)	46 - 164	A(9)	27 - 184
	B(3)	102 - 108	B(2)	101 - 109	B(1)	100 - 110



Table 2: Lottery payoffs in Experimental Currency Units

Lottery		Payoff	p	Expected value
1	$a_1$	160	.20	88
	$a_2$	70	.80	
	$A$	88	1.00	
2	$a_1$	150	.32	99
	$a_2$	75	.68	
	$A$	99	1.00	
3	$a_1$	178	.28	106
	$a_2$	78	.72	
	$A$	106	1.00	
4	$a_1$	140	.35	101
	$a_2$	80	.65	
	$A$	101	1.00	
5	$a_1$	135	.40	105
	$a_2$	85	.60	
	$A$	105	1.00	
6	$a_1$	188	.25	98
	$a_2$	68	.75	
	$A$	98	1.00	
7	$a_1$	130	.30	102
	$a_2$	90	.70	
	$A$	102	1.00	

Note:  $A$  denotes the certain payoff, whereas  $a_1$  and  $a_2$  denote the risky payoff of the lottery.

Table 3: Observed and expected trading volume between negatively framed sellers and positively and negatively framed buyers

	Positively framed buyers	
	Observed trading volume	Expected trading volume
Negatively framed sellers	870	820.4
Positively framed sellers	634	683.6
$\Sigma$	1,504	

Table 4: Observed and expected trading volume between negatively framed sellers and positively and negatively framed buyers

	Negatively framed sellers	
	Observed trading volume	Expected trading volume
Positively framed buyers	905	839.5
Negatively framed buyers	634	699.5
$\Sigma$	1,539	