Judgment and Decision Making (2023), **Vol. 18**:e14 1–21
doi:10.1017/jdm.2023.2

EMPIRICAL ARTICLE

Prospect theory's loss aversion is robust to stake size

Han Bleichrodt[1], and Olivier L'Haridon[2]

[1]Departamento Fundamentos de Análisis Económico, University of Alicante, Alicante, Spain and [2]CREM, University of Rennes, Rennes, France

Corresponding author: Han Bleichrodt; Email: hanbleichrodt@ua.es

Received: 17 January 2023; **Accepted:** 18 January 2023

Keywords: loss aversion; context dependence; measurement

Abstract

Several papers have challenged the robustness of loss aversion, claiming that it is context-dependent and disappears for small stakes. These papers use a behavioral definition of loss aversion that may be confounded by diminishing sensitivity and probability/event weighting under the new version of prospect theory (PT). We perform a new theory-based test of loss aversion that controls for these confounds. We found significant loss aversion for both small stakes and high stakes. The overall loss aversion coefficient varied between 1.25 and 1.45, less than commonly observed. Loss aversion decreased slightly for small stakes, but the effect was small and usually insignificant. Overall, our results indicate that, under PT, loss aversion is robust to stake size.

1. Introduction

Loss aversion is one of the key insights of behavioral economics. Both the lab and the field report abundant evidence supporting it (for overviews, see Brown et al., 2021; Fox and Poldrack, 2014). However, several authors (e.g., Erev et al., 2008; Ert and Erev, 2008, 2013; Gal and Rucker, 2018; Zeif and Yechiam, 2022) have challenged the generality of loss aversion. They claim that it is context-dependent and can be turned on and off by varying, among other things, the size of the stakes and using choices. For example, in one of their experiments, Ert and Erev (2013) observed that while 78% of their subjects preferred receiving nothing to a 50–50 prospect giving either a gain or a loss of 100 Sheqels ($30), only 52% preferred receiving nothing to a 50–50 prospect giving either a gain or a loss of 10 Sheqels ($3). They conclude that loss aversion disappears for small stakes.

These skeptics of loss aversion base their conclusions on a behavioral definition of loss aversion in Kahneman and Tversky (1979). As we will explain, this definition is equivalent to loss aversion under the original 1979 version of prospect theory (PT), but not under the new 1992 version, which is nowadays mostly used. Under the new version of PT, the definition of Kahneman and Tversky (1979), and thus the conclusions of Ert and Erev (2013), may confound loss aversion with differences in probability weighting and diminishing sensitivity between gains and losses (see also Zank, 2010). As argued by Köbberling and Wakker (2005) (see also Benartzi and Thaler, 1995; Kahneman, 2003), under PT, loss aversion is really reflected by the kink at the reference point. So while the evidence presented by skeptics like Ert and Erev (2013) undoubtedly raises questions about the existence of loss aversion, it does not present, at least under the new version of PT, conclusive evidence that loss aversion indeed disappears for small stakes.

The purpose of this paper is to perform a new theory-based test whether loss aversion disappears for small stakes. Using the new version of PT, we separate loss aversion from diminishing sensitivity and probability weighting by the method of Abdellaoui et al. (2016), which requires no simplifying assumptions about PT's parameters and measures loss aversion in full generality. Our test is choice-based and, thereby, addresses the skeptics' claim that loss aversion is less prevalent in choices. A limitation of our measurement, compared with Ert and Erev (2013), is that it is more complex.

We measured loss aversion for both small stakes and high stakes with the high stakes 200 times as large as the low stakes. We controlled for several other factors that increase loss aversion according to Ert and Erev (2013) and included both a risk and an uncertainty treatment. Because we used high stakes and losses, all stimuli were hypothetical.

We found loss aversion in all experiments and treatments, for risk, uncertainty, low stakes, and high stakes. The loss aversion coefficients varied between 1.25 and 1.45, which is lower than what is commonly observed in the literature (e.g., Brown et al., 2021), but close to the value obtained in the meta-analysis of Walasek et al. (2018).

Loss aversion under risk and uncertainty were correlated, suggesting that it reflects a behavioral property. Loss aversion decreased with stake size, but the effect was small and usually insignificant. Overall, our results suggest that even though loss aversion is smaller than often suggested in the literature, it cannot simply be turned off using small stakes.

2. Background

2.1. Prospect theory

Consider a decision-maker who has to make a choice in the face of uncertainty. Uncertainty is modeled through a *state space* S. Exactly one of the states will obtain, but the decision-maker does not know which one. Subsets E of S are called *events* and E^c denotes the complement of E.

Let $x_E y$ denote the *uncertain prospect* that pays €x when event E occurs and €y otherwise. If probabilities are known, we will call prospects *risky* and write $x_p y$ for the prospect that pays €x with probability p and €y with probability $1 - p$. Throughout the paper, we only consider prospects with at most two distinct payoffs.

Outcomes are expressed as gains and losses relative to a reference point x_0, which we assume equal to 0. PT does not specify the location of the reference point, however, as shown by Baillon et al. (2020), in decision under risk it is often the status quo, which in our experiment is 0. The decision-maker has a weak preference $\succcurlyeq$ over prospects and $\succ$ and $\backsim$ denote strict preference and indifference, respectively. *Gains* are positive money amounts (strictly preferred to 0) and *losses* are negative money amounts. A *gain prospect* involves no losses (i.e., x and y are both nonnegative), a *loss prospect* involves no gains, and a *mixed prospect* involves both a gain and a loss. For gain and loss prospects, the notation $x_E y$ means that the absolute value of x is at least as large as the absolute value of y: if x and y are gains, then $x \geq y$, and if x and y are losses, then $x \leq y$. For mixed prospects, the notation $x_E y$ means that x is a gain and that y is a loss: $x > 0 > y$.

Under *PT*, the decision-make *r*'s preferences over gains and loss prospects $x_E y$ are evaluated by

$$W^i(E)U(x) + \left(1 - W^i(E)\right) U(y), \tag{1a}$$

where $i = +$ for gains and $i = -$ for losses.

Preferences over mixed prospects $x_E y$ are evaluated by

$$W^+(E)U(x) + W^-\left(E^c\right) U(y). \tag{1b}$$

In Equations (1a) and (1b), U is an overall utility function that includes loss aversion. Hence, we must measure U to be able to measure loss aversion. In empirical applications, U is often decomposed in a basic utility function reflecting attitudes toward outcomes and a loss aversion coefficient λ, but we do

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

not need this simplification. U is strictly increasing (reflecting that higher payoffs are preferred) and satisfies $U(0) = 0$. The utility function is a ratio scale and we are free to choose the utility of one outcome other than the reference point.

The *event weighting functions* W^i, $i = +, -$ are real-valued functions with the following properties:

(i) $W^i(\varnothing) = 0$.
(ii) $W^i(S) = 1$.
(iii) W^i is *monotonic*: $E \supseteq F$ implies $W^i(E) \geq W^i(F)$.

The event weighting functions W^i may be different for gains and losses and they need not be additive. If they are additive, the event weights are subjective probabilities and PT is equivalent to subjective expected utility.

PT evaluates gain and loss risky prospects $x_p y$ as

$$w^i(p)U(x) + \left(1 - w^i(p)\right) U(y), i = +, -, \tag{2a}$$

and mixed risky prospects as

$$w^+(p)U(x) + w^-(1-p)\,U(y). \tag{2b}$$

The *probability weighting functions* w^i are strictly increasing and satisfy $w^i(0) = 0$ and $w^i(1) = 1$, $i = +, -$ and they may differ between gains and losses.

2.2. Loss aversion

In spite of its widespread use, there exists no common definition of loss aversion (Abdellaoui et al., 2007). Kahneman and Tversky (1979) defined loss aversion as the value function being steeper for losses than for gains: for all $x > 0, -U'(-x) > U'(x)$. Under the 1979 version of PT, this implies $x_{0.5}(-x) \prec 0$, which is the definition of loss aversion that skeptics of loss aversion like Ert and Erev (2013) test. However, under the 1992 version of PT, this implication no longer holds, because probability weighting may differ for gains and losses.

Consider, for example, a decision-maker who is indifferent between $x_{0.5}(-x)$ and 0. Under the definition of loss aversion used by Ert and Erev, this indifference implies no loss aversion. However, under PT, Equation (2b) gives

$$w^+(0.5)U(x) + w^-(0.5)U(-x) = 0, \tag{2c}$$

which is, for example, consistent with $-U'(-x) > U'(x)$ if $w^+(0.5) > w^-(0.5)$.[1] Likewise, the preference $x_{0.5}(-x) \sim 0$ need not imply that the decision-maker is neutral toward gains and losses. If, for example, $w^+(0.5) = 0.5$, $w^-(0.5) = 0.4$, and U is linear everywhere, then this preference is consistent with a loss aversion coefficient λ equal to 1.25.

Kahneman and Tversky's (1979) definition also implies that loss aversion increases with the stake size: if $y > x > 0$, then $y_{0.5}(-y) \prec x_{0.5}(-x)$. Ert and Erev (2013) and others found violations of this condition. The problem with Kahneman and Tversky's definition is that it might confound loss aversion with differences in diminishing sensitivity between gains and losses. For example, under new PT, indifference between $y_{0.5}(-y)$ and $x_{0.5}(-x)$ may reflect that diminishing sensitivity differs between gains and losses.

It is important to emphasize that we do not argue that the tests in Ert and Erev (2013) and others are wrong, because they clearly raise questions about the existence of loss aversion. However, our point

[1]The literature typically finds that $w^+(0.5)$ and $w^-(0.5)$ are on average close. There is, however, substantial variation at the individual level.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

is that to answer these questions convincingly, their behavioral tests need to be complemented by tests that have a clear foundation in theory and that remove all ambiguities. That is the purpose of our paper.

The most satisfactory definition of loss aversion was proposed by Köbberling and Wakker (2005). They argued that loss aversion in PT is really reflected by the kink at the reference point and suggested that it should be measured by the ratio of the left derivative of utility at the reference point over the right derivative of utility at the reference point: $U'_{\uparrow}(0)/U'_{\downarrow}(0)$.[2] The advantage of the method of Abdellaoui et al. (2016), to which we now turn, is that it gives an easy way to measure this ratio.

3. Measurement method

The method of Abdellaoui et al. (2016) measures a *standard sequence* of outcomes such that the utility difference between successive elements of the sequence is constant. The special feature of the method is that the standard sequence contains both gains and losses and runs through the reference point. This makes it possible to measure loss aversion as defined by Köbberling and Wakker (2005).

The method consists of three stages and is summarized in Table 1. The first stage connects utility for gains and utility for losses. The second and third stages measure the utility for gains and the utility for losses using the trade-off method of Wakker and Deneffe (1996). Table 1 shows the stimuli used in our experiments, for the high-stakes and small-stakes experiments.

3.1. First stage: connection utility for gains and utility for losses

We first selected an event E that we kept constant throughout the experiment and a gain G. In our experiments, the event E was drawing a ball of the subject's preferred color from an Ellsberg urn with 10 red and black balls in an unknown proportion. The gain G was €2000 in the high-stakes experiment and €10 in the small-stakes experiment. We elicited the loss L for which a subject was indifferent

Table 1. *Three-stage procedure to measure utility. The third column shows the quantity that was assessed in each of the three stages of the procedure. The fourth column shows the indifference that was elicited. The fifth column shows the stimuli used in the high-stakes experiment and the sixth column shows the stimuli used in the small-scale experiment. In both experiments, E designated the color of a ball drawn from an unknown Ellsberg urn and was equal to ½ for the ball drawn from a known Ellsberg urn. The reference point x_0 was taken to be zero.*

				Choice variables	
		Assessed quantity	Indifference	High-stakes experiment	Small-stakes experiment
		L	$G_E(L) \sim x_0$	G = €2000	G = €10
Stage 1		x_1^+	$x_1^+ \sim G_E x_0$		
		x_1^-	$x_1^- \sim L_{E^c} x_0$		
Stage 2	Step 1	$\mathcal{L}$	$x^+_{1\,E}\mathcal{L} \sim \ell_{E^c} x_0$	ℓ = −€300; $k_G = 5$	ℓ = −€1.50
	Step 2 to k_G	x_j^+	$x^+_{j\,E}\mathcal{L} \sim x^+_{j-1\,E}\ell$		
Stage 3	Step 1	$\mathcal{G}$	$\mathcal{G}_E x_1^- \sim g_E x_0$	g = €300; $k_L = 5$	g = €1.50
	Step 2 to k_L	x_j^-	$\mathcal{G}_E x_j^- \sim g_E x^-_{j-1}$		

[2]See also Benartzi and Thaler (1995) and Kahneman (2003).

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

between $G_E(L)$ and receiving 0. It follows from Equation (1a) that

$$W^{+}(E)U(G) + W^{-}(E^{c})\,U(L) = 0. \tag{3}$$

We next elicited the subject's certainty equivalents x_1^+ and x_1^- such that $x_1^+ \sim G_E 0$ and $x_1^- \sim L_{E^c} 0$. These indifferences imply that

$$U(x_1^+) = W^{+}(E)U(G) \tag{4}$$

and

$$U(x_1^-) = W^{-}(E^{c})\,U(L). \tag{5}$$

Combining Equations (3)–(5) gives

$$U(x_1^+) = -U(x_1^-). \tag{6}$$

Equation (6) defines the first elements x_1^+ and x_1^- of the standard sequences of gains and losses that we will construct in the second and third stages.

For choice under risk, the elicitation of x_1^+ and x_1^- was similar except that the event E was replaced by a known probability ½ (drawing a ball of the subject's preferred color from an urn containing five red and five black balls), and that in Equations (3)–(6), the weights $W^{+}(E)$ and $W^{-}(E^{c})$ are replaced by $w^{+}\left(\frac{1}{2}\right)$ and $w^{-}\left(\frac{1}{2}\right)$, respectively.

3.2. *Second and third stages: elicitation of utility for gains and losses*

The second stage elicited the utility for gains. Let ℓ be a prespecified loss, −€300 in the high-stakes experiment and −€1.50 in the small-stakes experiment. We first elicited the loss $\mathcal{L}$ such that a subject was indifferent between the acts $x_1^+{}_E\mathcal{L}$ and $\ell_{E^c}0$, where x_1^+ is the gain that was elicited in the first stage. This indifference implies that

$$W^{+}(E)U(x_1^+) + W^{-}(E^{c})\,U(\mathcal{L}) = W^{-}(E^{c})\,U(\ell)\,. \tag{7}$$

Rearranging Equation (7) gives

$$U(x_1^+) - U(x_0) = \frac{W^{-}(E^{c})}{W^{+}(E)}\left(U(\ell) - U(\mathcal{L})\right). \tag{8}$$

Next, we elicited the gain x_2^+ such that $x_2^+{}_E\mathcal{L} \sim x_1^+{}_E\ell$. This indifference implies

$$U(x_2^+) - U(x_1^+) = \frac{W^{-}(E^{c})}{W^{+}(E)}\left(U(\ell) - U(\mathcal{L})\right). \tag{9}$$

Combining Equations (8) and (9) gives

$$U(x_2^+) - U(x_1^+) = U(x_1^+) - U(x_0)\,. \tag{10}$$

We proceeded by eliciting a series of indifferences $x_j^+{}_E\mathcal{L} \sim x_{j-1}^+{}_E\ell, j = 2, \ldots, k_G$, to obtain the sequence $\{x_0, x_1^+, x_2^+, \ldots, x_{k_G}^+\}$. It is easy to see that for all j, $U(x_j^+) - U(x_{j-1}^+) = U(x_1^+) - U(x_0)$. For decision under risk, we applied the above procedure with the event E replaced by probability ½.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

The standard sequence of losses was constructed similarly. We selected a gain g, €300 in the high-stakes experiment and €1.50 in the small-stakes experiment and elicited the gain $\mathcal{G}$ such that $\mathcal{G}_E x_1^- \sim g_E 0$. We then elicited a standard sequence $\{x_0, x_1^-, x_2^-, \ldots, x_{k_L}^-\}$ of losses through a series of indifferences $\mathcal{G}_E x_j^- \sim g_E x_{j-1}^-, j = 2, \ldots, k_L$. For risk, we replaced the event E by probability ½.

The above procedure elicits a sequence $\{x_{k_L}^-, \ldots, x_1^-, x_0, x_1^+, \ldots, x_{k_G}^+\}$ that runs from the domain of losses through the reference point to the domain of gains, for which the utility difference between successive elements was constant, and for which $U(x_{k_L}^-) = -U(x_{k_G}^+)$. We scaled utility by setting $U(x_0) = 0$ and $U(x_{k_G}^+) = 1$. Then $U(x_{k_L}^-) = -1$. Because $k_G U(x_1^+) = U(x_{k_G}^+) = 1$, $U(x_1^+) = \frac{1}{k_G}$. Because $U(x_2^+) - U(x_1^+) = U(x_1^+) - U(x_0) = \frac{1}{k_G}$, it follows that $U(x_2^+) = \frac{2}{k_G}$. Continuing this process, we get $U(x_j^+) = \frac{j}{k_G}$. Repeating it for the x_j^-, we get $U(x_j^-) = -\frac{j}{k_G}$. It follows that $U(x_j^+) = j/k_G$, for $j = 1, \ldots, k_G$, and $U(x_j^-) = -j/k_G$, for $j = 1, \ldots, k_L$.

4. Experiment

4.1. Design

Subjects were 266 students of the Erasmus School of Economics, Rotterdam (118 female; mean age of 21.1 years) who were recruited using the ORSEE software (Greiner, 2015). The experiment was run on computers in the Econlab of the Erasmus School of Economics. There were 19 sessions in total: 11 sessions for the high-stakes experiment (144 subjects) and 8 sessions for the small-stakes experiment (122 subjects). During each session, three experimenters were present.[3]

After the instructions, subjects answered five training questions. We told them that there were no correct or false answers and that they could go through the experiment at their own pace. They could approach an experimenter if they needed clarification about the experimental tasks. Subjects completed the experiment in 25 minutes on average. They received a €10 participation fee. Because the experiments involved losses, we did not play out questions for real. It is difficult to find subjects willing to participate in experiments where they can lose (substantial) amounts of money.[4] Detailed instructions for the small-stakes experiment are in Appendix B.

As mentioned above, risk and uncertainty were implemented using Ellsberg urns. The first computer screen introduced the known urn and the unknown urn (Figure A4 in Appendix A). The known urn contained 5 red and 5 black balls, and the unknown urn contained 10 red and 10 black balls in unknown proportion. Subjects were asked to select their winning color (red or black) that would give them the most favorable payoff in each prospect. They then answered two practice questions based on Stage 1 for the known urn and two practice questions based on Stages 1 and 2 for the unknown urn.

In the actual experiment, we randomized the order of the risk and the uncertainty questions between sessions. Within the risk and uncertainty parts, we also randomized the order in which the gain sequence and the loss sequence were elicited. The first stage, the elicitation of x_1^+ and x_1^-, always came first because these outcomes were used as inputs in the other stages.

[3] The role of the experimenters was to assign subjects to their cubicles, to introduce the experiment, to answer any questions, and to proceed to payment. With three experimenters, these tasks were efficiently conveyed and reduced the delay of responses, particularly for answering the questions and proceeding to payment. Guerin (1986) suggests two presence effects induced by experimenters. One is related to uncertainty in the experimenter's behavior, and the other is related to social norms and implicit approval or disapproval. In both experiments, the roles of the experimenters were clearly explained in the introduction to the experiment. We cannot rule out a mere presence effect of experimenters on a social norm of loss-averse behavior even though we believe it is unlikely.

[4] In Ert and Erev (2013), subjects could actually lose money for real from some initial endowment. In their small-stakes experiments, the initial endowment was either a windfall or earned and handed to the subjects before the actual experiment started. In their large-stakes experiment, the initial endowment was unknown to the participants before the actual experiment started.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

4.2. Details

The final column of Table 1 shows the selected stimuli in the high-stakes and in the small-stakes experiments. The small stakes were obtained from the high-stakes experiment by dividing all payoffs by 200.

For both gains and losses, we elicited five points of the utility function under risk and under uncertainty. Figures A1–A3 in Appendix A show how we elicited indifference values in the uncertainty part for the high-stakes experiment (for a subject who chose red as the winning color). The screens under risk were similar, except that the two branches would say 50% instead of ‘Red’ and ‘Black’.

Our measurements consisted of finding payoffs that made subjects indifferent between two prospects. The elicitations started with three pairwise choices between two prospects denoted as alternatives A and B. Each binary choice corresponded to an iteration in a bisection process and narrowed down an interval within which the indifference value should lie. After these three pairwise choices, subjects saw a scrollbar (Figure A2), which allowed specifying indifference values up to €1 precision in the high-stakes experiment and up to 5 cents precision in the small-stakes experiment. In the large-stakes experiment, the scrollbar allowed for substantial values outside the range predicted by the iterative process. As a consequence, the data on the scrollbar give an indication of the quality of the data. If many subjects gave answers that did not align with their previous choices in the iterative process, this might signal poor understanding of the task. However, most subjects gave answers that aligned well with their previous choices.[5] After specifying a value with the scrollbar, subjects were asked to confirm their choice (Figure A3). If they canceled their choice, the process started anew. If subjects confirmed their choice, they moved on to the next elicitation.

4.3. Analyses

4.3.1. Utility curvature

Two different methods were used to investigate utility curvature. In the first, nonparametric, method, we calculated the area under the utility function. The domain of U was normalized to $[0, 1]$ for both gains and losses, by transforming every gain x_j^+ to the value x_j^+/x_5^+ and every loss x_j^- to x_j^-/x_5^-.[6] If utility is linear, the area under this normalized curve equals ½. For gains, we considered utility to be convex (concave) if the area under the curve was smaller (larger) than ½. For losses, utility was considered to be convex (concave) if the area under the curve was larger (smaller) than ½.

We also analyzed the utility function by the parametric estimation of the power family, x^α. For gains (losses), $\alpha > 1$ corresponds to convex (concave) utility, $\alpha = 1$ corresponds to linear utility, and $\alpha < 1$ corresponds to concave (convex) utility. The estimation was done by nonlinear least squares.

4.3.2. Loss aversion

Kahneman and Tversky’s (1979) definition of loss aversion implies (under original PT) that $-U(-x) > U(x)$ for all $x > 0$. As we explained in Section 2, this idea cannot be operationalized under new PT by asking subjects to choose between 0 and $x_{0.5}(-x)$, because probability weighting interferes. However, we could use our measurements to obtain a measure of loss aversion that reflects the spirit of Kahneman and Tversky’s (1979) definition. We computed $-U(-x_j^+)/U(x_j^+)$ and $-U(x_j^-)/U(-x_j^-)$, for $j = 1, \ldots, 5$, whenever possible.[7] Usually $U(-x_j^+)$ and $U(-x_j^-)$ could not be observed directly and had to be determined through linear interpolation. A subject was classified as loss-averse if $-U(-x)/U(x) > 1$ for all observations, as loss-neutral if $-U(-x)/U(x) = 1$ for all observations, and as gain seeking

[5] The median average individual prediction rate was equal to 82% in the large-stakes experiment.

[6] Six subjects (three for risk and three for uncertainty) violated monotonicity so that x_5^- was not the largest loss. For this subject, we transformed losses x_j^- to $x_j^-/\{\min_{i=1,\ldots,5} x_i^-\}$.

[7] These computations required that $-x_j^+$ was contained in $[x_5^-, 0)$ and $-x_j^-$ in $(0, x_5^+]$.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

if $-U(-x)/U(x) < 1$ for all observations. To account for response error, we also used a more lenient approach, classifying subjects as loss-averse, loss-neutral, or gain-seeking if the above inequalities held for more than half of the observations.

As mentioned above, Köbberling and Wakker (2005) defined loss aversion as $U'_{\uparrow}(0)/U'_{\downarrow}(0)$, where $U'_{\uparrow}(0)$ represents the left derivative and $U'_{\downarrow}(0)$ the right derivative of U at the reference point. To operationalize this definition, we computed each subject's coefficient of loss aversion as the ratio of $U(x_1^-)/x_1^-$ over $U(x_1^+)/x_1^+$, because x_1^- and x_1^+ are the loss and the gain closest to the reference point. Given that $U(x_1^-) = -U(x_1^+)$, this ratio is equal to $x_1^+/-x_1^-$. Hence, the method of Abdellaoui et al. (2016) permits a straightforward measurement of loss aversion according to Köbberling and Wakker (2005). A subject was classified as loss-averse if $x_1^+/-x_1^-$ exceeded 1, as loss-neutral if $x_1^+/-x_1^-$ was equal to 1, and as gain-seeking if $x_1^+/-x_1^-$ was smaller than 1.

5. Results

For one subject, the program crashed and we lost his data. Twenty-three subjects violated stochastic dominance in critical, early steps of the measurement procedure. These violations undermine subsequent answers and these subjects were removed from the analyses. For the remaining 242 subjects, we could determine the entire utility function, for both gains and losses and under both risk and uncertainty, and could, thus, measure their loss aversion.

5.1. Consistency checks

We included several consistency checks in the experiment. First, we repeated the final iteration of each task. Subjects made the same choice in 79.8% of these repeated choices. This reversal rate compares favorably to those that have usually been found (Stott, 2006; Wakker et al., 1994), particularly if one takes into account that subjects were close to indifference in the final iteration. There were no differences in consistency between the high-stakes and small-stakes experiments ($p = 0.56$) and between risk and uncertainty ($p = 0.23$).

We also repeated the entire elicitation of x_3^+ for the high-stakes and low-stakes experiments and for risk and uncertainty. The correlation between the original measurement and the repeated measurement was substantial: Kendall's τ varied between 0.73 (risk in the small-stakes experiment) and 0.85 (uncertainty in the high-stakes experiment). Again, there were no differences between the high-stakes and small-stakes experiments and between risk and uncertainty.

5.2. Samuelson's colleague problem and relative loss aversion

We will first show two data patterns that agree with Ert and Erev (2013). According to them, these challenge loss aversion. We will argue instead that these patterns can be compatible with loss aversion.

In Samuelson's colleague problem (Samuelson, 1963), subjects are asked whether they want to play a prospect that offers a 50% chance to win €2000 and a 50% chance to lose €500. Most subjects refuse to play this gamble, which is often explained by loss aversion. Ert and Erev (2013) showed that if Samuelson's colleague problem is presented in a more abstract form as a choice between €0 with certainty and a prospect paying €2000 with probability 0.5 and −€500 with probability 0.5, then 78% of their subjects chose the prospect.

Our data confirm Ert and Erev's finding. Many of our subjects faced a choice between €0 and €2000$_{0.5}$ (−€500) and for those who did not we could derive their preference from monotonicity.[8]

[8] If they preferred €2000$_{0.5}$ − €1000 to€0, then by monotonicity they should also prefer €2000$_{0.5}$ − €500 to€0. We had several tests of monotonicity in the experiment. The results were similar if we removed the subjects who violated monotonicity.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

For risk, 81% of the subjects preferred €$2000_{0.5}$ (−€500) to €0. For uncertainty, 77% of the subject preferred €2000_E (−€500) to €0.

Ert and Erev (2013) findings also challenge what they refer to as 'relative loss aversion': the finding that people are more risk-averse for mixed prospects than for gain prospects. Ert and Erev found relative loss aversion for high stakes but for low stakes it disappeared and in some of their experiments it even reversed. We found no evidence for relative loss aversion either, neither for high stakes nor for low stakes. For risk, in the high-stakes experiment, 80% of our subjects preferred €0 to €$2000_{0.5}$ (−€2000) and 78% preferred €1000 to €$2000_{0.5}0$, and in the low-stakes experiment, 76% preferred €0 to €$10_{0.5}$ (−€10)[9] and 68% preferred €5 to €$10_{0.5}0$. For uncertainty, in the high-stakes experiment, 85% of our subjects preferred €0 to €$2000_{0.5}$ (−€2000) and 83% preferred €1000 to €$2000_{0.5}0$, and in the low-stakes experiment, 81% preferred €0 to €$10_{0.5}$ (−€10) and 71% preferred €5 to €$10_{0.5}0$.

Note, however, that neither of these findings is necessarily inconsistent with loss aversion. Both the choice in Samuelson's colleague problem and the choice pattern that challenges relative loss aversion are consistent with PT with the parameters usually found in empirical studies (Fox and Poldrack, 2014). For example, PT with Tversky and Kahneman's (1992) parameters predicts all these choices. To test whether loss aversion exists, we must measure it. To that measurement, we now turn.

5.3. Utility for gains and losses

Figure 1 shows the utility for gains and losses based on the median data for the small-stakes experiment under risk (Panel A), the high-stakes experiment under risk (Panel B), the small-stakes experiment under uncertainty (Panel C), and the high-stakes experiment under uncertainty (Panel D). Visual inspection reveals that utility looked similar between the small-stakes and high-stakes experiments except that utility under risk in the small-stakes experiment was somewhat closer to linearity. All utility functions are consistent with PT's assumption of S-shaped utility, concave for gains and convex for losses.

In interpreting Figure 1, it should be kept in mind that the domains of the functions differ considerably. We obtain a more detailed picture by looking at the individual level. Table 2 presents the classification of subjects according to the shape of their utility function. Two things are noteworthy. First, the distributions are very close to the small-stakes and the high-stakes experiments and they do not differ statistically (Fisher's exact test, $p = 0.19$ and $p = 0.67$). Second, S-shaped utility, concave for gains and convex for losses, was clearly the most common pattern: around 50% of the subjects fell in this category. Everywhere concave utility, which is traditionally assumed in economics and in decision theory, was much less common and less than 20% of the subjects belonged to this category.

We also estimated for each subject a best-fitting power function. Table 3 shows the medians of the estimated power functions at the individual level. Several authors have argued that utility is more curved for larger payoffs (Birnbaum, 2008; Edwards, 1955; Luce, 2000; Rabin, 2000; Wakker, 2010), but we found little evidence for this. We observed no differences in utility curvature for risk between the high-stakes experiment and the small-stakes experiment (both $p > 0.54$). For uncertainty, there was no difference in curvature between the two experiments for losses ($p = 0.46$), but we found less curvature in the low-stakes experiment than in the high-stakes experiment for gains ($p = 0.04$, one-sided test).

[9]Note that this majority preference is consistent with the behavioral definition of Kahneman and Tverksy (1979) used by Ert and Erev (2013). We return to this finding in Section 6.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

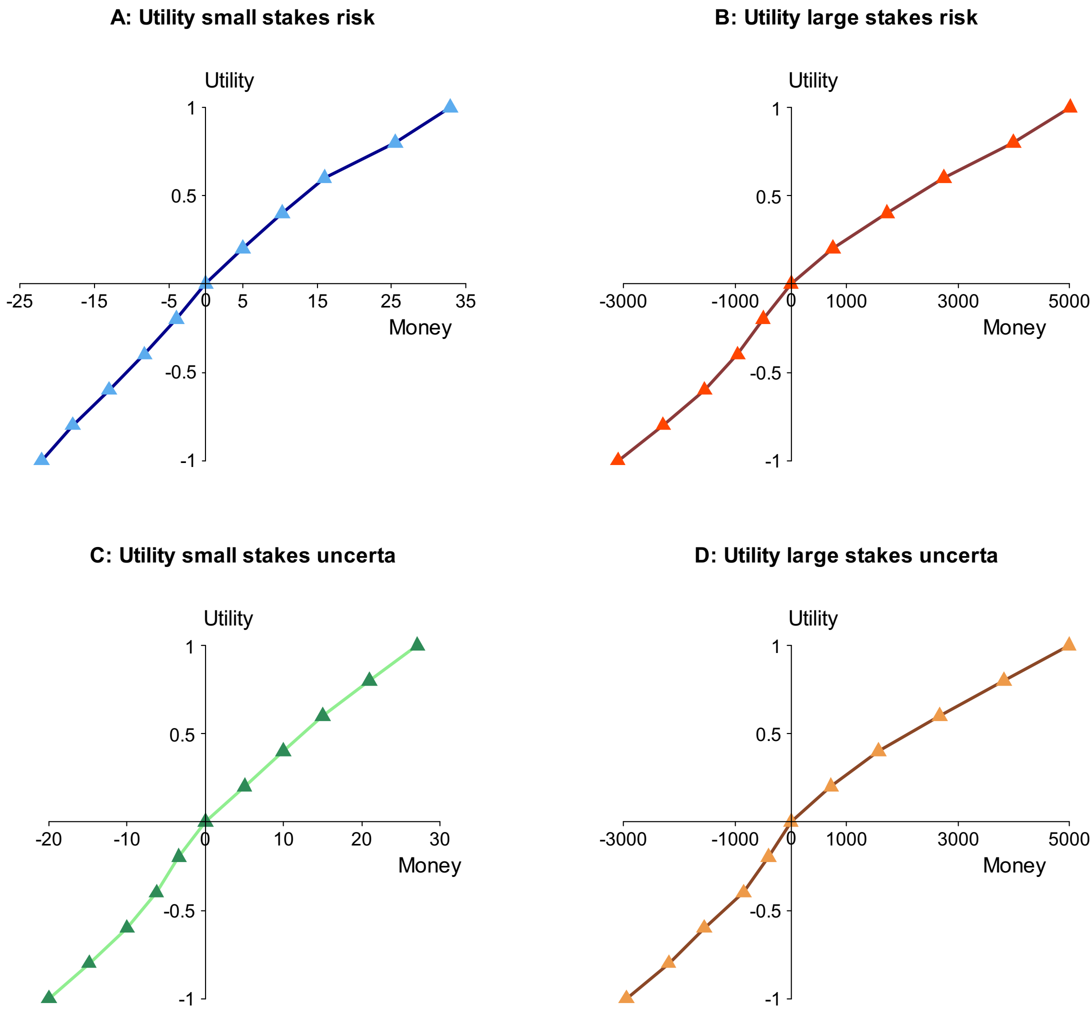


Figure 1. *The utility for gains and losses based on the median data. The figure displays the utility for gains and losses based on the median responses. Panel A displays utility for the small-stakes experiment under risk. Panel B displays utility for the high-stakes experiment under risk. Panel C displays utility for the small-stakes experiment under uncertainty. Panel D displays utility for the high-stakes experiment under uncertainty.*

5.4. Loss aversion

Figure 2 shows the relationships between the medians of x_j^+ and $-x_j^-$ for the small-stakes and high-stakes experiments and for risk and uncertainty. Consistent with Kahneman and Tversky's (1979) definition of loss aversion, $-x_j^-$ was always lower than x_j^+ (for all j) for both the small-stakes experiment and the high-stakes experiment and for both risk and uncertainty.

In each panel, we estimated a linear regression between $-x_j^-$ and x_j^+. The estimated regression coefficients can be interpreted as aggregate loss aversion coefficients under the definition of Kahneman and Tversky (1979). All four estimated values of β were different from 1 ($p < 0.01$), which indicates that there was significant loss aversion in both experiments and for both risk and uncertainty. Hence, we did not observe that loss aversion disappeared in the small-stakes experiment. However, loss aversion was lower in the small-stakes experiment than in the high-stakes experiment, which is consistent with Ert and Erev's (2008, 2013) magnitude effect for loss aversion. The difference between the estimated

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

Table 2. *Classification of subjects according to the shape of their utility function. The table classifies the subjects according to the shape of their utility function for the small-stakes and high-stakes experiments based on the area under the normalized utility function. Panel A displays the results under risk. Panel B displays the results under uncertainty.*

	Small stakes				High stakes			
	Losses				Losses			
Gains	Concave	Convex	Linear	Total	Concave	Convex	Linear	Total
Panel A: Risk								
Concave	20	57	1	78	18	60	0	78
Linear	12	19	0	31	25	12	0	37
Convex	2	1	8	11	1	2	4	7
Total	34	77	9	120	44	74	4	122
Panel B: Uncertainty								
Concave	25	44	2	71	27	52	4	83
Linear	18	18	2	38	21	12	1	34
Convex	2	4	5	11	0	2	3	5
Total	45	66	9	120	48	66	8	122

Table 3. *Summary of individual parametric fittings of utility. The table depicts the results of fitting power functions on each subject's choices individually for each experiment separately. Shown are the median and the interquartile range (IQR) for the resulting estimates.*

		Risk		Uncertainty	
Experiment		Gains	Losses	Gains	Losses
Small-stakes	Median	0.84	0.82	0.88	0.89
	IQR	[0.70–1.02]	[0.65–1.03]	[0.71–1.07]	[0.69–1.24]
High-stakes	Median	0.80	0.84	0.82	0.84
	IQR	[0.60–1.20]	[0.61–1.21]	[0.64–1.03]	[0.64–1.18]

values of β for the small-stakes experiment and the high-stakes experiment was significant, for both risk and uncertainty (both $p < 0.01$).

At the individual level, we found no evidence for this magnitude effect. We observed that $x_j^+ > -x_j^-$ for all j, for both the small-stakes experiment and the high-stakes experiment and for both risk and uncertainty (Wilcoxon test, all $p < 0.01$), which is consistent with the existence of loss aversion. However, we could not reject the null that the ratios $x_j^+/-x_j^-$ were the same for the small-stakes and high-stakes experiments (Wilcoxon test, all $p > 0.29$), which is inconsistent with lower loss aversion in the small-stakes experiment.

Table 4 and Figure 3 show the results of the individual analyses of loss aversion based on Kahneman and Tversky's (1979) and Köbberling and Wakker's (2005) definitions of loss aversion. Under both definitions, we found clear evidence of loss aversion in both the low-stakes experiment and the high-stakes experiment. Considerably more subjects were loss averse than displaying the opposite type of behavior (gain-seeking) in both experiments and for both risk and uncertainty. Moreover, the subject

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

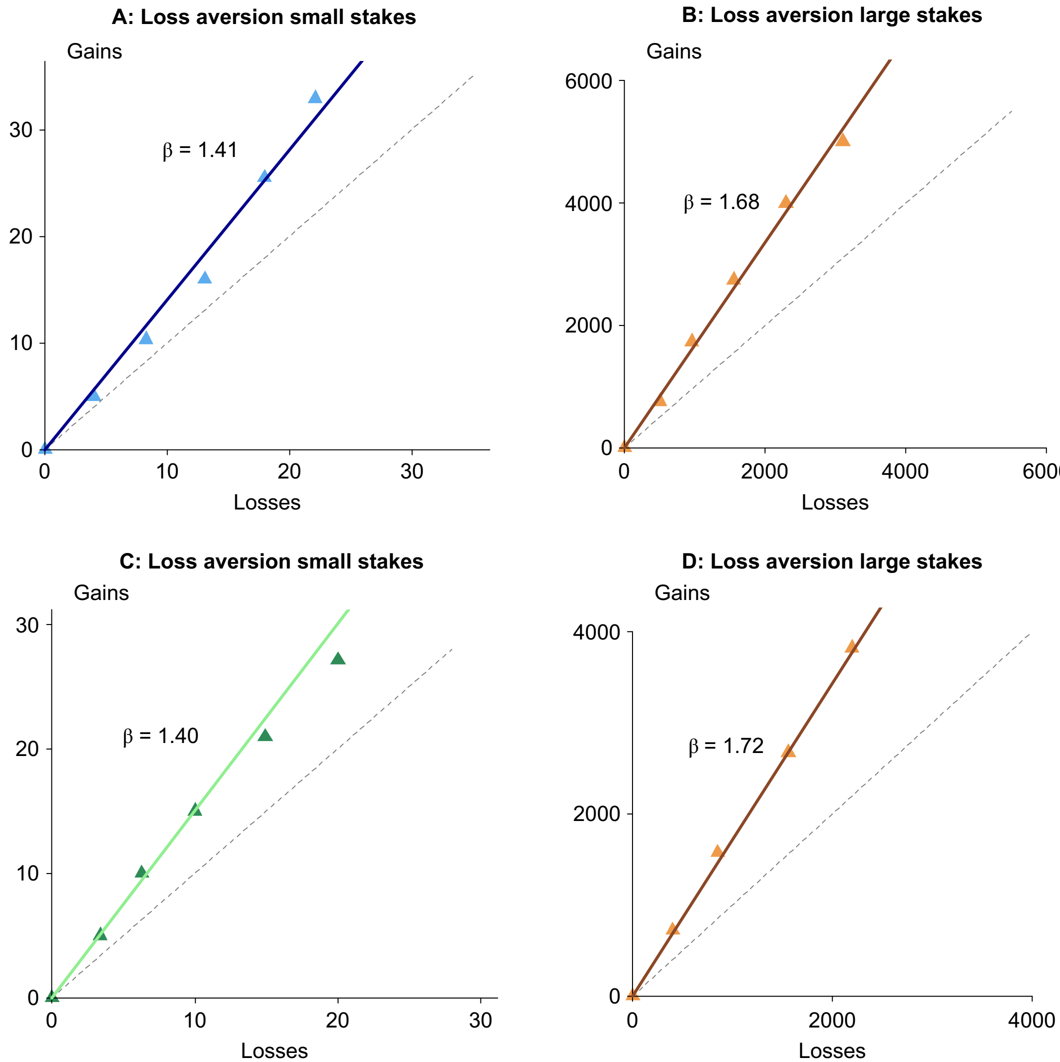


Figure 2. *The relationship between median gains and median losses with the same absolute utility. Panel A displays the relationship between median gains and losses for small stakes under risk, Panel B displays this relationship for high stakes under risk, Panel C for small stakes under uncertainty, and Panel D for high stakes under uncertainty. The dashed lines in each panel correspond to the case where gains and losses of the same absolute utility would be equal. The straight lines with slope β correspond to the best-fitting linear equation.*

classifications were very close between the experiments. Under the definition of Kahneman and Tversky (1979), we could not reject the null hypothesis of identical classifications in the low-stakes experiment and the high-stakes experiment for both risk and uncertainty (Fisher's exact test, $p > 0.18$). Under the definition of Köbberling and Wakker (2005), we could reject the null of identical classifications in the low-stakes experiment and the high-stakes experiment for risk ($p = 0.05$), but not for uncertainty ($p = 0.10$).

All loss aversion coefficients significantly exceeded 1 (Wilcoxon test, all $p < 0.01$), consistent with loss aversion. The loss aversion coefficients were slightly lower in the low-stakes experiment than in

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

Table 4. *Results under the various definitions of loss aversion. The table depicts the results under the two definitions of loss aversion for both risk and uncertainty. The table displays how the coefficients are defined, their medians and interquartile ranges, and the number of loss-averse, gain-seeking, and loss-neutral subjects. The numbers for Kahneman and Tversky's definition correspond to the case where response errors are taken into account.*

Definition	Condition	Experiment	Median [IQR]	Loss-averse	Gain-seeking	Loss-neutral
Kahneman and Tversky (1979)	Risk	Small-stakes	1.25 [0.98, 2.07]	76	26	6
		High-stakes	1.46 [0.82, 2.96]	73	39	3
	Uncertainty	Small-stakes	1.40 [0.99, 2.44]	76	24	2
		High-stakes	1.46 [0.89, 3.43]	76	36	2
Köbberling and Wakker (2005)	Risk	Small-stakes	1.24 [1.00, 1.81]	78	20	22
		High-stakes	1.35 [0.95, 2.55]	73	35	14
	Uncertainty	Small-stakes	1.33 [1.00, 2.64]	86	20	14
		High-stakes	1.44 [0.89, 3.00]	77	34	11

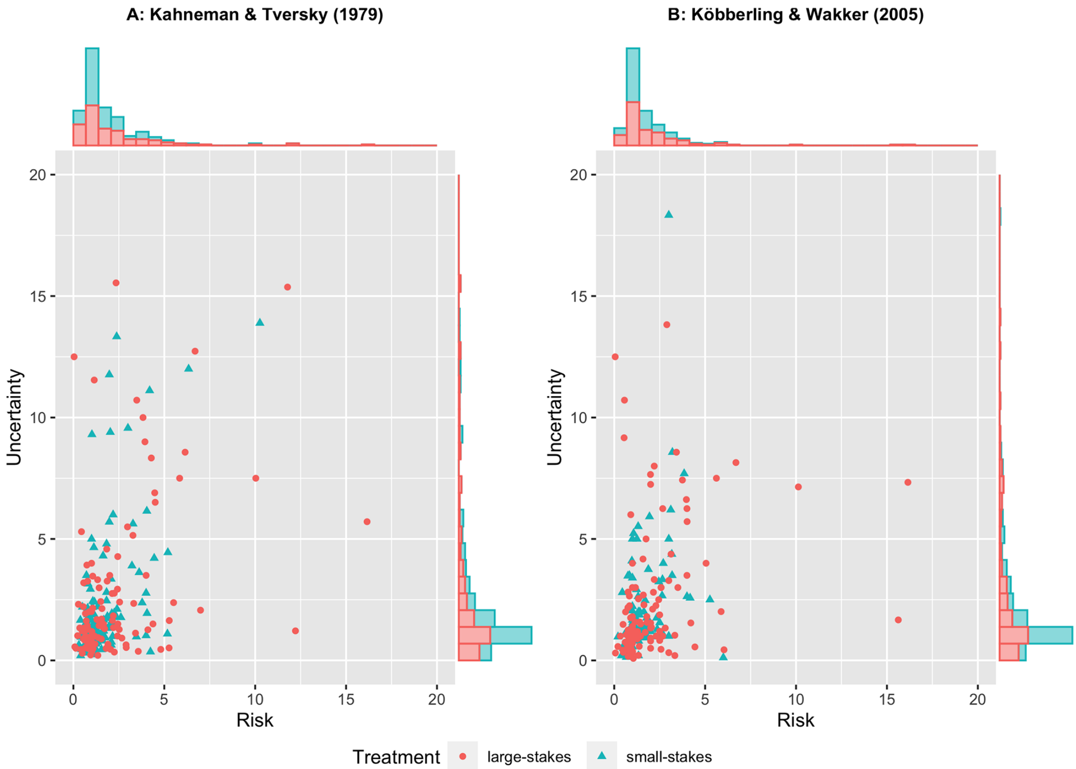


Figure 3. *Distribution of individual loss aversion coefficients under the various definitions of loss aversion. Panel A displays the relationship between individual loss aversion coefficients for small and large stakes under risk and uncertainty for the Kahneman and Tversky (1979) definition. Panel B shows the relationship between individual loss aversion coefficients for small and large stakes under risk and uncertainty for the Köbberling and Wakker (2005) definition. For the sake of readability, the range is restricted to [0,20]: 10 observations outside the range were removed in Panel A and 9 observations were removed in Panel B.*

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

the high-stakes experiment, but the difference was insignificant (Wilcoxon test, all $p > 0.38$) and we could not confirm that lower stakes led to less loss aversion.

Finally, the correlation between loss aversion under risk and loss aversion under uncertainty is fair to moderate (between 0.38 and 0.44), suggesting that loss aversion is a more or less stable behavioral trait.

6. Discussion

Our findings provide little support for the conjecture that loss aversion disappears for small stakes. Both under the definition of Kahneman and Tversky (1979), which is used by Ert and Erev (2013), and under the definition of Köbberling and Wakker (2005), which is now commonly used, we found significant loss aversion for both large and small stakes. Under the definition of Kahneman and Tversky (1979), we found some evidence that loss aversion decreased with stake size at the aggregate level, but not at the individual level. Under the definition of Köbberling and Wakker (2005), stake size did not affect loss aversion. Moreover, we show that some of the choices that have been interpreted as violating loss aversion (e.g., Samuelson's colleague problem) are consistent with the existence of loss aversion. Taken together, our findings suggest that under PT, loss aversion is robust to stake size.

We do find that loss aversion is less than originally estimated. In that, our results are consistent with the meta-analysis of Walasek et al. (2018), even though they used a different methodology. Tverksy and Kahneman's (1992) estimate of a loss aversion coefficient of 2.25 is probably too high. A value around or slightly below 1.50 seems more plausible.

Our results show loss aversion for gains and losses of around 10 Euros. Ert and Erev (2013) found loss aversion for prospects involving gains and losses of 100 Sheqels (about 25 Euros), but not for prospects with gains and losses of 10 Sheqels (about 2.50 Euros). It could be that our stakes were still too large, even in the small-stakes experiment and that less aversion might disappear somewhere between 2.50 and 10 Euros. Remember that 76% of our subjects preferred zero to the prospect $10_{0.5}(-10)$, which is consistent with the behavioral definition of Kahneman and Tversky (1979). It might be interesting to repeat our study for even smaller stakes than we used.

Ert and Erev's (2013) contribution raises questions about the behavioral relevance of loss aversion. Of course, our findings do not imply that Ert and Erev's claim that loss aversion is volatile and context-dependent is untrue. They identified several factors besides the size of the stakes that affect the amount of loss aversion. However, our findings do suggest that the effect of stake size is less important than they suggested. Whether the other factors survive in the presence of theory-based tests of loss aversion is a topic for future research.

Unlike some of Ert and Erev's (2013) experiments, we used hypothetical payoffs because we wanted to detect loss aversion for both small stakes and high stakes. In the small-stakes experiment, we could have used real incentives and provided subjects with an initial endowment in a way similar to Ert and Erev's (2013). In the large-stakes experiment, given the amounts at stake, such a procedure was infeasible. The literature on the importance of real incentives in decision under risk and uncertainty does not offer clear guidance. While some studies found risk attitudes, and especially risk aversion, to increase with stakes (Holt and Laury, 2002),[10] most studies found that for small to modest stakes, there was little or no effect of using real instead of hypothetical choices for the kinds of tasks that we asked our subjects to perform (Bardsley et al., 2010). Therefore, we believe that the potential advantage of using real incentives with an initial endowment does not outweigh the benefits of being able to use more significant outcomes and losses.

In our experiments, we controlled for several of the other factors that enhance loss aversion according to Ert and Erev (2013). Ert and Erev (2013) argue that loss aversion will be present if the safer

[10]Holt and Laury did not use losses, so it is hard to derive conclusions about the effect of stake size on loss aversion from their study.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

prospect has a higher probability of a positive outcome in the mixed domain than in the gain domain. This never happened in our study. The probability of positive outcomes was the same in nearly all of our questions and the heuristic to maximize the probability of a gain (Payne, 2005) could not explain our findings.

Second, Ert and Erev argue that some of the evidence for loss aversion comes from framing the safe option as the status quo. Then status quo bias could lead to observed loss aversion. This problem does not apply to our study. We only used abstract choices and avoided to frame the safe prospect as the status quo. Ert and Erev (2013) found that the abstract framing led to less loss aversion.

Third, we avoided the use of choice lists, which can also lead to more loss aversion (Ert and Erev, 2013, Study 3), maybe because complexity introduces its own set of biases. Further, we only used 50–50 prospects in the risk treatment. Ert and Erev found that these led to less loss aversion. As we used probability 0.50, expected values were easy to compute and we always started the elicitation process with a choice between the prospect and its expected value. Ert and Erev (2013) found that simplifying choices led to less loss aversion.

However, Ert and Erev (2013) also found that repeated choice without feedback facilitated loss-averse-like behavior even with small stakes. Because our experiments used several choice iterations to find the indifference points, they resembled this context and this may have led to more loss aversion. Whether feedback affects loss aversion in our method is interesting to explore. It might (to some extent) bridge the gap between our results and those of Ert and Erev (2013).

A recent study by Zeif and Yechiam (2022) reevaluated the evidence for loss aversion in Mrkva et al. (2020) and argued that it was due to properties of the choice lists they used. In their choice lists, losses were presented in increasing order, and if subjects would switch between accepting and rejecting a prospect in the middle of the list (a bias often observed in choice lists), then they would appear loss-averse. Likewise, not accepting the prospect was presented as the status quo, which might additionally inflate loss aversion. Taking account of these possible biases, Zeif and Yechiam (2022) found no loss aversion for small stakes (and less for large stakes). None of their explanations applies to our findings and, hence, the (carefully designed) experiments in Zeif and Yechiam do not explain our findings. Moreover, their measure of loss aversion (unlike ours, but like the one in Mrkva et al., 2020) assumes linear utility and no probability weighting. As we argued in Section 1, this confounds the measurement of loss aversion. Their argument that the assumption of no probability weighting is not material, because probabilities and thus probability weights are the same for gains and losses (p. 1020), is only true under original PT, but not under new PT.

We measured loss aversion for both risk and uncertainty. Many real-world decisions involve uncertainty and decision under uncertainty is widely studied (Trautmann and Van De Kuilen, 2015; Wakker, 2010). Empirical studies suggest that loss aversion plays an important role in shaping decisions under uncertainty (Baillon and Bleichrodt, 2015; Trautmann et al., 2011). We find similar loss aversion across risk and uncertainty. Gächter et al. (2022) found that loss aversion for risk and certainty were correlated.[11] Taken together, these findings suggest that loss aversion is a robust behavioral characteristic and cannot be turned on and off at will.

Tversky and Kahneman (1991) propose a model in which loss aversion is constant over different attributes. Constant loss aversion is (obviously) easier to measure than general loss aversion. Whether loss aversion indeed is constant across attributes has to the best of our knowledge not been explored. Our findings suggest that loss aversion is approximately constant across risk and uncertainty. Extending our findings to other attributes seems interesting to explore for future research.

Our theory-based test of loss aversion assumed PT. However, our measurements only involved binary prospects. For binary gain prospects, many models of decision under risk and uncertainty have the same representation as PT, as has been pointed out by Miyamoto (1988) and Luce (2000). Hence, the assumption of binary PT is rather mild. In a pilot experiment, we included tests of the central

[11] They do, however, assume linear utility and no probability weighting. Their results are also subject to the criticism of Zeif and Yechiam (2022).

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

condition underlying this model and we could not reject it, providing further support for our theoretical assumption.

7. Conclusion

Several authors have challenged the robustness of loss aversion. They argue that it is not a stable perceptual construct and that loss aversion can be turned on and off depending on the context in which preferences are elicited. We have argued that this evidence is inconclusive as it uses a behavioral definition of loss aversion that cannot separate loss aversion, probability weighting, and diminishing sensitivity under the commonly used version of PT. We perform a new theory-based test of the effect of stake size on loss aversion that controls for probability weighting and diminishing sensitivity and that complements the earlier behavioral tests. Our results show little to no evidence of the effect of stake size on loss aversion. They suggest that loss aversion is robust and, even though less than commonly found, does not depend on stake size.

Data availability statement. Data and experimental instructions are available at: https://osf.io/4y38q/.

Acknowledgment. We are grateful to the Editor (Andreas Glöckner), Eyal Ert, and an anonymous reviewer for their constructive comment on previous versions of our paper.

References

Abdellaoui, M., Bleichrodt, H., L'Haridon, O., & Van Dolder, D. (2016). Measuring loss aversion under ambiguity: A method to make prospect theory completely observable. *Journal of Risk and Uncertainty*, *52*, 1–20.

Abdellaoui, M., Bleichrodt, H., & Paraschiv, C. (2007). Loss aversion under prospect theory: A parameter-free measurement. *Management Science*, *53*, 1659–1674.

Baillon, A., & Bleichrodt, H. (2015). Testing ambiguity models through the measurement of probabilities for gains and losses. *American Economic Journal: Micro*, *7*, 77–100.

Baillon, A., Bleichrodt, H., & Spinu, V. (2020). Searching for the reference point. *Management Science*, *66*(1), 93–112.

Bardsley, N., Cubitt, R., Loomes, G., Moffatt, P., Starmer, C., & Sugden, R. (2010). *Experimental Economics*. Princeton: Princeton University Press.

Benartzi, S., & Thaler, R. H. (1995). Myopic loss aversion and the equity premium puzzle. *Quarterly Journal of Economics*, *110*, 73–92.

Birnbaum, M. H. (2008). New paradoxes of risky decision making. *Psychological Review*, *115*, 463–501.

Brown, A. L., Imai, T., Vieider, F., & Camerer, C. (2021). Meta-analysis of empirical estimates of loss-aversion. Available at SSRN 3772089.

Edwards, W. (1955). The prediction of decisions among bets. *Journal of Experimental Psychology*, *50*, 201–214.

Erev, I., Ert, E., & Yechiam, E. (2008). Loss aversion, diminishing sensitivity, and the effect of experience on repeated decisions. *Journal of Behavioral Decision Making*, *21*, 575–597.

Ert, E., & Erev, I. (2008). The rejection of attractive gambles, loss aversion, and the lemon avoidance heuristic. *Journal of Economic Psychology*, *29*, 715–723.

Ert, E., & Erev, I. (2013). On the descriptive value of loss aversion in decisions under risk: Six clarifications. *Judgment and Decision Making*, *8*, 214–235.

Fox, C. R., & Poldrack, R. A. (2014). Prospect theory and the brain. In P. Glimcher & E. Fehr (Eds.), *Handbook of neuroeconomics* (2nd ed., pp. 533–567). New York: Elsevier.

Gächter, S., Johnson, E. J., & Herrmann, A. (2022). Individual-level loss aversion in riskless and risky choices. *Theory and Decision*, *92*(3-4), 599–624.

Gal, D., & Rucker, D. D. (2018). The loss of loss aversion: Will it loom larger than its gain? *Journal of Consumer Psychology*, *28*, 497–516.

Greiner, B. (2015). Subject pool recruitment procedures: organizing experiments with ORSEE. *Journal of the Economic Science Association*, *1*, 114–125.

Guerin, B. (1986). Mere presence effects in humans: A review. *Journal of Experimental Social Psychology*, *22*(1), 38–77.

Holt, C. A., & Laury, S. K. (2002). Risk aversion and incentive effects. *American Economic Review*, *92*, 1644–1655.

Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review*, *93*, 1449–1475.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263–291.

Köbberling, V., & Wakker, P. P. (2005). An index of loss aversion. *Journal of Economic Theory*, *122*, 119–131.

Luce, R. D. (2000). *Utility of gains and losses: Measurement-theoretical and experimental approaches*. Mahwah, NJ : Lawrence Erlbaum Associates, Inc.
Miyamoto, J. M. (1988). Generic utility theory: Measurement foundations and applications in multiattribute utility theory. *Journal of Mathematical Psychology*, *32*, 357–404.
Mrkva, K., Johnson, E. J., Gächter, S., & Herrmann, A. (2020). Moderating loss aversion: Loss aversion has moderators, but reports of its death are greatly exaggerated. *Journal of Consumer Psychology*, *30*, 407–428.
Payne, J. W. (2005). It is whether you win or lose: The importance of the overall probabilities of winning or losing in risky choice. *Journal of Risk and Uncertainty*, *30*, 5–19.
Rabin, M. (2000). Risk aversion and expected-utility theory: A calibration theorem. *Econometrica*, *68*, 1281–1292.
Samuelson, P. A. (1963). Risk and uncertainty: A fallacy of large numbers. *Scientia*, *98*, 108–113.
Stott, H. P. (2006). Cumulative prospect theory's functional menagerie. *Journal of Risk and Uncertainty*, *32*, 101–130.
Trautmann, S. T., & Van De Kuilen, G. (2015). Ambiguity attitudes. In G. Keren & G. Wu (Eds.), *The Wiley Blackwell handbook of judgment and decision making* (pp. 89–116). Oxford: Wiley-Blackwell.
Trautmann, S. T., Vieider, F. M., & Wakker, P. P. (2011). Preference reversals for ambiguity aversion. *Management Science*, *57*, 1320–1333.
Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, *106*, 1039–1061.
Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*, 297–323.
Wakker, P. P. (2010). *Prospect theory: For risk and ambiguity*. Cambridge: Cambridge University Press.
Wakker, P. P., & Deneffe, D. (1996). Eliciting von Neumann–Morgenstern utilities when probabilities are distorted or unknown. *Management Science*, *42*, 1131–1150.
Wakker, P. P., Erev, I., & Weber, E. U. (1994). Comonotonic independence: The critical test between classical and rank-dependent utility. *Journal of Risk and Uncertainty*, *9*, 195–230.
Walasek, L., Mullett, T. L., & Stewart, N. (2018). A meta-analysis of loss aversion in risky contexts. Available at SSRN 3189088.
Zank, H. (2010). On probabilities and loss aversion. *Theory and Decision*, *68*, 243–261.
Zeif, D., & Yechiam, E. (2022). Loss aversion (simply) does not materialize for smaller losses. *Judgment and Decision Making*, *17*, 1015–1042.

Appendix A: Display of the experimental questions

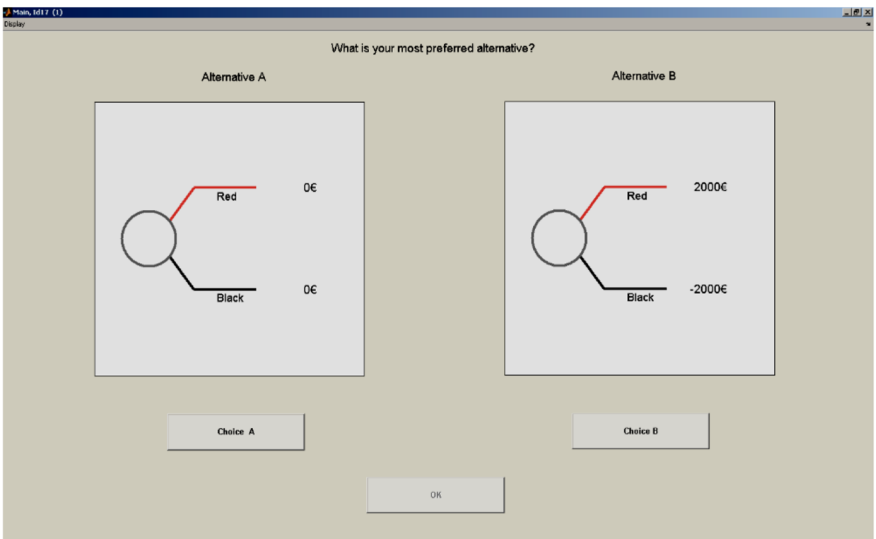


Figure A1. *Choice screen under uncertainty.*

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

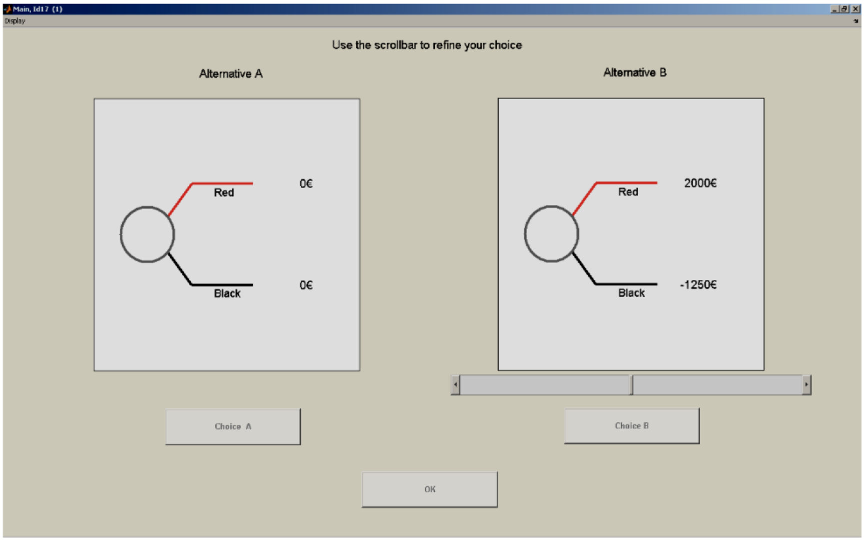


Figure A2. *Scrollbar screen under uncertainty.*

Note: The iteration process between Figures A1 and A2 is the following: suppose that the participant chooses Alternative B in Figure A1. A second pairwise choice offers two alternatives: Alternative A (unchanged) and a new, more attractive version of Alternative B in which the loss is equal to −1000. Suppose, on this second pairwise choice, that Alternative A is now selected. The third pairwise choice consists of Alternative A (unchanged) and a version of Alternative B where the loss equals −1500. Here, Alternative B is less attractive than with a loss of −1000 but more attractive than with a loss of −2000. Suppose that the participant selects Alternative A on the third choice. The interval in which the indifference value lies is between −1000 and − 1500. The scrollbar in Figure A2 shows the option to be made within this interval, centered on −1250.

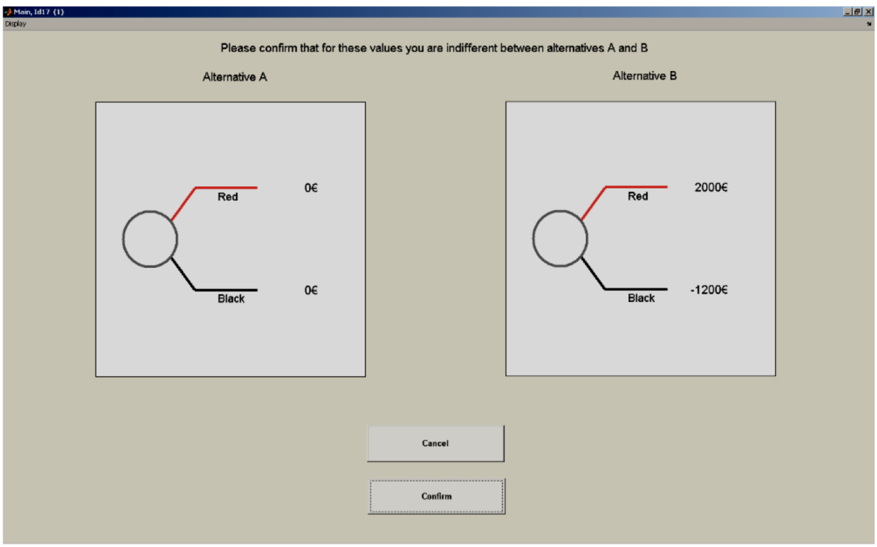


Figure A3. *Confirmation screen under uncertainty.*

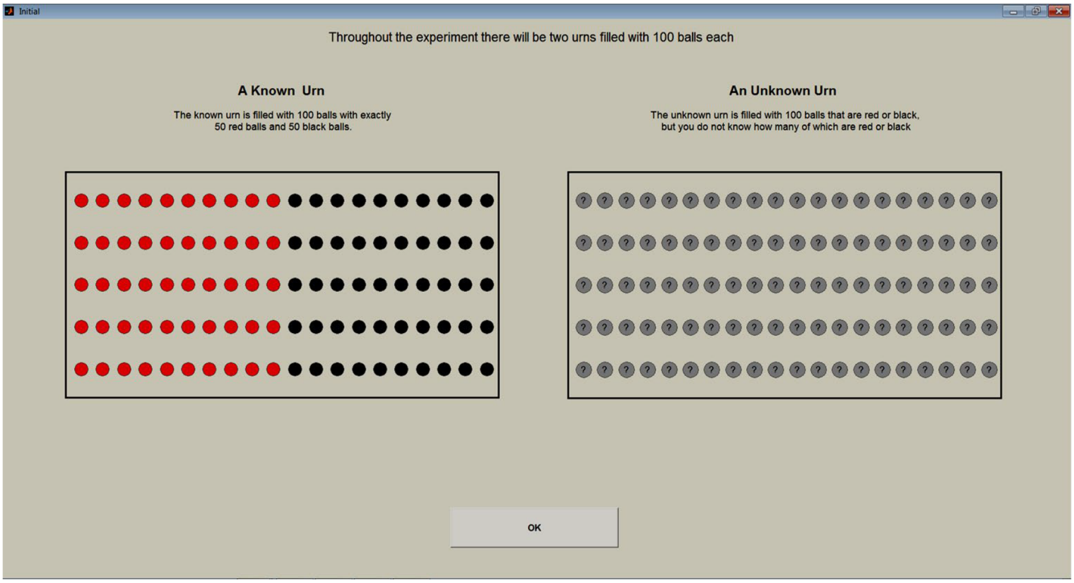


Figure A4. *Known versus unknown urn in the second experiment.*

Appendix B: Instruction sheet for the small-stakes experiment

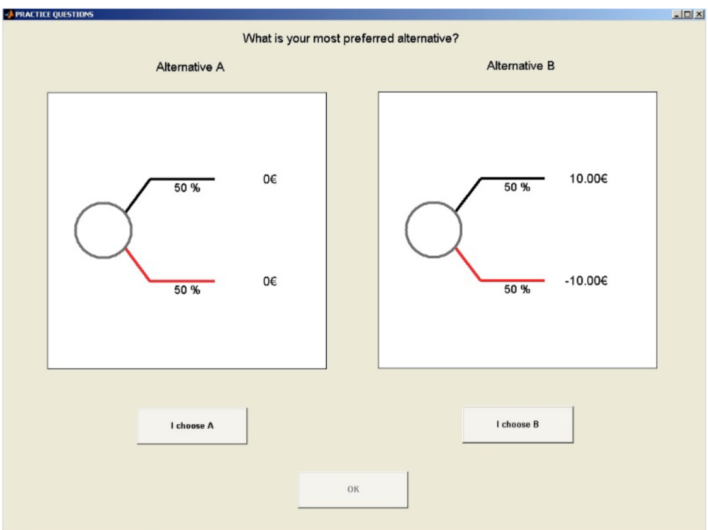
In this experiment, you will face several series of questions between bets. Each series consists of five steps.

Step 1: Choice between Alternatives A and B

You must choose between Alternatives A and B. To select your preferred alternative, click either on 'I choose A' (if you prefer A) or 'I choose B' (if you prefer B).

Please pay attention to the colors and the amounts before choosing.

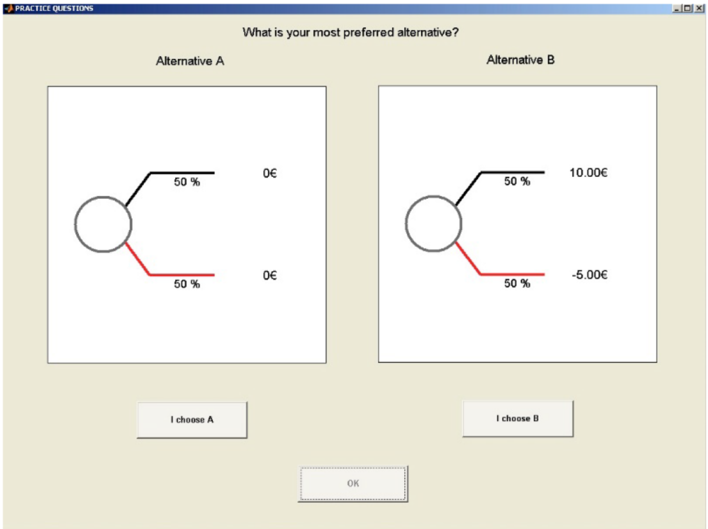
Once you have selected your preferred alternative, click on OK to proceed to step 2.



https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

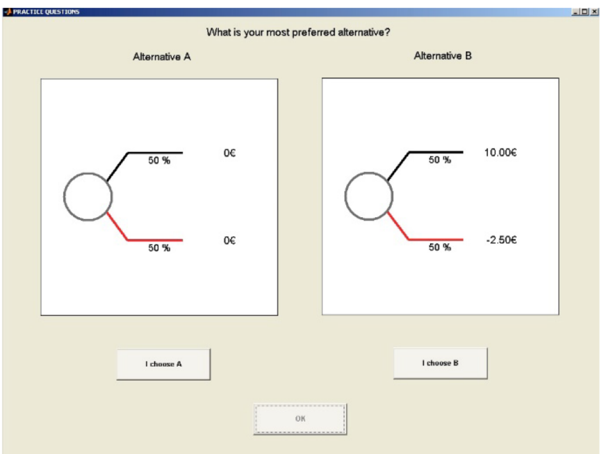
Step 2: Choice between Alternatives A and B

Step 2 is similar to Step 1, except that one amount of Alternative B has changed.
Please pay attention to the colors and the amounts before choosing.
Once you have selected your preferred alternative, click on OK to proceed to Step 3.



Step 3: Choice between Alternatives A and B

Step 3 is similar to Steps 1 and 2, except that, once again, one amount of alternative B has changed.
Please pay attention to the colors and the amounts before choosing.
Once you have selected your preferred alternative, click on OK to proceed to Step 3.

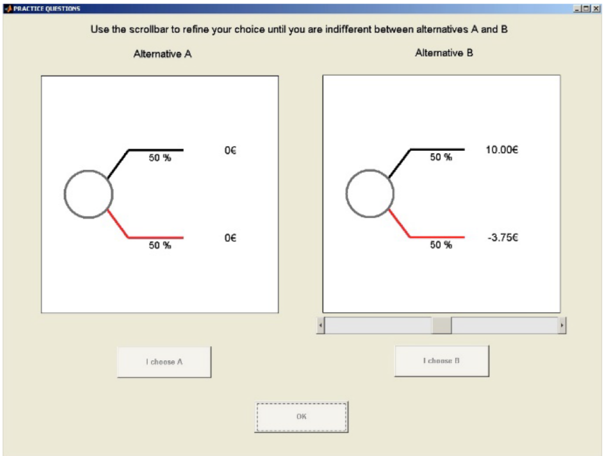


Step 4: Scrollbar

A scrollbar now appears below Alternative B. By moving the scrollbar left or right, you can increase or decrease one amount of Alternative B. Please change that amount until you are indifferent between Alternatives A and B. By clicking on the arrows, you can obtain any degree of precision.

https://doi.org/10.1017/jdm.2023.2 Published online by Cambridge University Press

Once you have selected the amount for which you are indifferent between Alternatives A and B, click on OK to proceed to the confirmation screen.

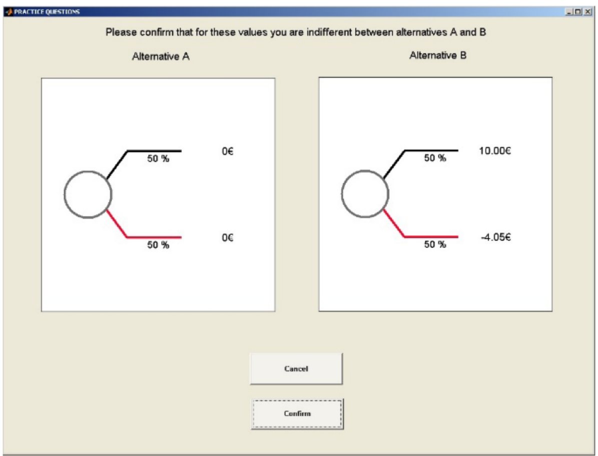


Step 5: Confirmation screen

Your indifference is shown on the screen.

If you agree that you are indifferent, please click on Confirm.

Otherwise, click on Cancel to start anew from Step 1.



Cite this article: Bleichrodt, H., & L'Haridon, O. (2023). Prospect theory's loss aversion is robust to stake size. *Judgment and Decision Making,* e14. https://doi.org/10.1017/jdm.2023.2