The Journal of Psychology and Financial Markets
2002, Vol. 3, No. 4, 227–235

Hindsight Bias and Individual Risk Attitude within the Context of Experimental Asset Markets

Tarek El-Sehity, Hans Haumer, Christian Helmenstein, Erich Kirchler, and Boris Maciejovsky

This paper investigates the robustness of hindsight bias in experimental asset markets, the time-invariance of the different experimental risk elicitation methods of certainty equivalents and binary lottery choices, and their correspondence. The results of our within–subject approach with 133 traders do not support the conjecture that hindsight bias is a general phenomenon. Furthermore, our findings challenge the presumption of time-stable risk preferences and of procedural invariance with respect to different experimental risk elicitation methods.

Financial economics is, perhaps, the least behavioral of the various subdisciplines of economics (DeBondt and Thaler [1995, p. 385]).

Standard finance theory is based on expected utility theory and rational expectations (encompassing Bayesian updating), which leads to the belief that individual investment decisions are driven solely by the expected utility of returns. It is assumed that investors can identify relevant information (and discriminate against irrelevant information) and weight and process it accurately according to expected states.

Experimental evidence, however, indicates that actual investment decisions seldom follow these restrictive assumptions. Kirchler, Maciejovsky, and Weber [2001] and Dittrich et al. [2002] have shown that objectively irrelevant and selectively presented information also influence individual trading behavior in an experimental asset market. In a wider behavioral context, phenomena such as endowment framing (Weber, Keppe, and Meyer-Delius [2000]), the disposition effect (Shefrin and Statman [1985] and Weber and Camerer [1998]), overconfidence (Kirchler and Maciejovsky [2002] and Odean [1998b]), and loss aversion (Myagkov and Plott [1997] and Odean [1998b]) weaken the predictive power of standard finance theory.

Tarek El-Sehity is a research assistant at the University of Vienna, Department of Psychology.

Hans Haumer is managing partner of Wealth Architecture Ltd., Austria.

Christian Helmenstein is head of the department of Economics and Finance at the Institute for Advanced Studies in Austria.

Erich Kirchler is a professor with the University of Vienna, Department of Psychology.

Boris Maciejovsky is with the Max Planck Institute for Research into Economic Systems.

Requests for reprints should be sent to: Boris Maciejovsky, Max Planck Institute for Research into Economic Systems, Strategic Interaction Group, Kahlaische Strasse 10, D-07745 Jena, Germany. Email: maciejovsky@mpiew-jena.mpg.de

Although using standard finance theory to characterize optimal behavior is undisputed, using it to describe actual behavior is not. "The representative investor is assumed to understand the economy and the process determining asset prices; the individual investor frequently does not" (Brennan [1995, p. 61]).

A promising approach to describe and possibly explain financial decision-making may be the consideration of psychological factors. In particular, heuristics and biases need to be integrated. We have three aims in this paper:

1. To investigate whether hindsight bias, as a specific decision bias that has been extensively studied by psychologists, is robust in individual decision-making and in market environments by using a within–subject approach.
2. To analyze the time stability of individual risk attitudes, as inferred from certainty equivalents and binary lottery choices.
3. To analyze the correspondence of these experimental risk elicitation methods, that is, whether different methods yield identical classifications.

Our results question the hindsight bias as a general phenomenon. Rather, we find it is moderated by the specific methodological approach used. In addition, our findings challenge the presumption of time-stable risk preferences and of procedural invariance with respect to different experimental risk elicitation methods.

Hindsight Bias

Hindsight bias is based on empirical evidence indicating that individuals, after receiving outcome information, claim to have "known it all along" (Fischhoff [1975]). This is because, after they have occurred, events tend to seem more comprehensible and predictable. Moreover, individuals who have received such outcome information are largely unaware of its effect on their judgment.

Most experimental studies investigating hindsight bias use between–subject designs. Subjects are randomly split into a "foresight" and a "hindsight" group. The foresight group is asked to predict the likelihood of certain events; the hindsight group is told the outcome and asked to predict the likelihood of the events as if they were unaware of the outcome. If individuals are prone to hindsight bias, the hindsight group is expected to assign the outcome a higher probability than the foresight group. Empirical findings support this conjecture, emphasizing that people asked to predict an event do not find the prediction as easy as hindsight subjects claim it is (Fischhoff [1975]).

Hindsight bias has been demonstrated in a large variety of fields, including general knowledge tasks (Wood [1978]), employee evaluation (Mitchell and Kalb [1981]), accounting (Helleloid [1988]), and business decisions (Bukszar and Connolly [1998] and Connolly and Bukszar [1990]). However, in a meta-analysis of data from 122 independent experiments (Christensen-Szalanski and Willham [1991]), hindsight bias was found to be three times larger for studies using almanac questions as compared to other domains.

Hindsight bias has been explained by motivational factors (Campbell and Tesser [1983], Pennington et al. [1980], and Verplanken and Pieters [1988]) and by cognitive factors (Beckerian and Bowers [1983] and Hawkins and Hastie [1990]) such as memory impairments and reconstruction biases (Erdfelder and Buchner [1998]). Hell et al. [1988]) report an interaction effect for motivation: With high motivation to recall accurately, the point in time of outcome information had no effect on judgments. Generally, though, cognitive factors are believed to be more important than motivational factors in explaining hindsight bias (Christensen-Szalanski and Willham [1991]). Also, instructions to "try harder" (Fischhoff [1977], Leary [1981, 1982], Synodinos [1986]), or to ignore the feedback information (Bukszar and Connolly [1998], Fischhoff [1975], Hennessey and Edgell [1991]), or even monetary incentives (Camerer, Loewenstein, and Weber [1989], Tversky and Kahneman [1974]) were not capable of reducing hindsight bias.

Recent empirical evidence questions the robustness of hindsight bias and emphasizes moderating variables. For instance, feedback information (Hoch and Loewenstein [1989]) and the self-relevance of an event (Mark and Mellor [1991]) reduce hindsight bias. Also, the extent of cognitive effort during choice (Creyer and Ross [1993]), individual attitudes (Hölzl, Kirchler, and Rodler [2002]), the information made available to subjects (Stahlberg, Eller, and Frey [1993]), and the plausibility of additional information (Pohl [1998]) systematically influence the strength of the bias. Introducing randomly selected items (Winman [1997]) eliminates the hindsight bias, and very surprising outcomes even reverse the effect (Ofir and Mazursky [1997]).

Hindsight bias has also been found to be slightly attenuated in groups (Stahlberg et al. [1995]). Also, basic experimental design features, such as the between- versus within-subject approach, seem to moderate hindsight bias. Wendt [1993] studied the robustness of the bias within the context of the 1988 and 1992 parliamentary elections in the German province of Schleswig-Holstein. One week before the elections, subjects were asked to predict the election outcomes, and one week after the elections, they were asked to remember their predictions. The results did not support hindsight bias. Also, Stahlberg et al. [1993] found no hindsight bias with respect to remembering subject test scores in a within–subject sample, and Winman [1997] reported the hindsight phenomenon only in between–subject designs, not in within–subject designs. In contrast, however, Bryant and Brockway [1997] confirmed hindsight bias for a within–subject sample: The probability estimates of conviction made two hours before the not-guilty verdict in the O.J. Simpson criminal trial were higher than estimates of prior probability made two days after the verdict.

We examine here the robustness of hindsight bias in an experimental asset market environment using a within–subject design. We investigate whether traders in an experimental asset market are prone to hindsight bias with respect to their price predictions. We focus on individual decision behavior in one-time situations, but we also capture the dynamics of personal experience over multiple trading periods, which allows for feedback about individual market earnings.

At the beginning of each trading period, participants were asked to predict the next period's average trading prices. On the basis of these predictions, the objective outcome average price predictions were computed. At the market close, participants were asked to subjectively estimate their total average price predictions across all trading periods. Four weeks later, participants were given their outcome average price predictions, and were asked to remember their initial estimates. If participants are prone to hindsight bias, their remembered estimates will deviate from their initial estimates in the direction of the outcome average price predictions.

Experimental Risk Elicitation Methods

According to standard theory, different procedures to infer risk attitude should nevertheless yield the same outcome. Empirical evidence, however, indicates that results differ across methods, violating the assumption of procedural invariance. Fellner and Maciejovsky [2002] study the relationship between individual risk attitudes as inferred by the procedures of certainty equivalents and lottery choices and market behavior on an experimental asset market. As the results of elicitation methods are not positively correlated with each other, the two methods yield no unambiguous classifications. Kirchler, Maciejovsky, and Weber [2001], using an experimental asset market, found that the higher the degree of risk aversion, the lower the total number of contracts concluded irrespective of the risk elicitation method.

In general, the correspondence of certainty equivalents and binary lottery choices was weak, however. Exploring the effect of the binary lottery procedure in an auction, Rietz [1993] shows that observed behavior does not follow the predictions of expected utility theory. Davis and Holt [1993], Roth [1995], and Krahnen, Rieck, and Theissen [1997b] conclude that experimental approaches to infer risk attitude have severe shortcomings. Particularly, Krahnen, Rieck, and Theissen [1997a] doubt the usefulness of individual certainty equivalents as meaningful indicators of individual risk attitude, and Selten, Sadrieh, and Abbink [1999] question the usefulness of the binary lottery mechanism to induce risk neutrality. While money appears to be ineffective in inducing risk neutrality, binary lotteries perform even worse in this respect.[1]

We examine the stability of individual risk attitudes over a time horizon of four weeks, and the correspondence of different experimental risk elicitation methods.

The Experiment

Participants

A total of 133 students at the University of Vienna and the Vienna University of Economics and Business Administration participated in the study. Fifty-three of the subjects traded one risky asset, while the remaining eighty subjects traded two risky assets. Four weeks after the experiment, participants obtained their payoff, which on average amounted €14.45, with a standard deviation of €15.35. The subjects consisted of forty-one females and ninety-two males, aged 18 to 43 (M = 22.31, SD = 3.53). Ninety-seven participants were economics students, while the remaining thirty-six were enrolled in other social science disciplines.

Experimental Design and Procedure

Subjects participated in asset markets conducted using computers and the software z-Tree (the Zurich Toolbox for Ready-made Economic Experiments, see Fischbacher [1999]). The sequence of events in the experiment is shown in Figure 1. Each market lasted for thirteen to eighteen trading periods of 180 seconds each. The exact number of trading periods was randomly determined with equal probabilities.

Before the asset markets opened, participants were asked to 1) reveal their certainty equivalent for a lottery with a payoff of 100 Experimental Guilders[2] with a probability of $p = 0.50$ and zero otherwise, and 2) make seven decisions among risky lotteries. The payoffs of the lotteries are listed in Table 1.

For controlling position effects, the lotteries were systematically varied with respect to a_1 (the highest possible payoff) and a_2 (the lowest possible payoff), as well as to A (certain payoff) and to the sequence of a_1/ a_2 (risky payoffs). The certainty equivalent allows the experimenter to infer the participants' attitudes toward risk, in other words, to discriminate among risk aversion, risk neutrality, and risk-seeking behavior.

For example, a certainty equivalent that is lower than the expected value of the lottery (50 Experimental Guilders) would indicate risk aversion. A certainty equivalent equal to the expected value would indicate risk neutrality. And a certainty equivalent above the expected value would indicate 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, it is only possible to distinguish between risk aversion (certain payoff) and risk neutrality (risky payoff).

One of the seven decisions was randomly selected to determine the individual payoff. Conversely, the revealed certainty equivalents did not translate into individual monetary payoffs. The payoff from the lotteries

Table 1. *Lottery Payoffs in Experimental Guilders*

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

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

was added to the total payoff from the market. Four weeks after the experiments were conducted, participants were again asked to 1) reveal their certainty equivalent for a lottery with a payoff of 100 Experimental Guilders with a probability of $p = 0.50$ and zero otherwise, and 2) make seven decisions among lotteries.

Subjects either traded assets on one market or on two different markets. In the latter case the markets are referred to as Market A and Market B, whereby their sequence was determined randomly (see Figure 1). For the latter, the assets were separately traded on two independent markets where the sequence was determined randomly. At the beginning of each trading period, participants were asked to predict the next period's average trading price of the asset(s).[3] On the basis of these predictions, the outcome average price predictions (p_o) were computed as the individual average of price predictions across all periods.[4] These served as the individual objective outcome information with which participants were confronted four weeks later. Directly after market closing, in a post-experimental questionnaire, participants were asked to estimate their total average price predictions across all trading periods (p_s), that is, to subjectively "compute" the average of all their price predictions. Note that both p_o and p_s actually relate to the same reference value, the individual average price predictions across trading periods. However, p_o refers to the objective average value, and p_s reflects the subjective estimate of it. Although participants were not paid according to their accuracy, the high correlation between individual predictions and actual average trading prices across all trading periods indicates that subjects made their decisions very carefully and also accurately ($r(133) = 0.82$, $p < 0.001$).[5]

Four weeks later, participants obtained their payoff from the asset market experiments. Subjects were given their outcome average price predictions (p_o), and were asked to remember their initial subjective estimates (p_s) (henceforth referred to as $\hat{p}_s$). Recall that if traders are prone to hindsight bias, their remembered estimates should deviate from their initial estimates in the direction of the outcome average price predictions ($|p_o - \hat{p}_s| < |p_s - \hat{p}_s|$). Put differently, participants would orient their responses to the exogenously presented information (p_o), rather than to the direction of their initial predictions (p_s).

Experimental Results

Hindsight Bias

Our results did not confirm the above hypothesis, which indicates that our traders were not generally prone to hindsight bias. Only about half the subjects (twenty-six out of fifty-three) displayed the expected behavior and were prone to hindsight bias ($\chi^2 = 0.20$, $p = 0.81$) when just one risky asset was traded. In case two assets were traded, thirty-two of eighty participants were prone to hindsight bias with respect to the first asset ($\chi^2 = 1.61$, $p = 0.20$), compared to thirty-eight for the second asset ($\chi^2 = 0.03$, $p = 0.89$). Overall, only nineteen of the participants were constantly prone to hindsight bias for both assets.

If the means of the difference between p_o and $\hat{p}_s$ is compared to that between p_s and $\hat{p}_s$, no statistically significant difference is observed for either case (see Table 2). So the existence of hindsight bias on an experimental asset market is not supported, either with respect to the frequency of its presence or to the size of the bias.

Individual risk attitude

We investigate the stability of individual risk attitudes as elicited by the experimental methods of certainty equivalents and binary lottery choices and the correspondence between these two methods.

The average certainty equivalent of participants was 43.15 (SD = 30.30) before the asset markets opened, and 40.31 (SD = 25.49) directly before participants received their payoff four weeks later. Thus, the results indicate a slight increase in individual risk aversion, although it is not statistically significant (t = 0.98, $p = 0.33$). If the revealed individual certainty equivalents are pooled to risk aversion (certainty equivalents < 50), risk neutrality (certainty equivalents = 50), and risk-seeking behavior (certainty equivalents > 50), the frequency of risk-averse certainty equivalents decreased slightly from $t = 0$ to $t = 1$, while the frequency of risk-seeking behavior dropped dramatically by 50% ($\chi^2 = 30.60$, $p < 0.001$).

Thus, our results indicate that subjects' willingness to engage in risky lottery choices substantially decreased directly before they obtained their payoffs. Figure 2 displays the frequency of risk-averse, risk-neutral, and risk-seeking certainty equivalents for $t = 0$ and $t = 1$.

We computed an index for risk attitude ranging from 0 = risk neutrality to 7 = risk aversion for the seven binary lottery decisions. The average risk attitude before the asset markets opened was 3.51 (SD = 2.03), indicating that participants chose the secure alternative in 3.51 out of the 7 cases. Directly before payoff four weeks later, the average risk attitude was 3.99 (SD = 2.17). We find that individual risk aversion increased significantly right before payoff ($t = -1.80$, $p = 0.075$). Figure 3 shows that the frequency of risk-averse lottery choices (i.e., a risk index of 7) increased significantly at $t = 1$, while less risk-averse choices (indices of 1 or 3) decreased ($\chi^2 = 3.57$, $p = 0.059$). Thus, prior to payoff, participants were less inclined to engage in risky choices with respect to the certainty equivalent, and more inclined to engage in risk-averse choices with respect to the binary lottery method.

FIGURE 1
The Sequence of Events in the Experiment

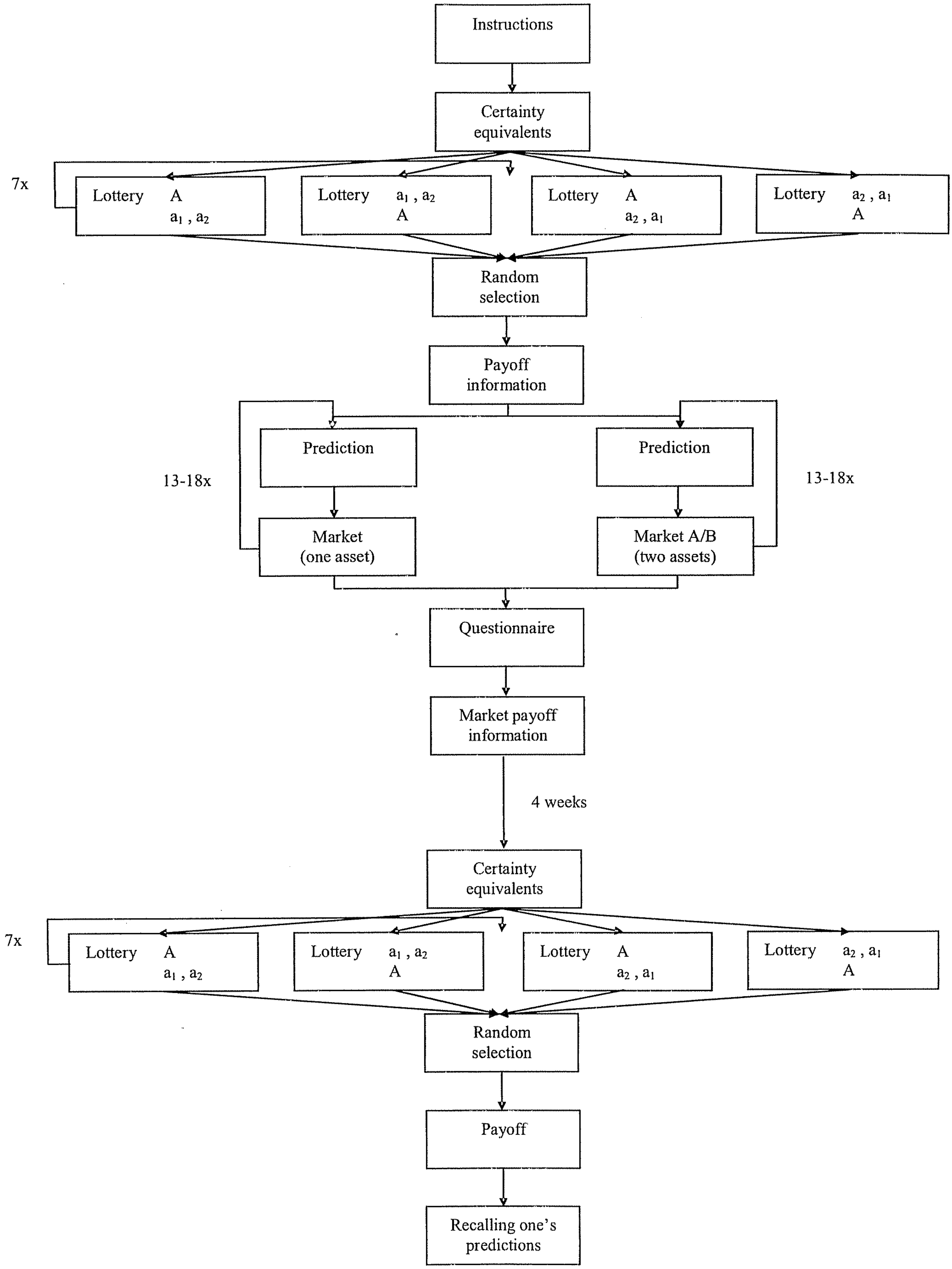

Table 2. *Means and Standard Deviation for the Differences Between Average Outcome Predictions and Remembered Average Price Estimates and for the Differences Between Initial Average Price Estimates and Remembered Average Prices*

Number of Assets Traded		*M*	*SD*	t-value	p-value
One asset	$\lvert p_O - \hat{p}_S \rvert$	47.82	72.97	0.004	.99
	$\lvert p_S - \hat{p}_S \rvert$	47.79	85.42		
Two assets	$\lvert p_O - \hat{p}_S \rvert$	65.23	81.97	–0.22	.83
	$\lvert p_S - \hat{p}_S \rvert$	68.12	118.35		

Note: p_O denotes the average outcome predictions, p_S the initial average price estimates, and $\hat{p}_S$ the remembered average price estimates.

On an individual level, we found risk attitude as elicited by certainty equivalents ($\chi^2 = 65.03, p < 0.001$) and binary lottery choices ($\chi^2 = 15.23, p < 0.001$) to be unstable between the two points of time. Only 30.30% of all individual risk patterns with respect to certainty equivalents, and 15.15% with respect to lottery choices, remained constant over the four weeks of examination. By far the most stable pattern was a certainty equivalent of 50, displaying risk neutrality (12.12%).

In a further step, we studied the correspondence of different experimental risk elicitation methods more precisely between certainty equivalents and binary lottery choices. The results show no positive correlation either before the asset markets opened ($r(109) = -0.04$, p = 0.70) or directly before payoff four weeks later ($r(120) = -0.06, p = 0.51$).[6]

In fact, no relationship was observed between these two methods, a result that continued to hold when extreme cases were analyzed. There was no correspondence between risk attitudes measured by certainty equivalents or by lottery decisions, that is, a certainty equivalent of 0 (complete risk aversion) and 50 (risk neutrality), or for a risk index computed from the lottery decisions of 0 (complete risk neutrality) and a value of 7 (complete risk aversion; see Table 3).

Discussion and Conclusion

The scope of this article was threefold. First, we wanted to study the robustness of hindsight bias in an experimental market by applying a within–subject design and allowing for multitrading periods and individual earnings feedback. Second, we wanted to investigate the time stability between the two different experimental risk elicitation methods of certainty

FIGURE 2
Frequency of Individual Risk Attitudes Inferred by Certainty Equivalent for *t*=0 and *t*=1

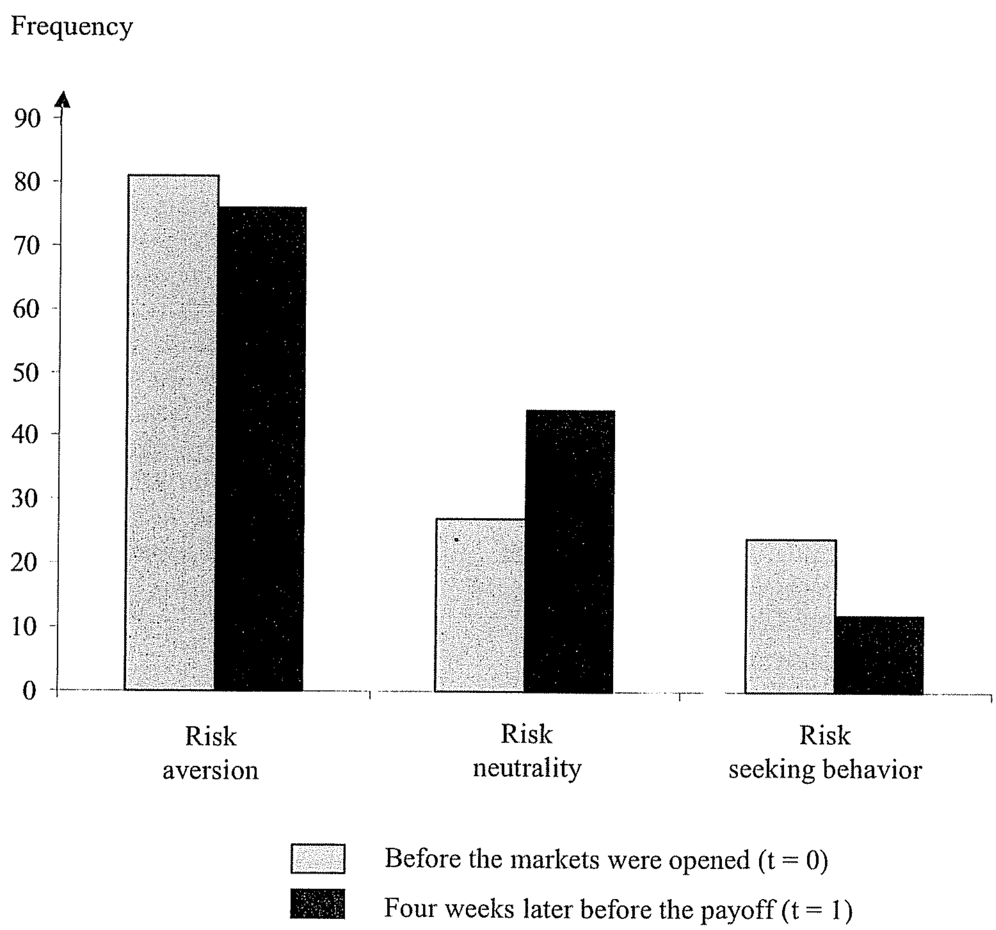

FIGURE 3
Frequency of Individual Risk Attitudes Inferred by Lottery Choices for t=0 and t=1

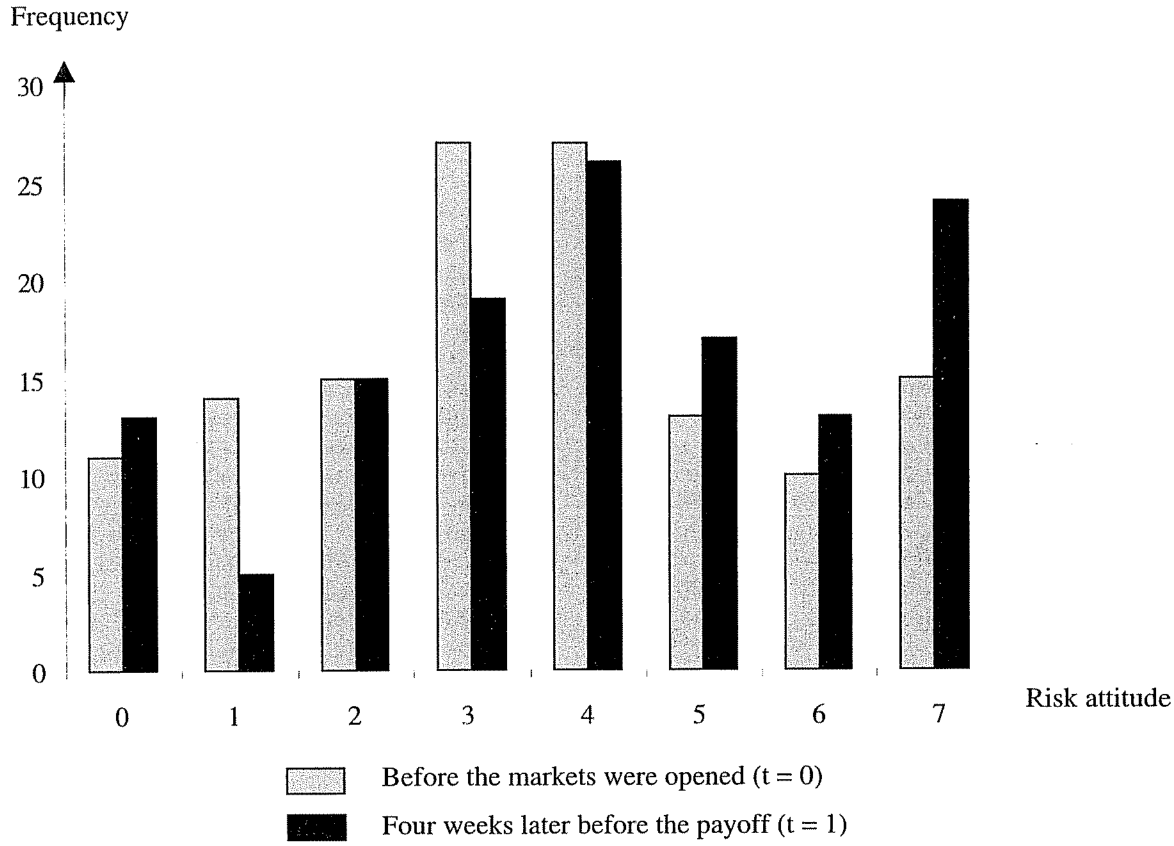

Table 3. *Correspondence Between Certainty Equivalents and Lottery Decisions for Extreme Cases*

	Certainty Equivalent			Lottery Decisions		
Risk Attitude	Time	Frequency of Correspondence (with Lottery Choices)	N	Time	Frequency of Correspondence (with Certainty Equivalents)	N
Risk neutrality	$t = 0$	4	27	$t = 0$	4	11
	$t = 1$	4	44	$t = 1$	5	13
Risk aversion	$t = 0$	0	0	$t = 0$	0	15
	$t = 1$	0	2	$t = 1$	0	24

equivalents and binary lottery choices. Third, we tested for the correspondence between these two methods.

Our results do not support the conjecture that traders in an experimental asset market are prone to hindsight bias in remembering their price predictions. Moreover, our results show that hindsight bias is not generally present; rather, it was moderated by the methodology in use. This result may be content-specific. In studies with almanac questions, hindsight bias seems robust, but in our experimental approach, personal experience and feedback about financial performance may crowd out the bias.

Another explanation for our finding may be the within–subject design itself, more specifically an asymmetry in the ability to draw on prior information. Repeated participation in the experiment enables subjects to remember their estimates. But with the between–subject design, each participant starts fresh from an informational point of view, and the subjects in the group with information may use that information as an anchor for individual judgments.

More generally, in light of our results, the cognitive approach may be more effective than the motivational approach to explain the presence of hindsight bias. The cognitive approach rests on a strong directional anchor, and favors a biased estimate, while the motivational approach—which lacks a directional anchor—leads to a random outcome independent of the design. In a different domain, our results challenge the assumption of time-invariant risk attitudes. Both on the individual as well as on the aggregate level, experimentally inferred risk attitudes are not identical between the two points of investigation. With decreasing distance to payoff, participants are less inclined to engage in risk-seeking behavior as measured by certainty equivalents, but more inclined to exhibit risk-averse behavior as measured by lottery choices. Thus, in experiments with delayed or no payoffs at all, we would expect to see an increasing degree of "gambling behavior," which could generate misleading inferences about risk preferences.

Our results suggest there is almost no correspondence between the two risk elicitation methods of certainty equivalents and lottery choices, which indicates that different elicitation methods yield different risk classifications. This does not only violate the procedural invariance axiom of normative theory, but also questions the general validity of measuring attitudes toward risk. Thus, it is important to take into consideration that empirical findings about risk behavior may be moderated by the method used.

Acknowledgments

The authors acknowledge financial support by the Austrian National Bank (Jubiläumsfonds, Project number 8382). Thanks are also due to Eva Hofmann and Herbert Schwarzenberger, who helped to run the experiment at the University of Vienna. Helpful comments by Werner Güth and an anonymous referee are gratefully acknowledged.

Notes

1. More critique on the binary lottery mechanism as a means to induce risk neutrality is put forward by Cox, Smith, and Walker [1985] and Walker, Smith, and Cox [1990]. Note, however, that in strategic settings it is probably the only way of inducing commonly known idiosyncratic risk attitudes. For an application of the binary lottery mechanism in an investment experiment, see Dittrich, Guth, and Maciejovsky [2001].
2. 100 Experimental Guilders equals € 7.27.
3. Recall that if two assets are traded, subjects predicted the next period's trading prices separately for both assets.
4. When more than one asset was traded, this was done separately for the two assets.
5. The correlation coefficients across trading periods ranged from $r(133) = 0.26$ in the third period ($p < 0.001$) to $r(133) = 0.89$ in the twelfth period ($p < 0.001$).
6. We only used the certainty equivalents that discriminated between risk aversion and risk neutrality, because the lotteries were also designed this way.

References

Beckerian, D.A., and J.M. Bowers. "Eyewitness Testimony: Were We Misled?" *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, (1983), pp. 139–145.

Brennan, M.J. "The Individual Investor." *Journal of Financial Research*, 18, (1995), pp. 59–74.

Bryant, F.B., and J.H. Brockway. "Hindsight Bias in the Reaction to the Verdict in the O.J. Simpson Criminal Trial." *Basic and Applied Social Psychology*, 19, (1997), pp. 225–241.

Bukszar, E., and T. Connolly. "Hindsight Bias and Strategic Choice: Some Problems in Learning from Experience." *Academy of Management Journal*, 31, (1998), pp. 628–641.

Camerer, C., G. Loewenstein, and M. Weber. "The Curse of Knowledge in Market Settings: An Experimental Analysis." *Journal of Political Economy*, 97, (1989), pp. 1232–1254.

Campbell, J.D., and A. Tesser. "Motivational Interpretations of Hindsight Bias: An Individual Difference Analysis." *Journal of Personality*, 51, (1983), pp. 605–620.

Christensen–Szalanski, J.J., and C.F. Willham. "The Hindsight Bias: A Meta-Analysis." *Organizational Behavior and Human Decision Processes*, 48, (1991), pp. 147–168.

Connolly, T., and E.W. Bukszar. "Hindsight Bias: Self-Flattery or Cognitive Error?" *Journal of Behavioral Decision Making*, 3, (1990), pp. 205–211.

Cox, J.C., V.L. Smith, and J.M. Walker. "Experimental Development of Sealed-Bid Auction Theory: Calibration Controls for Risk Aversion." *American Economic Revue, Papers and Proceedings*, 75, (1985), pp. 160–165.

Creyer, E., and W.T. Ross. "Hindsight Bias and Inferences in Choice: The Mediating Effect of Cognitive Effort." *Organizational Behavior and Human Decision Processes*, 55, (1993), pp. 61–77.

Davis, D.D., and C.A. Holt. *Experimental Economics*. Cambridge: Cambridge University Press, 1993.

DeBondt, W.F.M., and R.H. Thaler. "Financial Decision-Making in Markets and Firms: A Behavioral Perspective." In R. Jarrow, V. Maksimovic, and W. T. Ziemba, eds., *Finance: Handbooks in Operations Research and Management Science 9*. Amsterdam: North Holland, (1995), pp. 385–410.

Dittrich, D., W. Güth, and B. Maciejovsky. "Overconfidence in Investment Decisions: An Experimental Approach." Working paper 3, Paper on Strategic Interaction, Max Planck Institute for Research into Economic Systems, 2001.

Dittrich, D., H. Haumer, C. Helmenstein, E. Hofmann, E. Kirchler, and B. Maciejovsky. "Information Dissemination on an Experimental Asset Market With Completely, Optimistically, Pessimistically, and Uninformed Traders." Paper on Strategic Interaction, Max Planck Institute for Research into Economic Systems, 2003.

Erdfelder, E., and A. Buchner. "Decomposing the Hindsight Bias: A Multinomial Processing Tree Model for Separating Recollection and Reconstruction in Hindsight." *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, (1998), pp. 387–414.

Fellner, G., and B. Maciejovsky. "Risk Attitude and Market Behavior: Evidence from Experimental Asset Markets." Working paper 34. Paper on Strategic Interaction, Max Planck Institute for Research into Economic Systems, 2002.

Fischbacher, U. "z-Tree: Zurich Toolbox for Readymade Economic Experiments: Experimenter's Manual." Working paper 21, Institute for Empirical Research in Economics at the University of Zurich, 1999.

Fischhoff, B. "Hindsight Foresight: The Effect of Outcome Knowledge on Judgment Under Uncertainty." *Journal of Experimental Psychology: Human Perception and Performance*, 1, (1975), pp. 288–299.

Fischhoff, B. "Perceived Informativeness of Facts." *Journal of Experimental Psychology: Human Perception and Performance*, 3, (1977), pp. 349–358.

Hawkins, S.A., and R. Hastie. "Hindsight: Biased Judgments on Past Events After the Outcomes are Known." *Psychological Bulletin*, 107, (1990), pp. 311–327.

Hell, W., G. Gigerenzer, S. Gauggel, M. Mall, and M. Müller. "Hindsight Bias: An Interaction of Automatic and Motivational Factors?" *Memory and Cognition*, 16, (1988), pp. 533–538.

Helleloid, R. "Hindsight Judgments about Taxpayers' Expectations." *Journal of the American Taxation Association*, 9, (1988), pp. 31–46.

Hennessey, J.E., and S.E. Edgell. "Hindsight Bias in a Very Sparse Environment." *Bulletin of the Psychonomic Society*, 29, (1991), pp. 433–436.

Hoch, S.J., and G.F. Loewenstein. "Outcome Feedback: Hindsight and Information." *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, (1989), pp. 605–619.

Hölzl, E., E. Kirchler, and C. Rodler. "Hindsight Bias in Economic Expectations: I Knew All Along What I Want to Hear." *Journal of Applied Psychology*, forthcoming, 2002.

Kirchler, E., and B. Maciejovsky. "Simultaneous Over- and Underconfidence: Evidence from Experimental Asset Markets." *Journal of Risk and Uncertainty*, 25, (2002), pp. 65–85.

Kirchler, E., B. Maciejovsky, and M. Weber. "Framing Effects on Selected Information and Market Behavior: An Experimental Analysis." Working paper, National Research Center Quantification and Simulation of Economic Processes at the Humboldt-University of Berlin, 2001.

Krahnen, J.P., C. Rieck, and E. Theissen. "Inferring Risk Attitudes from Certainty Equivalents: Some Lessons from an Experimental Study." *Journal of Economic Psychology*, 18, (1997a), pp. 469–486.

Krahnen, J.P., C. Rieck, and E. Theissen. "Messung Individueller Risikoeinstellungen." Working paper, University of Frankfurt, 1997b.

Leary, M.R. "The Distorted Nature of Hindsight." *Journal of Social Psychology*, 115, (1981), pp. 25–29.

Leary, M.R. "Hindsight Distortion and the 1980 Presidential Election." *Personality and Social Psychology Bulletin*, 8, (1982), pp. 257–263.

Mark, M.M., and S. Mellor. "Effect of Self-Relevance of an Event on Hindsight Bias: The Foreseeability of a Layoff." *Journal of Applied Psychology*, 76, (1991), pp. 569–577.

Mitchell, T.R., and L.S. Kalb. "Effects of Outcome Knowledge and Outcome Valence on Supervisors' Evaluations." *Journal of Applied Psychology*, 66, (1981), pp. 604–612.

Myagkov, M., and C. Plott. "Exchange Economies and Loss Exposure: Experiments Exploring Prospect Theory and Competitive Equilibria in Market Environments." *American Economic Review*, 87, (1997), pp. 801–828.

Odean, T. "Are Investors Reluctant to Realize their Losses?" *Journal of Finance*, 53, (1988a), pp. 1775–1798.

Odean, T. "Volume, Volatility, Price, and Profit When All Traders Are Above Average." *Journal of Finance*, 53, (1988b), pp. 1887–1934.

Ofir, C., and D. Mazursky. "Does a Surprising Outcome Reinforce or Reverse the Hindsight Bias?" *Organizational Behavior and Human Decision Processes*, 69, (1997), pp. 51–57.

Pennington, D.C., D.R. Rutter, K. McKenna, and I.E. Morley. "Estimating the Outcome of a Pregnancy Test: Women's Judgments in Foresight and Hindsight." *British Journal of Social and Clinical Psychology*, 19, (1980), pp. 317–324.

Pohl, R.F. "The Effects of Feedback Source and Plausibility of Hindsight Bias." *European Journal of Cognitive Psychology*, 10, (1998), pp. 191–212.

Rietz, T.A. "Implementing and Testing Risk-Preference-Induction Mechanisms in Experimental Sealed-Bid Auctions." *Journal of Risk and Uncertainty*, 7, (1993), pp. 199–213.

Roth, A.E. "Introduction to Experimental Economics." In A.E. Roth and J.H. Kagel, *Handbook of Experimental Economics*. Princeton: Princeton University Press, 1995.

Selten, R., K. Sadrieh, and K. Abbink. "Money Does Not Induce Risk Neutral Behavior, But Binary Lotteries Do Even Worse." *Theory and Decision*, 46, (1999), pp. 211–249.

Shefrin, H., and M. Statman. "The Disposition to Sell Winners Too Early and Ride Losers Too Long." *Journal of Finance*, 40, (1985), pp. 777–790.

Stahlberg, D., F. Eller, and D. Frey. "Die Wirkung Nachträglicher Information: Perseveranz- und Hindsight-Effekte." *Zeitschrift für Experimentelle und Angewandte Psychologie*, 40, (1993), pp. 294–309.

Stahlberg, D., F. Eller, A. Maass, and D. Frey. "We Knew It All Along: Hindsight Bias in Groups." *Organizational Behavior and Human Decision Processes*, 63, (1995), pp. 46–58.

Stahlberg, D., F. Eller, A. Romahn, and D. Frey. "Der Knew-It-All-Along-Effekt in Urteilssituationen Von Hoher und Geringer Selbstwertrelevanz." *Zeitschrift für Sozialpsychologie*, 24, (1993), pp. 94–102.

Synodinos, N.E. "Hindsight Distortion: 'I Knew-It-All Along and I Was Sure About It'." *Journal of Applied Social Psychology*, 16, (1986), pp. 107–117.

Tversky, A., and D. Kahneman. "Judgment Under Uncertainty: Heuristics and Biases." *Science*, 185, (1974), pp. 1124–1131.

Verplanken, B., and R.G.M. Pieters. "Individual Differences in Reverse Hindsight Bias: I Never Thought Something like Chernobyl Would Happen. Did I?" *Journal of Behavioral Decision Making*, 1, (1988), pp. 131–147.

Walker, J. M., V.L. Smith, and J.C. Cox. "Inducing Risk Neutral Preferences: An Examination in a Controlled Market Environment." *Journal of Risk and Uncertainty*, 3, (1990), pp. 5–24.

Weber, M., and C. Camerer. "The Disposition Effect in Securities Trading: An Experimental Analysis." *Journal of Economic Behavior and Organization*, 33, (1998), pp. 167–184.

Weber, M., H.-J. Keppe, and G. Meyer-Delius. "The Impact of Endowment Framing on Market Prices: An Experimental Analysis." *Journal of Economic Behavior and Organization*, 41, (2000), pp. 159–176.

Wendt, D. "Kein Hindsight Bias ("Knew-it-all-Along-Effekt") Bei den Landtagswahlen in Schleswig-Holstein 1988 und 1992." *Journal of Economic Behavior and Organization*, 24, (1993), pp. 273–279.

Winman, A. "The Importance of Item Selection in 'Knew-It-All-Along' Studies of General Knowledge." *Scandinavian Journal of Psychology*, 38, (1997), pp. 63–72.

Wood, G. "The Knew-It-All-Along Effect." *Journal of Experimental Psychology: Human Perception and Performance*, 4, (1978), pp. 345–353.