

Framing Effects on Asset Markets

- An Experimental Analysis - *

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Abstract

In this paper we investigate four hypotheses which are inconsistent with expected utility theory, but may well be explained by prospect theory. It deals with framing, the non-linearity of subjective probabilities, the disposition effect, and the correspondence of different experimental risk elicitation methods.

Overall, 64 participants traded two assets on eight markets in a computerized continuous double auction. The results (i) indicate that the framing of information influenced individual trading behavior and asset holdings. However (ii), the variation of the probability of the framed information had no influence on trading volume. In addition, the results (iii) confirm the disposition effect. Participants who experienced a gain sold their assets more rapidly than participants who experienced a loss. In line with previous empirical results, we (iv) found little correspondence between different experimental risk elicitation methods.

Keywords: Prospect Theory, Framing, Disposition Effect, Financial Markets, Risk Attitude

JEL-Classification: D44, C91, G12

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1. Introduction

Standard finance theory is based on expected utility theory, Bayesian updating, and rational expectations leading to a picture of investors as fully rational utility maximizers. According to this paradigm individual decisions are based on expected utility of returns. It is assumed that investors are able to identify relevant information, weight and process it accurately according to expected states, and finally choose the combination of assets offering the highest expected utility.

Empirical evidence, however, suggests that individual decision makers frequently violate the prescriptive predictions of standard finance theory and prove it to be descriptively false. Among others, standard finance theory fails to explain the disposition effect (Shefrin and Statman, 1985; Weber and Camerer, 1998), the equity premium puzzle (Benartzi and Thaler, 1995), framing effects (Weber, Keppe and Meyer-Delius, 2000), or loss aversion (Myagkov and Plott, 1997; Odean, 1998).

While these phenomena cannot be explained by expected utility theory, prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) as a descriptive approach is regarded as helpful and powerful in explaining them (Camerer, 1998). Features of the theory, such as reflection effect, loss-aversion, and non-linear weighting of probability, are sufficient to explain the above-described phenomena. In contrast to expected utility theory the carriers of value are not final outcomes, but rather gains and losses in wealth relative to a reference point. Thus in a financial context, prospect theory predicts that investors do not only care about total absolute wealth, but rather about *fluctuations* in wealth. Furthermore, investors are predicted to exhibit risk-averse behavior in the domain of gains, and risk-seeking behavior in the domain of losses.

The aim of the present study is to investigate individual decision making within the context of an experimental asset market. The focus lies, in particular, on framing effects, on the non-linearity of probabilities in the decision process, on the disposition effect, and on the correspondence of different experimental risk elicitation methods. It is (i) hypothesized that objectively *irrelevant* information that is framed in terms of gains or in terms of losses influences individual trading behavior (framing effects). More precisely our hypothesis is pointed to individual asset holdings: It is expected that positively framed buyers purchase assets rather from negatively than from positively framed sellers, whereas in turn negatively framed sellers are expected to rather sell their assets to positively framed buyers than to negatively framed buyers. It is (ii) hypothesized that the framed dividend information forms and shapes individual price expectations, and thus also individual trading volume (non-linearity of subjective probabilities). It is (iii) hypothesized that individual investors try to secure gains by immediate selling and undo or "repair" losses by holding assets (disposition effect). Eventually it is (iv) investigated whether different experimental risk elicitation methods lead to similar results. More precisely, correspondence with respect to the method of certainty equivalents and binary lottery decisions is investigated. All four hypotheses imply violations of expected utility theory, but are consistent with prospect theory.

The paper is organized as follows: Section 1.1 briefly deals with literature on framing effects, section 1.2 discusses evidence about the non-linearity of subjective probabilities, and section 1.3 focuses on the disposition effect as one of the possible implications of prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) with respect to individual trading behavior on asset markets. Section 1.4 deals with empirical evidence on the procedural invariance of different experimental risk elicitation methods. In section 2 the

experiment is introduced. Also, the participants, the experimental design, and the procedure are briefly discussed. Section 3 deals with the experimental results, and section 4 concludes the most striking results.

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, Pauker, Sox and Tversky (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, Kahneman and Riepe (1998) as well as Statman (1995) applied the concept of framing to financial decisions, such as dollar-cost averaging.

Weber, Keppe and Meyer-Delius (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, Keppe and Meyer-Delius (2000) found that overpricing¹ was more often observed for negatively framed market participants than for positively framed participants.

In contrast to Weber, Keppe and Meyer-Delius (2000) who altered participants' initial actual endowments, the present study investigates whether framing effects are also robust under weaker conditions, for instance when participants only obtain different and more importantly *irrelevant* information. In our experiment, participants were informed that dividends were randomly determined and drawn out of a normal distribution with a commonly known fixed μ and a fixed σ . Besides, participants obtained an objectively irrelevant additional information, namely either a dividend that could be greater than or equal to X_m with a probability p that exceeded μ (positive framing) or a dividend less than or equal to X_n with a probability p that fell short of μ (negative framing), with $X_n < \mu < X_m$ and $0 < p < 1$.

Note that our experimental procedure to investigate framing effects 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 in terms of "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. For instance, 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 at all emerged. 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 focussing on Asian disease-like studies, by Kühberger,

¹ Overpricing refers to market prices that exceed the total value of the lotteries traded (Rietz, 1993a).

Schulte-Mecklenbeck and Perner (1999) indicate that risk preference depends on the size of payoffs, on the probability levels, and on the type of good at stake.

In our experimental procedure, the decision problem is actually sufficiently described by the information about a commonly known fixed μ and a fixed σ . It is expected that μ serves as the neutral reference point from which "gains" - dividend information that positively deviates from μ (positive framing), and from which "losses" - dividend information that negatively deviates from μ (negative framing), are defined. From this assumption our main hypothesis with respect to individual asset holdings is derived:

Hypothesis 1: Framing of dividend information influences individual trading behavior: Positively framed buyers are expected to purchase assets rather than from negatively framed sellers, whereas in turn negatively framed sellers are expected to rather sell their assets to positively framed buyers than to negatively framed buyers.

1.2 Subjective probabilities

Expected utility theory predicts linearity in probabilities. Thus, reducing the probability of winning from 1.00 to .25 should have the same effect as a reduction from .80 to .20, both should be considered to be a reduction of factor four, regardless of the starting point. Empirical evidence, however, suggests that this prediction is systematically violated in actual decision making (i.e., first noted by Allais, 1953), indicating that probabilities are not perceived as being linear. Thus, an event has more impact when it turns from impossibility into possibility, or possibility into certainty, than when it merely makes a possibility more likely (Tversky and Fox, 1995). Correspondingly, individuals overweight outcomes that are considered certain, relative to outcomes perceived as merely probable.

Camerer (1987) investigated whether biases in probability judgments matter on experimental asset markets. He found that generally, asset prices tended towards the Bayesian predictions, but there was still some evidence of biased prices and allocations. However, the degree of bias was small, and tended to be even lower for experienced participants, although experience did not completely eliminate the bias. Duh and Sunder (1986) also reported that prices were close to Bayesian predictions, but asset allocations were strongly supportive of representativeness heuristic. Anderson and Sunder (1989) compared students with professional securities and commodity traders. Observed prices were far from Bayesian predictions in the student sessions, and closer to Bayesian predictions in the sessions with experienced traders. Jamal and Sunder (1996) showed that markets populated by traders who used simple adaptive heuristics can converge to Bayesian equilibrium, even though the heuristics were myopic and ignored base rate information.

In the present study, participants traded assets on two separate markets which are referred to as market A and market B. The framed information on market A deviates more extremely from the reference point than the framed information on market B. More precisely, on market A participants obtained information about the next dividend being either greater than or equal to X_m or less than or equal to X_n , whereby the probability p that a dividend larger equal X_m or smaller equal X_n actually occurs is only 5%. On market B, on the contrary, a dividend larger than or equal to X_k or less than or equal to X_l had a probability p of 90% ($X_n < X_l < \mu < X_k < X_m$).

If the framed information is strong enough to form and shape individual expectations, it can be assumed that the trading volume will be higher on market A than on market B, since the

dividend information on the former market stronger deviates from μ than on the latter market. Extreme information is assumed to create more diverging price expectations which will increase the likelihood that pairs of participants willing to trade will actually meet on the market.

Hypothesis 2: Varying the probabilities of the framed information influences individual price expectations. Due to the fact that dividend information is more extreme on market A it is expected that also the trading volume on this market will be higher than on market B.

1.3 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 on gains and losses relative to a reference point and not on the basis of absolute levels of final wealth. Prospect theory predicts that subjective gains are associated with risk aversion, whereas subjective losses imply risk-seeking behavior. Thus in a financial context, one can 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, Läger and Oehler, 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 a median of 124 days, whereas winners were only held for 104 days. Heilmann, Läger and Oehler (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, Läger and Oehler (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 as subject's purchase price as Weber and Camerer (1998) did. 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 using the software z-Tree (Fischbacher, 1998).

Hypothesis 3: 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.

1.4 Experimental risk elicitation methods

According to expected utility theory different procedures to infer risk attitude should yield the same outcome. However, there is empirical evidence that the results differ across methods. For instance, Rietz (1993b) explores the effect of the binary lottery procedure in an auction and finds evidence that observed behavior does not follow the predictions of expected utility theory. Davis and Holt (1993), Roth (1995), and Krahen, Rieck and Theissen (1997b) summarize that initial experimental work to infer risk attitude is not encouraging. Particularly, Krahen, Rieck and Theissen (1997a) seriously doubt the usefulness of individual certainty

equivalents as meaningful indicators of individual risk attitude, and Selten, Sadrieh and Abbink (1999) doubt the usefulness of the binary lottery mechanism to induce risk neutrality. The authors conclude that money does not induce risk neutrality, but binary lotteries do even worse.

In the present study correspondence of different experimental risk elicitation methods was studied. Particularly, it was investigated whether participants' risk attitude inferred by the method of certainty equivalents corresponds to the risk attitude inferred by binary lottery choices. In line with previous empirical evidence on the correspondence of different experimental risk elicitation methods, it is expected that individual risk attitude differs across the methods studied.

Hypothesis 4: Individual risk attitude will differ across the methods of certainty equivalents and binary lottery choices.

2. Experiment

2.1 Participants

Overall, 64 participants, all students either at the University of Vienna or at the Vienna University of Economics and Business Administration, participated in eight sessions of an experimental asset market. On average, participants earned a remuneration of ATS 263.34, approximately \$17 in June 2000 when the experiment was conducted, the standard deviation was ATS 205.58 (about \$13). Remuneration ranged from a minimum of ATS 19.58 to a maximum of ATS 870.78. 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 introductory courses in statistics during their studies.

2.2 Experimental Design

The experiment was conducted in a 2×2 factorial design in order to allow 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) as a within-subjects factor. Participants were randomly assigned to one of the two framing conditions.

All participants were informed that the next dividend would be randomly drawn out of a normal distribution with $\mu \in \{\mu_1, \dots, \mu_3\}$ and $\sigma \in \{\sigma_1, \dots, \sigma_3\}$. For the combination and the sequence of μ and σ see Table 1. (i) In the experimental condition "framing of dividend information", participants obtained an additional item of information about the next dividend that could either be larger than or equal to X_m with a probability p that exceeded μ (positive framing) or less than or equal to X_n with a probability p that fell short of μ (negative framing), with $X_n < \mu < X_m$ and $0 < p < 1$. (ii) In the experimental condition "probability of the framed information", assets could be traded on two independent markets, A and B. On market A, participants were informed about dividends (larger equal X_m , smaller equal X_n) with an unlikely probability p of 5%, whereas on market B, the dividends (larger equal X_k , smaller equal X_l) had a high probability p of 90% (with $X_n < X_l < \mu < X_k < X_m$).

Table 1: Dividend information of market A and market B for all periods

	Market and (Period)	$\sigma_1 = 20$ $X_m - X_n /$ $X_k - X_l$	Market and (Period)	$\sigma_2 = 30$ $X_m - X_n /$ $X_k - X_l$	Market and (Period)	$\sigma_3 = 40$ $X_m - X_n /$ $X_k - X_l$
$\mu_1 = 95$	A (1)	134 - 56	A (2)	154 - 36	A (3)	173 - 17
	B (9)	98 - 93	B (9)	99 - 91	B (7)	100 - 90
$\mu_2 = 135$	A (4)	174 - 96	A (5)	194 - 76	A (6)	213 - 57
	B (6)	138 - 133	B (5)	139 - 131	B (4)	140 - 130
$\mu_3 = 105$	A (7)	144 - 68	A (8)	164 - 46	A (9)	183 - 27
	B (3)	108 - 103	B (2)	109 - 101	B (1)	110 - 100

Note that both, the framing of dividend information and the probabilities of the framed information are objectively irrelevant information to the decision maker, because the decision problem is sufficiently described by μ and σ . According to standard economic theory, irrelevant information is not only required to not interfere with the decision being made, but should also leave the decision problem itself merely unchanged. In other words, the presence of irrelevant information should not increase the probability that it is actually used in the decision process nor that it irradiates on the decision problem itself and thereby influences choice.

2.3 Procedure

The experiment consisted of four phases. In the first phase, subjective propensity towards risk was measured experimentally by the methods of certainty equivalents and by binary lottery decisions in order to control for 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 1.

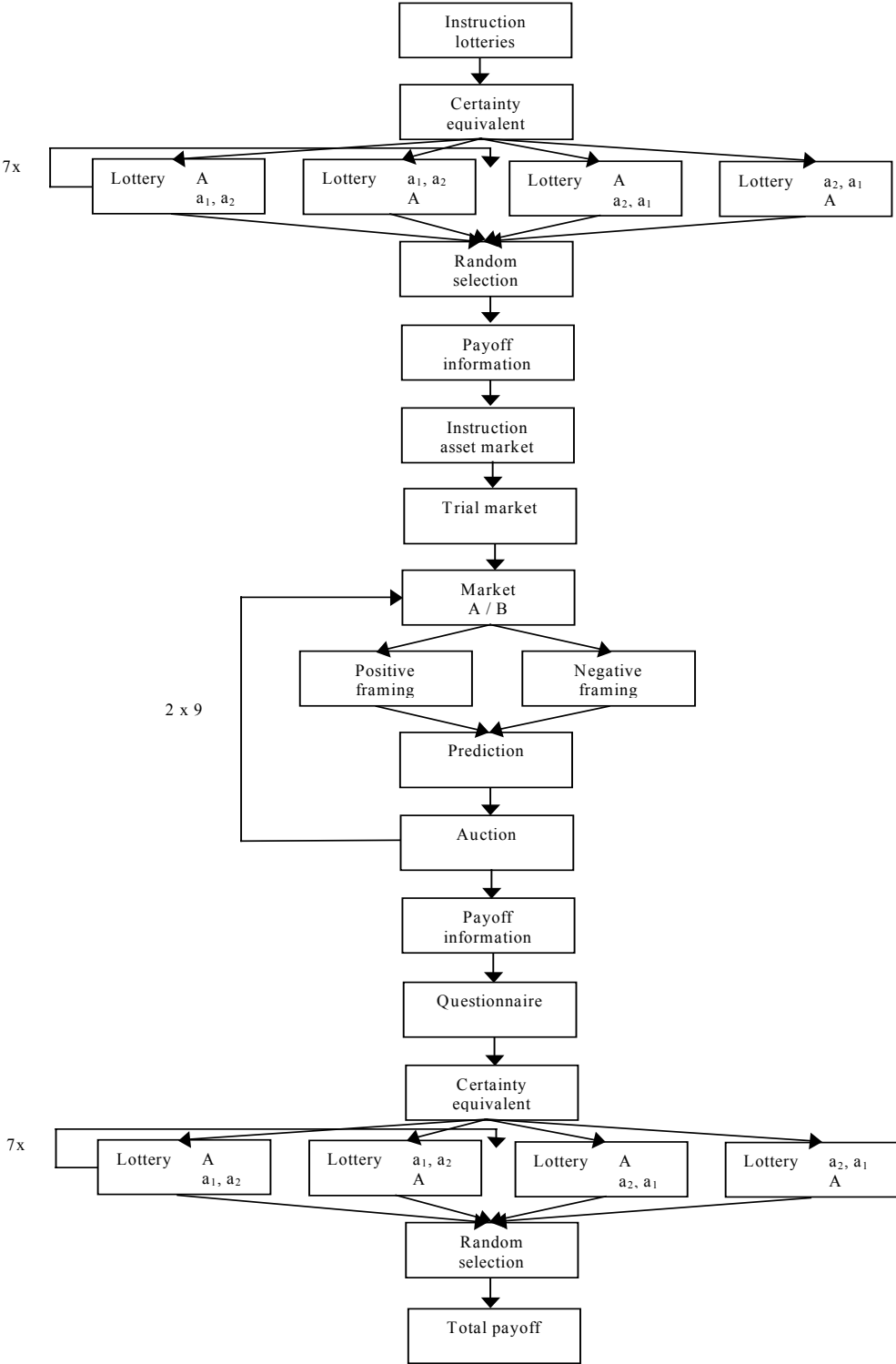
Phase 1: After brief instructions, participants were asked (i) to reveal their certainty equivalent for a lottery that offers a payoff of 100 Experimental Guilders² with a probability of $p = .50$, and zero Experimental Guilders otherwise; and (ii) to make seven decisions among risky lotteries. The payoffs 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).

The certainty equivalent allows the experimenter to infer participants' attitude towards risk. More precisely, it allows him/her 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 Experimental Guilders, indicates risk aversion, whereas a certainty equivalent equal to the expected value indicates risk neutrality, and finally a certainty

² The exchange rate for Experimental Guilders was 10 to 1, that is 10 Experimental Guilders equal 1 Austrian Schilling.

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)

Figure 1: Sequence of events in the experiment



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 auction. The time required for phase 1 was about 15 to 20 minutes.

Table 2: Lottery payoffs in Experimental Guilders

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.

Phase 2: After receiving instructions about the experimental asset market, 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, programmed by z-Tree (Zurich Toolbox for Readymade Economic Experiments, Fischbacher, 1998).

The computer screen for the auction is displayed in Figure 2. Each market participant was entitled (i) to submit bids and asks, (ii) to accept standing bids and asks, whereas only better offers, for instance higher bids and lower asks respectively were allowed, or (iii) to stay aloof. Bids and asks were automatically ranked, indicating the most favorable offer. Information about trading history, provided as a chronological list of contracts, was common knowledge.

The experiment was performed as a continuous anonymous double auction. Participants were endowed with 1,000 Experimental Guilders (exchange rate: 100 Experimental Guilders equal 2.5 Austrian Schillings) 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 out of 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.

Figure 2: Computer screen for the auction

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

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) they received either positively framed dividend information or negatively framed information, and (iii) they had to predict the next average trading price of the assets, generate a subjective confidence interval of 98 percent range, and they had to state how certain they were that their predictions were accurate. The time required for conducting phase 2 was about 80 to 90 minutes.

Phase 3: Participants were asked to fill out a computerized post-experimental 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. The total time required for phase 3 was about 15 to 20 minutes.

Phase 4: Finally, participants again had to reveal their certainty equivalent for a lottery offering a payoff of 100 Experimental Guilders with a probability of $p = .50$ and zero Guilders otherwise; and to make seven decisions among lotteries. The exchange rate was 10:1, that is 10 Experimental Guilders equal 1 Austrian Schilling. The payoffs were identical with those used in phase 1 and displayed in Table 2. The time required for phase 4 was 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 Guilders (SD = 390.71).

Figure 3a and Figure 3b indicate that over the trading periods, the percentages of concluded contracts decreased both in market A ($\chi^2 = 112.91$, $p < .001$) and in market B ($\chi^2 = 73.83$, $p < .001$), while the percentages of not accepted offers increased in market A ($\chi^2 = 75.02$, $p < .001$) and market B ($\chi^2 = 20.16$, $p < .05$).

Figure 3a: Percentage of accepted and not accepted offers for market A

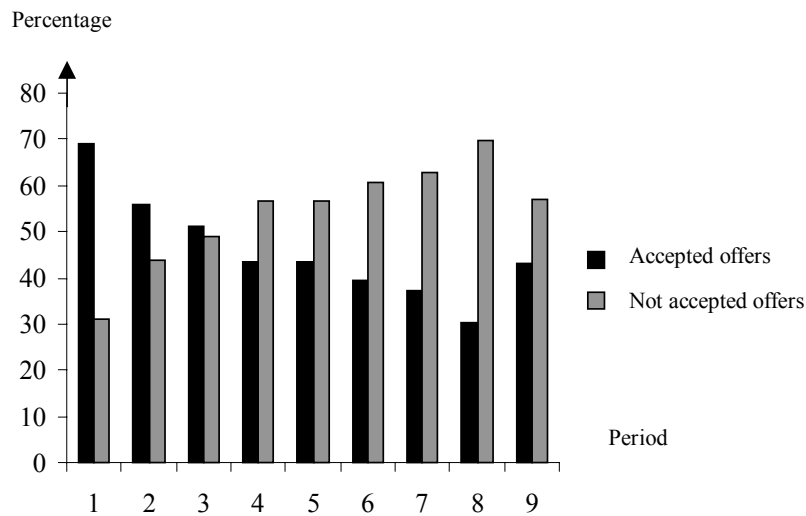
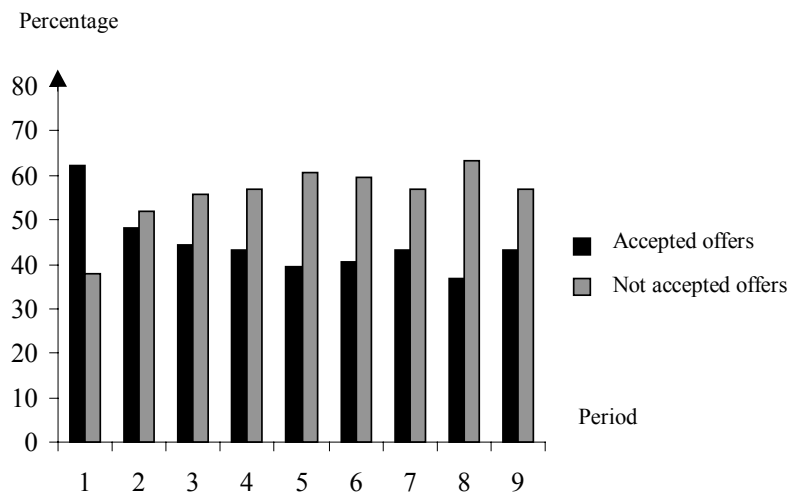


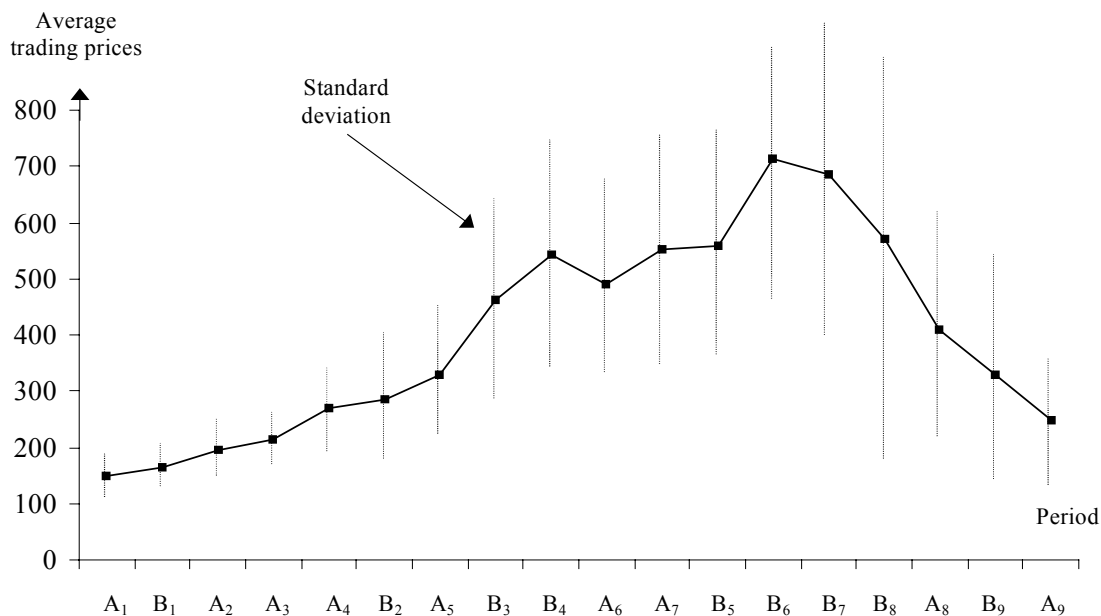
Figure 3b: Percentage of accepted and not accepted offers for market B



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 4 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 prices were still higher in the last period than in the first. Figure 4 also indicates that in times of high uncertainty, especially in late trading periods, the variance of market prices increased.

Figure 4: Average trading prices and standard deviations for market A and market B across periods



To control for 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), indicating that in 3.66 cases the secure rather than the risky alternative in the lottery was chosen. Again no statistically significant difference between the eight sessions was observed ($F(7; 56) = 0.95$, $p = .47$). Also, there was no 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, it can be expected that any differences observed in the experiment between experimental conditions were not caused by different risk attitudes.

In addition, it was found that risk attitude does not differ between the first measurement before the auction was performed and the second measurement after the auction, both for certainty equivalents ($M_I = 44.23$, $SD_I = 31.20$; $M_{II} = 45.58$, $SD_{II} = 31.91$; $F(1; 62) = 0.15$, $p = .70$) as well as 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 reactive 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 their selling orders (M = 6.09, SD = 2.08). Subjects also agreed that they had tried to maximize their earnings (M = 6.83, SD = 1.94). Generally, participants found it more difficult to accurately predict the next market price in early trading periods (M = 4.56, SD = 2.25) as compared to late trading periods (M = 5.30, SD = 2.52). All questions were formulated as statements that subjects could disagree with or agree with (ranging from 1=I do not agree to 9=I agree).

In the following our four hypotheses, concerning (i) framing effects, (ii) non-linear subjective probabilities, (iii) the disposition effect, and (iv) risk elicitation methods are investigated.

3.2 Framing effects

It was hypothesized that trading activity, particularly individual asset holdings, would differ depending on the framing conditions involved. Thus, it was expected that objectively irrelevant information about dividends influences trading behavior. Like Keppe and Weber (1993) the focus of our analysis lies on individual asset holdings. It was expected that positively framed buyers would purchase assets rather from negatively than from positively framed sellers, whereas in turn negatively framed sellers would rather sell their assets to positively framed buyers than to negatively framed buyers.

The experimental results with respect to individual asset holdings confirm hypothesis 1. Figure 5a shows the relative frequency of concluded contracts for positively framed buyers with respect to negatively and to positively framed sellers. The results indicate that positively framed buyers purchased assets rather from negatively than from positively framed sellers ($\chi^2 = 37.03$; $p < .001$). On the contrary, Figure 5b shows the relative frequency of concluded contracts for negatively framed sellers with respect to positively and to negatively framed buyers. The results indicate that negatively framed sellers rather sold their assets to positively framed buyers than to negatively framed buyers ($\chi^2 = 7.56$; $p < .01$).

Figure 5a: Relative frequency of concluded contracts by positively framed buyers with positively and negatively framed sellers

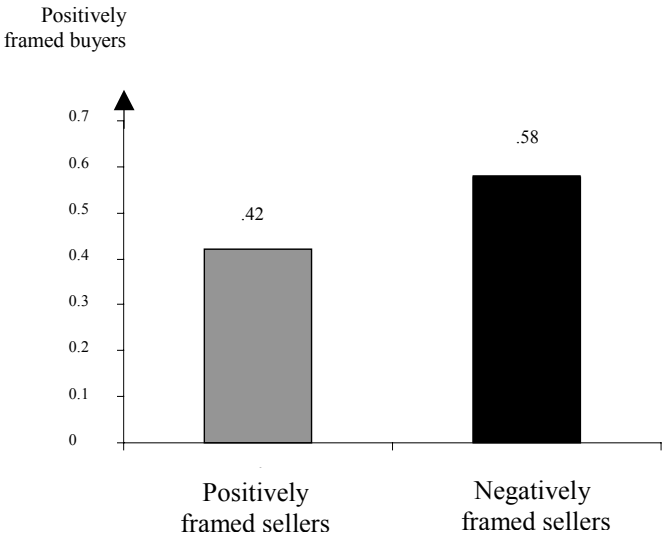
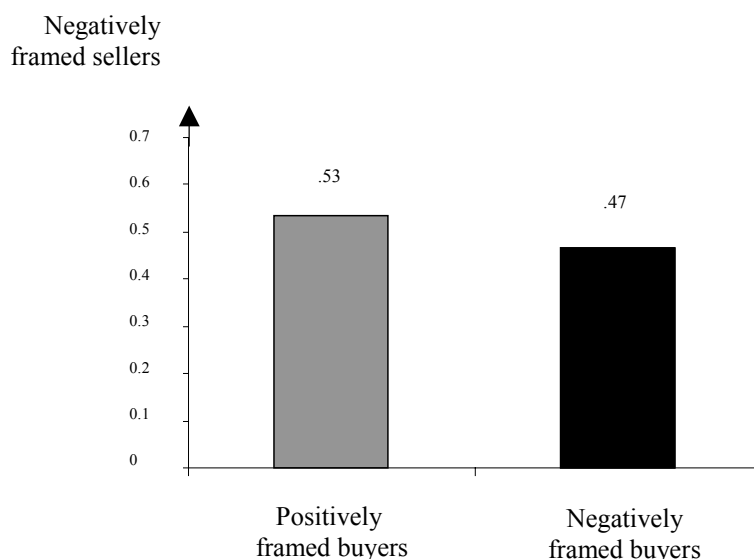


Figure 5b: Relative frequency of concluded contracts by negatively framed sellers with positively and negatively framed buyers



As can be seen from Table 3, there was a difference between the trading activity of positively and negatively framed subjects. Generally, negatively framed subjects concluded more buying contracts ($\chi^2 = 8.08$, $p < .01$) than positively framed subjects. However, with respect to the number of selling contracts, no statistically significant difference was observed ($\chi^2 = 2.56$, $p = .11$). Also, the number of submitted buying and selling offers that were not accepted by other market participants differed between positively and negatively framed subjects. The number of not accepted selling offers was significantly higher for positively framed participants than for negatively framed participants ($\chi^2 = 9.77$, $p < .05$) as well as the number of not accepted buying offers which were again higher for positively than for negatively framed participants ($\chi^2 = 8.80$, $p < .01$).

Table 3: Frequency of accepted and not accepted offers for positively and negatively framed subjects

Framing	Accepted offers		Not accepted offers	
	Selling offers	Buying offers	Selling offers	Buying offers
Positively framed subjects	1,539	1,504	889	1,151
Negatively framed subjects	1,629	1,664	762	1,013

Overall, positively framed participants ($f(x) = 2,055$) submitted more offers than negatively framed participants ($f(x) = 1,792$; $\chi^2 = 17.98$; $p < .001$). However, these offers did not increase the number of contracts concluded ($f(x) = 1,594$ vs. $f(x) = 1,574$; $\chi^2 = 0.13$; $p = .76$). Table 4 indicates that the trading activity was highest among those market participants who obtained differently framed information (e.g., between negatively framed buyers and positively framed sellers), and lowest within the same informational conditions (e.g., between positively framed buyers and sellers; $\chi^2 = 56.70$; $p < .001$).

Table 4: Frequencies of concluded contracts with respect to dividend information

Seller	Buyer		Total
	Positively framed information	Negatively framed information	
Positively framed information	634	905	1,539
Negatively framed information	870	759	1,629
Total	1,504	1,664	3,168

In a next step trading behavior over time was analyzed. This analysis was run only on contracts based on actively submitted offers to the market. The acceptance of offers by other market participants were excluded from the subsequent analysis. In a further step the difference between contracts based on subjects' selling offers minus contracts based on subjects' buying offers were computed. If this figure is positive, then selling activity exceeded buying activity, whereas if the figure is negative, buying exceeded selling activity. Figure 6 shows the difference between the contracts based on selling offers minus contracts based on buying offers for both markets, A and B, according to their overall sequence.

Figure 6: Difference between the contracts based on selling offers minus contracts based on buying offers for both markets

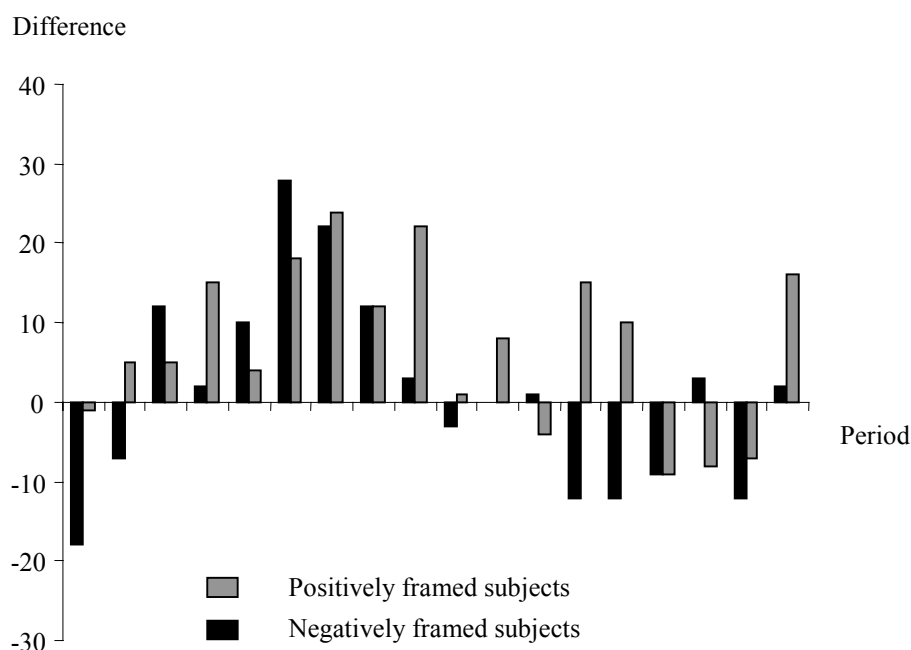


Figure 6 indicates that in general, negatively framed subjects were able to complete buying offers more often than positively framed subjects, especially in the first two periods, whereas positively framed subjects were able to complete selling offers more often, particularly in the last trading period.

3.3 Subjective probabilities

Second, it was hypothesized that varying the probabilities of the framed information would form and 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 market would be higher than the trading volume of the latter market.

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

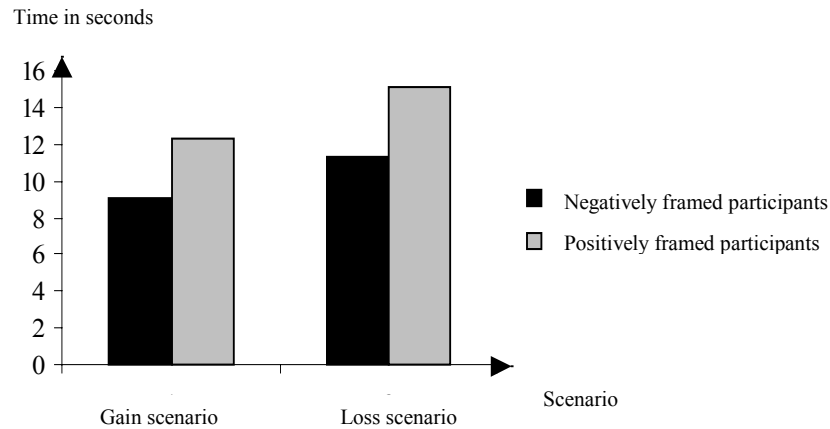
However, since Figure 4 indicates that participants seemed not to distinguish between the two asset markets, the observed higher trading volume on market A may be due to the unbalanced sequence of periods of the two markets. Figure 4 indicates that prices followed an upward trend on both markets up to 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 unexperienced, market A was more often opened 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. If we take this possibility into account and interpret our results conservatively, we cannot reject the null hypothesis, saying that the number of contracts is the same on both markets, A and B.

3.4 Disposition effect

Third, it was hypothesized that the purchase price would be employed as the reference point in market participants' decisions. Based on prospect theory, one would expect that a purchase price lower than the previous market price would imply a gain situation that would lead to more rapid selling, whereas a purchase price higher than the previous trading price would imply a loss situation that would lead to less rapid selling.

To test this hypothesis two different scenarios, one describing a gain situation and another describing a loss situation, were defined. 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, 1998) used in the experiment enables us to calculate the exact time in seconds between a subject's buying and a subject's selling. It could 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 moderated 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 were more optimistically than negatively framed participants about the likely performance and profit of the assets and thus were more patiently, both in gain and loss situations.

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



The results confirm hypothesis 3, stating that winner assets are sold more readily than loser assets. In addition, it was shown that objectively irrelevant information framed either in terms of gains or in terms of losses did influence market behavior.

3.5 Correspondence of different experimental risk elicitation methods

Fourth, it was hypothesized that risk attitude would differ according to the methods of certainty equivalents and lottery decisions involved.

The results indicate that the two methods, namely certainty equivalents and lottery decisions, were not positively correlated with each other ($r(53) = -.10, p = .94$).³ In fact, no relation whatsoever was observed between these two methods. In a further step, correspondence between risk attitude and the method of certainty equivalents and lottery decisions was analyzed only for extreme cases, that is a certainty equivalent of 0 (complete risk aversion) and 50 (risk neutrality), as well as for a risk index computed from the lottery decisions of 0 (complete risk neutrality) and a value of 7 (complete risk aversion). Table 5 confirms the low correspondence between the methods.

Table 5: Correspondence between certainty equivalents and lottery decisions for extreme cases

Risk attitude	Certainty equivalents			Lottery decisions		
	Framing	Correspondence in percent	N	Framing	Correspondence in percent	N
Risk neutrality	Positive	0	11	Positive	0	2
	Negative	30	10	Negative	50	6
Risk aversion	Positive	0	0	Positive	0	9
	Negative	0	0	Negative	0	2

³ Only those certainty equivalents were used which discriminated between risk aversion and risk neutrality, because the lotteries were also designed in a way that allows one to discriminate only between risk aversion and risk neutrality.

In addition, an analysis was made to determine whether there was a relationship between risk attitude inferred by lottery decisions and individual market behavior. The results indicate that there is a statistically significant negative correlation between risk attitude and concluded contracts based on submitted buying offers ($r(61) = -.40, p < .01$) and selling offers ($r(59) = -.34, p < .01$) as well as between risk attitude and the total number of contracts ($r(63) = -.25, p < .05$). This finding based on lottery decisions indicates that the higher the degree of risk aversion, the lower the number of buying offers and selling offers resulting in a contract, and the lower the total number of contracts concluded in general.

It was also investigated whether there was a relationship between risk attitude inferred by certainty equivalents and individual market behavior. If one conducts a median-split and divides the sample into two groups, namely (i) risk averse and (ii) risk neutral and risk seeking subjects, then one can see that the two subsamples differ (Table 6).

Table 6 indicates that the number of not accepted offers did not differ significantly between the subsamples. However, the number of accepted offers was significantly lower for risk averse subjects than for risk neutral and risk seeking subjects.

Table 6: Number of accepted and not accepted offers with respect to individual risk attitude inferred by certainty equivalents

	Risk attitude	N	M	SD	χ^2 -Value	p
Not accepted offers	Risk aversion	1919	395.47	371.40	0.14	.71
	Risk neutrality & Risk seeking	1896	447.56	446.62		
Accepted offers	Risk aversion	1460	365.25	375.04	19.41	< .001
	Risk neutrality & Risk seeking	1708	370.62	403.71		

In general, the results indicate that despite the low correspondence between the method of binary lottery decisions and certainty equivalents, there is a tendency for risk aversion to lead to a lower number of concluded contracts, irrespective of the method used to infer individual risk attitude. However, both methods lead to different results with respect to the number of offers submitted to the market. According to the results of the binary lottery decisions, risk averse participants submitted a lower number of buying and selling offers, whereas according to the results of the certainty equivalents the number of offers was not lower for risk averse participants than for risk neutral and risk seeking participants.

4. Conclusion

Our experiment tried to further investigate to which degree individual biases well known in the literature show up in the context of a market environment. The main purpose of the paper was to investigate four hypotheses which are inconsistent with expected utility theory – still one of the dominant paradigms in standard finance – but may well be explained by prospect theory.

First, we investigated whether objectively irrelevant information that is framed in terms of gains or losses influences individual asset holdings. We used a novel type of framing that is not based on semantic variations of a decision problem. Our results indicate that positively framed buyers purchased assets rather from negatively than from positively framed sellers,

whereas in turn negatively framed sellers rather sold their assets to positively framed buyers than to negatively framed buyers. Thus, objectively irrelevant information shaped individual expectations which in turn influenced trading patterns and market behavior.

Second, the impact of a probability variation of the framed information was studied. It was expected that the framed information forms and shapes individual price expectations which imply that the trading volume on the market with the more extreme information (market A) will be higher than the trading volume on the other market. The results tendentially supported our conjecture. However, we believe that this effect is not due to the dividend information, but rather due to the unbalanced sequence of trading periods of the two asset markets.

Third, it was hypothesized that participants try to secure gains by immediate selling and undo or "repair" losses by holding assets. The results confirmed our conjecture. Participants more readily sold their assets in gain situations than in loss situations. Furthermore, this effect was moderated 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.

Fourth, correspondence between different experimental risk elicitation methods was studied. Our results indicate that the method of binary lottery decisions was not correlated to the method of certainty equivalents. Nevertheless we found that risk attitude as elicited by both methods was related to individual market behavior. Risk averse participants concluded less buying and selling contracts. However, both methods lead to different results with respect to the number of offers submitted to the market.

Our approach contrasts experimental findings with the predictions of expected utility theory. Three out of four findings violate expected utility theory, but may well be explained by prospect theory. In contrast to other studies which aim to investigate framing effects, we have not semantically framed the decision environment, but introduced a novel type of framing, based on the assumption that the expected dividend is employed as the reference point in the decision process. Framing was manipulated by introducing objectively irrelevant dividend information that either positively or negatively deviated from the reference point. Future research could further address the relation between experimentally inferred risk attitude and individual trading behavior.

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