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**Conference Paper**

## Experiments on bivariate risk preferences

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# EXPERIMENTS ON BIVARIATE RISK PREFERENCES

*Submission prepared for the Verein für Socialpolitik 2015 Annual Meeting.*

*Preliminary and incomplete. Please do not distribute.*

We study cross-risk preferences over wealth and two other attributes to obtain theory-free evidence of correlation aversion as well as higher-order cross-traits like cross-prudence and cross-temperance. Two experiments elicit the dependence structure of risk preferences between wealth and, respectively, waiting time and someone else's wealth. The latter experiment, which could be called "risk preferences for you, me, and us", connects bivariate risk preferences with (higher-order) inequality aversion. This first systematic exploration of bivariate risk attitudes helps assess the appropriateness of assumptions in economic models on health prevention, inequality, saving, or insurance.

KEYWORDS: Correlation Aversion, Higher-Order Risk Preferences, Inequality aversion, Multivariate risk, Prudence, Risk Aversion

JEL: D03, D81.

## 1. INTRODUCTION

Bernoulli (1738/1954), Arrow (1965) and Pratt (1964) have demonstrated the ubiquitous importance of risk aversion for economic decisions. Already in the early 1960's it was realized though, that so-called higher-order risk preferences complement risk aversion in important ways. The third-order trait of prudence, for example, is necessary and sufficient for a precautionary savings motive in an expected utility framework (Leland, 1968; Sandmo, 1970; Kimball, 1990). The fourth-order trait of temperance is decisive for saving in the presence of macroeconomic risks, such as interest rate or unemployment risk (Eeckhoudt and Schlesinger, 2008). Within expected utility theory with smooth utility function  $u$ , risk aversion, prudence, and temperance respectively correspond to the assumption that  $u'' < 0$ ,  $u''' > 0$ , and  $u'''' < 0$ .

Not until the risk apportionment model of Eeckhoudt and Schlesinger (2006), however, these technical conditions were given an intuitive interpretation using simple lotteries. Moreover, recent research has exploited the risk apportionment idea to test for higher-order risk preferences – in the univariate wealth case – empirically. Deck and Schlesinger (2010), Ebert and Wiesen (2011), and Maier and Ruger (2011) comprise the first experiments in this regard, and mostly find evidence for risk aversion, prudence and temperance. Noussair et al. (forthcoming) confirm these findings for a representative dataset of the Dutch population. Recently, Deck and Schlesinger (forthcoming) find strong evidence that risk preferences, at least up to the fifth order, may stem from a general preference for combining good with bad.<sup>1</sup>

While many economic models consider wealth as the one (and only one) most important decision variable, numerous researchers recognize the fact that, in many situations, more

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<sup>1</sup>Some further evidence is given in Ebert and Wiesen (2014). The fact that the theoretical insights of Eeckhoudt and Schlesinger (2006) and succeeding papers made way for empirical tests of higher-order risk preferences is also evidenced by the fact that only few studies tackled this problem before. As such, under restrictive assumptions Tarazona-Gomez (2004) is the first to obtain evidence for prudence. Results from Dittmar (2002) and Guiso et al. (1996) are consistent with temperance.

than one attribute is important. Such attributes include time, health, and the well-being of others. Moreover, the interactions between risk preferences over the two attributes, i.e., their dependence structure, is decisive. This dependence structure is determined by the cross-risk attitudes that we study in this paper.

Correlation aversion (Richard, 1975; Epstein and Tanny, 1980) – the second-order cross-risk attitude – is a preference for disaggregating two harms (one of each attribute) across states of nature. Regarding preference over waiting time, for example, correlation aversion predicts that an individual is more willing to accept additional waiting time in a state where wealth is higher.

The third-order trait of cross-prudence over health (Eeckhoudt et al., 2007; Tsetlin and Winkler, 2009), for example, can be characterized by an individual being more willing to take an unavoidable wealth risk in states where she is healthier (Eeckhoudt et al., 2007). Not surprisingly, correlation aversion, cross-prudence, and cross-temperance – or their counterparts, correlation seeking, cross-imprudence, cross-intemperance – are important assumptions in models that treat more than one attribute. These traits determine the dependence structure of risk preferences across attributes. Only if the individual is cross-risk neutral for all orders, then risk preferences are independent and utility is additive in the two attributes.

Eisner and Strotz (1961) are probably the first to point out that the marginal utility of wealth is sensitive to other, non-pecuniary attributes, which is consistent with correlation aversion. We refer to Eeckhoudt et al. (2007) for a more comprehensive overview of how higher-order cross risk attitudes determine the outcomes of various economic models of health, labor, tax, or saving. It is also interesting to note that in the same way that prudence relates to skewness-preference, cross-prudence relates to a preference for co-skewness that plays a crucial role in asset pricing models such as Harvey and Siddique (2000). In analogy to the univariate case, within smooth expected utility, (higher-order) cross-risk preferences are characterized by conditions on the cross-derivatives of the utility functions. Assumptions on the cross-derivatives such as submodularity are also crucial in comparative statics analysis (e.g. Milgrom and Roberts (1994), Athey (2002)); see Nocetti (2015) for a recent contribution.

In contrast to the extensive theoretical study of cross risk attributes, there is little empirical evidence on cross-risk attributes. This may be due to two reasons. First, as in the univariate case, a theoretical characterization amenable to experiments had not been given until recently. Eeckhoudt et al. (2007) and Tsetlin and Winkler (2009), however, provide us with a multivariate extension of the risk apportionment model of Eeckhoudt and Schlesinger (2006). Second, employing a second attribute in experiments is challenging. Recently, however, Noussair and Stoop (forthcoming) make the important observation that waiting time satisfies the three precepts concerning the relationship between decisions and subject rewards

that Smith (1982) proposes: non-satiation, salience, and dominance (see the original article for details).<sup>2</sup>

Building upon the theoretical developments of Eeckhoudt et al. (2007) and the experimental progress made by Noussair and Stoop (forthcoming); Abdellaoui and Kemel (forthcoming), we provide experimental evidence on cross-risk attributes over wealth and waiting time as well as in a social setting. The contributions are as follows. First, our paper is the first to provide evidence on correlation aversion using the simple, theory-free risk apportionment approach. Second, our experiment elicits higher-order risk preferences in an important non-monetary domain: waiting time. Third, the experiment is the first to study higher-order cross-risk preferences such as cross-prudence and cross-temperance at all. Fourth, we study *within* dimensions (wealth and time) as well as *between* dimensions the idea that (higher-order) risk aversion roots in a fundamental preference for combining good with bad (Eeckhoudt et al. (2009); Tsetlin and Winkler (2009); Crainich et al. (2013); Ebert (2013a)). Fifth, we repeat the experiment replacing waiting time with another attribute: a fellow students' wealth. While first results in this social domain indicate that univariate risk preferences for oneself and another person are similar (similar to results reported in Heinrich and Mayrhofer (2014)), cross-risk preferences are *different* than those observed in the wealth-time experiment. We find correlation-seeking between subjects' own and others' wealth, which is consistent with inequality aversion. Moreover, we also find evidence for cross-imprudence in this case and discuss in what sense this "higher-order inequality aversion" implies ex-ante equality-seeking that may come along with increased inequality ex-post.

## 2. RISK APPORTIONMENT

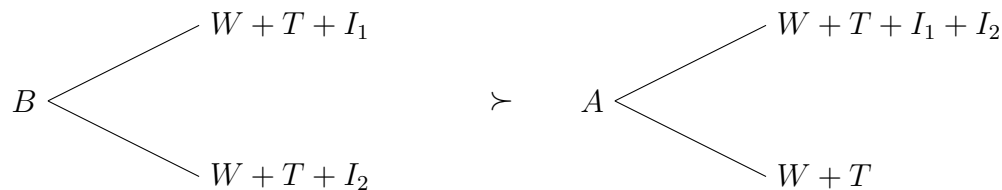
### 2.1. *Risk apportionment: The general idea*

Consider an individual with monetary endowment  $W$  and an endowment of waiting time  $T$ . Throughout we assume that all individuals prefer more wealth to less wealth and prefer less waiting time to more waiting time. *Risk apportionment* for two items  $I_1$  and  $I_2$ , depicted as  $B \succ A$  in Figure 1, corresponds to the preference for disaggregating the two items across two equally likely states of nature. As an example, item  $I_1$  could be a 50-50 risk of winning or losing 2 € and  $I_2$  could be an extra waiting time of 4 min. The abuse of notation (adding up amounts of time and money rather than consistently writing all items as bivariate wealth-time tuples) is convenient for our purposes and without loss of generality. In general, the items we will study can be one of the following: a fixed reduction in wealth; a fixed increase in time; a zero-mean risk over wealth; or a zero-mean risk over time. If both items are zero-

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<sup>2</sup>Noussair and Stoop (forthcoming) study dictator, ultimatum, and trust games for waiting time and find patterns that are largely consistent with those for time. One of the other few studies on waiting time is Abdellaoui and Kemel (forthcoming) who find that "time is not money" when eliciting prospect theory preferences.

FIGURE 1.— Preference for risk apportionment



*Notes.* This figure illustrates the general structure of a preference for risk apportionment.  $W$  and  $T$  denote the endowment of wealth and time, respectively. Each of the items  $I_1$  and  $I_2$  is one of the following: a fixed reduction in wealth; a fixed increase in time; a zero-mean risk over wealth; or a zero-mean risk over time. If both items are zero-mean risks, they are independent from each other. Risk apportionment for items  $I_1$  and  $I_2$  is the preference for disaggregating the two items across two equally likely states of nature. Assuming that both  $I_1$  and  $I_2$  are undesirable (i.e.,  $W + T \succ W + T + I_1$  and  $W + T \succ W + T + I_2$ ), risk apportionment ( $B \succ A$ ) corresponds to a preference for disaggregating the two harms  $I_1$  and  $I_2$  across states of nature.

mean risks, they are independent from each other. To avoid bankruptcy issues, we will choose parameters such that total wealth and waiting time are always positive. Even if both items are fixed amounts, we follow tradition and speak of “risk” apportionment.

Thanks to theoretical work of Eeckhoudt and Schlesinger (2006), Eeckhoudt et al. (2007), Eeckhoudt et al. (2009), and Tsetlin and Winkler (2009), by choosing different combinations of items  $I_1$  and  $I_2$ , elicitation of preferences over these simple lotteries is all we need to characterize univariate risk aversion, prudence, and temperance over wealth; univariate risk aversion, prudence, and temperance over time; and even multivariate risk preferences over wealth and time, i.e., correlation aversion, cross-prudence, and cross-temperance.<sup>3</sup> This is what we explain in the following. Because the lottery structures shown in Figure 1 are so central to this paper, we introduce the notation  $[x; y]$  to refer to a lottery that gives  $x$  and  $y$  with equal probability, where  $x$  and  $y$  denote (possibly risky) payoffs in wealth and/or time units.

## 2.2. Second-order risk apportionment (risk aversion)

Let us start with defining second-order risk apportionment and how it relates to risk aversion. To this means, consider as items two fixed reductions in wealth:  $I_1 = w_1 < 0$  and  $I_2 = w_2 < 0$ . Second-order risk apportionment is the preference  $B = [W + T + w_1; W + T + w_2] \succ A = [W + T + w_1 + w_2; W + T]$  for all  $W, T, w_1$ , and  $w_2$ . Consistent with the idea of diminishing marginal sensitivity, this means that any single, unavoidable reduction in wealth

<sup>3</sup>The assumption that fixed wealth items are negative and fixed time items are positive is without loss of generality. By extending the set of items, one could investigate risk preferences beyond the fourth order and provide alternative characteristic lottery preferences for the second- to fourth-order traits we study here. Deck and Schlesinger (forthcoming) give the explicit constructions and experimental evidence for the univariate case.

is preferred when wealth is higher. An alternative interpretation is that the decision maker prefers to apportion two “harms” in different rather than in the same of two possible states of nature.

Eeckhoudt and Schlesinger (2006), who focus on univariate risk preferences over wealth, show that an individual is risk-averse if and only if she exhibits risk apportionment. Indeed,  $B$  is easily shown to be a mean-preserving wealth contraction of  $A$  in the sense of Rothschild and Stiglitz (1970). If the decision maker’s preferences can be represented by a smooth utility function  $u$ , it is well known that risk aversion is characterized by utility being concave in wealth, i.e.,  $\frac{\partial^2 u}{\partial w^2} < 0$ .

Second-order risk apportionment for time is defined analogously and characterizes risk aversion over time. Simply let  $I_1 = t_1 > 0$  and  $I_2 > t_2$  be two fixed amounts of additional waiting time. Then second-order risk apportionment over time is equivalent to risk aversion over time; within smooth EU this corresponds to  $\frac{\partial^2 u}{\partial t^2} < 0$ .

The concept of correlation aversion dates back to Richard (1975) and Epstein and Tanny (1980). Eeckhoudt et al. (2007) noted that it is the natural multivariate extension of univariate second-order risk apportionment as proposed in Eeckhoudt and Schlesinger (2006). Indeed, to define correlation aversion simply let  $I_1 = w_1 < 0$  be a fixed wealth loss and  $I_2 = t_1 > 0$  be a fixed amount of additional waiting time. Correlation aversion is defined as the preference  $B = [W + T + w_1; W + T + t_1] \succ A = [W + T + w_1 + t_1; W + T]$  for all  $W, T, w_1$ , and  $t_1$ . This means that correlation aversion implies additional waiting time being less harmful when wealth is higher. Correlation seeking, on the other hand, implies that wealth is more valuable when having more time to spend it. Within EU, correlation aversion (correlation seeking) corresponds to  $\frac{\partial^2 u}{\partial t \partial w} < 0 (> 0)$ . In the monotone comparative statics literature, the former (latter) property is known as submodularity (supermodularity). Moreover, note that testing for correlation aversion using risk apportionment yields a most simple test for the separability of utility across attributes (i.e.,  $u(w, t) = u(w) + u(t)$ ).

### 2.3. *Third-order risk apportionment (prudence)*

The third-order trait of prudence over wealth received major attention when Kimball (1990) demonstrated that, within EU where prudence is characterized by  $\frac{\partial^3 u}{\partial w^3}$ , it is necessary and sufficient for a precautionary saving motive. Earlier results date back to Leland (1968) and Sandmo (1970). More recently, Crainich et al. (2013) and Nocetti (2015) demonstrate that third-order risk apportionment itself can explain precautionary effort. Numerous other papers have pointed out the importance of prudence for, e.g., precautionary effort, ecological discounting, or auction behavior.

Prudence over wealth is easily defined using risk apportionment by letting  $I_1 = w_1 < 0$  be again a fixed wealth loss, but  $I_2 = \tilde{w}_2$  being a zero-mean risk over wealth. In other words,

prudence over wealth is defined as the preference  $[W + T + w_1; W + T + \tilde{w}_1] \succ [W + T + w_1 + \tilde{w}_2; W + T]$  for all possible  $W, T, w_1 < 0$  and zero-mean risks  $\tilde{w}_1$ . Similarly, prudence over time is characterized by the preference  $[W + T + t_1; W + T + \tilde{t}_1] \succ [W + T + t_1 + \tilde{t}_1; W + T]$  for all possible  $W, T, t_1 > 0$  and zero-mean risks  $\tilde{t}_1$ .

Prudence, or risk apportionment of order three, is implied by downside risk aversion (Menezes et al. (1980)) and relates to a preference for positive skewness. Prudence is necessary but not sufficient for decreasing absolute risk aversion. Indeed, third-order risk apportionment implies that an unavoidable, additional zero-mean risk is preferred when wealth is higher. For risk apportionment of order three and four, the conditions on the (cross-) derivatives in the EU case are shown in Table I at the end of this subsection.

For the third order, the univariate risk apportionment idea can be extended to the multivariate setting in two ways. The first would be to let  $I_1 = w_1 < 0$  and  $I_2 = \tilde{t}_1$ , i.e., letting the individual apportion a fixed wealth amount and a zero-mean risk over time. This preference,  $[W + T + w_1; W + T + \tilde{t}_1] \succ [W + T + w_1 + \tilde{t}_1; W + T]$ , is called cross prudence for wealth. The second option would be to let  $I_1 = t_1 > 0$  and  $I_2 = \tilde{w}_1$ . In that case,  $[W + T + w_1; W + T + \tilde{t}_1] \succ [W + T + w_1 + \tilde{t}_1; W + T]$ , we speak of cross prudence for time. In other words, cross prudence for wealth (time) is characterized by the fixed amount being in wealth (time) units and the zero-mean risk, respectively, has payoffs of the other unit.

Similarly to the case of univariate prudence, cross-prudence for wealth implies that an unavoidable, zero-mean time risk is preferred in the state where wealth is higher. Likewise, cross-prudence for time is a preference for bearing an unavoidable wealth risk when having to wait less.

#### 2.4. Fourth-order risk apportionment (temperance)

Finally, fourth-order risk apportionment, or temperance, comprises the case where both items are independent zero-mean risks. Univariate fourth-order risk apportionment is a special case of outer risk aversion (Menezes and Wang (2005)) and relates to kurtosis aversion.<sup>4</sup> Table I summarizes the univariate and bivariate (higher-order) order risk preferences studied in this paper.

#### 2.5. Consistency of bivariate higher-order risk preferences

By adding two additional “zero items” (each zero wealth and zero waiting time) to the general risk apportionment preference, we can write it as

$$(1) \quad [W + T + I_1 + 0; W + T + I_2 + 0] \succ A = [W + T + I_1 + I_2; W + T + 0 + 0].$$

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<sup>4</sup>Ebert (2013b) provides a comprehensive analysis of risk apportionment in terms of statistical moments.

TABLE I  
UNI- AND MULTIVARIATE RISK PREFERENCES OF HIGHER ORDER

Trait	Stage	Task	$I_1$	$I_2$	EU condition
Risk aversion for wealth	RA	RA-W	$w_1$	$w_2$	$u_{20} < 0$
Risk aversion for time	RA	RA-T	$t_1$	$t_2$	$u_{02} < 0$
correlation (or cross- ) risk aversion	RA	X-RA	$w_1$	$t_1$	$u_{11} < 0$
Prudence for wealth	PR	PR-W	$w_1$	$\tilde{w}_1$	$u_{30} > 0$
Prudence for time	PR	PR-T	$t_1$	$\tilde{t}_1$	$u_{03} > 0$
cross-prudence for wealth	PR	X-PR-W	$w_1$	$\tilde{t}_1$	$u_{12} > 0$
cross-prudence for time	PR	X-PR-T	$\tilde{w}_1$	$t_1$	$u_{21} > 0$
Temperance for wealth	TE	TE-W	$\tilde{w}_1$	$\tilde{w}_2$	$u_{40} < 0$
Temperance for time	TE	TE-T	$\tilde{t}_1$	$\tilde{t}_2$	$u_{04} < 0$
cross-temperance	TE	X-TE	$\tilde{w}_1$	$\tilde{t}_1$	$u_{22} < 0$

*Notes.* Table I summarizes the construction of lotteries that define the ten risk attitude traits studied in the first three stages of the Time condition of the experiment. RA (PR, TE) refer to risk aversion (prudence, temperance) and an “X” indicates a cross-trait. “W” refers to wealth and “T” refers to time.  $w_1 < 0$  and  $w_2 < 0$  ( $t_1 < 0$  and  $t_2 < 0$ ) denote fixed euro losses (waiting time gains) and  $\tilde{w}_1$  and  $\tilde{w}_2$  ( $\tilde{t}_1$  and  $\tilde{t}_2$ ) denote independent zero-mean wealth (time) risks.

Consider risk apportionment of order 2 where both items are “bad” fixed amounts: either reductions in wealth or increases in waiting time. Relative to each of these items, a zero is “good.” Eeckhoudt et al. (2009) and Tsetlin and Winkler (2009) formalized how risk apportionment relates to a “preference for combining good with bad.” Risk apportionment of order 3 and 4, however, imply a preference for combining good with bad only if the risky zero-mean items are “bad.” But zero-mean risks are bad (i.e., less preferred than zero) if and only if the individual is a risk averter.

Crainich et al. (2013) remind us of the seemingly forgotten group of risk lovers and show that risk-lovingness relates to “a preference for combining good with good (and bad with bad).” They then make the insightful observation that both risk averters who consistently like to combine good with bad (called mixed risk averters; Caballé and Pomansky (1996)) as well as risk lovers who consistently like to combine good with good (called mixed risk lovers) are prudent; but that mixed risk averters are temperate and mixed risk lovers are intemperate. This dichotomy of risk preferences was confirmed experimentally by Deck and Schlesinger (forthcoming) and received additional support, though to a lesser extent, by Ebert and Wiesen (2014).

Our experimental design also allows to analyze bivariate consistency of the multi-attribute preference for combining good with bad (Tsetlin and Winkler (2009)). In this subsection, we lay out the predictions for our experiment if individuals consistently were to prefer good with bad. Since we assume monotonicity for both wealth and time, the items used in all second-order risk apportionment tasks are bads. A consistent preference for combining good



with bad *across attributes* thus implies, for second-order risk apportionment, risk aversion over wealth, risk aversion over time, and correlation aversion. Subjects who consistently like to combine good with good (and bad with bad) across attributes should be risk-loving for wealth, risk loving for time, and correlation seeking. We call the former subjects bivariate mixed risk averters and the latter subjects bivariate mixed risk lovers. Of course, empirically it is well possible that individuals are risk averters over one attribute but not over another attribute. Such behavior is inconsistent with the good-with-bad paradigm.

In analyzing consistency *across orders of risk apportionment*, we need to distinguish between bivariate mixed risk averters and lovers.<sup>5</sup> It turns out that, both types should exhibit third-order risk apportionment, i.e., both cross-prudence for wealth and cross-prudence for time. To see this, note that the bivariate mixed risk averter finds each fixed amount bad and also the zero-mean risk is bad. The preference to combine good with bad and thus equation (1) holds. For bivariate mixed risk lovers the fixed amount is bad, but the zero-mean risk is good. The preference to combine good with *good* thus, also, yields equation (1). Therefore, just as noted by Crainich et al. (2013) for the univariate case, both bivariate mixed risk averters and lovers are cross-prudent in either attribute, even though for different reasons: the former like to combine good with bad and the latter like to combine good with good.

### 3. EXPERIMENTAL DESIGN

#### 3.1. *Participants*

The experiments were conducted in the fall of 2014. In total, 211 subjects took part, all of whom were students of the university; 109 participated in the *Time* condition, 102 in the *Social* condition (see below). Subjects were only allowed to participate in one of the two conditions. The mean age of subjects was 22 years. The majority of subjects (53%) were female.

#### 3.2. *Conditions*

In the Time condition, subjects faced lotteries yielding monetary outcomes (in euros) and outcomes in waiting time (in minutes). At the start of the experiment, subjects were randomly allocated to an isolated room with a single computer and were asked to leave their possessions outside their private cubicle. Subjects had to wait their earnings in waiting time

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<sup>5</sup>Similarly to the previous argument regarding consistency across attributes within an order of risk apportionment, if a subject is risk-averse over wealth but risk-loving over time, we can of course derive the predictions of a preference for combining good with bad (resp. good with good) for third-order risk apportionment. However, since at the second order the subject has shown a preference for combining good with bad for one attribute (wealth) and a preference for combining good with good for the other attribute (time), it is unclear what his preference should be for the cross-risk attributes. Therefore, the concept of consistency is only sensible across attributes and across orders of risk apportionment simultaneously. Bivariate consistency is thus, mechanically, a stronger property than univariate consistency.

in their cubicle after the experiment and were not allowed to do anything (e.g., read, write, use the computer or their cellphone) while waiting. The waiting time started the moment the experiment was finished. Subjects were paid their earnings in euros in private, after the waiting time had elapsed.

In the Social condition, subjects faced lotteries yielding monetary outcomes (in euros) for themselves and for another participant of the experiment. At the start of the experiment, subjects were randomly matched with another participant of the experiment. The identity of the other participant was never revealed to subjects. Importantly, subjects were informed that with 50/50 chance, either their choice or the choice of the other participant in the randomly chosen task was implemented for real. Thus, earnings of the subjects in the Social condition were either determined by their own decision or by the decision made by the other participant. At the end of the experiment, subjects were asked whether they like the experimenter to add €2 to the earnings of the other participant (unconditional monotonicity). In addition, we asked them whether they would have liked to do so depending on the difference between their earnings (from the choice tasks) and the earnings of the other participant (conditional monotonicity). In particular, we asked them whether they would like to increase the earnings of the other participant by €2 if the other participant earned at least €2 less than the subjects and whether they would like to do so if the other participant earned more than, the same as, or at most €2 less than the subject. These questions were included to probe whether subjects considered payments to the other participant harmful or beneficial, i.e., whether payments to the other participant were considered to be a "good" or a "bad".

### 3.3. *Treatments and Controls*

To test the robustness of preferences for (higher-order) risk apportionment, subjects were randomly assigned to treatments. In particular, the domain (gains vs. loss) of each of the two attributes was varied across treatments, resulting in a 2x2 between-subject factorial design in each condition. Thus, in the Time condition, subjects faced the outcomes in euros and waiting time framed in terms of gains or losses. Expected payments for each choice were kept the same across treatments by varying the endowments (see also Table III in the appendix in the appendix discussed below). In particular, 28 subjects were assigned to the *Wealth Gains, Time Gains* (WGTG) treatment, 27 subjects to the *Wealth Losses, Time Losses* (WLTL) treatment, 27 subjects to the *Wealth Gains, Time Losses* (WGTL) treatment, and 27 subjects to the *Wealth Losses, Time Gains* (WLTG) treatment. In the Social condition, outcomes for subjects themselves or for the other participant were framed as gains or losses. In particular, 26 subjects were assigned to the *You Gains, Other Gains* (YGOG) treatment, 24 subjects were assigned to the *You Losses, Other Losses* (YLOL) treatment, 26 subjects were assigned to the *You Gains, Other Losses* (YGOL) treatment, and 26 subjects were

assigned to the *You Losses, Other Gains* (YLOG) treatment. Finally, the position of the lotteries on the screen (left or right) as well as the winning roll (odd or even) was randomly determined for each question, in order to control for potential preferences for a particular position of the lotteries or outcomes of the dice.

### 3.4. Choice Tasks

The experiment consisted of four stages. At the start of each stage, instructions were distributed on paper and read aloud. The first stage consisted of 9 choice tasks to gauge individual attitudes towards risk (second-order risk apportionment). The second stage consisted of 12 choice tasks designed to obtain individual measures of the degree of (cross-) prudence (third-order risk apportionment). The third state was designed to elicit individual degrees of (cross-) temperance (fourth-order risk apportionment) and consisted of 9 choice tasks. Table III in the appendix presents each of the 30 choices that were used to measure preferences for (higher-order) risk apportionment in the Time condition. The precise parameters used in each of the 30 choices in the Social condition can be found in Table IV in the appendix. In order to gauge the individual exchange rate between monetary outcomes and outcomes in waiting time (in the Time condition) and outcomes accruing to oneself or to someone else (in the Social condition) we elicited preferences between lotteries listed in so-called choice-lists in the final stage of the experiment (see next subsection).

All risks involved in the experiment were equiprobable and were determined by a roll of the die (odd or even), on the color of a card (black or red) drawn at random from a deck of 5 red and 5 black playing cards, or on the color of a ball (yellow or white) drawn at random from an opaque bag containing 5 yellow and 5 white balls. In order to keep the framing of the lotteries as close as possible to existing literature on higher order risk attitudes, the lotteries were presented in compound format, which makes the choice of whether to aggregate or dis-aggregate beneficial and harmful outcomes explicit (e.g., Deck and Schlesinger (forthcoming)).<sup>6</sup>

### 3.5. Elicitation of Exchange Rates

In the final stage of the experiment, we elicited the exchange rate between the attributes using two choice lists. In particular, in the Time condition, the amount of euros subjects were willing to accept in order to have to wait an additional 15 minutes (list 1) and the amount of minutes subjects were willing to wait for an additional €5 (list 2) were elicited. In the Social condition, the amount of euros subjects were willing to accept in order to decrease the payment of the other participant by €3 (list 1) as well as the amount of euros

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<sup>6</sup>Maier and R uger (2011) employ the risk apportionment lotteries in reduced form and obtain very similar results.

that had to be added to the payment of the other participant in order to forgo €3 (list 2) were elicited. Each choice-list consisted of 21 rows. Each row involved a choice between two options, labeled Option L (left) and R (Right). Option R was made systematically more attractive as one moved down the list. Subjects were asked to report the first row of each list in which they preferred Option R, by typing in the number that corresponded with their choice. Subjects were also allowed to indicate that they preferred Option L or Option R in each row of the list.

### 3.6. *Payment*

At the end of the experiment, one choice of each subject was randomly selected to be paid for real. For this purpose, one subject was asked to randomly draw and sign an envelope from a pile of sealed envelopes, each containing a numbered card. Subjects were told that the envelope would be opened at the end of the experiment and that the task corresponding to the number on the card inside it would determine the earnings. If the randomly chosen task concerned a task from one of the first three stages, the chosen option would be paid for real, conditional on the realization of any random processes. If the randomly chosen task concerned a task from stage 4, the computer randomly selected one of the rows of the corresponding choice list. The chosen option in that row (depending on whether/where the subject switched from choosing the left option to the right option) would then be paid for real.<sup>7</sup> Subjects were paid a show-up fee of €4 on top of their choice-contingent earnings. In the Social condition, subjects were also paid either the conditional or the unconditional monotonicity question with equal chance. On average, subjects earned €24.70 and waited 20 minutes in the Time condition. In the Social condition, the average earnings were €20.90. The experiment was programmed in z-Tree Fischbacher (2007).

## 4. FIRST RESULTS

Table II shows the average number out of the three choices in each of the ten tasks that subjects answered in the (higher-order and potentially cross-) risk-averse way. Rows 1 to 3 are for univariate risk preferences over wealth for both the Time condition (column 2) and the Social Condition (Column 4). The only difference is that subjects in the Time condition had a “background endowment” of 20 minutes of waiting time while subjects in the Social condition had a background endowment of 14 euro for the other participant, i.e.,

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<sup>7</sup>This procedure prevents confounding income effects – such as Thaler and Johnson’s (1994) house money effect – that might arise if more than one task is being paid. Starmer and Sugden (1991) provide evidence that selecting one decision for payment, rather than all decisions, does not affect choice behavior. As a result, this procedure is nowadays most often used in experiments designed to measure individual risk preferences (e.g., Myagkov and Plott 1997; Holt and Laury 2002). Randomly selecting the task that is paid for real at the start of the experiment (without subject knowing which task that is) further enhances isolation (Johnson et al. 2014).

the participant matched to the decision-making subject. Moreover, recall that stakes in the Time condition were a bit higher to compensate subjects for potentially having to wait in the cubicle.

TABLE II  
AGGREGATE RISK PREFERENCE IN THE TIME AND SOCIAL EXPERIMENTS

Task	Mean	Task	Mean
RA-W	2.24***	RA-Y	1.92***
PR-W	2.53***	PR-Y	2.45***
TE-W	1.94***	TE-Y	1.91***
RA-T	2.35***	RA-O	1.97***
PR-T	2.23***	PR-O	1.98***
TE-T	2.15***	TE-O	1.76***
X-RA	2.17***	X-RA	0.85***
X-PR-W	2.27***	X-PR-Y	1.58
X-PR-T	2.45***	X-PR-O	1.38
X-TE	1.64	X-TE	0.91***

*Notes.* Table II gives the mean numbers of (higher-order and cross-) risk-averse choices out of the three choices in each of the ten tasks (rows 1 to 10) in the Time condition (column 2) and the Social condition (column 4). The ten tasks are second-, third- and fourth-order risk preferences over wealth (rows 1-3), second-, third- and fourth-order risk preferences over time (rows 4-6), and cross-risk preferences (rows 7-10). RA (PR, TE) refer to risk aversion (prudence, temperance) and an “X” indicates a cross-trait. “W” refers to wealth and “T” refers to time. Similarly, columns 3 and 4 summarize the choices of 102 subjects in the Social condition where “Y” indicates the subject herself (communicated as “you” on the subject’s decision screen) and “O” refers to “other”, i.e., to the subject matched to the decision-making subject. \*\*\* (\*\*, \*) indicates significance at the 1% (5%, 10%) level according to Wilcoxon-signed rank tests. Two-sided t-tests yield similar results.

Judging by the numbers in rows 1 to 3 of Table II, differences in the (background) endowment are not decisive as results for risk aversion over wealth are very similar in the Time and Social conditions. Moreover, results are similar to those in earlier experiments like Deck and Schlesinger (2010, forthcoming); Ebert and Wiesen (2011, 2014); Maier and Ruger (2011): Individuals are not only risk-averse, but also prudent and temperate. The evidence for temperance is weaker, which is also a stylized finding of previous research. In fact, Deck and Schlesinger (2010) find weak evidence for intemperance. The other papers all find mild evidence for temperance. This replication indicates that the background endowment does not matter to subjects’ decisions. It also shows that, when restricting to univariate risk preferences over wealth, our design produces similar findings than the seminal studies in the field did.

Next, rows 4-6 in column 2 provide evidence for risk preferences for an important attribute other than wealth: waiting time. Indeed, we find strong evidence for risk aversion, prudence, and temperance. Next to Abdellaoui and Kemel (forthcoming), who elicit prospect theory preferences over waiting time, to the best of our knowledge, ours is the only other evidence

on risk preferences over waiting time. In particular, our paper is the first to present evidence on higher-order risk preferences over time.

Rows 4-6 in column 4 show that individuals also decide risk-averse, prudently, and temperately when others' wealth is at stake. This result on univariate risk preferences in a social setting is somewhat in the spirit of results obtained by Heinrich and Mayrhofer (2014) who elicit higher-order risk preferences and vary how an individual's decision is made (alone or while communicating with a partner) and who is affected by the decision (only the individual or the partner *as well*). The results can not be compared directly as in our social condition the decision-maker decides over the other's wealth *only*. Both situations are realistic and important, and thus the results complement each other nicely.

The most interesting results are shown in rows 7 to 10, which analyze cross-risk preferences for wealth and time (columns 1 and 2) and cross-risk preferences for wealth and others' wealth (column 3 and 4). For time (column 2), cross-risk preferences follow the stylized pattern of risk aversion, prudence, and mild (here, insignificant) temperance that is observed in the univariate case for each attribute. This means that, on the aggregate, individuals prefer unavoidable additional waiting time when getting paid more. Likewise, they prefer an unavoidable zero-mean risk over one attribute in the state where the other attribute is better. This indicates that negative wealth and waiting time are substitutes to subjects. If an attribute is bad in one state, subjects prefer compensating it with the other attribute in that state, rather than using it to improve the better state. That is, subjects do prefer to compensate a bad in one attribute through a good of another attribute.

We close this preliminary analysis of our data with a look at cross-risk preferences over subjects' own and others' wealth in rows 7-10 and column 4. What immediately catches the eye is that the average numbers are smaller, and for the first time we observe significant correlation-seeking and cross-intemperance. For the first time, likewise, we observe an insignificant third-order trait.

Correlation-seeking over one's own and others' wealth is consistent with inequality aversion. Subjects prefer to receive an additional unavoidable loss in the same state where the other subject receives a loss. By having exploited recent theoretical advances (Epstein and Tanny, 1980; Eeckhoudt et al., 2007), this test precisely proves correlation seeking for one's own and other's wealth in the sense of Richard (1975), i.e., signs the cross-derivative of bivariate utility negative. Moreover, significant cross-intemperance indicates a preference for ex-ante inequality aversion in the sense that individuals prefer to face a zero-mean risk in the same state where another subject faces the zero-mean risk, not knowing how either risk will turn out. Therefore, since the zero-mean risks are independent, cross-intemperance fosters more ex-post inequality at the cost of ex-ante equality. Cross-intemperance, as studied in our experiment, is thus an indicator that our experimental subjects strive for equality of chance

rather than equality of payoffs.

## 5. CONCLUSION

Despite a vast theoretical literature on bivariate risk preferences and bivariate utility functions, we are not aware of a single experimental paper that investigates well-known and important properties of such preferences in a systematic way. In this paper, we report results from two large-scale experiments on bivariate risk preferences conducted in October and November 2014, with payments to subjects equaling about €4800.

We investigate bivariate risk preferences over wealth and waiting time (condition Time) and own wealth and others' wealth (condition Social). Our experimental design exploits recent theoretical advances made in the theory of multivariate (higher-order) risk preferences to obtain theory-free tests of traits such as correlation aversion, cross-prudence, and cross-temperance. As an aside, we also obtain first evidence for univariate (higher-order) risk aversion over waiting time and others' wealth, and replicate previous evidence of higher-order risk preferences over wealth.

Most interestingly, our study is the first to study higher-order cross-risk attitudes. For wealth and waiting time, we find correlation aversion not only at the second order, but also at higher orders. This is not so in the social condition, where we observe correlation seeking and cross-intemperance. We give some first thoughts on how these results connect to the (higher-order) risk preferences literature and to the concept of ex-ante and ex-post inequality aversion.

The write-up of this paper is at an early stage, and much work on the data analysis and robustness of results must be done. Further results can be expected from the analysis of stage 4 of the experiment, which elicits exchange rates between risk and waiting time, and from a within-subject analysis of the bivariate version of the preference for combining good with bad. We hope that this preliminary draft raises interest in the subject matter as we would be eager to present the paper at the Verein für Socialpolitik 2015 Annual Meeting.

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TABLE III.— Lotteries Time Condition

Choice #	WGTC			WGTL			WLTC			WTLT						
	W	T	$I_1$	$I_2$	W	T	$I_1$	$I_2$	W	T	$I_1$	$I_2$	W	T	$I_1$	$I_2$
RA_W1	+€11	+20 min	+€6	+€12	+€11	+20 min	+€6	+€12	+€29	+20 min	-€6	-€12	+€29	+20 min	-€6	-€12
RA_W2	+€14	+20 min	+€4	+€8	+€14	+20 min	+€4	+€8	+€26	+20 min	-€4	-€8	+€26	+20 min	-€4	-€8
RA_W3	+€8	+20 min	+€8	+€16	+€8	+20 min	+€8	+€16	+€32	+20 min	-€8	-€16	+€32	+20 min	-€8	-€16
RA_T1	+€20	+35 min	-10 min	-20 min	+€20	+5 min	+10 min	+20 min	+€20	+35 min	-10 min	-20 min	+€20	+5 min	+10 min	+20 min
RA_T2	+€20	+32 min	-8 min	-16 min	+€20	+8 min	+8 min	+16 min	+€20	+32 min	-8 min	-16 min	+€20	+8 min	+8 min	+16 min
RA_T3	+€20	+29 min	-6 min	-12 min	+€20	+11 min	+6 min	+12 min	+€20	+29 min	-6 min	-12 min	+€20	+11 min	+6 min	+12 min
X_RA1	+€17	+25 min	+€6	-10 min	+€17	+15 min	+€6	+10 min	+€23	+25 min	-€6	-10 min	+€23	+15 min	-€6	-10 min
X_RA2	+€18	+24 min	+€4	-8 min	+€18	+16 min	+€4	+8 min	+€22	+24 min	-€4	-8 min	+€22	+16 min	-€4	-8 min
X_RA3	+€16	+23 min	+€8	-6 min	+€16	+17 min	+€8	+6 min	+€24	+23 min	-€8	-6 min	+€24	+17 min	-€8	-6 min
PR_W-1	+€17	+20 min	+€6	+€8	+€17	+20 min	+€6	+€8	+€23	+20 min	-€6	+€8	+€23	+20 min	-€6	+€8
PR_W2	+€18	+20 min	+€4	+€12	+€18	+20 min	+€4	+€12	+€22	+20 min	-€4	+€12	+€22	+20 min	-€4	+€12
PR_W3	+€16	+20 min	+€8	+€10	+€16	+20 min	+€8	+€10	+€24	+20 min	-€8	+€10	+€24	+20 min	-€8	+€10
PR_T1	+€20	+25 min	-10 min	+8 min	+€20	+15 min	+10 min	+8 min	+€20	+25 min	-10 min	+8 min	+€20	+15 min	+10 min	+8 min
PR_T2	+€20	+24 min	-8 min	+6 min	+€20	+16 min	+8 min	+6 min	+€20	+24 min	-8 min	+6 min	+€20	+16 min	+8 min	+6 min
PR_T3	+€20	+23 min	-6 min	+10 min	+€20	+23 min	-6 min	+10 min	+€20	+23 min	-6 min	+10 min	+€20	+17 min	+6 min	+10 min
XPR_W1	+€17	+20 min	+€6	+8 min	+€17	+20 min	+€6	+8 min	+€23	+20 min	-€6	+8 min	+€23	+20 min	-€6	+8 min
XPR_W2	+€18	+20 min	+€4	+6 min	+€18	+20 min	+€4	+6 min	+€22	+20 min	-€4	+6 min	+€22	+20 min	-€4	+6 min
XPR_W3	+€16	+20 min	+€8	+10 min	+€16	+20 min	+€8	+10 min	+€24	+20 min	-€8	+10 min	+€24	+20 min	-€8	+10 min
XPR_T1	+€20	+25 min	+€8	-10 min	+€20	+15 min	+€8	+10 min	+€20	+25 min	+€8	-10 min	+€20	+15 min	+€8	-10 min
XPR_T2	+€20	+24 min	+€12	-8 min	+€20	+16 min	+€12	+8 min	+€20	+24 min	+€12	-8 min	+€20	+16 min	+€12	+8 min
XPR_T3	+€20	+23 min	+€10	-6 min	+€20	+17 min	+€10	+6 min	+€20	+23 min	+€10	-6 min	+€20	+17 min	+€10	-6 min
TE_W1	+€20	+20 min	+€8	+€8	+€20	+20 min	+€8	+€8	+€20	+20 min	+€8	+€8	+€20	+20 min	+€8	+€8
TE_W2	+€20	+20 min	+€12	+€4	+€20	+20 min	+€12	+€4	+€20	+20 min	+€12	+€4	+€20	+20 min	+€12	+€4
TE_W3	+€20	+20 min	+€10	+€6	+€20	+20 min	+€10	+€6	+€20	+20 min	+€10	+€6	+€20	+20 min	+€10	+€6
TE_T1	+€20	+20 min	+8 min	+8 min	+€20	+20 min	+8 min	+8 min	+€20	+20 min	+8 min	+8 min	+€20	+20 min	+8 min	+8 min
TE_T2	+€20	+20 min	+10 min	+10 min	+€20	+20 min	+10 min	+10 min	+€20	+20 min	+10 min	+10 min	+€20	+20 min	+10 min	+10 min
TE_T3	+€20	+20 min	+5 min	+5 min	+€20	+20 min	+5 min	+5 min	+€20	+20 min	+5 min	+5 min	+€20	+20 min	+5 min	+5 min
XTE1	+€20	+20 min	+€8	+8 min	+€20	+20 min	+€8	+8 min	+€20	+20 min	+€8	+8 min	+€20	+20 min	+€8	+8 min
XTE2	+€20	+20 min	+€12	+6 min	+€20	+20 min	+€12	+6 min	+€20	+20 min	+€12	+6 min	+€20	+20 min	+€12	+6 min
XTE3	+€20	+20 min	+€10	+10 min	+€20	+20 min	+€10	+10 min	+€20	+20 min	+€10	+10 min	+€20	+20 min	+€10	+10 min

Note. This table describes the parameters of the lotteries that were used in each of the treatments of the Time condition. RA (PR, TE) refers to risk aversion (prudence, temperance) and an “X” indicates a cross-trait. “W” refers to the wealth endowment and “T” refers to the time endowment. Respondents were asked to choose between the option  $B = [W + T + I_1 + 0; W + T + I_2 + 0]$  and  $A = [W + T + I_1 + I_2; W + T + 0 + 0]$ . Three choices were made for each task as indicated by the subscripts 1, 2 and 3.  $\pm$  denotes a zero-mean (50/50) risk yielding  $+a$  or  $-a$ , i.e.  $[+a; -a]$ . Note that the choice that corresponds with combining good with bad differs between treatments.

TABLE IV.— Lotteries Social Condition

Choice #	YGOG						YGOL						YLOG						YLOL						
	Y		I <sub>1</sub>		I <sub>2</sub>		Y		I <sub>1</sub>		I <sub>2</sub>		Y		I <sub>1</sub>		I <sub>2</sub>		Y		I <sub>1</sub>		I <sub>2</sub>		
RA_Y1	+€9	+€14	+€4	+€6	+€6	+€6	+€9	+€14	+€4	+€6	+€6	+€9	+€14	+€4	+€6	+€6	+€9	+€14	+€4	+€6	+€6	+€9	+€14	+€4	+€6
RA_Y2	+€10	+€14	+€6	+€2	+€2	+€2	+€10	+€14	+€6	+€2	+€2	+€10	+€14	+€6	+€2	+€2	+€10	+€14	+€6	+€2	+€2	+€10	+€14	+€6	+€2
RA_Y3	+€9	+€14	+€2	+€8	+€8	+€8	+€9	+€14	+€2	+€8	+€8	+€9	+€14	+€2	+€8	+€8	+€9	+€14	+€2	+€8	+€8	+€9	+€14	+€2	+€8
RA_O1	+€14	+€9	+€4	+€6	+€6	+€6	+€14	+€9	+€4	+€6	+€6	+€14	+€9	+€4	+€6	+€6	+€14	+€9	+€4	+€6	+€6	+€14	+€9	+€4	+€6
RA_O2	+€14	+€10	+€6	+€2	+€2	+€2	+€14	+€10	+€6	+€2	+€2	+€14	+€10	+€6	+€2	+€2	+€14	+€10	+€6	+€2	+€2	+€14	+€10	+€6	+€2
RA_O3	+€14	+€9	+€2	+€8	+€8	+€8	+€14	+€9	+€2	+€8	+€8	+€14	+€9	+€2	+€8	+€8	+€14	+€9	+€2	+€8	+€8	+€14	+€9	+€2	+€8
X_RA1	+€12	+€12	+€4	+€4	+€4	+€4	+€12	+€12	+€4	+€4	+€4	+€12	+€12	+€4	+€4	+€4	+€12	+€12	+€4	+€4	+€4	+€12	+€12	+€4	+€4
X_RA2	+€11	+€11	+€6	+€6	+€6	+€6	+€11	+€11	+€6	+€6	+€6	+€11	+€11	+€6	+€6	+€6	+€11	+€11	+€6	+€6	+€6	+€11	+€11	+€6	+€6
X_RA3	+€13	+€13	+€2	+€2	+€2	+€2	+€13	+€13	+€2	+€2	+€2	+€13	+€13	+€2	+€2	+€2	+€13	+€13	+€2	+€2	+€2	+€13	+€13	+€2	+€2
PR_Y1	+€12	+€14	+€4	+€5	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5
PR_Y2	+€11	+€14	+€6	+€4	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4
PR_Y3	+€13	+€14	+€2	+€7	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7
PR_O1	+€14	+€12	+€4	+€5	+€5	+€5	+€14	+€12	+€4	+€5	+€5	+€14	+€12	+€4	+€5	+€5	+€14	+€12	+€4	+€5	+€5	+€14	+€12	+€4	+€5
PR_O2	+€14	+€11	+€6	+€4	+€4	+€4	+€14	+€11	+€6	+€4	+€4	+€14	+€11	+€6	+€4	+€4	+€14	+€11	+€6	+€4	+€4	+€14	+€11	+€6	+€4
PR_O3	+€14	+€13	+€2	+€7	+€7	+€7	+€14	+€13	+€2	+€7	+€7	+€14	+€13	+€2	+€7	+€7	+€14	+€13	+€2	+€7	+€7	+€14	+€13	+€2	+€7
XPR_Y1	+€12	+€14	+€4	+€5	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5	+€5	+€12	+€14	+€4	+€5
XPR_Y2	+€11	+€14	+€6	+€4	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4	+€4	+€11	+€14	+€6	+€4
XPR_Y3	+€13	+€14	+€2	+€7	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7	+€7	+€13	+€14	+€2	+€7
XPR_O1	+€14	+€12	+€5	+€4	+€4	+€4	+€14	+€12	+€5	+€4	+€4	+€14	+€12	+€5	+€4	+€4	+€14	+€12	+€5	+€4	+€4	+€14	+€12	+€5	+€4
XPR_O2	+€14	+€11	+€4	+€6	+€6	+€6	+€14	+€11	+€4	+€6	+€6	+€14	+€11	+€4	+€6	+€6	+€14	+€11	+€4	+€6	+€6	+€14	+€11	+€4	+€6
XPR_O3	+€14	+€13	+€7	+€2	+€2	+€2	+€14	+€13	+€7	+€2	+€2	+€14	+€13	+€7	+€2	+€2	+€14	+€13	+€7	+€2	+€2	+€14	+€13	+€7	+€2
TE_Y1	+€14	+€14	+€5	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5
TE_Y2	+€14	+€14	+€4	+€6	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6
TE_Y3	+€14	+€14	+€7	+€3	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3
TE_O1	+€14	+€14	+€5	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5
TE_O2	+€14	+€14	+€4	+€6	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6	+€6	+€14	+€14	+€4	+€6
TE_O3	+€14	+€14	+€7	+€3	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3	+€3	+€14	+€14	+€7	+€3
XTE1	+€14	+€14	+€5	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5	+€5	+€14	+€14	+€5	+€5
XTE2	+€14	+€14	+€4	+€4	+€4	+€4	+€14	+€14	+€4	+€4	+€4	+€14	+€14	+€4	+€4	+€4	+€14	+€14	+€4	+€4	+€4	+€14	+€14	+€4	+€4
XTE3	+€14	+€14	+€7	+€7	+€7	+€7	+€14	+€14	+€7	+€7	+€7	+€14	+€14	+€7	+€7	+€7	+€14	+€14	+€7	+€7	+€7	+€14	+€14	+€7	+€7

Note. This table describes the parameters of the lotteries that were used in each of the treatments of the Time condition. RA (PR, TE) refers to risk aversion (prudence, temperance) and an "X" indicates a cross-trait. "Y" refers to the wealth endowment of the decision-making subject ("you") and "O" refers to the other subject's endowment. Respondents were asked to choose between the option B = [Y + O + I<sub>1</sub> + 0; Y + O + I<sub>2</sub> + 0] and A = [Y + O + I<sub>1</sub> + I<sub>2</sub>; Y + O + 0 + 0]. Three choices were made for each task as indicated by the subscripts 1, 2 and 3.  $\pm$  denotes a zero-mean (50/50) risk yielding +a or -a, i.e. [+a; -a]. Note that the choice that corresponds with combining good with bad differs between treatments.