

Vieider, Ferdinand M.; Cingl, Lubomír; Martinsson, Peter; Stojic, Hrvoje

Working Paper

Separating attitudes towards money from attitudes towards probabilities: Stake effects and ambiguity as a test for prospect theory

WZB Discussion Paper, No. SP II 2013-401

Provided in Cooperation with:

WZB Berlin Social Science Center

Suggested Citation: Vieider, Ferdinand M.; Cingl, Lubomír; Martinsson, Peter; Stojic, Hrvoje (2013) : Separating attitudes towards money from attitudes towards probabilities: Stake effects and ambiguity as a test for prospect theory, WZB Discussion Paper, No. SP II 2013-401, Wissenschaftszentrum Berlin für Sozialforschung (WZB), Berlin

This Version is available at:

<https://hdl.handle.net/10419/83653>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



Ferdinand M. Vieider
Lubomír Cingl
Peter Martinsson
Hrvoje Stojic

Separating attitudes towards money from attitudes towards probabilities: stake effects and ambiguity as a test for prospect theory

Discussion Paper

SP II 2013–401

August 2013

**Social Science Research Center Berlin
(WZB)**

Research Area

Markets and Politics

WZB Junior Research Group

Risk and Development

Wissenschaftszentrum Berlin für Sozialforschung gGmbH
Reichpietschufer 50
10785 Berlin
Germany
www.wzb.eu

Copyright remains with the author(s).

Discussion papers of the WZB serve to disseminate the research results of work in progress prior to publication to encourage the exchange of ideas and academic debate. Inclusion of a paper in the discussion paper series does not constitute publication and should not limit publication in any other venue. The discussion papers published by the WZB represent the views of the respective author(s) and not of the institute as a whole.

Affiliation of the authors other than WZB:

Lubomír Cingl
Charles University Prague, Czech Republic

Peter Martinsson
University of Gothenburg, Sweden

Hrvoje Stojic
Pompeu Fabra University, Spain

Separating attitudes towards money from attitudes towards probabilities: stake effects and ambiguity as a test for prospect theory

Ferdinand M. Vieider
WZB, Berlin, Germany

Lubomír Cingl
Charles University Prague, Czech Republic

Peter Martinsson
University of Gothenburg, Sweden

Hrvoje Stojic
Pompeu Fabra University, Spain

14 June 2013

Abstract

Prospect theory (PT) is the dominant descriptive theory of decision making under risk today. For the modeling of choices, PT relies on a psychologically founded separation of risk attitudes into attitudes towards outcomes, captured in a value function; and attitudes towards probabilities, captured in a probability weighting function. However, while it is theoretically sound, it is unclear whether this clear separation is reflected in actual choices. To test this, we designed two experiments. In the first experiment, we elicit the value and probability weighting functions both under known and unknown probabilities. The results support PT and show that the value function is unaffected by the nature of the probabilities, which only affects probability weighting. More in general, this finding supports theories that represent ambiguity attitudes through probability transformations rather than utility transformations. In the second experiment, we examine the effects of an increase in stakes on risk attitudes. We find that the stake increase is not reflected in the value function, but rather in the weighting function, thus contradicting PT's prediction.

JEL Classification: C91; D03; D81

Key Words: prospect theory; value functions; probability weighting; risk attitudes; ambiguity aversion; modeling of preferences

1. Motivation

Prospect theory (PT; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) is the dominant descriptive theory of decision making under risk today (Starmer, 2000). Contrary to expected utility theory (EUT), which expresses deviations from expected value maximization through only one subjective parameter, utility curvature, PT allows for several subjective parameters which are based on psychological interpretations (Lopes, 1987). Other than under EUT, the utility function is generally thought to express only attitudes towards monetary outcomes, and is preferably referred to as the *value function* to underline this different interpretation. Attitudes towards uncertainty, on the other hand, are expressed through a probability weighting function. Attitudes towards uncertainty are furthermore measured relative to a reference point, and losses are generally thought to loom larger than gains, resulting in *loss aversion* (Abdellaoui, Bleichrodt, & Paraschiv, 2007; Kahneman & Tversky, 1979; Köbberling & Wakker, 2005).

Prospect theory can be applied both to known probabilities (*risk*) and unknown probabilities (*uncertainty*), which makes it widely applicable, given that the latter case is more general than the former (Abdellaoui, Baillon, Placido, & Wakker, 2011; Abdellaoui, Vossman, & Weber, 2005; Wu & Gonzalez, 1999). Since according to the theory the value function only expresses attitudes towards money, and since the only difference between risk and uncertainty is the way in which the probabilities are expressed (Frisch & Baron, 1988; Raiffa, 1961), under PT the value function ought to be unaffected by any variation in the information provided about probabilities (Baillon, Driesen, & Wakker, 2012). Any difference between risk and uncertainty—generally going in the direction of subjects having higher valuations for risky than for uncertain prospects, a difference known as *ambiguity aversion* (Ellsberg, 1961; Kocher & Trautmann, 2013; Muthukrishnan, Wathieu, & Xu, 2009)—should in this case be reflected purely in the weighting function. This stands in contrast to recent models of ambiguity aversion that express such attitudes through utility (Klibanoff, Marinacci, & Mukerji, 2005; Neilson, 2010). However, to the best of our knowledge it has never been tested yet whether ambiguity aversion will

empirically be reflected in the utility or the weighting function.¹ This issue is also related to the more general question whether utility over money in different decision realms is the same, or whether it differs between decision domains. For instance, there is increasing evidence that utility of money under risk and over time are different (Mohammed Abdellaoui, Bleichrodt, L'Haridon, & Paraschiv, 2013; Andreoni & Sprenger, 2012).

Whether a clear separation between utility and weighting is legitimate in practice has recently been called into question at least for pure risk. Fehr-Duda, Bruhin, Epper, & Schubert (2010) showed that if all outcomes are scaled up from a baseline, the resulting increase in risk aversion is fully reflected in the weighting function, rather than in the value function (see also Hogarth & Einhorn, 1990, for an earlier theoretical argument). This is troubling inasmuch as the separability precept described above would require a change that takes place purely in the outcome dimension to be fully reflected in the value function. This thus constitutes a direct violation of prospect theory.

We present results from an experiment designed to elicit both the value and probability weighting function under both risk and uncertainty², thus being able to single out whether ambiguity attitudes affect the value function or the weighting function (or both). We find that ambiguity attitudes are fully reflected in the probability weighting function, while the value function is unaffected. This confirms PT's prediction of probabilistic knowledge being purely reflected in attitudes towards probabilities. It also provides an indication that PT may be a more realistic modeling choice for ambiguity compared to alternative models expressing ambiguity attitudes through utility. We also take a fresh look at stake increases using a between-subject design rather than the within-subject design used by Fehr-Duda et al. (2010). Between-subject designs avoid contrast effects and thus constitute a more stringent test (Greenwald, 1978). The results show that the separability violation is indeed stable to this change in experimental

¹ We recently became aware of a working paper by Abdellaoui, Bleichrodt, l'Haridon, & van Dolder (2013), who elicit the value function under both risk and uncertainty using a modification of the tradeoff method (Wakker & Deneffe, 1996). They do, however, not elicit a probability weighting function. Their results on utility are in agreement with ours.

² The term *risk* is henceforth used to indicate known-probability outcome generatug processes, whereas *uncertainty* indicates unknoww probabilities. *Ambiguity* is then used to designate the difference between the two. A similar notation is used, e.g., by Trautmann & Zeckhauser (2013).

methodology—we do not find any effects of the stake increases on the curvature of the value function, while we find clear effects on probability weighting.

2. Theoretical model and functional specifications

Theoretical premises. We describe binary prospects providing an outcome x with probability p and an outcome y with a complementary probability $1-p$, represented as $\{p: x; y\}$. Under PT, attitudes towards uncertainty (here taken to contain risk as a special case) are expressed through a value function, $v(x)$, and a weighting function, $w(p)$. For outcomes that fall purely into one domain, i.e. either $x, y \geq 0$ or $x, y \leq 0$, a prospect can be represented as follows:

$$u(\xi) = w^{i,j}(p)v(kx) + (1 - w^{i,j}(p))v(ky) \quad , |x| > |y|$$

, where $u(\xi)$ indicates the utility of prospect $\xi = \{p: x; y\}$, the superscript i indicates the domain (gain or loss) and can thus take the value $+$ or $-$, the superscript j indicates the knowledge of probabilities, and can take the value r for risk and u for uncertainty, and k indicates a multiplicative constant. For mixed prospects, i.e. $y > 0$ and $x < 0$, the utility of the prospect $u(\xi)$ takes the following form:

$$u(\xi) = w^{+,j}(p)v(kx) + w^{-,j}(1 - p)v(ky)$$

We assume probabilities rather than subjective beliefs since the implementation of uncertainty through Ellsberg urns results in clear normative probabilities (Raiffa, 1961).³ This case is thus different from the one of naturally occurring uncertainties, where the belief component has to be assessed separately from the weighting component (Abdellaoui et al., 2011; Abdellaoui, Vossman, & Weber, 2005; Wu & Gonzalez, 1999). The weighting function usually reflects diminishing sensitivity, with small probabilities being overweighted and large probabilities being underweighted, and insensitivity to intermediate changes in

³ Indeed, using two-color urns Ellsberg (1961) found that subjects preferred betting on the urn with the known composition of colors *no matter what the color*. This type of behavior could thus not be explained through subjective probabilities, given that the latter are supposed to sum to 1.

probability. This patterns tends to be more pronounced for uncertainty than for risk (Fox & Tversky, 1998; Tversky & Fox, 1995).

The theoretical exposition above makes clear predictions about the effect of increased stakes and of ambiguity. Increased stakes enter only the value function under the form of the multiplicative constant k . The weighting function is in theory unaffected by the scaling of outcomes, since it depends only on probabilities. The knowledge of the exact probabilities involved, on the other hand, should in theory affect only the weighting function, which is made explicit by the weighting function's dependence on this element. We will test this hypothesis simply by estimating the whole structural equation model and letting both the weighting function and the value function depend on stakes and knowledge about probabilities.

Functional forms. For the value function, we use an exponential form. The exponential form has some desirable properties (e.g., Abdellaoui, Bleichrodt, L'Haridon, & Paraschiv, 2013), and has been indicated to provide a better fit for data than alternative specifications (von Gaudecker, van Soest, & Wengström, 2011). We use the following specification:

$$v(x) = \begin{cases} \frac{1 - e^{-\mu kx}}{\mu} & \text{if } x \geq 0 \\ -\lambda \frac{1 - e^{-vk(-x)}}{v} & \text{if } x < 0 \end{cases}$$

, where μ indicates curvature for gains (0 indicating linearity, values larger than 0 concavity and values smaller than 0 convexity), v indicates utility curvature for losses (0 indicating linearity, values larger than 0 convexity and values smaller than 0 concavity), and λ indicates loss aversion (1 indicating loss neutrality, and values larger than 1 loss aversion).

For the weighting function, we use a two-parameter function developed by Prelec (1998):

$$w^j(p) = \exp \{-\beta^j (-\ln(p))^{\alpha^j}\}$$

, where α is a parameter indicating mostly probabilistic sensitivity, i.e. how much the weighting function changes with a change in probability, with 1 indicating linear probability weights, and values smaller than 1 probabilistic insensitivity; and β indicates mostly the elevation of the weighting function, with 1 indicating zero elevation and smaller values indicating a higher elevation. The interpretation of this elevation, however, changes between gains and losses. For gains, a higher elevation indicates more probabilistic optimism; for losses, a higher elevation indicates more pessimism. Using different functions from the two-parameter family does not affect our results, whereas one-parameter functional forms impose much greater restrictions on the shape of the weighting function, and are thus generally not well suited.

Econometric specification. Subjects are asked to make choices between a series of prospects and different sure amounts of money (see below). We use these choices to estimate the structural model presented above by maximum likelihood estimations.⁴ Errors are clustered at the subject level. Following Conte, Hey, & Moffatt (2011), we allow for two error terms (see also von Gaudecker et al., 2011). The first error type consists in Fechner errors (Hey & Orme, 1994), which enters the equation at the level of the utility estimation. The difference in utilities between the prospect and a given sure amount of money is divided by a noise term:

$$\Delta(U) = \frac{u(\xi) - u(S)}{\sigma}$$

, where $\Delta(U)$ indicates the difference in utility from choosing the prospect or choosing the sure amount, $u(\xi)$ indicates the utility of the prospect, $u(S)$ the utility of the sure amount (which, being riskless, is equal to the value of the sure amount, $v(S)$), and σ indicates a noise terms that is assumed to be normally

⁴ A different method consists in a step-wise estimation procedure. Following Abdellaoui, Bleichrodt, & L'Haridon (2008), one could estimate the value function in addition to the fixed weight assigned to a probability of 0.5 using only 50-50 prospects using non-linear least squares. Weighting could then be estimated in a second step using the individual value functions thus estimated as an input. Our results do not change if we use such a procedure instead.

distributed. In addition, we allowed for a ‘tremble’ term (Harless & Camerer, 1994), indicating errors made at the level of single choices between a prospect and different sure amounts, so that the likelihood of choosing the prospect can be indicated as follows:

$$\Pi(\xi|.) = (1 - \varphi)\Delta(U) + \varphi/2 = (1 - \varphi)\frac{u(\xi) - u(S)}{\sigma} + \frac{\varphi}{2}$$

, where φ indicates the tremble term, i.e. the likelihood of choosing at random in *given* the difference in utilities between the two alternatives. In the estimation, the tremble term is made to depend on the same variables as the parameters of the model throughout. The noise term is made to depend on the main experimental condition (ambiguity or stakes), as well as being allowed to differ by decision domain (gains versus losses, versus mixed prospects). This provides the best fit for our data.

3. Experiments and results

3.1 Experimental 1: risk and ambiguity

Subjects. 48 subjects were recruited at the Melessa Lab at the University of Munich in June 2011. They were recruited using ORSEE (Greiner, 2004), and only subjects who had participated in less than 3 experiments previously were invited. One subject was eliminated because she manifestly did not understand the task, and alternately chose only the sure amount or only the lottery. 38% of the subjects were male and the average age was 25 years. The experiment was run using paper and pencil.

Experimental task. We presented subjects with 56 different binary prospects (28 for gains, 26 for losses, and 2 mixed prospects over gains and losses). Subjects had to make a choice between these prospects and different sure amounts of money, bounded between the highest and the lowest amount in the prospect (instructions in appendix). Gains were always presented first, and losses were administered from an endowment in a second part, the instructions for which were distributed once the first part was finished. Etchart-Vincent & L’Haridon

(2011) found that it makes no difference whether losses are real or take place from an endowment, and also found no order effects for losses being administered before or after gains. Prospects were always kept in a fixed order. A pilot showed that this made the task less confusing for subjects, while no significant differences were found in certainty equivalents for different orders. Table 1 shows the prospects used in the usual notation $\{p: x; y\}$, where p indicates the probability of winning or losing x , and y obtains with a complementary probability $1-p$.

Table 1: list of prospects

risky gains	uncertain gains	risky losses	uncertain losses
$\{0.5: 5; 0\}$	$\{0.5: 5; 0\}$	$\{0.5: -5; 0\}$	$\{0.5: -5; 0\}$
$\{0.5: 10; 0\}$	$\{0.5: 10; 0\}$	$\{0.5: -10; 0\}$	$\{0.5: -10; 0\}$
$\{0.5: 20; 0\}$	$\{0.5: 20; 0\}$	$\{0.5: -20; 0\}$	$\{0.5: -20; 0\}$
$\{0.5: 30; 0\}$	$\{0.5: 30; 0\}$	$\{0.5: -20; -5\}$	$\{0.5: -20; -5\}$
$\{0.5: 30; 10\}$	$\{0.5: 30; 10\}$	$\{0.5: -20; -10\}$	$\{0.5: -20; -10\}$
$\{0.5: 30; 20\}$	$\{0.5: 30; 20\}$	$\{0.125: -20; 0\}$	$\{0.125: -20; 0\}$
$\{0.125: 20; 0\}$	$\{0.125: 20; 0\}$	$\{0.125: -20; -10\}$	$\{0.125: -20; -10\}$
$\{0.125: 20; 10\}$	$\{0.125: 20; 10\}$	$\{0.25: -20; 0\}$	$\{0.25: -20; 0\}$
$\{0.25: 20; 0\}$	$\{0.25: 20; 0\}$	$\{0.385: -20; 0\}$	$\{0.385: -20; 0\}$
$\{0.385: 20; 0\}$	$\{0.385: 20; 0\}$	$\{0.625: -20; 0\}$	$\{0.625: -20; 0\}$
$\{0.625: 20; 0\}$	$\{0.625: 20; 0\}$	$\{0.75: -20; 0\}$	$\{0.75: -20; 0\}$
$\{0.75: 20; 0\}$	$\{0.75: 20; 0\}$	$\{0.875: -20; 0\}$	$\{0.875: -20; 0\}$
$\{0.875: 20; 0\}$	$\{0.875: 20; 0\}$	$\{0.875: -20; -10\}$	$\{0.875: -20; -10\}$
$\{0.875: 20; 10\}$	$\{0.875: 20; 10\}$	mixed: $\{0.5: 20; -L\}$	mixed: $\{0.5: 20; -L\}$

Notice how the exact same prospects are administered for risk (known probabilities) and uncertainty (unknown or vague probabilities). This will allow us to study ambiguity attitudes, i.e. the difference in behavior between uncertainty and risk. Preferences were elicited using choice lists, with sure amounts changing in equal steps between the extremes of the prospect. In the mixed prospects, the sure amount was kept fixed at 0 while the loss varied. Figure 1 shows an example of an experimental task.

Decision 6

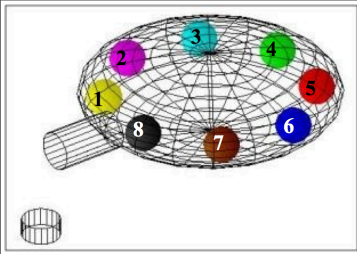
	Lottery	Sure
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
	O	O
Win € 30 if one of the following balls is extracted:	O	O
1 2 3 4	O	O
Win € 20 if one of the following balls is extracted:	O	O
5 6 7 8	O	O
	O	O

Figure 1 Example of choice task

Incentives. At the end of the game, one of the tasks was chosen for real play, and then one of the lines for which a choice had to be made in that task. This provides an incentive to reveal one's true valuation of a prospect, and is the standard way of incentivizing this sort of task (Baltussen, Post, van den Assem, & Wakker, 2012; Bruhin, Fehr-Duda, & Epper, 2010; Cubitt, Starmer, & Sugden, 1998). Subjects obtained a show-up fee of €4. The expected payoff for one hour of experiment was above €15.

Risk and uncertainty. Risk was implemented using an urn with 8 consecutively numbered balls. Uncertainty was also implemented using an urn with 8 balls, except that subjects were now told that, while the balls all had a number between 1 and 8, it was possible that some balls may recur repeatedly while others could be absent. The description—as well as the visual display of the urns—closely followed the design of Abdellaoui, Baillon, Placido, & Wakker (2011). The main differences were that we ran the experiment using paper and pencil instead of with computers; that we used numbers instead of colors in order to allow for black and white printing; and that we ran the experiment in sessions of 15-25 subjects instead of individually.

Results. The main results are reported in Table 2. The tremble term did not show any differences across the different independent variables and has been omitted

from the table. We did find significantly more noise under uncertainty than under risk ($p=0.038$), and marginally significantly more noise for losses than for gains. The regression controls for age (normalized so that the youngest participant, aged 19, is 0) and sex. The effects found for these demographic variables are quite typical, and we do not discuss them further.

We start by looking at the parameters of the value function, which are our main point of interest. The constant of the value function parameter for gains indicates that the value function of young males under risk tends toward slight concavity, but that we cannot statistically reject linearity. For losses, we see a very similar picture. The constant indicates a function that tends towards convexity, though not significantly so. Linearity of utility is indeed the outcome that we would expect for relatively modest stakes (Wakker, 2010). Turning now to our treatment effects, the value function parameters estimated under uncertainty are not significantly different from the parameters estimated under risk either for gains or for losses. Ambiguity thus has no effect on the curvature of the value function. Consistent with this result, we also find no effect of ambiguity on loss aversion. Overall, the value function is thus unaffected by ambiguity, and the same function is estimated under risk and under uncertainty.

Table 2: Regression of PT parameters

	value function			gains		losses	
	μ	ν	λ	α^+	β^+	α^-	β^-
ambiguity	-0.003 (0.010)	0.010 (0.008)	-0.079 (0.055)	-0.283*** (0.038)	0.101 (0.081)	-0.066 (0.045)	-0.198*** (0.035)
female	0.005 (0.011)	0.034** (0.012)	-0.359* (0.140)	-0.207** (0.069)	0.215# (0.130)	0.127 (0.109)	-0.553*** (0.097)
age	-0.001 (0.001)	-0.004 (0.003)	0.012 (0.008)	0.017*** (0.004)	0.005 (0.012)	-0.008# (0.004)	0.056* (0.026)
constant	0.016 (0.011)	0.004 (0.012)	1.367*** (0.109)	0.682*** (0.057)	1.027*** (0.141)	0.857*** (0.055)	0.932*** (0.106)
Subjects	47	47	47	47	47	47	47
Wald χ^2	2.54	2.54	2.54	2.54	2.54	2.54	2.54

Standard errors in parentheses; # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For the theoretical prediction made above to be confirmed, however, we do not only need the absence of an effect of ambiguity on the value function, but we also need to find an effect on the probability weighting function. For gains and risk,

we find the typical pattern of an inverse S-shaped probability weighting function, indicating optimism for small probabilities and pessimism for moderate to large probabilities. Ambiguity, however, results in much lower sensitivity towards probabilistic changes, i.e. more extreme jumps at the ends of the probability scale. This is fully consistent with previous findings (Abdellaoui et al., 2011; Maafi, 2011; Tversky & Fox, 1995).

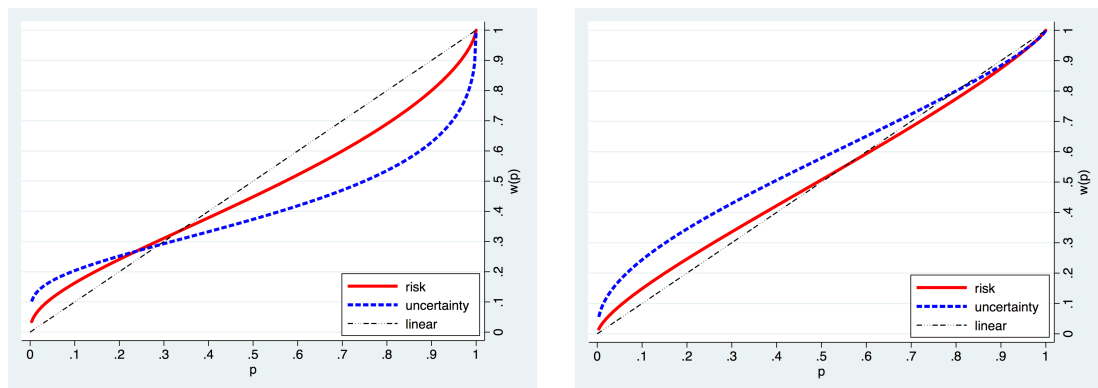


Figure 2 Weighting functions for gains (left) and losses (right)

Figure 2 shows the weighting functions for gains and losses. For losses, the effect of ambiguity is reflected mostly in the elevation of the weighting function, with choices being more pessimistic under uncertainty than under risk. This corroborates the results obtained by (Abdellaoui et al., 2005), who also found that decision weights for uncertain events were more elevated under losses than under gains, and that this effect was especially strong for likely events. Under risk, we find again an inverse S-shaped weighting function, even though the crossing point of the 45° line is slightly higher than for gains, while the function is somewhat flatter. Under uncertainty, the whole function shifts upwards, resulting in global probabilistic pessimism. Indeed, the elevation parameter measured under uncertainty is not only significantly different from the one measured under risk; it is also significantly smaller than 1, indicating global pessimism and—since the value function is linear—global risk aversion. The results do thus fully support the theoretical prediction based on PT—ambiguity attitudes are reflected purely in the weighting function, constituting a probabilistic phenomenon; the value function is unaffected by the knowledge of probabilities.

3.2 Experiment 2: stake effects

Subjects. We recruited 157 subjects at the campus of Management and Information Sciences at Addis Ababa University, Ethiopia. The subjects were recruited by the experimenters using flyers around campus. 12 subjects had to be excluded because they manifestly did not understand the task, leaving us with 145 subjects. 73% of the participants were male, and the average age was 21.1 years. The experiments were run in English, the teaching language of the university (it is also the only language shared by all the students; the experiments were run by an Ethiopian who could give additional explanations in Amharic and Tigrinya, the two main other languages spoken at the school).

Tasks and setup. The experimental setup was identical to the one of experiment 1 described above. We used only 44 tasks from the list displayed in table 1 but all the prospects under risk were the same. We did not use the 50-50 prospects under uncertainty, which were introduced in experiment 1 specifically to test for the effect of probability knowledge on utility estimations; uncertainty will be disregarded in this experiment.⁵

Treatments. In addition to a baseline condition, which follows the exact same design as described above with all amounts converted into PPP Birr, we ran a high stakes condition in which all outcomes were doubled. While this seems a modest increase in stakes compared to other stake manipulations in the literature, one ought to keep in mind that incentives in our baseline condition are much higher than in other studies (for instance, Holt & Laury, 2002, increase the stakes up to 20-fold, but from a base of about \$2-3 in expectation; our study has an expected payoff of about €15 in the baseline, and thus almost €30 in the high stakes treatment). Stakes were manipulated between-subjects. Indeed, within-subject designs have been criticized for studying the effects of stakes or incentive provision (Lefebvre, Vieider, & Villeval, 2010; Read, 2005), and in general the potential demand effects in within-subject designs introduce the danger of a confound to the main treatment (Greenwald, 1978).

⁵ The effects of stakes on ambiguity attitudes are analyzed by Vieider, Martinsson, & Medhin, (2012)

Results. Table 3 shows the results of a maximum likelihood regression on the dummy indicating high stakes, plus the usual sex and (normalized) age variables as controls. Noise is again marginally significantly lower for losses compared to gains, and tremble is significantly lower in the high stakes condition. In the baseline treatment, we again find the value function to be not significantly different from linear for both gains and losses. As to our hypotheses, however, none of the value function parameters is significantly affected by the stakes variation. This clearly runs counter to the separability prediction.

Table 3 Regression of PT parameters on stakes

	value function			gains		losses	
	μ	ν	λ	α^+	β^+	α^-	β^-
high stakes	0.004 (0.009)	0.008 (0.014)	-0.406 (0.253)	-0.004 (0.093)	0.207* (0.081)	0.068 (0.085)	-0.140 (0.091)
female	0.008 (0.008)	0.005 (0.013)	0.403 (0.245)	0.135 (0.119)	-0.004 (0.080)	0.017 (0.089)	0.046 (0.085)
age	0.007* (0.003)	0.005 (0.005)	-0.007 (0.070)	-0.036 (0.049)	-0.035 (0.028)	-0.047 (0.039)	-0.027 (0.030)
constant	0.008 (0.007)	-0.019 (0.014)	2.027*** (0.229)	0.758*** (0.113)	0.759*** (0.069)	0.701*** (0.095)	1.124*** (0.101)
Subjects	145	145	145	145	145	145	145
Wald χ^2	7.86	7.86	7.86	7.86	7.86	7.86	7.86

Standard errors in parentheses; # $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The stake manipulation does, on the other hand, register in the weighting functions. Indeed, the only significant variation in the parameters of the structural model resulting from the stake variation is a larger beta for gains, indicating an increase in pessimism. This corresponds precisely to earlier findings obtained with a within-subject design by Fehr-Duda et al. (2010). Figure 3 shows the weighting functions for gains (left) and losses (right), for the two stake levels. While for losses there is but the slightest (and as we have seen, non-significant) difference between the two functions, for gains the weighting function clearly shifts downward, indicating decreased probabilistic optimism (risk seeking is often found for very poor countries—see Vieider et al., 2012). This clearly violates separability, as according to prospect theory an increase in stakes ought to be reflected purely in the value function.

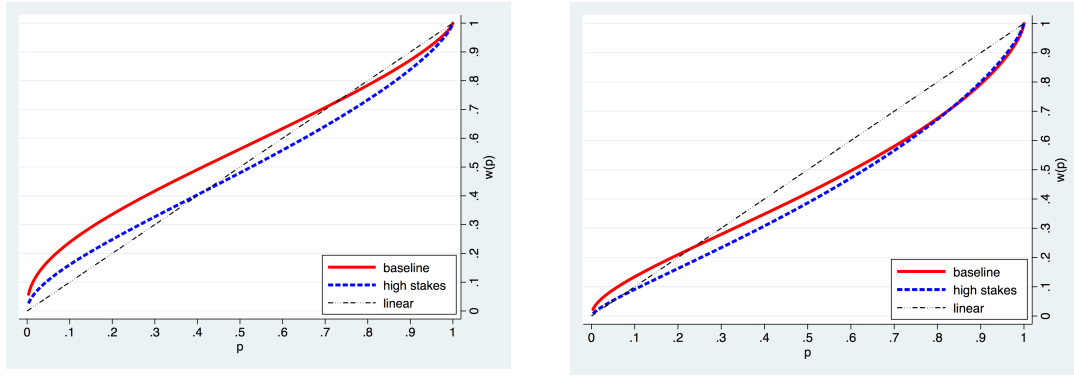


Figure 3: Weighting functions by stakes, for gains (left) and losses (right)

4. Discussion and conclusion

We set out to test the prediction underlying prospect theory that attitudes towards monetary gambles can be separated into two distinct parts—attitudes towards money, reflected in a value function, and attitudes towards probabilities, reflected in a weighting function. We did so in two different experiments. One varied outcomes—a manipulation that according to the separability precept ought to be fully reflected in the value function. The other manipulated probabilities, or rather the knowledge thereof—a manipulation that ought to be reflected fully in weighting functions. The verdict for prospect theory deriving from this is mixed. Increasing stakes clearly violated the separability precept, given how the effects were entirely reflected in probability weighting. This replicates an earlier result by Fehr-Duda et al. (2010), using a between-subject design instead of their within-subject design. Eliciting parameters under risk and Ellsbergian uncertainty, we find the value function to be the same, while it is again the weighting functions that change. In this case, this exactly follows the prediction.

Indeed, the results on ambiguity attitudes being reflected fully in the probability weighting function allows us to discriminate amongst different modeling approaches to ambiguity. In general, it is consistent with theories that express ambiguity attitudes in the probability dimension (Gilboa & Schmeidler, 1989; Sarin & Wakker, 1992). The decreased probabilistic sensitivity we found for gains, in particular supports models that attribute different weights to different sources of uncertainty (Abdellaoui et al., 2011; Tversky & Fox, 1995). Indeed, such a change in probabilistic sensitivity rather than overall pessimism,

cannot be explained by modeling approaches that assume different utility functions for risk and uncertainty (Klibanoff et al., 2005; Neilson, 2010). Such models could only explain choices that become more pessimistic over the whole probability space, given that the evaluation of outcomes is the only subjective dimension. They cannot explain the contemporary occurrence of ambiguity seeking for small probabilities and ambiguity aversion for large probabilities—at least not with a consistently concave second-order utility. A function that displays higher insensitivity under ambiguity, on the other hand, is consistent with account according to which different decision processes may be at work in the two cases. In particular, since the probabilistic dimension is less quantifiable and more blurred under uncertainty, this may activate increased reliance on feelings rather than calculations (Hsee & Rottenstreich, 2004).

Overall, a common trend seems to be that the probability weighting function is more easily affected by experimental interventions than the value function. This may occur for different reasons. Hogarth & Einhorn (1990) hypothesized that the size of stakes would influence the strength of a simulation processes used to determine decision weights in an anchoring-and-adjustment framework. Also, more recent evidence suggests that the affect prompted by the stimuli may affect probability weighting even when probabilities and the utility of outcomes are held constant (Rottenstreich & Hsee, 2001). To really determine the underlying reasons of the violation we found, however, must be left to future research.

The results on stake effects clearly constitute a challenge for prospect theory. They are furthermore not only troubling from a theoretical point of view, but also create doubts for its empirical value. Using preference measurements to predict real world behavior is a central preoccupation of decision theorists and experimental economists (Karlan, 2005; Levitt & List, 2007; Sutter, Kocher, Rützler, & Trautmann, 2012). In this respect, one of the strengths of prospect theory is that one can measure risk attitudes with relatively moderate stakes, and then extrapolate any findings to decisions involving higher stake, since this ought to be fully reflected in a more concave value function. The violation of separability found here, however, casts doubt on the validity of using such an approach.

A more clement interpretation of the results would be that the problem lies not with the theory, but rather with the measurement methods. However, this is already the second study finding the same problem. And while in empirical estimations with a limited number of choices collinearity between value functions and weighting can never be completely excluded, the violation here observed is resistant to using other estimation procedures, for instance, a step-wise estimation procedure in which only utility is estimated first, and then weighting is estimated in a second step, taking utility as an input (Abdellaoui, Bleichrodt, & L'Haridon, 2008). That is, our methods *are* able to separate the two elements, but do so in a way not predicted by the theory.

Appendix: Instructions

Thank you for participating in this experiment in decision making! You will obtain 4 Euros for having come to the experiment—those 4 Euros are yours to keep independently of the outcomes in the experiment. In addition, you will be compensated with whatever you earn during the experiment according to the procedures described in the instructions.

The instructions will be read to you in a short while. You may consult these instructions at any time during the experiment. In case you should have any questions or doubts, please raise your hand and an experimenter will come and assist you in private.

Please consider each decision carefully. Take a careful look at outcomes and the probabilities associated to them before taking a decision. Remember that your final payoffs from this experiment will depend on the decisions you make (and of course, on chance).

Please remain seated when you are finished with the tasks. This experiment consists of two parts. Once everybody has finished the tasks in part I, new instructions will be read to you for part II. At the very end of the experiment, you will be asked to fill out a questionnaire. The answer to the questionnaire as well as all your answers to the tasks will be private, and cannot be traced back to you personally. Once you are done filling in the questionnaire, an experimenter will call you up. Your payoff will then be determined in private, you will be given the money you won, after which you can leave.

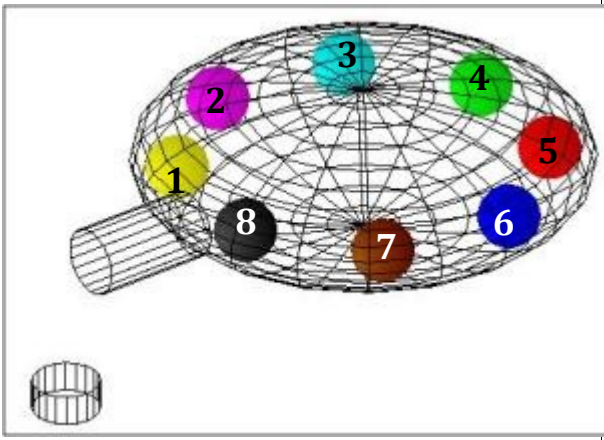
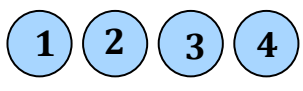
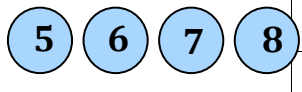
PART I

Choice tasks

In the present experiment, you will be asked to choose repeatedly between a fixed amount of money and a lottery. The lottery will always give you a chance to win one of two amounts of money. Figure 1 shows a typical choice task. You are asked repeatedly to choose between playing the lottery and obtaining a sure amount of money. **For each row**, you are asked to indicate whether you would prefer to play the lottery or to obtain the sure amount of money by ticking the preferred option.

The urn indicated in the figure contains eight numbered balls. One ball will be extracted from the urn to determine your payoffs in case you should play the lottery. In the lottery displayed, if ball 1, 2, 3, or 4 is extracted, you obtain €10; if ball 5, 6, 7, 8 is extracted, you obtain nothing. Please pay close attention to the amounts to be won as well as the number of balls associated with each outcome, since they change across decisions.

Fig. 1: Example of a typical decision task

	Lottery	Sure amount	
	<input type="radio"/>	<input type="radio"/>	€ 0.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 1.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 1.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 2.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 2.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 3.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 3.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 4.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 4.50 for sure
Win € 10 if one of the following balls is extracted:	<input type="radio"/>	<input type="radio"/>	€ 5.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 5.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 6.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 6.50 for sure
Win € 0 if one of the following balls is extracted:	<input type="radio"/>	<input type="radio"/>	€ 7.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 7.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 8.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 8.50 for sure
	<input type="radio"/>	<input type="radio"/>	€ 9.00 for sure
	<input type="radio"/>	<input type="radio"/>	€ 9.50 for sure

We are interested in the amount for which you will switch from preferring the lottery to preferring the sure amount. Most likely, you will begin by choosing the lottery for small sure amounts, and at a certain point switch to the sure amount as the latter increases. If you do not want the lottery at all, you can choose to get the sure amount in the first row and then continue with the sure amount for all choices (logic: if you prefer €0.50 over the lottery you should also prefer €1.00 over the lottery, etc.). Where you will switch from the lottery to the sure amount depends entirely on your preferences—there are no right or wrong answers. However, **you should NOT switch back and forth several times between lottery and sure amount!** You will be excluded from the experiment if you do so or if it is not possible to clearly recognize your preference (for example, if you have not ticked any box for a given row or ticked both boxes for a given row).

Types of choices

You will be asked to take 22 decisions, for each one of which you will need to decide between a lottery and a series of sure amounts as exemplified in figure 1 above. **Please pay close attention to the amounts to be won as well as the number of balls associated with each outcome!**

Indeed, both the higher and lower amount, as well as the number of balls, change between decision problems. Since your final payoff depends on these decisions, it is crucial for you to pay close attention to these features.

There are **two different types of lotteries** involved. Figure 2 below shows the two different types of lotteries that you will encounter. Fig 2a shows the urn already familiar from figure 1 above. It contains exactly eight (8) balls, numbered from 1 to 8.

In Urn in Fig. 2b also contains exactly eight (8) balls. However, you cannot see what numbers the balls contained in the urn have. This means that **you do not know the exact numbers that are present in that urn**. All balls bear a number between 1 and 8 inclusive (have either 1, 2, 3, 4, 5, 6, 7, or 8 written on them), but it is possible that some numbers are absent from this urn while others occur repeatedly. You thus do not know the exact composition of the urn.

Fig. 2a: transparent urn

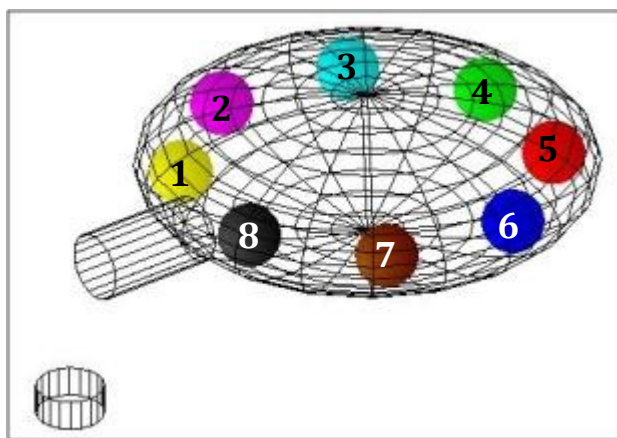
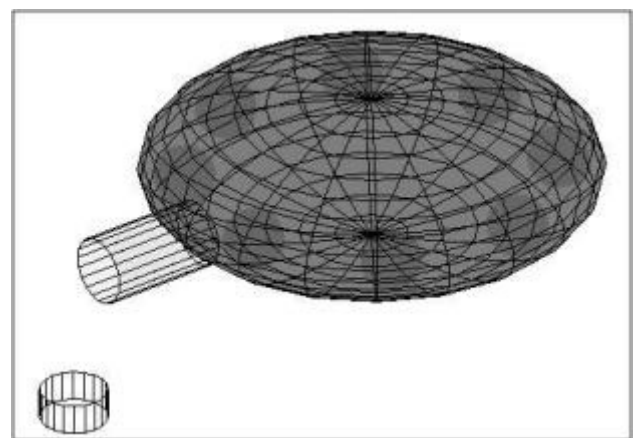


Fig. 2b: opaque urn



Payoff determination

After you have taken all the decisions, one of your decisions will be randomly drawn for real pay, i.e. **the amounts indicated in the decision problem will be paid out for real**. First, either part I or part II will be selected for real play by a coin flip. If part I is selected, then one of the decision tasks is drawn at random, using a chance device with equal probability for each decision task to be extracted. For the extracted decision task, one of your decisions, corresponding to one row for which you had to indicate your preference between the sure amount and the lottery, will then be drawn at random with **equal probability for each row**. If for the row that is drawn you have indicated that you prefer the sure amount of money, you will simply be paid that amount.

In case you have chosen the lottery for the randomly determined row, then that lottery will be played according to the probabilities indicated. For the transparent urn, this will involve drawing a ball from an urn in which all numbers from 1 to 8 inclusive are present. If you should desire to do so, you can verify that there are indeed all balls from 1 to 8 in the urn. You will then be paid the outcome corresponding to the ball you drew.

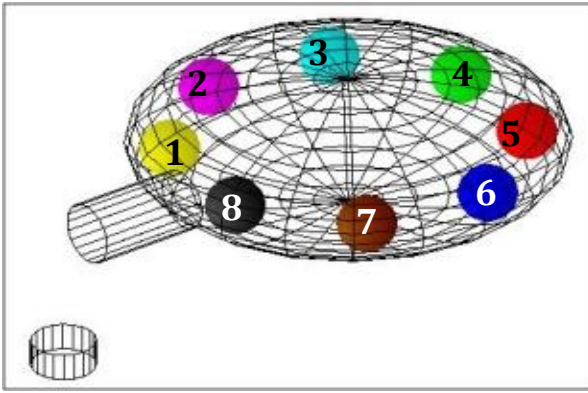
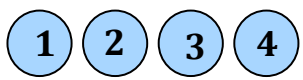
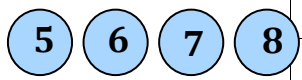
For the opaque urn, the procedure is exactly analogous, except that you will now draw a ball from a pre-composed urn, the exact composition of which you do not know. You will also be paid the outcome corresponding to the ball you drew. If you should desire to do so, after the draw you can verify that there are indeed 8 balls with numbers between 1 and 8 inclusive in the urn.

PART II

If part II should be chosen for real play, you are endowed with €20. These €20 are yours, but it is possible that you will lose part or all of the money in the experiment (but no more than that).

In part II you are again asked to repeatedly choose between the two types of lotteries you have already encountered in part I of the experiment and a series of sure amounts. However, the main difference now is that **the amounts involved are negative instead of positive**. Figure 4 shows an example of such a choice.

Fig. 4: example of a typical decision task from part II

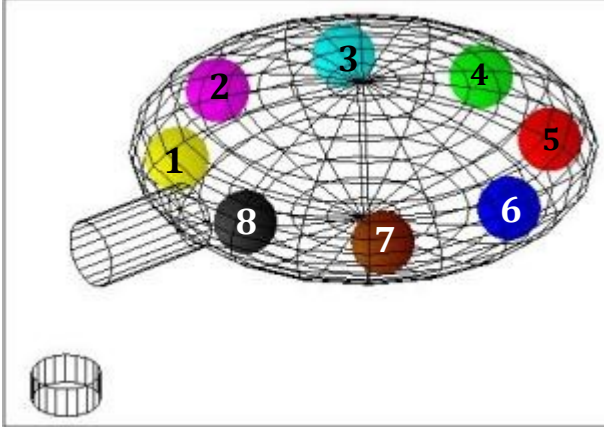
	<input type="radio"/>	<input type="radio"/>	– € 0.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 1.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 1.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 2.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 2.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 3.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 3.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 4.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 4.50 for sure
Lose € 10 if one of the following balls is extracted:	<input type="radio"/>	<input type="radio"/>	– € 5.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 5.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 6.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 6.50 for sure
Lose € 0 if one of the following balls is extracted:	<input type="radio"/>	<input type="radio"/>	– € 7.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 7.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 8.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 8.50 for sure
	<input type="radio"/>	<input type="radio"/>	– € 9.00 for sure
	<input type="radio"/>	<input type="radio"/>	– € 9.50 for sure

In the example displayed, you face the following lottery: if a ball with the number 1, 2, 3, or 4 is extracted, **you lose €10**. If a ball with the number 5, 6, 7, or 8 is extracted, you lose nothing. Please choose again for each row whether you would rather give up (i.e., pay) the sure amount indicated to the right or play the lottery.

Notice that, most likely, you will now **begin to the right** by choosing to give up the sure amounts as long as this implies giving up small amounts, and then switch to the lottery at a certain point. If you do not want to give up sure amounts at all, then in the first row you can choose the lottery and then continue with the lottery for all choices (logic: if you are not willing to pay €0.50 to avoid playing the lottery, then you should not be willing to pay €1.00 to avoid it). Once again, when exactly you switch from the sure loss to the lottery depends entirely on your preferences—there are no right or wrong answers. However, **you should NOT switch back and forth several times between lottery and sure amount!** You will be excluded from the experiment if you do so or if it is not possible to clearly recognize your preference (for example because you have not ticked any box for a given row or ticked both boxes for a row).

In addition to the pure loss choices described above, you will also face some choices in which **both negative and positive amounts are involved**. Also, what changes is now not the sure amount to the right, which is always equal to zero, but rather the amount you can lose in the lottery. Figure 3 shows an example of this kind of choice problem.

Fig. 3: decision task where lottery amount changes

				
Win € 20 if one of the following balls is extracted:				
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;">1</div> <div style="border: 1px solid black; border-radius: 50%; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;">2</div> <div style="border: 1px solid black; border-radius: 50%; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;">3</div> <div style="border: 1px solid black; border-radius: 50%; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;">4</div> </div>				
If one of the following balls is extracted, then:				
	5	6	7	8
	Lose € 20	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 19	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 18	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 17	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 16	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 15	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 14	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 13	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 12	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 11	<input type="radio"/>	<input type="radio"/>	€ 0 for sure
	Lose € 10	<input type="radio"/>	<input type="radio"/>	€ 0 for sure

What is required of you in this task is exactly the same as for the other tasks. For each row, you should choose whether you prefer the sure amount to the right (which is now always zero), or the lottery to the left. Pay attention however: **what changes is now the amount that can be lost in the lottery**. Most likely, you would thus start from the right and choose zero for high losses, and then switch to the left as the losses in the lottery get smaller. You can however also start with the lottery and continue with it if that is your preference (if you prefer a lottery in which you can win €20 or lose €20 to zero, then you should also prefer the lottery when you can lose only €19). At what point you switch from the zero sure amount to the lottery depends only on your

preferences—there is no right or wrong answer. However, **you should NOT switch back and forth several times between lottery and sure amount!** You will be excluded from the experiment if you do so or if it is not possible to clearly recognize your preference (for example because you have not ticked any box for a given row or ticked both boxes for a row).

Payoff determination

In case part II should be chosen for real play, your payoff from part II will be determined in a way analogous to the payoff determination in the first part. First, one of the decision tasks will be chosen at random, and then one of the rows for which you had to indicate a choice. In each case, every choice task or row has an equal probability of being selected. According to your choice, you will then either have to pay the sure amount or the lottery will be played out by drawing a ball from the indicated urn.

References

- Abdellaoui, M., Bleichrodt, H., & Paraschiv, C. (2007). Loss Aversion Under Prospect Theory: A Parameter-Free Measurement. *Management Science*, 53(10), 1659–1674. doi:10.1287/mnsc.1070.0711
- Abdellaoui, Mohammed, Baillon, A., Placido, L., & Wakker, P. P. (2011). The Rich Domain of Uncertainty : Source Functions and Their Experimental Implementation. *American Economic Review*, 101, 695–723.
- Abdellaoui, Mohammed, Bleichrodt, H., & L'Haridon, O. (2008). A tractable method to measure utility and loss aversion under prospect theory. *Journal of Risk and Uncertainty*, 36(3), 245–266. doi:10.1007/s11166-008-9039-8
- Abdellaoui, Mohammed, Bleichrodt, H., L'Haridon, O., & Paraschiv, C. (2013). Is There One Unifying Concept of Utility? An Experimental Comparison of Utility under Risk and Utility over Time. *Management Science*, forthcoming.
- Abdellaoui, Mohammed, Bleichrodt, H., L'Haridon, O., & Van Dolder, D. (2013). Source-dependence of utility and loss aversion: A critical test of ambiguity models. *working paper*.
- Abdellaoui, Mohammed, Vossman, F., & Weber, M. (2005). Choice-based elicitation and decomposition of decision weights for gains and losses under uncertainty. *Management Science*, 51.
- Andreoni, J., & Sprenger, C. (2012). Risk Preferences are not Time Preferences. *American Economic Review*, forthcoming.

- Baillon, A., Driesen, B., & Wakker, P. P. (2012). Relative concave utility for risk and ambiguity. *Games and Economic Behavior*, 75(2), 481–489.
doi:10.1016/j.geb.2012.01.006
- Baltussen, G., Post, T., van den Assem, M. J., & Wakker, P. P. (2012). Random Incentive Systems in a Dynamic Choice Experiment. *Experimental Economics*, *forthcomin*.
- Bruhin, A., Fehr-Duda, H., & Epper, T. (2010). Risk and Rationality: Uncovering Heterogeneity in Probability Distortion. *Econometrica*, 78(4), 1375–1412.
- Conte, A., Hey, J. D., & Moffatt, P. G. (2011). Mixture models of choice under risk. *Journal of Econometrics*, 162(1), 79–88.
doi:10.1016/j.jeconom.2009.10.011
- Cubitt, R. P., Starmer, C., & Sugden, R. (1998). On the Validity of Random Lottery Incentive Systems. *Experimental Economics*, 1, 115–131.
- Ellsberg, D. (1961). Risk, Ambiguity and the Savage Axioms. *Quarterly Journal of Economics*, 75(4), 643–669.
- Etchart-Vincent, N., & L'Haridon, O. (2011). Monetary Incentives in the Loss Domain and Behavior toward Risk: An Experimental Comparison of Three Reward Schemes Including Real Losses. *Journal of Risk and Uncertainty*, 42, 61–83.
- Fehr-Duda, H., Bruhin, A., Epper, T. F., & Schubert, R. (2010). Rationality on the Rise: Why Relative Risk Aversion Increases with Stake Size. *Journal of Risk and Uncertainty*, 40(2), 147–180.
- Fox, C. R., & Tversky, A. (1998). A Belief-Based Account of Decision under Uncertainty. *Management Science*, 44(7), 879–895.

- Frisch, D., & Baron, J. (1988). Ambiguity and rationality. *Journal of Behavioral Decision Making*, 1(3), 149–157. doi:10.1002/bdm.3960010303
- Gilboa, I., & Schmeidler, D. (1989). Maxmin expected utility with non-unique prior. *Journal of Mathematical Economics*, 18(2), 141–153.
doi:10.1016/0304-4068(89)90018-9
- Greenwald, A. G. (1978). Within-Subject Designs: To Use or Not to Use? *Psychological Bulletin*, 314–320.
- Greiner, B. (2004). The Online Recruitment System ORSEE 2.0 - A Guide for the Organization of Experiments in Economics. *University of Cologne, Working Paper Series in Economics 10*.
- Harless, D. W., & Camerer, C. F. (1994). The Predictive Utility of Generalized Expected Utility Theories. *Econometrica*, 62(6), 1251–1289.
doi:10.2307/2951749
- Hey, J. D., & Orme, C. (1994). Investigating Generalizations of Expected Utility Theory Using Experimental Data. *Econometrica*, 62(6), 1291–1326.
doi:10.2307/2951750
- Hogarth, R. M., & Einhorn, H. J. (1990). Venture Theory: A Model of Decision Weights. *Management Science*, 36(7), 780–803.
- Holt, C. A., & Laury, S. K. (2002). Risk Aversion and Incentive Effects. *American Economic Review*, 1644–1655.
- Hsee, C., & Rottenstreich, Y. (2004). Music, Pandas, and Muggers: On the Affective Psychology of Value. *Journal of Experimental Psychology: General*, 133(1), 23–30.
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263 – 91.

- Karlan, D. (2005). Using Experimental Economics to Measure Social Capital and Predict Financial Decisions. *American Economic Review*, 95(5), 1688–1699.
- Klibanoff, P., Marinacci, M., & Mukerji, S. (2005). A Smooth Model of Decision Making under Ambiguity. *Econometrica*, 73(6), 1849–1892.
doi:10.2307/3598753
- Köbberling, V., & Wakker, P. P. (2005). An index of loss aversion. *Journal of Economic Theory*, 122(1), 119 – 131.
- Kocher, M. G., & Trautmann, S. T. (2013). Selection into Auctions for Risky and Ambiguous Prospects. *Economic Inquiry*, 51(1), 882–895.
doi:10.1111/j.1465-7295.2010.00347.x
- Lefebvre, M., Vieider, F. M., & Villeval, M. C. (2010). Incentive Effects on Risk Attitude in Small Probability Prospects. *Economics Letters*, 119, 115–120.
- Levitt, S. D., & List, J. A. (2007). What do laboratory experiments measuring social preferences reveal about the real world? *Journal of Economic Perspectives*, 21(2), 153–174.
- Lopes, L. L. (1987). Between Hope and Fear: the Psychology of Risk. *Advances in Experimental Social Psychology*, 255–295.
- Maafi, H. (2011). Preference Reversals under Ambiguity. *Management Science*, *forthcomin*.
- Muthukrishnan, A. V., Wathieu, L., & Xu, J. A. (2009). Ambiguity Aversion and the Preference for Established Brands. *Management Science*, 55(12), 1933–1941.

- Neilson, W. S. (2010). A simplified axiomatic approach to ambiguity aversion. *Journal of Risk and Uncertainty*, 41(2), 113–124. doi:10.1007/s11166-010-9099-4
- Prelec, D. (1998). The Probability Weighting Function. *Econometrica*, 66, 497–527.
- Raiffa, H. (1961). Risk, Ambiguity and the Savage Axioms: Comment. *Quarterly Journal of Economics*, 75(4), 690–694.
- Read, D. (2005). Monetary incentives, what are they good for? *Journal of Economic Methodology*, (June), 265–276. doi:10.1080/13501780500086180
- Rottenstreich, Y., & Hsee, C. K. (2001). Money, Kisses, and Electric Shocks: On the Affective Psychology of Risk. *Psychological Science*, 12(3), 185–190. doi:10.1111/1467-9280.00334
- Sarin, R., & Wakker, P. (1992). A Simple Axiomatization of Nonadditive Expected Utility. *Econometrica*, 60(6), 1255–1272. doi:10.2307/2951521
- Starmer, C. (2000). Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk. *Journal of Economic Literature*, 38, 332–382.
- Sutter, M., Kocher, M., Rützler, D., & Trautmann, S. T. (2012). Impatience and Uncertainty: Experimental Decisions Predict Adolescent's Field Behavior. *American Economic Review*, *forthcomin*.
- Trautmann, S. T., & Zeckhauser, R. J. (2013). Shunning uncertainty: The neglect of learning opportunities. *Games and Economic Behavior*, 79, 44–55. doi:10.1016/j.geb.2013.01.001

- Tversky, A., & Fox, C. R. (1995). Weighing Risk and Uncertainty. *Psychological Review*, 102(2), 269–283.
- Tversky, A., & Kahneman, D. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty*, 5, 297–323.
- Vieider, F. M., Chmura, T., & Martinsson, P. (2012). Risk Attitudes, Development, and Growth. Macroeconomic Evidence from Experiments in 30 Countries. *working paper*.
- Vieider, F. M., Martinsson, P., & Medhin, H. (2012). Stake effects on ambiguity attitudes for gains and losses. *working paper*.
- Von Gaudecker, H.-M., van Soest, A., & Wengström, E. (2011). Heterogeneity in Risky Choice Behaviour in a Broad Population. *American Economic Review*, 101(2), 664–694.
- Wakker, P., & Deneffe, D. (1996). Eliciting von Neumann-Morgenstern Utilities When Probabilities Are Distorted or Unknown. *Management Science*, 42(8), 1131–1150. doi:10.1287/mnsc.42.8.1131
- Wakker, P. P. (2010). *Prospect Theory for Risk and Ambiguity*. Cambridge: Cambridge University Press.
- Wu, G., & Gonzalez, R. (1999). Nonlinear Decision Weights in Choice under Uncertainty. *Management Science*, 45(1), 74–85. doi:10.2307/2634923

Discussion Papers of the Research Area Markets and Choice 2013

Research Unit: **Market Behavior**

- Nadja Dwenger, Dorothea Kübler, Georg Weizsäcker** SP II 2013-201
Preference for Randomization: Empirical and Experimental Evidence
- Kai A. Konrad, Thomas R. Cusack** SP II 2013-202
Hanging Together or Being Hung Separately: The Strategic Power of Coalitions where Bargaining Occurs with Incomplete Information
- David Danz, Frank Hüber, Dorothea Kübler, Lydia Mechtenberg, Julia Schmid** SP II 2013-203
'I'll do it by myself as I knew it all along': On the failure of hindsight-biased principals to delegate optimally
- David Hugh-Jones, Morimitsu Kurino, Christoph Vanberg** SP II 2013-204
An Experimental Study on the Incentives of the Probabilistic Serial Mechanism
- Yan Chen, Onur Kesten** SP II 2013-205
From Boston to Chinese Parallel to Deferred Acceptance: Theory and Experiments on a Family of School Choice Mechanisms
- Thomas de Haan, Roel van Veldhuizen** SP II 2013-206
Willpower Depletion and Framing Effects
- Dietmar Fehr, Steffen Huck** SP II 2013-306
Who knows it is a game? On rule understanding, strategic awareness and cognitive ability
- Christine Binzel, Dietmar Fehr** SP II 2013-207
Giving and sorting among friends: evidence from a lab-in-the field experiment

Research Unit: **Economics of Change**

- Luisa Herbst, Kai A. Konrad, Florian Morath** SP II 2013-301
Endogenous Group Formation in Experimental Contests
- Kai A. Konrad, Florian Morath** SP II 2013-302
Evolutionary Determinants of War
- Armin Falk, Nora Szech** SP II 2013-303
Organizations, Diffused Pivotality and Immoral Outcomes
- Maja Adena, Steffen Huck, Imran Rasul** SP II 2013-304
Charitable Giving and Nonbinding Contribution-Level Suggestions. Evidence from a Field Experiment

All discussion papers are downloadable:

<http://www.wzb.eu/en/publications/discussion-papers/markets-and-choice>

Dominik Rothenhäusler, Nikolaus Schweizer, Nora Szech SP II 2013-305
Institutions, Shared Guilt, and
Moral Transgression

Dietmar Fehr, Steffen Huck SP II 2013-306
Who knows it is a game? On rule understanding, strategic awareness
and cognitive ability

Maja Adena, Michal Myck SP II 2013-307
Poverty and Transitions in Health

Friedel Bolle, Jano Costard SP II 2013-308
Who Shows Solidarity with the Irresponsible?

WZB Junior Research Group: **Risk and Development**

Ferdinand M. Vieider, Lubomír Cingl, Peter Martinsson, Hrvoje Stojic SP II 2013-401
Separating attitudes towards money from attitudes towards probabilities:
stake effects and ambiguity as a test for prospect theory