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Eliciting Prospect Theory When Consequences Are Measured in Time Units: "Time Is Not Money"

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We elicited the prospect theory components (utility, probability weighting, and loss aversion) when consequences are expressed as the time dedicated to a specific task or activity. A similar elicitation was performed for monetary consequences to allow an across-attribute (time/money) comparison of the elicited components (at the individual level). We obtained less concave utility and smaller loss aversion for time than for money. Moreover, while the probability weighting was predominantly inverse *S*-shaped for both attributes, it was less sensitive to probabilities and more elevated for time than for money. This finding implies more optimism for gains and more pessimism for losses.

Keywords: time risk; expected utility; prospect theory; reference point; utility; probability weighting; decision weights; loss aversion
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1. Introduction

Although decision theory is not limited to behavior involving monetary consequences, most studies do focus on this particular attribute. Except for medical decision making, we know relatively little about risky decisions for nonmonetary consequences. This paper will consider time units as nonmonetary consequences. Time risks, i.e., risks whose consequences are measured in units of time, belong to this category. For instance, time can express the duration of life after surgery, as in medical decision making (Bleichrodt and Pinto 2000) or the time dedicated to a specific activity or task (Keeney and Raiffa 1976, §§7.3.4 and 8.6.4). Unlike money, time does not need to have a monotonic subjective value or utility. For the sake of simplicity, however, this paper focuses on situations in which the value of time is monotonic. For example, a business traveler who is heading to the airport by car, and who has to answer important e-mails before boarding, will monotonically appreciate any time saved in relation to the expected arrival time. The study of time as the duration that a person has to wait until she receives a consequence in intertemporal choice (discounting) is not tackled in our study (Ebert and Prelec 2007, Onay and Öncüler 2007, Baucells and Heukamp 2012).

Despite the old saying that "time is money," we can find several fundamental differences between monetary units and time units. First, time is less fungible than money. The fungibility of money may encourage people to take risks more easily, because a loss resulting from a particular decision can be compensated by a gain in another activity, which is less true in the case of time. This may explain why a loss of time in a traffic jam between the airport and downtown during a two-day trip to Venice may have more impact on an individual than the resulting increase in the taxi fare. Leclerc et al. (1995) suggested that the difference in fungibility between time and money can result in more risk aversion when individuals face time losses than when they face monetary losses.

The second difference between time and money lies in the fact that time aggregation is difficult. Unlike money, time cannot be easily saved or stored. Zeckhauser (1973, p. 670) remarked that many activities require a degree of preparation that implies time indivisibility: "the process of preparation may be enjoyable, but surely the payoff to a half-completed painting, manuscript, [...] education is not proportional to the payoff for the whole." This specificity may impact the value of time as "[i]ndivisibilities create one source of increasing returns for time allocations."

Another difference between time and money is related to the way in which their amounts are mentally accounted. For instance, Soman (2001) reports experimental findings showing that people lack the same ability to account for time as they do when they account for money. He found, in particular, that while the sunk-cost effect (i.e., the exaggerated attention attached to nonrecoverable past costs) is not observed for past investments of time, it does systematically reappear for monetary investments. In a similar vein, Ariely and Zakay (2001) suggested that when people consider time as a commodity while making a decision, they tend not to take duration into account. For example, several studies by psychologists report *duration neglect*: when people evaluate a past painful experience, they take the end and the peak of the experience into consideration, but not its duration (Kahneman et al. 1993).

The aforementioned differences between time and money and the relevance of time risks to everyday life make it worthwhile to undertake a systematic study of the psychology of time risks. We will use a more descriptive model than the traditional expected utility (EU). Up to now, models of travelers' decision making regarding travel time have mostly used EU to capture attitudes toward time risk. However, many specialists in transport studies have recently pleaded in favor of relaxing the restrictive EU hypothesis. Noland and Polak (2002, p. 52) wrote, "[V]ery little is also known about how travelers perceive reliability. In particular, to what extent do subjective probability distortions exist, and what relationship might these have to objective distributions. The present authors could not identify any research that analyzed this question."

This paper elicits individual preferences assuming prospect theory (PT), probably the most descriptively valid model of decision under risk currently available (Tversky and Kahneman 1992, Starmer 2000). The elicitation process we used deals with risky consequences measured in time units as well as in money units. A real incentive scheme was used in the time attribute experiments for both gains and losses. For each attribute (time or money), we elicited utility, probability weighting for gains and losses, and loss-aversion coefficients. While most available results on PT elicitation concern money (Wakker 2010 and references therein) or health states (Abellan-Perpiñan et al. 2009), we are not aware of any complete and systematic elicitations (for gains and losses) of PT for time risks.[1]

Previous experimental findings have shown differences between time and money in terms of attitude toward risk. For instance, Leclerc et al. (1995) found that, in the loss domain, people tend to take more risk when consequences are measured in monetary units than when they are measured in time units. Along with the aforementioned differences between the attributes money and time, we can expect differences in utility and/or probability weighting.

This paper makes a direct comparison of attitudes toward time and money for both gains and losses at the individual level. For time, gains were defined as time savings, offered by the possibility of leaving the experiment earlier than expected (with the same payment). Time loss was measured by the waiting time beyond the expected duration of the experiment. Time, as defined in this experiment, allowed an original implementation of real incentive for both gains and losses.

The results of our experiment show that while utility and probability weighting exhibit similar shapes across attributes, and loss aversion exists for both time and money, the preferences elicited are clearly attribute-dependent. In the gain domain, utility is more concave for money than for time. Furthermore, probability weighting for time exhibits more optimistic (pessimistic) attitudes toward probabilities in the gain (loss) domain, and less sensitivity to probabilities for time in both gain and loss domains. Furthermore, the loss-aversion coefficients are systematically lower for time than for money.

This paper also demonstrates that time is a useful tool for implementing a real incentive scheme for both gains and losses. As explained in §6.3, the implementation of real incentives for monetary consequences is problematic when it comes to losses. Among other things, the provision of an initial endowment can result in subjects integrating the payoffs and then not perceiving any loss. The use of time can help resolve this problem because it is easier to integrate money with money than to integrate money (prior endowment) with time (losses).

2. Theoretical and Empirical Background

We consider a decision maker who has to choose between *risky prospects* (x, p, y) that give *consequence* x with probability p, and consequence y with probability $1 - p$. A *monetary prospect* gives monetary consequences, and a *time prospect* gives consequences measured in time units. The individual has *preferences* over prospects, and we use the conventional notation $\succcurlyeq$, $\succ$, and $\sim$ to represent *weak preference*, *strict preference*, and *indifference*. Consequences are deviations from an exogeneously given *reference point* r, known to the decision maker. Gains are positive and losses are negative. In the sequel, a *domain* designates a set of consequences that consists of either gains (gains domain) or losses (losses domain). A prospect (x, p, y) that involves a gain and a loss is called *mixed* with $x > 0 > y$, otherwise it is either a *gain prospect* with $x \geq y \geq 0$ or a *loss prospect* with $0 \geq y \geq x$.

[1] In medical decision making, Bleichrodt and Pinto (2000) elicited utility and probability weighting under rank-dependent utility (Quiggin 1982). Consequences were measured in terms of life duration (in years) in relation to medical treatments.

While monetary gains and losses are straightforwardly observed with respect to the natural reference point 0, time gains and losses in a specific decision-making situation could not be observed without setting a particular reference timing. For instance, driving to the office in the morning every working day might usually take/cost one hour. But if the decision maker is trapped in an unexpected traffic jam, she loses time as compared to the expected timing. Expressing consequences in terms of gains and losses in this example requires taking into account deviations from the expected timing (cost) of −60 minutes, i.e., the reference duration. Hence, observing a total timing of −75 minutes results in a consequence of −15 minutes, i.e., a loss of 15 minutes. Similarly, observing a total timing of −50 minutes entails a consequence of 10 minutes, i.e., a gain of 10 minutes. Finally, a total timing of 60 minutes results in the neutral consequence 0, i.e., the "recoded" reference point $r = 0$.

Under PT, the value assigned to a prospect by the decision maker is expressed in terms of a *utility* function $u(\cdot)$, a *weighting* function for gains $w^+(\cdot)$, and a weighting function for losses $w^-(\cdot)$. The utility function assigns a value to each consequence that reflects the desirability of that outcome. It is strictly increasing and satisfies $u(0) = 0$. The probability weighting functions are strictly increasing and satisfy $w^s(0) = 0$ and $w^s(1) = 1$ for $s = +, -$. The value of a nonmixed prospect (x, p, y) is given by

$$w^s(p)u(x) + (1 - w^s(p))u(y), \tag{1}$$

where $s = +$ for gain, and $s = -$ for losses. If the prospect is mixed, its value is given by

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

Formula (1) generalizes EU through the replacement of probabilities p and $1 - p$ by *decision weights* $w^s(p)$ and $1 - w^s(p)$, respectively. Each decision weight (DW) reflects the rank-ordering of the corresponding consequence. Formula (2) extends the abovementioned generalization to mixed prospects.

The utility function implicitly takes *loss aversion*, i.e., higher sensitivity to losses than to gains, into account. To formally materialize loss aversion, we assume, as in Tversky and Kahneman (1992), that

$$u(z) = \begin{cases} z^\alpha & \text{if } z \geq 0, \\ -\lambda(-z)^\beta & \text{if } z < 0, \end{cases} \tag{3}$$

where the coefficient $\lambda > 0$ represents the *loss-aversion index*, reflecting the different processing of gains and losses. Paying more attention to losses than to gains, as assumed in PT, results in λ exceeding 1.

Most empirical studies on the utility of money confirm that the utility for gains is concave, assuming either EU (Fishburn and Kochenberger 1979) or PT (Tversky and Kahneman 1992, Abdellaoui 2000, Bleichrodt et al. 2010, Booij et al. 2010). As underlined by Abdellaoui et al. (2007), the empirical evidence on utility for losses is less clear-cut. Under PT, most studies find slight convexity for losses (Fennema and van Assen 1998), and concavity for a sizable minority of subjects (Abdellaoui et al. 2011b). Globally, the findings are consistent with a concave (convex) utility for gains (losses), i.e., utility is *S*-shaped.

As for loss aversion, the parametric specification of utility given by Equation (3) implicitly assumes the ratio $\lambda = -u(-\$1)/u(\$1)$ as an index of loss aversion (Wakker 2010). This index has become popular in the empirical literature, and many studies have taken its estimate of 2.25 by Tversky and Kahneman (1992) as a reference empirical value. Abdellaoui et al. (2007) compared several other definitions of loss aversion and elicited their corresponding indexes. They found a similar aggregated estimate of loss aversion to that found by Tversky and Kahneman (1992).

Finally, the empirical evidence accumulated during the last 20 years regarding probability weighting predominantly suggests that the weighting function is inverse *S*-shaped for both monetary gains and losses (Wu and Gonzalez 1996, Gonzalez and Wu 1999, Abdellaoui et al. 2011b) and for life duration (Bleichrodt and Pinto 2000). Most results suggest that probabilities below 1/3 are overweighted and probabilities above 1/3 are underweighted.

3. Experiment

3.1. Elicitation Method

To elicit PT for time and money at the individual level, we used the method initially implemented (for money) by Abdellaoui et al. (2011b, c). For a specific attribute (money or time), the method consists of three stages. In the first stage, utility is elicited in the gain domain (parameter α in Equation (3)), and in the loss domain (parameter β). In the second stage, decision weights $w^s(k/6)$ are elicited for $k = 1, 2, 3, 4, 5$ and $s = +, -$; $w^+(3/6)$ and $w^-(3/6)$ are also determined during the utility elicitation process. The loss-aversion coefficient λ is elicited in the third stage.

Utility can be obtained as follows. First, a gain (loss) probability $p_g(p_l)$ is fixed and certainty equivalents (CEs) $G_i(L_i)$ are determined for m prospects (x_i, q, y_i), $i = 1, \ldots, m$, where $q = p_g(p_l)$. A power utility is used for both time and money. This specification is commonly used for money and was also used in situations where the value of time is monotonic, as with life duration in health (Bleichrodt 2000) and travel time in transport literature (Senna 1994, de Palma and

Picard 2005). Taking the power specification given by Equation (3) into account, we have

$$\begin{aligned} G_i &= [w^+(p_g)(x_i^\alpha - y_i^\alpha) + y_i^\alpha]^{1/\alpha}, \\ L_i &= -[w^-(p_l)((-x_i)^\beta - (-y_i)^\beta) - (-y_i)^\beta]^{1/\beta}. \end{aligned} \tag{4}$$

Parameters α (β) and $w^+(p_g)$ ($w^-(p_l)$) can be estimated from gains (losses) using minimization of nonlinear least squares (Abdellaoui et al. 2011b).

Elicitation of decision weights $w^+(k/6)$ for $k = 1, 2, 3, 4, 5$ first requires determining the certainty equivalents z_k of five prospects $(x_*, k/6, 0)$, where x_* is a fixed consequence in the gain domain $\{x_i: i = 1, \ldots, m\}$ used to elicit utility for gains. For gains, we obtain

$$w^+(k/6) = \frac{(z_k)^\alpha}{(x_*)^\alpha}. \tag{5}$$

The elicitation of $w^-(k/6)$ for $k = 1, 2, 3, 4, 5$ is similar, with x_* standing for a fixed consequence in the loss domain.

With utility and probability weighting at hand, the loss-aversion coefficient λ can be elicited straightforwardly using a single indifference. We fix a probability p, select a consequence $l_* < 0$ in the set (of losses) $\{y_i: i = 1, \ldots, m\}$ and determine the consequence $g_* > 0$ such that $(g_*, p, l_*) \sim 0$. The loss-aversion coefficient is given by the following equation:

$$\lambda = \frac{w^+(p)}{w^-(1-p)} \frac{(g_*)^\alpha}{(-l_*)^\beta}. \tag{6}$$

The procedure does not impose any constraint on λ. Both loss aversion ($\lambda > 1$) and gain seeking ($\lambda < 1$) are possible (Abdellaoui et al. 2011b).

3.2. Experimental Design

3.2.1. Preference Measurement. The experiment was conducted through individual computer-based interview sessions. Subjects were told that there were neither right nor wrong answers. Their responses were entered into the computer by the experimenter so that the subject could focus on the choice questions. Before the experiment started, each subject was asked several practice questions. Half of the subjects started with choice questions involving monetary consequences, and half with choice questions involving time consequences.

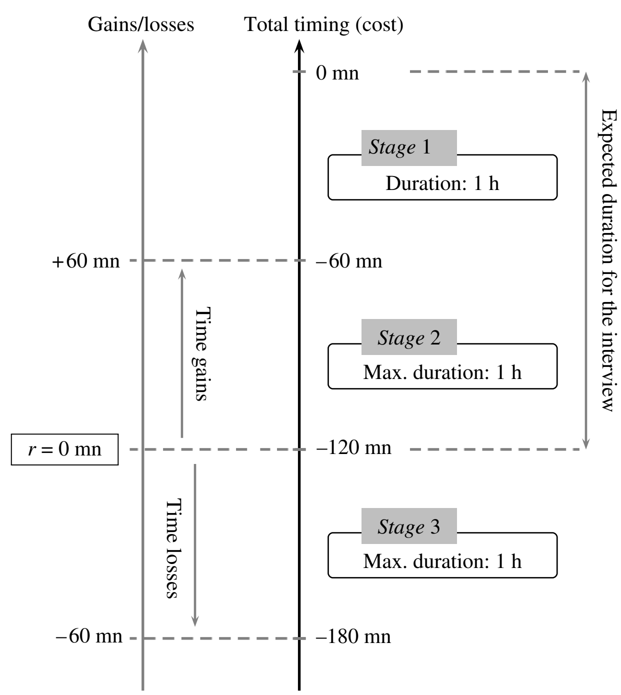
All indifferences were constructed through a series of choices between a sure (possibly null) outcome and a two-outcome prospect. Prospects were displayed as pie charts, with the sizes of the slices of the pie corresponding to the probabilities (see Appendix A). Time prospects were formulated in terms of gains and losses. For a given indifference, each binary choice corresponded to an iteration in a bisection process as described in Appendix B (Abdellaoui et al. 2011b).

3.2.2. Subjects and Methods. Subjects were 70 Ph.D. and graduate students from different disciplines recruited at Ecole Normale Supérieure (ENS, Paris). We divided the set into two subsamples of 35 subjects each to investigate whether the presence of real time incentives might influence subjects' behavior. For both groups, monetary choice questions were hypothetical. The use of real incentives for monetary gains and losses would have required the provision of a prior monetary endowment and led to the possibility of subjects integrating the payoff and then not perceiving any loss. We preferred to implement real incentives for time to avoid the integration issue. This point is discussed in §6. More than 20 pilot interviews were run to test and fine-tune the computer program and to check whether or not the subjects would agree to participate in the experiment with real time incentives. Prospects were formulated in terms of gains and losses.

First subset of subjects. In this group, subjects were given a flat payment of €30 each. Before they were recruited, the subjects were informed that the experiment was expected to last about two hours and that, due to the difference in course of the experiment for each participant, the experiment could last between one and three hours.

At the beginning of their interview, each subject was told that the experiment consisted of two one-hour sessions (Figure 1, stages 1 and 2). They were informed that during the first session, they would be confronted with a series of choice questions including questions involving time and monetary gains

Figure 1 **Course of the Experiment**



and losses. Subjects were also told that one of the choice questions concerning time would be randomly selected and played out for real at the end of the first session. If the subject won time (up to one hour), the second session would be shorter, so that she could leave in under two hours, which was the expected duration of the experiment (Figure 1). If the subject lost time (up to one hour), she would have to wait in a room after the end of the second (one-hour) session before receiving her flat payment. Subjects were also told that if they lost time, they would have no access to "entertainment devices" such as a cell phone, audio/video player, or book. The second one-hour session experiment was devoted to the pilot of a different experimental investigation.

Second subset of subjects. In this group, subjects were invited to participate in a one-hour experiment with a flat payment of €15 (Figure 1, stage 1). They were told at the start that they would have to make hypothetical choices about money and time. This group of subjects was not asked to participate in the second part of the experiment (Figure 1, stage 2). However, at the beginning of stage 1 subjects were asked to imagine that, for time, stage 1 would be followed by a second one-hour session and that the entire experiment would last two hours. Time gains would refer to the possibility of shortening the second (hypothetical) session and leaving the experiment sooner than (hypothetically) expected. Time losses would refer to the obligation to wait after the second session before receiving their flat payment.

3.2.3. Stimuli. As explained in §3.2.1, the elicitation of PT parameters relied on a series of binary choices between a sure consequence and a two-consequence prospect (Table 1). For time prospects, the consequences used were 0, 15, 30, 45, and 60 minutes (both as gains and as losses). These consequences were found to be of interest to the subjects. For monetary prospects, and for reasons similar to those for time, we considered amounts between €0 and €1,200 (Table 1).

Table 1 Nonmixed Prospects Used to Elicit Utility and Decision Weights for Time and Money

	Index i									
	1	2	3	4	5	6	7	8	9	10
Time										
$\lvert x_i \rvert$	15	30	45	45	60	60	30	30	30	30
$\lvert y_i \rvert$	0	0	0	15	0	30	0	0	0	0
Money										
$\lvert x_i \rvert$	300	600	900	900	1,200	1,200	600	600	600	600
$\lvert y_i \rvert$	0	0	0	300	0	600	0	0	0	0
Probability p_i	3/6	3/6	3/6	3/6	3/6	3/6	1/6	2/6	4/6	5/6

Note. Time expressed in minutes, money in euros.

For each attribute (money, expressed in euros, and time, expressed in minutes), and each domain (gains and losses), the CEs of the first six prospects $(x_i, 3/6, y_i)$, $i = 1, \ldots, 6$ given in Table 1 were used to elicit utility. Similarly, five CEs corresponding to prospects $i = 2$ and $i = 7, \ldots, 10$ in Table 1 were used to elicit the decision weights assigned to probabilities 3/6, 1/6, 2/6, 4/6, 5/6, respectively, for both attributes as well as for both gains and losses.

To determine the loss-aversion coefficient for time, we elicited two time gains $t_1, t_2 > 0$ such that $(t_1, 3/6, -10) \sim 0$ and $(t_2, 2/6, -20) \sim 0$. For money, we similarly determined two monetary gains m_1, m_2 such that $(m_1, 3/6, -200) \sim 0$ and $(m_2, 2/6, -400) \sim 0$.

It appeared from the pilot study that subjects felt more comfortable when the experiment started with less cognitively demanding choice questions. This was the case when dealing with gains rather than with losses, and when dealing with a series of constant probability prospects rather than with prospects in which both probabilities and outcomes varied. Consequently, subjects were confronted with choices between prospects in the following order. First, utility was elicited in the gain domain, then it was elicited in the loss domain. Second, loss-aversion coefficients were elicited using mixed prospects. Third, decision weights were elicited for gains and then for losses. Moreover, the order was randomized within each category of tasks (utility, loss aversion, decision weights).

4. Analysis of Raw Data

The present section reports a model-free analysis of the collected data focusing on the consistency of subjects' answers, on their attribute-dependence, domain-dependence, and attitudes toward risk.

4.1. Reliability

At the end of each bisection process, the subject faced one of the previously answered choice questions again. This repeated choice question corresponded either to the first or to the third iteration (the additional iteration was randomly selected within each bisection process). The repeated questions provide the means to assess subject preference consistency, i.e., reliability. Table 2 presents the corresponding consistency results (rate of preference reversals).

Table 2 Reliability by Sign and Attribute

	Money (%)		Time (%)	
	Gains	Losses	Gains	Losses
Total	93	91	91	90
Utility	92	88	92	91
Weights	91	92	88	88
Loss aversion	94		91	

Table 3 Certainty Equivalents for Utility and Decision Weights

	Time prospects							Monetary prospects						
		Gains			Losses				Gains			Losses		
i	EV	Median	Mean	SD	Median	Mean	SD	EV	Median	Mean	SD	Median	Mean	SD
1	7.5	8.5	8.55	2.20	7	7.57	1.57	150	110	114.14	41.89	155	150.29	41.38
2	15	14	13.89	3.80	16	15.96	3.09	300	195	191.82	82.09	305	307.82	92.65
3	22.5	19	19.36	5.69	24.5	25.61	4.89	450	291.5	273.93	114.21	472.5	478.50	26.40
4	30	27	27.16	5.13	28	27.64	5.23	600	495	512.89	93.33	590	574.36	94.60
5	30	23	24.19	7.85	35	33.52	6.90	600	340	354.32	163.95	668.5	649.07	75.60
6	45	44	42.97	4.57	43	42.86	4.05	900	841.5	850	101.14	870	849.68	98.50
7	5	11.5	11.21	4.28	11.5	11.58	3.84	100	92.5	93.54	54.88	155	171.29	79.52
8	10	11	12.28	4.33	14	13.71	3.46	200	142.5	146.04	73.76	220	229.86	85.14
9	20	16	15.68	3.56	16.5	18.11	3.82	400	273.8	244.70	97.30	382.5	360.71	86.11
10	25	17	17.53	3.83	19.2	19.54	4.15	500	377.5	344.39	115.66	415	419.71	97.60

Note. EV, expected value.

We note from this table that the overall reliability is higher than 88% for gains and losses, for time as well as for money. For money, the percentages of consistent answers are slightly higher than those obtained by Abdellaoui et al. (2011b): 93% against 82% for money gains, 91% against 87% for money losses. Additional tests regarding reliability are provided in Appendix C.

4.2. Certainty Equivalents

Table 3 reports medians, means, and standard deviations for the prospects used to elicit utility (rows 1–6) and probability weighting (rows 2, 7–10) for gains and for losses. At an aggregate level, the comparison of medians with expected values reveals that the subjects tended to exhibit a nonneutral attitude toward risk. This tendency is also confirmed by statistical tests. For time, two-tailed t-tests show that CEs differ from expected values for all prospects, except for prospect $i = 1$ in the loss domain. Results are similar for money, except for loss prospects $i = 1, 2$ for which no discrepancies were detected between CEs and the corresponding expected values.

We performed a $2 \times 2 \times 2$ ANOVA test on nonmixed prospects. Attribute (time/money) and domain (gains/losses) were considered as within factors and order (time first/money first) as a between-subject factor. As expected, the attribute factor appeared to be significant ($p < 0.001$). Domain was also significant ($p < 0.001$), as was its interaction with attribute ($p < 0.001$). No order effect was detected ($p = 0.13$). Additionally, our data did not reveal a significant impact of real incentives on the elicited time CEs ($p = 0.41$).

Table 4 reports the percentage of CEs exhibiting risk aversion, according to the sign and attribute. For time and money gain prospects, risk aversion seems to predominate, although the percentage of CEs exhibiting risk aversion is clearly higher for money than for time. This pattern is not influenced by the partition of prospects into utility prospects and decision weight prospects.

Table 4 Percentage of CEs Exhibiting Risk Aversion

	Time (%)		Money (%)	
	Gains	Losses	Gains	Losses
Total	60	56	86	54
Utility prospects	63	53	85	49
DW prospects	56	52	88	42
Mixed prospects	71		92	

To test the impact of experimental conditions on risk attitudes, we estimated a mixed-effect logit model (as in Appendix C). Such a model allows the introduction of a random normal effect accounting for between-subject variability. For time, order and incentives were considered as experimental conditions. Neither of these two factors had an effect ($p = 0.37$ for order and $p = 0.09$ for incentives); nor did their interaction ($p = 0.11$). A similar analysis of risk attitudes for money did not detect any order effect ($p = 0.6$).

We then analyzed the impact of domain and attribute on risk attitudes. In addition to the effect of these two factors ($p < 0.001$ for both domain and attribute), we also detected an interaction between them ($p < 0.001$). When addressing the impact of attribute on risk attitudes, we observed more risk aversion for monetary prospects than for time prospects in the gain domain ($p < 0.001$). In contrast, when dealing with losses, the subjects exhibited more risk aversion for time than for money ($p = 0.01$).

4.3. Indifferences for Mixed Prospects

As explained in §3.2.3, two loss-aversion coefficients were elicited for each attribute. Table 5 reports medians, means, and standard deviations for the assessed quantities, i.e., gains $t_g > 0$ and $m_g > 0$.

At an aggregate level, the elicited gains for time and money are consistent with loss aversion. We observed

Table 5 Elicited Gains for Time and Money

	Time t_g				Money m_g			
p	$\lvert t_l^* \rvert$	Median	Mean	SD	$\lvert m_l^* \rvert$	Median	Mean	SD
0.50	10	13.25	14.76	8.39	200	495	727.54	543.18
0.66	20	27.65	27.61	13.94	400	797.50	982.32	733.39

Note. t_l^* and m_l^* were such that $(t_g, p, t_l^*) \sim 0$ and $(m_g, p, m_l^*) \sim 0$.

that for $p = 0.50$, 0.66, the ratio $-m_g/m_l^*$ is higher than the ratio $-t_g/t_l^*$, suggesting more loss aversion for money than for time (as shown in the next section). The null hypothesis of equal ratios was rejected by our observations for both probabilities (two-tailed paired t-tests: $p < 0.01$).

5. Results Under Prospect Theory

5.1. Utility and Loss Aversion for Time and Money

As mentioned in §3.1, a power utility was assumed for time and money. At the aggregate level, the goodness of fit of this parametric specification, as measured by the sum of squared errors (SSE), is slightly better for money than for time (i.e., higher median SSEs for time gains and losses). More specifically, a paired t-test did not detect differences between the SSEs across attributes for gains ($p = 0.08$). In contrast, differences in terms of goodness of fit (for money) were detected between time and money for losses ($p = 0.03$). The slightly better goodness of fit might be due to the observation that people are less used to mental accounting regarding duration than monetary consequences (Soman 2001), resulting in more noisy observations for time than for money (Kemel and Travers 2013).

The estimated parameters for utility are reported in Table 6 (medians, means, and standard deviations). All median estimates, under PT, differ from 1 at the 1% level (t-tests). At an aggregate level, utility for time exhibits slight concavity for gains and losses. In contrast, while utility for money also exhibits slight concavity for losses, it exhibits a pronounced concavity on the gain domain, as recently observed in Abdellaoui et al. (2011b).

Table 7 Classification of Subjects in Terms of Utility Curvature

	Losses					
	Concavity		Convexity		Total	
	Time	Money	Time	Money	Time	Money
Gains						
Convexity	17	7	6	5	23	12
Concavity	33	36	14	22	47	58
Total	50	43	20	27	70	70

When comparing parameters across domains (gains versus losses), paired t-tests detected a difference between parameters α and β for both time and monetary prospects ($p < 0.01$). At the individual level, 54 (57) out of 70 subjects satisfied the inequality $\alpha < \beta$ for time (money). A comparison of the estimated powers across attributes detected differences in the gain domain (Table 6, paired t-tests). Specifically, 52 out of 70 subjects had a lower power estimate α for monetary than for time gains (Figure 2(a)). For losses, however, no difference was detected, and only 38 out of 70 subjects had a lower power estimate β for money than for time (Figure 2(b)). A 2×2 ANOVA test, performed on time utility parameters, with order (money-time/time-money) and the presence of real incentives (yes/no) as between-subject factors, did not reveal an impact of any of these factors (order: $p = 0.36$; real incentives: $p = 0.67$; interaction: $p = 0.77$).

Ignoring probability weighting, assuming (a reference-dependent version of) EU, results in more concavity of utility for both attributes in the gain domain. In contrast, in the loss domain, the impact of probability weighting is weak.

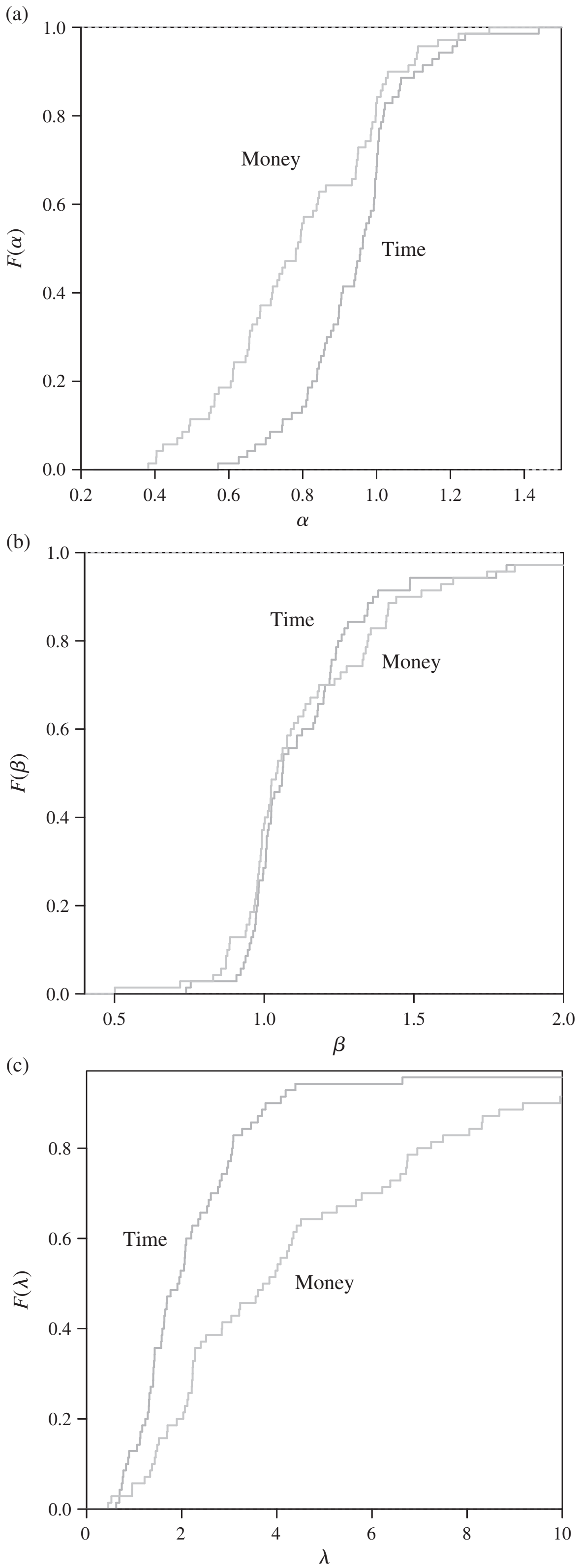
Table 7 reports the classification of subjects in terms of utility curvature. The most common pattern we observed is concavity in both the gain and loss domains (36 out of 70). S-shaped utility (concave for gains and convex for losses) is the second-most represented pattern, albeit with a significantly lower proportion (22 subjects out of 70). For time prospects, the most common pattern is concavity in gains and losses (33 subjects out of 70), while the second-most represented pattern is an inverse S-shaped utility (with 17 out of 70 subjects). The proportion of

Table 6 Estimates for Utility Parameters and Paired t-Tests

		Time			Money			Comparison	
Sign	Model	Median	Mean	SD	Median	Mean	SD	t_{69}	$\#(\Delta \gtrless 0)$
Gains: α	PT	0.96	0.94	0.15	0.78	0.79	0.22	-4.73^{**}	52/18
	EU	0.80	0.84	0.25	0.57	0.60	0.23	-7.02^{**}	59/11
Losses: β	PT	1.06	1.14	0.26	1.04	1.15	0.30	0.49^{ns}	38/32
	EU	1.19	1.21	0.35	1.06	1.23	0.64	0.27^{ns}	40/30

Note. $\#(\Delta \gtrless 0) = 52/18$ means that $\#(\Delta > 0) = 52$ and $\#(\Delta < 0) = 18$.
$^{**}p < 0.01$; ns, nonsignificant.

Figure 2 Empirical CDFs for Utility Across Attributes (Power and Loss Aversion)



people exhibiting a convex utility for gains is twice as high for time than for money (23 versus 12 subjects). Overall, these observations suggest that the hypothesis of an S-shaped utility (initially assumed by PT for money) is not consistent with our data. For money, this confirms the recent results in Abdellaoui et al. (2008).

Table 8 Loss-Aversion Coefficients for Time and Money

	Time				Money				Comparison	
p	$\lvert t_l^* \rvert$	Median	Mean	SD	$\lvert m_l^* \rvert$	Median	Mean	SD	t_{69}	$\#(\Delta \gtrless 0)$
0.50	10	1.81	2.54	3.79	200	3.52	5.70	8.85	−3.03	20/50
0.66	20	1.83	3.80	9.41	400	3.51	4.85	4.67	−1.29	20/50

Note. t_l^* and m_l^* were such that $(t_g, p, t_l^*) \sim 0$ and $(m_g, p, m_l^*) \sim 0$.

Overall, the median values of λ reveal loss aversion for both attributes. For both lotteries used to elicit loss aversion for time (money), 61 (66) out of 70 subjects exhibited a loss-averse behavior ($\lambda > 1$). A 2×2 ANOVA test, performed on loss aversion for time, with the presence of real incentives (yes/no) as a between-subject factor and the type of prospect as a within-subject factor shows that neither of those factors was found to be significant ($p = 0.69$ for incentives and $p = 0.08$ for prospects).

Table 8 shows that median loss-aversion coefficients for time are smaller than those obtained for money. Paired t-tests rejected the null hypothesis that attribute does not impact loss aversion ($p < 0.01$).

5.2. Probability Weighting for Time and Money

5.2.1. Preliminary Analysis of Elicited Decision Weights. At an aggregate level, the median DWs reported in Table 9 seem to be impacted by both domain (gains versus losses) and attribute (time versus money). This is confirmed by a $5 \times 2 \times 2$ ANOVA test with repeated measures, with probability, domain, and attribute as within-subject factors. These three factors were found to impact the DWs ($p < 0.001$, $p < 0.05$, and $p < 0.001$, respectively). Significant interactions were observed between attribute and domain ($p < 0.01$), between probabilities and domain ($p < 0.05$), and between probabilities and attribute ($p < 0.001$). Another 2×2 ANOVA, using order and the presence of real incentives as between-subject factors, was run on DWs (for time). Neither of these factors was found to have an impact on DWs ($p = 0.2$ and $p = 0.6$, respectively, $p = 0.09$ for the interaction).

5.2.2. Inverse S-Shaped Probability Weighting. For both time and money, our observations reveal an inverse S-shaped probability weighting. In the gain (loss) domain, the null hypothesis $w^s(p) = p$ with $s = +$ ($s = -$) was rejected for $p = 0.17$ for both attributes (Table 9, row 1 [6], paired t-tests). Moreover, individual observations show that 64 and 42 (61 and 42) subjects out of 70 overweighted this

Table 9 **Decision Weights for Time and Money and t-Tests ($w^s(p)$ vs. p)**

		Time					Money				
	p	Median	Mean	SD	t_{69}	$\#(\Delta \gtrless 0)$	Median	Mean	SD	t_{69}	$\#(\Delta \gtrless 0)$
Gains	0.17	0.39	0.40	0.15	13.00^{**}	64/6	0.20	0.24	0.13	4.52^{**}	42/28
	0.33	0.41	0.43	0.15	5.90^{**}	53/17	0.33	0.33	0.13	0.23^{ns}	34/36
	0.50	0.49	0.49	0.12	-0.81^{ns}	34/36	0.42	0.41	0.11	-6.38^{**}	15 /55
	0.66	0.54	0.55	0.11	-8.26^{**}	10/60	0.49	0.50	0.15	-9.14^{**}	11/59
	0.83	0.61	0.61	0.13	-14.83^{**}	5/65	0.67	0.65	0.16	-9.28^{**}	8 /62
Losses	0.17	0.35	0.35	0.13	11.51^{**}	61/9	0.24	0.26	0.15	4.71^{**}	42 /28
	0.33	0.41	0.42	0.13	5.83^{**}	53/17	0.34	0.35	0.14	1.08^{ns}	37/33
	0.50	0.52	0.49	0.11	-0.42^{ns}	37/33	0.48	0.48	0.13	-1.14^{ns}	37/33
	0.66	0.55	0.57	0.13	-5.89^{**}	17/53	0.58	0.57	0.13	-5.42^{**}	18/52
	0.83	0.60	0.62	0.15	-11.99^{**}	8/62	0.68	0.67	0.14	9.58^{**}	8/62

Notes. Time expressed in minutes, money in euros. $\Delta = w^s(p) - p$.
$^{**}p < 0.01$; ns, nonsignificant.

probability, $w^s(0.17) > 0.17$ with $s = +$ ($s = -$) for time and for money, respectively. The picture is somewhat different across attributes for probability $p = 0.33$. The null hypothesis $w^s(0.33) = 0.33$ with $s = +$ ($s = -$) was rejected for time savings (losses), which is not consistent with the data obtained in a number of previous studies involving monetary prospects (Tversky and Kahneman 1992). In addition, 53 (53) subjects out of 70 exhibited overweighting of probability 0.33 for time savings (losses).

For probability 0.5, the null hypothesis $w^s(0.5) = 0.5$ was not rejected for either time gains or time losses. It was rejected only for monetary gains. For probabilities above 0.5, i.e., $p = 0.66$, 0.83, the null hypothesis was systematically rejected for both attributes (paired t-tests, 5% level). Moreover, more than 59 (52) subjects underweighted these probabilities for time savings (losses) on one hand and for monetary gains (losses) on the other.

When we focused on differences between DWs across domains (gains versus losses), we detected only one difference ($p = 0.17$) for time (Table 10, row 1). For money, the difference was significant for probability values $p = 0.50$, 0.66 (Table 10, rows 3 and 4). Figures 3(a) and 3(b) illustrate the differences between the probability weighting functions

Table 10 **Paired t-Tests for Decision Weights: $w^+(p)$ vs. $w^-(p)$**

	Time		Money	
Probability p	t_{69}	$\#(\Delta \gtrless 0)$	t_{69}	$\#(\Delta \gtrless 0)$
0.17	2.20^{*}	45/25	-0.58^{ns}	31/39
0.33	0.65^{ns}	36/34	-0.62^{ns}	30/40
0.50	-0.33^{ns}	35/35	-3.07^{**}	23/47
0.66	-0.99^{ns}	35/35	-2.92^{**}	28/42
0.83	-0.47^{ns}	38/32	-0.99^{ns}	28/42

Note. Time expressed in minutes, money in euros.
$^{*}p < 0.05$; $^{**}p < 0.01$; ns, nonsignificant.

Table 11 **Paired t-Tests for Decision Weights: $w^s(p)$ for Time vs. $w^s(p)$ for Money**

	Gains		Losses	
Probability p	t_{69}	$\#(\Delta \gtrless 0)$	t_{69}	$\#(\Delta \gtrless 0)$
0.17	6.35^{**}	51/19	4.48^{**}	48/22
0.33	6.10^{**}	55/15	3.72^{**}	46/24
0.50	3.81^{**}	49/21	0.61^{ns}	38/32
0.66	2.02^{*}	45/25	-0.25^{ns}	35/35
0.83	-1.92^{ns}	25/45	-2.78^{**}	25/45

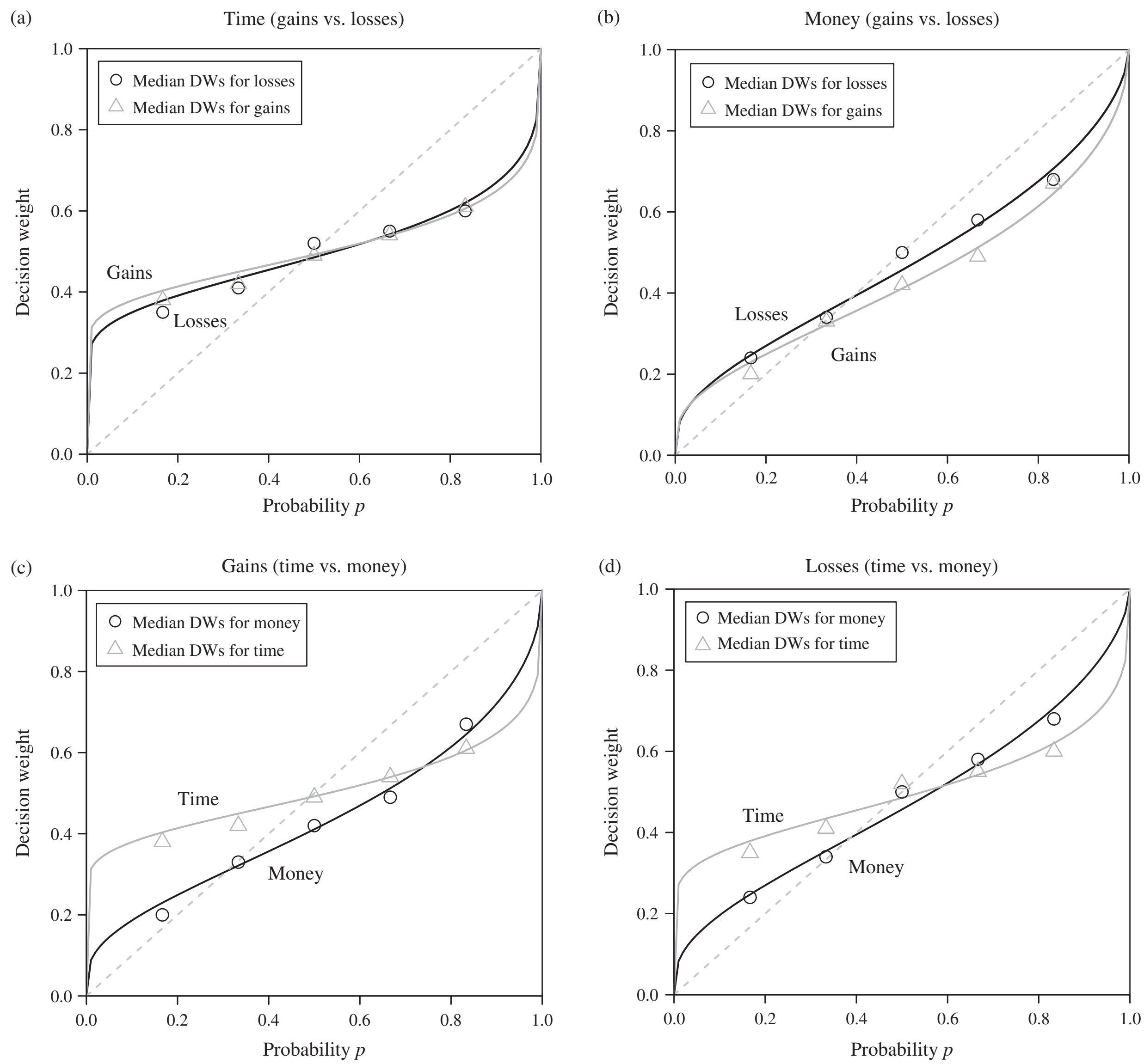
Note. Time expressed in minutes, money in euros.
$^{*}p < 0.05$; $^{**}p < 0.01$; ns, nonsignificant.

(assuming the Prelec specification given by Equation (8)), fitted on median data, across attributes for gains and losses.

Table 11 shows that for most probability values, the DWs were different across attributes for both gains and losses. In the gain domain, paired t-tests rejected the null hypothesis of equal DWs across attributes for probability values $p = 0.17, 0.33, 0.50, 0.66$. At an individual level, and for each probability (below 0.83), more than 45 out of 70 subjects exhibited more elevated DWs for time than for money. The picture is similar for losses, except that the hypothesis of equal DWs across attribute is rejected for probability values $p = 0.17, 0.33, 0.83$. At an individual level, 48 and 46 subjects out of 70 exhibited higher DWs for probabilities 0.17 and 0.33 for time than for money, respectively. For probability 0.83, 45 out of 70 subjects had higher DWs for money than for time. Figures 3(c) and 3(d) illustrate the across-attribute differences in terms of probability weighting at the aggregate level for gains and losses, respectively.

5.2.3. Parametric Analysis of Probability Weighting. To further analyze the difference between time and money in terms of probability weighting, we

Figure 3 Elicited Probability Weighting Functions for Median Data (Using Prelec)



estimated the most widely used parametric forms. The first was initially adopted by Goldstein and Einhorn (1987) and used in Wu and Gonzalez (1999), as well as in other works. It is called the linear in-log odds, and is given by

$$w(p) = \frac{\delta p^{\gamma}}{\delta p^{\gamma} + (1-p)^{\gamma}}. \tag{7}$$

In this parametric form (henceforth, GE), δ reflects elevation (i.e., optimism/pessimism), while γ represents curvature (i.e., sensitivity to probabilities). The second parametric form, the compound invariance family, is due to Prelec (1998) and is such that

$$w(p) = (\exp(-(-\ln(p))^{\gamma}))^{\delta}, \tag{8}$$

where γ mainly controls curvature, and δ represents an anti-index of elevation.

Table 12 gives the median estimates of the elevation and curvature parameters along with their corresponding standard deviations (see also Figure 4). At an aggregate level, the median results reveal less sensitivity to probabilities (reflected by curvature) for time than for money in both the gain and loss domains. The null hypothesis of equal sensitivity across attributes is rejected in both the gain and loss domains and for both parametric specifications (paired t-tests, Table 13). Furthermore, at an individual level, in each of the four cases (GE/Prelec for time and money, gains and losses) at least 56 out of 70 subjects exhibited higher sensitivity for money than for time.

Table 12 **Median Estimates for Probability Weighting:** $\delta p^\gamma/(\delta p^\gamma + (1-p)^\gamma)$ **and** $\exp(-(-\ln(p))^\gamma)^\delta$

	Time						Money					
	Gains			Losses			Gains			Losses		
Parametric form	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD
GE												
δ	1.00	1.03	0.39	0.95	1.02	0.36	0.74	0.78	0.34	0.88	0.91	0.34
γ	0.26	0.29	0.21	0.31	0.39	0.32	0.61	0.59	0.32	0.58	0.62	0.28
Prelec												
δ	0.78	0.82	0.23	0.81	0.87	0.32	1.08	1.11	0.33	0.98	1.00	0.29
γ	0.26	0.29	0.21	0.31	0.39	0.32	0.53	0.54	0.29	0.61	0.61	0.29

When we focus on elevation, the picture is somewhat different. While the null hypothesis of equal elevation across attributes is rejected (paired t-tests) for gains under the two parametric specifications, the same hypothesis for losses is rejected only when it assumes the Prelec specification. At an individual level, in the gain domain, 54 (57) out of 70 subjects exhibited a more elevated GE (Prelec) curve

Figure 4 **Empirical CDFs for Elevation and Sensitivity Across Attributes (Prelec)**

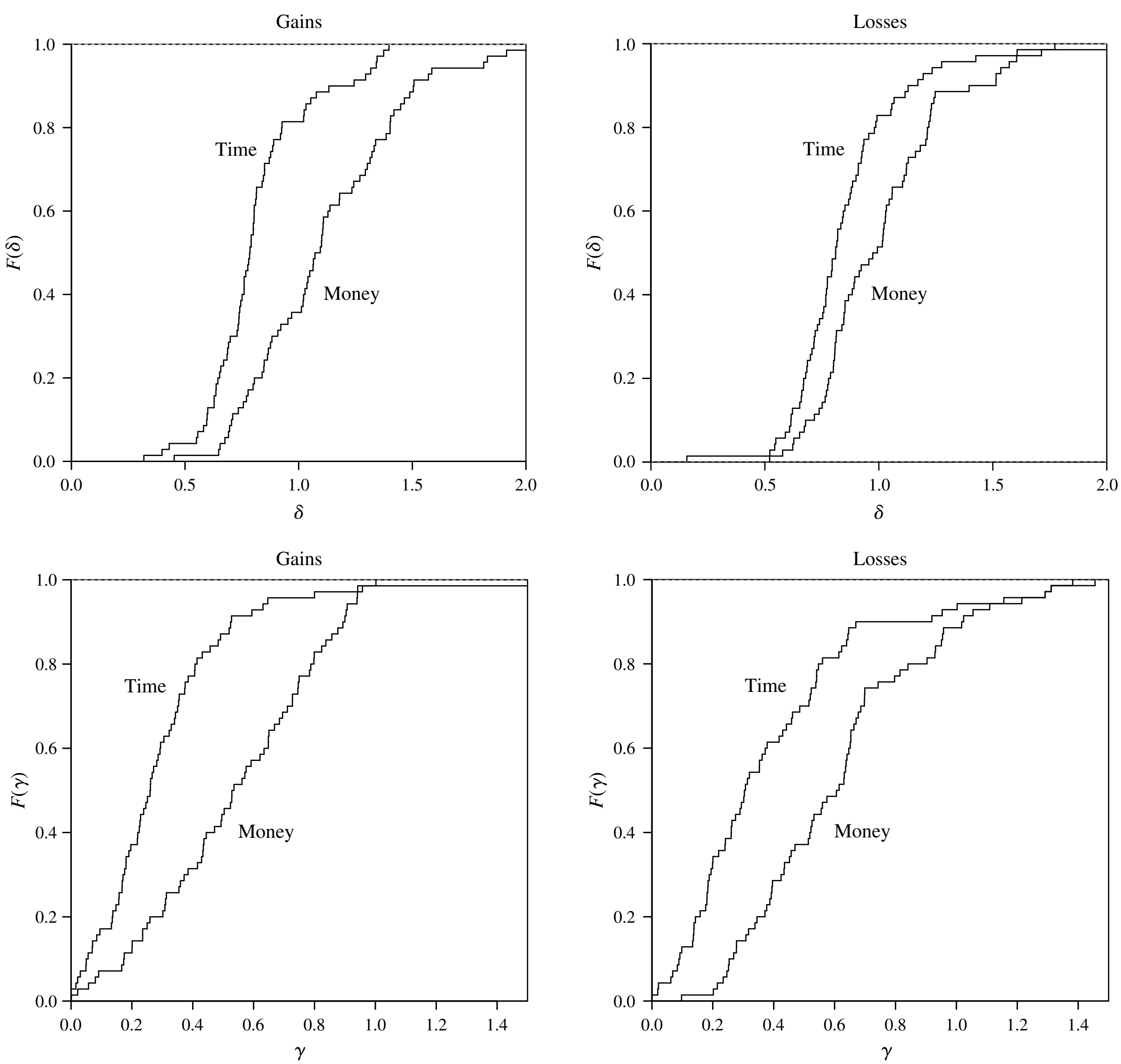


Table 13 Paired *t*-Tests for Elevation and Curvature Parameters: Time vs. Money

	Gains		Losses	
	t_{69}	$\#(\Delta \gtrless 0)$	t_{69}	$\#(\Delta \gtrless 0)$
GE				
Elevation: δ	4.46^{**}	54/16	0.28^{ns}	42/28
Curvature: γ	-6.95^{**}	13/57	-5.38^{**}	12/58
Prelec				
Elevation: δ	-6.74^{**}	13/57	-3.18^{**}	20/50
Curvature: γ	-6.38^{**}	13/57	-5.07^{**}	14/56

Note. Time measured in minutes, money in euros.
$^{**}p < 0.01$; ns, nonsignificant.

Table 14 Paired *t*-Tests for Elevation and Curvature Parameters: Gains vs. Losses

	Time		Money	
	t_{69}	$\#(\Delta \gtrless 0)$	t_{69}	$\#(\Delta \gtrless 0)$
GE				
Elevation: δ	0.26^{ns}	37/33	-1.94^{ns}	26/44
Curvature: γ	-2.54^{**}	25/45	-0.78^{ns}	27/43
Prelec				
Elevation: δ	-1.16^{ns}	28/42	2.12^{*}	45/25
Curvature: γ	-2.58^{*}	27/43	-1.59^{ns}	26/44

Note. Time measured in minutes, and money in euros.
$^{*}p < 0.05$; $^{**}p < 0.01$; ns, nonsignificant.

(i.e., more optimism) for time than for money. In the loss domain, 50 subjects out of 70 exhibited a more elevated Prelec curve.[2]

When the analysis is restricted to one attribute across domains (gains versus losses), differences were detected regarding both elevation and curvature (Table 14). These differences were less pronounced, however, than in the across-attribute analysis (Figures 3(a) and 3(b)). When a GE parametric form is assumed, differences were detected for time but only with regard to curvature. At an individual level, 45 out of 70 subjects exhibited a more pronounced curvature for losses than for gains. In contrast, when a Prelec parametric form was assumed, we detected a difference in terms of curvature across domains for time and a significant difference in terms of elevation across domains for money.

Both parametric specifications tell the same story. In terms of goodness of fit, the median residuals are not significantly different from one parameterization to another.

[2] We also performed a between-subject analysis of probability weighting across attributes using two subsamples of 17 and 18 subjects for which no incentives were used. All the results of Table 13 were confirmed by means of a Wilcoxon test, except for the GE specification in the loss domain, where the same test detected differences in terms of elevation ($p < 0.01$) and did not detect differences in terms of curvature ($p = 0.05$).

6. Discussion

We compared individual behavior under risk for time units and for money. Using a within-subject experimental design, we studied these differences in terms of utility, loss aversion, and probability weighting.

Two concerns may be raised. First, the observed differences in risk attitudes across attributes may be impacted by the relatively large amounts of money involved as compared to the amounts of time (e.g., most people would not value a gain of 1 hour as 1,200 euros). Actually, our results for money are consistent with those obtained in similar elicitations involving lower amounts of money (Abdellaoui et al. 2011b).[3] Consequently, we do not think that the first concern holds regarding the present study. Second, one might argue that the absence of real incentives for money in our experiment distorts the comparison of the different attitudes toward time and money. Again, the findings for monetary consequences in this paper are consistent with previous findings in the literature, including those using real incentives (Abdellaoui et al. 2011b). Moreover, we observed similar across-attribute differences in the subgroup of subjects that faced hypothetical choices for both time and money.

6.1. Utility and Loss Aversion Across Attributes

In terms of utility, differences were detected across attributes (time/money) in the gain domain. Under PT as well as under EU, utility exhibited more concavity for money than for time; in addition, under PT, while more than one-third of the utilities for gains exhibited convexity for time prospects, this percentage declined by half for monetary prospects (Tables 6 and 7). In contrast, no differences in terms of the subjective treatment of consequences were detected across attributes for losses, under either PT or EU. As for loss aversion, our data suggest its existence for both attributes, but its magnitude is clearly greater for money than for time.

6.2. Decision Weights Across Attributes

The elicited probability weighting functions are globally inverse *S*-shaped for both attributes, confirming the findings accumulated for monetary consequences (Wu and Gonzalez 1996; Gonzalez and Wu 1999; Abdellaoui et al. 2011a, b). For time prospects, probability weighting is not domain-dependent (gains versus losses). In contrast, probability weighting for money exhibits more elevation (in the middle of the probability interval) for losses than for gains, confirming previous findings (Abdellaoui et al. 2011b).

[3] In a follow-up study, Kemel and Travers (2013) obtained very similar results (in a within-subject design) for money and time with monetary consequences lying between 0 and 150 euros and comparable amounts of time.

The most remarkable observation is a difference across attributes. In the gain as well as in the loss domain, probability weighting for time is clearly different in terms of both elevation and curvature, as compared to probability weighting for money. In the gain domain, probability weighting for time is more elevated on the first two-thirds of the unit interval. This suggests that subjects are more optimistic when they are confronted with gain prospects for time with low and moderate good-news probabilities (i.e., probabilities assigned to the upper outcome) than when they face similar monetary prospects. This probability overweighting for time turns out to be more pronounced than for money and concerns not only small but also moderate probabilities. In terms of risk attitude, this reveals that individuals tend to take more risks when they face time risk than when they face monetary risk. It is also worth noting that subjects are considerably less sensitive to probabilities when they face time risk than when they face monetary risk. An increase in the winning probability in the middle of the probability interval has less impact for time than for money. This results in a more pronounced possibility effect (measuring the impact of a small increase of probability from 0) and in a more pronounced certainty effect (measuring the impact of a small increase of probability near 1 resulting in certainty) for time than for money.

For losses, the observed probability weighting across attributes is similar to that observed for gains, except that the smaller gap between DWs across attributes comes from a more elevated probability weighting for monetary losses. Once again, for time risk, probability weighting for losses exhibits the same overweighting of small and moderate probabilities as in the gain domain, revealing a tendency of the subjects to be more risk averse for small and moderate loss probabilities than for large ones.

In contrast to EU, where attitudes toward consequences and attitudes toward risk are both reflected by utility, PT assigns the role of capturing attitude toward consequences to utility, and the role of revealing attitude toward chance to probability weighting. Assuming that attitude toward chance is reflected by probability weighting, our data show that this attitude clearly differs across attributes. This implies that risk perception is influenced by the nature of the unit used to measure consequences.

6.3. Real Incentives Implementation for Time vs. Money

The implementation of real incentives for monetary consequences in individual choice under risk is known to be somewhat problematic when it comes to loss/mixed prospects (Wakker 2010). First, an implementation of this type imposes the playing out of loss/mixed questions for real, which is ethically questionable (Etchart-Vincent and L'Haridon 2011).[4] Second, using an initial endowment with real losses could be costly given that one has to elicit utility on a sufficiently wide interval of monetary losses to observe its curvature. Furthermore, subjects benefiting from a prior endowment may integrate the payoffs and then not perceive any loss. Formally speaking, the provision of an initial endowment (which is a side payment) could impact the location of the reference point, usually set at 0 under PT (Wakker 2010, Chap. 8).

The use of consequences measured in time units can allow for a less problematic implementation of real incentives for losses. The provision in our experiment of a prior (flat) monetary payment when people face the risk of losing time avoids the aforementioned ethical issue. Moreover, it is easier to integrate money with money than money with time. Hence, it is plausible that subjects do not integrate in our experiment when facing time losses.

Our study investigates the impact of the presence of real incentives on the collected choices for time. As explained in §3.2.2, the sample of subjects was divided into two subsamples: the first one faced real choice questions, and the second faced hypothetical choice questions. Our results suggest that the observations regarding utility, probability weighting, and loss aversion were not impacted by the presence/absence of real incentives in the choice tasks implemented. We speculate that the use of consequences measured in time units can help in investigating the impact of real incentives in experimental decision making. This can be useful in the absence of a consensus regarding the impact of real incentives for monetary consequences. While many recent experimental elicitations using stimuli very similar to those in the present study did not detect any effect of the presence of real incentives on the estimated parameters (Abdellaoui et al. 2011b, Etchart-Vincent and L'Haridon 2011, Kemel and Travers 2013), other studies have detected such an impact (Abdellaoui et al. 2011c, Holt and Laury 2002).

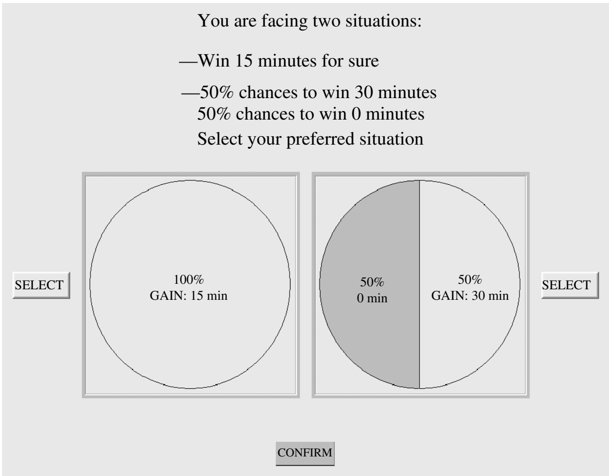
Acknowledgments

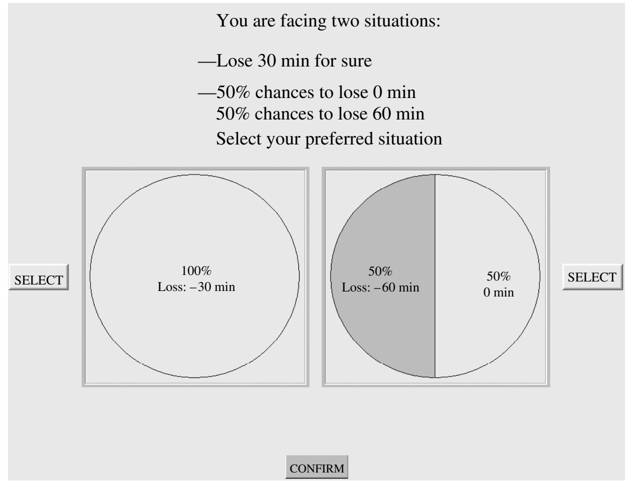
The authors thank Aurélien Baillon, Nathalie Etchart-Vincent, Olivier L'Haridon, Anisa Shyti, Peter Wakker, two anonymous reviewers, and an associate editor for their helpful remarks and suggestions.

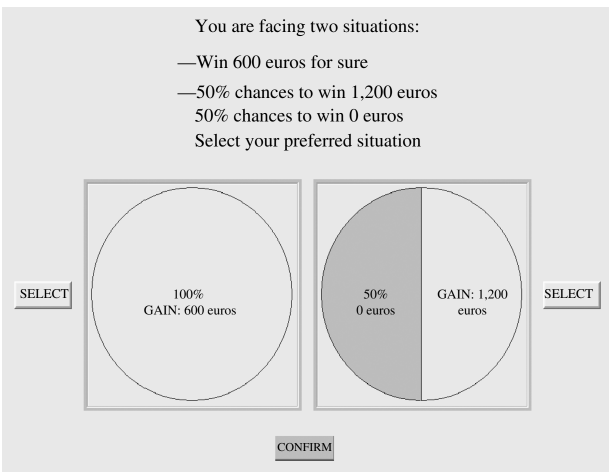
[4] Etchart-Vincent and L'Haridon (2011, p. 62) also observed that "it is difficult to recruit subjects prepared to lose money from their own pocket without subjecting their sample to a strong selection bias."

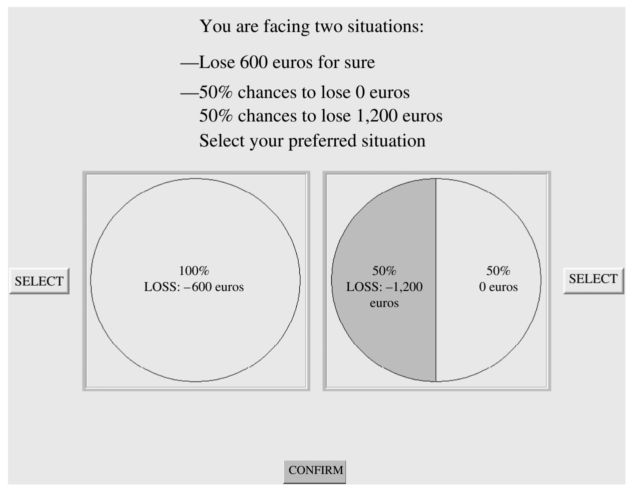
Appendix A. Displays

Displays A.1: Choice questions with nonmixed prospects

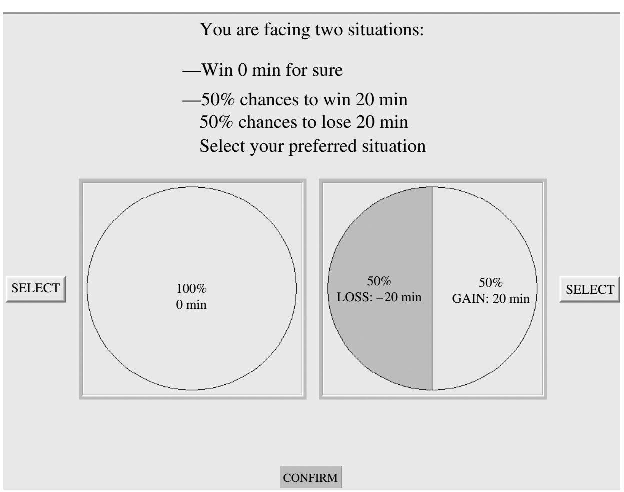


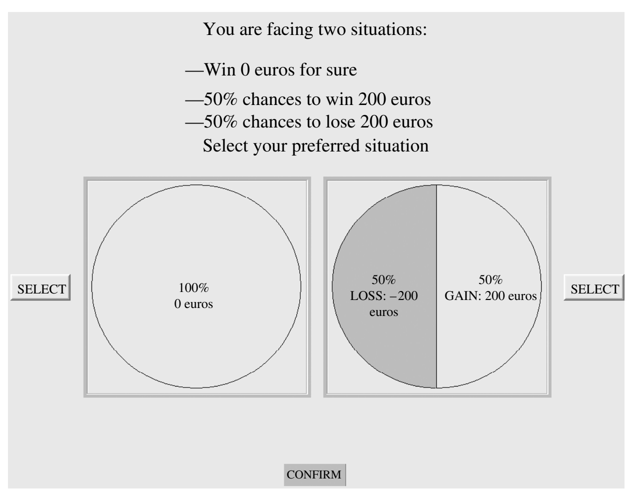






Displays A.2: Choice questions with mixed prospects





Appendix B. Bisection

The bisection method used to determine the outcome that makes the subject indifferent between two prospects A and B is described in Tables B.1 and B.2. It consists of a series of successive iterations, choice questions. The chosen prospect is printed in bold.

Table B.1 describes the bisection process used to determine the certainty equivalent of prospect 5, $(0, 1/2; -1{,}200)$ for money, $(0, 1/2; -60)$, for time. In the first iteration (first choice question) for money, the subject had to choose between prospect A and its expected value $B = -600$. At this stage, choosing A means that the certainty equivalent of A belongs to the interval $[-600, 0]$; otherwise, the certainty equivalent would be in $[-1{,}200, -600]$. Taking the previous choice into account, the subject faced a new choice between prospect A and the sure amount $B = -300$ (the midpoint of the interval $[-600, 0]$). Choosing B, as assumed in Table B.1, implies that the certainty equivalent belongs to the interval $[-600, -300]$. In the following iteration, the subject faced a choice between prospect A and the sure amount $B = -450$ (the midpoint of the interval $[-600, -300]$). The stopping rule we used stipulates that the certainty equivalent should lie within an interval of 5 euros for money and 2 minutes for time. Pilot sessions showed subjects were not sensitive to finer bisections.

Table B.2 gives an example of the bisection process that was used to elicit loss-aversion parameters. The second column shows how to determine the monetary gain g_* such that $0 \sim (g_*, 2/3; -400)$. In the first iteration, the subject had to choose between the mixed prospect $A = (200, 2/3; -400)$ and $B = 0$. Declining to hold A implies that gain g_* should be higher than 200 (conversely, accepting to hold A in the first iteration implies that gain g_* should lie between 0 and 200). Since gains were considered in the $[0, 1{,}200]$ interval, in the second iteration, the subject faced a choice between $A = (700, 02/3; -400)$ and $B = 0$, where $g_* = 700$ is the midpoint of the interval $[200, 1{,}200]$. Declining to hold B implies that the gain g_* should lie between 200 and 700.

Using similar reasoning from iteration 3 to 10, the choice pattern *AABBAABB* implies that g_* should lie between 799 and 801. Then, the midpoint of the interval $[799, 801]$ is taken as the indifference value g_*.

As shown by the third column, the process is the same for the time attribute.

Table B.1 An Illustration of the Bisection Method for CE Elicitation, for Prospect 5

	Choice questions	
Iteration	For money	For time
1	(**0**, **1/2**; **−1,200**) vs. −600	(**0**, **1/2**; **−60**) vs. −30
2	(0, 1/2; −1,200) vs. **−300**	(0, 1/2; −60) vs. **−15**
3	(**0**, **1/2**; **−1,200**) vs. −450	(0, 1/2; −60) vs. **−22**
4	(0, 1/2; −1,200) vs. **−375**	(**0**, **1/2**; **−60**) vs. −26
5	(**0**, **1/2**; **−1,200**) vs. −412	(0, 1/2; −60) vs. **−24**
6	(0, 1/2; −1,200) vs. **−393**	(0, 1/2; −60) vs. **−15**[a]
7	(**0**, **1/2**; **−1,200**) vs. −402	
8	(0, 1/2; −1,200) vs. **−397**	
9	(0, 1/2; −1,200) vs. **−375**[a]	
Indifference value	−399.5	−25

Note. Bold text designates the selected alternatives.
[a]Repeated choice for consistency check.

Table B.2 An Illustration of the Bisection Method for Loss-Aversion Elicitation

	Choice questions	
Iteration	For money	For time
1	(200, 2/3; −400) vs. **0**	(10, 2/3; −20) vs. **0**
2	(700, 2/3; −400) vs. **0**	(**35**, **2/3**; **−20**) vs. 0
3	(**950**, **2/3**; **−400**) vs. 0	(22, 2/3; −20) vs. **0**
4	(**825**, **2/3**; **−400**) vs. 0	(**28**, **2/3**; **−20**) vs. 0
5	(762, 2/3; −400) vs. **0**	(25, 2/3; −20) vs. **0**
6	(793, 2/3; −400) vs. **0**	(**26**, **2/3**; **−20**) vs. 0
7	(**809**, **2/3**; **−400**) vs. 0	(**10**, **2/3**; **−20**) vs. **0**
8	(**801**, **2/3**; **−400**) vs. 0	
9	(797, 2/3; −400) vs. **0**	
10	(799, 2/3; −400) vs. **0**	
11	(**950**, **2/3**; **−400**) vs. 0[a]	
Indifference value	800	25.5

Note. Bold text designates the selected alternatives.
[a]Repeated choice for consistency checking.

Appendix C. The Impact of Attribute and Domain on Reliability

To test the impact of attribute and sign on reliability (i.e., preference reversal: yes/no), a mixed-effect logit model (Bates 2005, Bates and Sarkar 2005) was estimated, using these latter factors as fixed effect and subjects as a random effect. None of these factors was found to be significant ($p = 0.19$ and $p = 0.51$, respectively). A similar model was used to check whether or not the questions order (time-money versus money-time) or the presence of incentives impacted the reliability of time CEs. Our data do not show any impact of either order ($p = 0.81$) or incentives ($p = 0.53$) on reliability.

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