Federico Fornasari, Matteo Ploner, and Ivan Soraperra

Investment in Risk Protection and Social Preferences: An Experimental Study

CEEL Working Paper 3-15

Cognitive and Experimental Economics Laboratory

Via Inama, 5 38100 Trento, Italy

http://www-ceel.economia.unitn.it
tel. +39.461.282313

Investment in Risk Protection and Social Preferences: An Experimental Study

Federico Fornasari[*], Matteo Ploner[†], and Ivan Soraperra[‡]

Abstract

We investigate investment in risk protection when risk affects either the decision maker or another individual and when the cost to offset risk is borne either by the decision maker or by another individual. We assess behavior in the experiment against predictions obtained from a well-known social preferences model. In line with our predictions, we find that individuals invest more of others' resources than of their own resources to protect themselves, and individuals invest more of their own resources in risk protection when risk is borne by themselves than when risk is borne by the others. Furthermore, individuals invest more in risk protection when delegated to choose for others than when choosing for themselves.

Keywords: social preferences; risk; laboratory experiments; delegated choice
JEL-classification: C91; D03; D80; O12

[*]School of Social Sciences, University of Trento. E-mail: federico.fornasari@unitn.it
[†]CEEL, University of Trento. E-mail: matteo.ploner@unitn.it
[‡]DSE, University of Verona. E-mail: ivan.soraperra@univr.it

1 Introduction

Everyday life provides many examples of how we care for others' welfare: think of how many people are willing to give up part of their time and resources in order to help those in need. To a greater extent, these types of actions are not driven by any specific material incentive or reward. Rather, they depend on our concern for other individuals.

Previous experimental studies about other-regarding concerns mainly focused on interactions in which the consequences of actions are deterministic, like in the dictator game (for a review see Engel, 2011). Here we extend the inquiry of other-regarding concerns to environments in which the link between actions and consequences is governed by chance.

Our study focuses on how individuals manage own/others' resources to offset risk affecting themselves/others. Specifically, we study how individuals trade-off own/other resources to offset risk affecting themselves. Furthermore, we study choices under risk when these affect someone else and have no direct material consequences for the decision maker.

As such, this paper relates to two well-established research streams in economics: decision making under risk/uncertainty and social preferences. On the one hand, it has been widely documented that people display certain preferences and attitudes toward risk. As an example, Andersen et al. (2006) demonstrates that subjects taking part in laboratory experiments tend, in general, to be risk averse. On the other hand, widespread other-regarding concerns have been identified in field and lab experiments (e.g., Camerer, 2013). Several motives for other-regarding behavior have been put forward in the literature. We focus here on two outcome-based motives, namely inequity aversion (e.g., Fehr and Schmidt, 1999) and efficiency concerns (e.g., Engelmann and Strobel, 2004).

Several studies have given joint consideration to risk and social preferences in experimental settings (for a review of early works see Trautmann and Vieider, 2011). Güth et al. (2008) shows that individuals evaluate risk borne by others less negatively than risk borne by themselves. Krawczyk and Le Lec (2010) shows that individuals make choices that are generally socially and efficiency-oriented when these are in the domain of risk. Evidence collected by Lahno and Serra-Garcia (2015) suggests that when choosing among risky prospects, individuals show equity concerns, i.e. individuals select their risk exposure to avoid being worse off than someone else, once risk is resolved.

Another relevant stream of research is that of *delegated risky decision making*, i.e. a situation in which one party chooses the amount of risk another party has to bear, without any material incentive linking the choice of the decision maker to the outcome of the risky prospect. Within this domain, Agranov et al. (2014) provide evidence of what the authors define as the *Other People's Money* effect, i.e. other people's money is invested with much lower degrees of risk aversion than is agents' own money. Also Andersson et al. (2014) find that, when deciding for others, people are on average less risk averse, mainly because of a reduction in loss aversion produced by the usage of others resources. Chakravarty et al. (2011) interprets the shift in risk preferences as originating in biased beliefs about other people's preferences. Results reported by Eriksen and Kvaløy (2014) contrast with the evidence reported above, as participants in the experiment display a higher risk aversion with respect to people's money than their own. Further, evidence of a composite pattern in delegated risky decision making is reported by Pahlke et al. (2015). The study suggests that individuals are more risk averse with others' money in the domain of gains, but less risk averse in the domain of losses.

In spite of the lack of consistent results concerning risk propensity, studies on delegated decision making show a general tendency: individuals decide differently when using others' money rather than their own. To explain observed behavior, most of the studies mentioned above focus on the risk preferences of the decision maker and on their beliefs about the risk preferences of the counterpart. We suggest here that taking social preferences into account may provide a better understanding of behavior, helping to explain these apparently conflicting results. We test this intuition using the simple model of social preferences introduced by Charness and Rabin (2002).

We present a modified dictator game to test how much subjects are willing to pay to offset risk for themselves and for someone else, using either their own money or someone else's money. We focus on two specific types of subjects in terms of social preferences: difference-averse, and welfare-enhancing. Both types make delegated decisions that are consistent with higher degrees of risk aversion when the subject's own money is at stake. In addition to this, we observe that individuals having access to others' resources use these in order to protect themselves from risk. Furthermore, we find evidence of altruistic behaviors: subjects show a willingness to use their own wealth to buy protection for others. Overall, our results emphasize the importance of social preferences when risky choices have social spillovers.

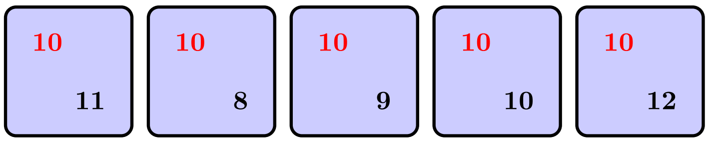
2 Methodology

2.1 Task

During the experiment, subjects are asked to perform a dictator game-like task and are assigned to two roles: decision maker (dictator) and passive player (recipient). Dictators are shown five cards on a computer screen, each one associated to a different payoff allocation for themselves and for the recipient. Dictators are asked to choose the one they prefer to determine the payoff for themselves and for the recipient they are paired with. Knowledge about the payoffs is experimentally manipulated.

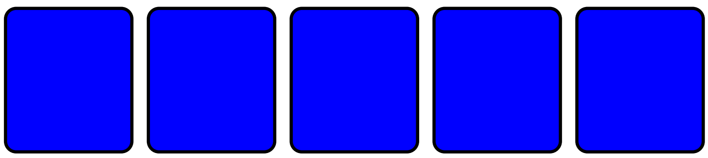
The experiment is divided into two parts. In part 1, the five cards are displayed face-up, each card reporting two outcomes in euro (see Figure 1). The value in the upper left corner of the card represents dictator's payoff (π_y), while the value in the lower right corner represents recipients' payoff (π_x). In part 1, the dictator's payoff is always equal to 10 euros, while the recipient's payoff can vary between 8 euros and 12 euros, so that the set of possible outcomes is $\Pi : \{(8, 10), (9, 10), (10, 10), (11, 10), (12, 10)\}$. Dictators choose the card they prefer and then proceed to the second part of the experiment.

Figure 1: Cards Face-up



In part 2, five cards are displayed, each implying a particular monetary outcome for both the dictator and the recipient, as in part 1. However, unlike in part 1, the cards are face-down and payoffs associated to each card are not known to the decision maker (see Figure 2). However, the distribution of outcomes for the dictator (π_y) and for the other is common knowledge (π_x), as explained in Section 2.2. Therefore, unlike in part 1, dictators face a genuinely risky choice.

Figure 2: Cards Face-down



Before making a blind choice, dictators have the option to turn over the five cards by participating in a lottery. This is implemented through a BDM procedure (Becker et al., 1964). Dictators post a monetary offer $0 \leq b \leq 6$ that represents their willingness to pay (WTP) to turn over the cards. We take this WTP as a direct measure of investment in risk protection.

After offers are made, a random value $0 \leq r \leq 6$ is drawn from a uniform distribution, so that all the values in the interval have the same probability of being extracted. If the random value drawn is smaller than, or equal to, the value offered by the subject ($r \leq b$), all five cards are turned and r is the price paid to resolve the uncertainty. If the random value drawn is higher than the value offered by subjects ($r > b$), the cards are not turned and no price is paid.

Once the procedure is over, the dictator chooses one of the five cards, either face-up or face-down, according to the outcome of the BDM procedure.

2.2 Treatments

As shown by Table 1, two factors are experimentally manipulated. The first factor, manipulated in a between-subjects fashion, is the identity of the subject bearing the cost of the bid (*Cost*). Depending on the treatment, the cost is deducted from either the dictator's payoff ($Cost.Self$) or from the recipient's payoff ($Cost.Other$).

The second factor we manipulate, this time in a within-subjects fashion over two distinct rounds of part 2, is the identity of the individual bearing the *risk* of a choice made with face-down cards (*Risk*). Specifically, in one round the dictator's payoff is always equal to 10 euros and recipient's payoff can be either 8, 9, 10, 11 or 12 euros, depending on the card chosen (*Risk.other*)). In this case, the recipient is the subject bearing the risk, while the dictator faces a safe payoff equal to the expected value of the recipient's risky payoffs. In the alternative round, the recipient's payoff is fixed at 10 euros, while the dictator bears the risk of getting either 8, 9, 10, 11 or 12 euros, with equal likelihood. The order of the phases was administered to balance the number of dictators and recipients bearing the risk in Phase 1, thus controlling for potential order effects.

Table 1: Table of Treatments and labels adopted.

		Risk	
		Self	Other
Cost	Self (N = 76)	CS/RS	CS/RO
	Other (N = 80)	CO/RS	CO/RO

2.3 Participants and Procedures

The experiment was conducted at the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento. Participants were recruited among undergraduate students. The experiment was programmed and conducted using z-Tree software (Fischbacher, 1999). We conducted 8 experimental sessions and a total of 156 subjects took part in the experiment. Each subject received a €3.00 show-up fee, plus a sum that varied depending on their performance in the experiment. This was, on average, equal to €10.13.

Upon their arrival, subjects were randomly assigned to a computer and received instructions for the experiment.[1] Subjects had 5 minutes to read the general instructions and those related to the first part of the experiment, then these were read aloud by one of the experimenters. Once all subjects successfully answered a comprehension test, the experiment started.

Choices were collected via a vector strategy method. Initially, all participants were assigned to the role of dictator. The software randomly paired subjects, and they did not know who they were paired with. Subjects all expressed their decisions as dictators and, only at the end of the experiment, before the determination of final payments, they were randomly divided into dictators and recipients. Note that participants were made aware that the choices of those assigned to be recipients did not affect the final payment.

Once subjects complete part 1 of the experiment, they were given two minutes to read the instructions for part 2. Then, an experimenter reads them out again and answered questions, when needed. Subjects completed a short comprehension questionnaire and then the second part of the experiment started.

Once subjects completed the second part of the experiment, they were randomly assigned the role of dictator or recipient, and they received feedback about the three cards chosen during the experiment (one in part 1 and two in part 2), either by themselves or by the dictator they were paired with. The software randomly drew one of the three choices to determine the final payment, thereby ending the experiment.

Before being paid, subjects were asked to answer two sets of questions.[2] The first was composed of eight questions extracted from the Levenson's IPC scale (Levenson, 1972) and produced a measurement of subjects' locus of control. The higher the score, the more subjects think events in their life depend on their own actions. The second questionnaire was composed of seven questions extracted from the Domain-Specific Risk-Taking (DOSPERT) Scale (Weber et al. (2002)), which measures subjects' risk attitudes. [3]

[1] An English translation is available in the appendix.
[2] An English version of the questionnaires is included in the appendix.
[3] We acknowledge that, from a psychological point of view, information we gather through

2.4 Behavioral Predictions

Risk-free choices in part 1 allow us to classify individuals in terms of their social preferences. In so doing, we rely on the following specification of the model by Charness and Rabin (2002)(henceforth CR):

$$CR_y(\pi_x, \pi_y) = \begin{cases} (1-\rho)\pi_y + \rho\pi_x & if \quad \pi_y \geq \pi_x \\ (1-\sigma)\pi_y + \sigma\pi_x & if \quad \pi_y < \pi_x \end{cases} \tag{1}$$

where CR_y is the utility of a player Y, ρ and σ capture the concern for other's welfare, π_x and π_y are respectively player X and player Y's payoffs. Depending on the payoff that dictators allocate to recipients, dictators can be assigned to the following three main categories: welfare-enhancing (WE), competitive (CP), and difference-averse (DA).[4] The model unambiguously predicts WE types to choose the highest outcome for the other (i.e., $\pi_x = 12$), DA types to choose the intermediate outcome (i.e., $\pi_x = 10$), and CP types to choose the lowest outcome (i.e., $\pi_x = 8$). Strictly selfish types do not have any preference as far as the other's payoff is concerned; thus, they are assumed to be randomly distributed among the five outcomes.

Based on model 1, we present here predictions about bid levels in alternative experimental conditions in part 2 of the experiment. The full derivation of our predictions is reported in Appendix C. We rely on the assumption that the decision maker maximizes her CR's expected utility. In addition to the standard assumptions of the model, we assume that $\rho \leq .5$, which implies that the individuals value their own utility more than the utility of the other when they are better off than the other. For the sake of simplicity, we rely on the original, (piece-wise) linear model specification. While the curvature of the utility function is a relevant factor in choices like those considered here, we maintain that the linear specification provides us with a satisfactory approximation of the actual preference structure.

Under these assumptions, we obtain a full rank of optimal bids in the 4 alternative conditions: $b^*_{CO/RS} \geq b^*_{CO/RO} \geq b^*_{CS/RS} \geq b^*_{CS/RO}$. Thus, irrespective of their type in the CR model, decision makers will post higher bids when the cost is borne by the other than when the cost is borne by themselves. In fact, when the cost is borne by subjects themselves, we have that $b^* \leq 2.6$ and, when the cost is borne by another, we have that $b^* > 2$.

In the light of these predictions, we proceed to test the following two Hypotheses, which consider the way decision makers manage the shifting of costs

these questionnaires is limited by the fact that it is retrieved via non-validated protocols. However, given time restrictions, we had to rely on excerpts of the original questionnaires.

[4]Types are characterized by distinct parameters constellations. For welfare-enhancing we have that 1$\geq \rho \geq \sigma > 0$; for difference-averse we have that $\sigma < 0 < \rho < 1$.

and risks between themselves and the experimental other.

Hypothesis 1 *Risk borne by dictators.*
When risk is borne by the dictators, they invest more in risk protection when the cost of the investment is borne by the other than when it is borne by themselves ($b^*_{CO/RS} > b^*_{CS/RS}$).

Hypothesis 2 *Cost borne by dictators.*
When the cost of investing in risk protection is borne by the dictators, they are investing more in risk protection when risk is borne by themselves than when it is borne by the other ($b^*_{CS/RS} > b^*_{CS/RO}$).

Our model predicts that individuals address risk differently when risk and costs are entirely born by themselves (CS/RS) rather than the other (CO/RO). In particular, as summarized below, our model provides us with clear-cut guidance as to how individuals behave in a setting of delegated decision making under risk, depending on whether they are choosing for others with others' resources, or choosing for themselves with their own resources.

Hypothesis 3 *Delegated risky choice.*
Dictators are going to buy more risk protection when risk and costs are borne by the other than when risk and costs are borne by themselves ($b^*_{CO/RO} > b^*_{CS/RS}$).

The model also provides us with testable predictions about how investment in risk protection differs according to an individual's social preference type. Under the assumption that DA and WE share the same ρ, DA are predicted to post higher bids than WE in all conditions but CS/RO. In this case, b^* is decreasing for $\sigma < 0$ and increasing for $\sigma > 0$ and this complicates the comparison between the two types; we have $\sigma < 0$ for the DA and $\sigma > 0$ for the WE. Furthermore, the difference in bids between condition CS/RS and conditions CO/RS, CO/RO should be larger for DA than for WE.

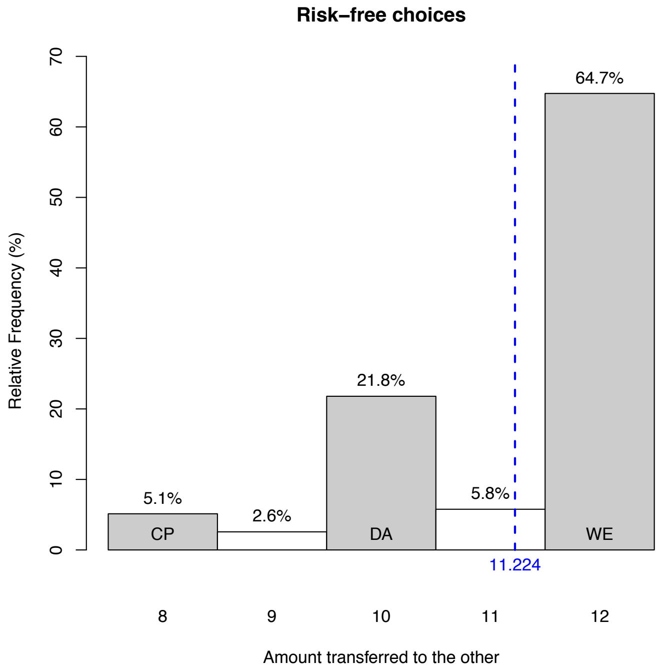
Hypothesis 4 *Risk protection and social types.*
Overall, DA types are going to buy more risk protection than WE types ($b^*_{DA} > b^*_{WE}$).

3 Results

3.1 Classification of Social Types

Figure 3 displays the distribution of choices in part 1, when cards are face-up and there is no uncertainty. Darker bars refer to participants that fall under a specific social type categorization, according the CR model presented above. Those giving 8, 10, and 12 can be identified with the competitive (CP), difference-averse (DA), and welfare-enhancing (WE) types, respectively.

Figure 3: Distribution of Social Preferences Types



As Figure 3 highlights, the large majority of choices is observed in correspondence to the maximum transfer ($\pi_x = 12$) to the other participant (64.7%). Intermediate transfers ($\pi_x = 10$) and minimal transfers ($\pi_x = 8$) capture the 21.8% and 5.1% of choices, respectively. This results in sustained average transfers (=11.2), close to the maximum of 12.

3.2 Investment in Risk Protection

Figure 4 presents the willingness to pay (WTP) distribution in the four experimental conditions of part 2. A higher WTP signals a higher attraction for the safe environment of choice relative to the uncertain one. Boxplots capture quartiles of the distributions and circles provide a representation of the frequency of each choice, with the radius of the circle proportional to the number of choices observed for a given level of WTP. Bold lines and numbers identify median and average choices, respectively.

Figure 4: Distribution of WTP across Conditions

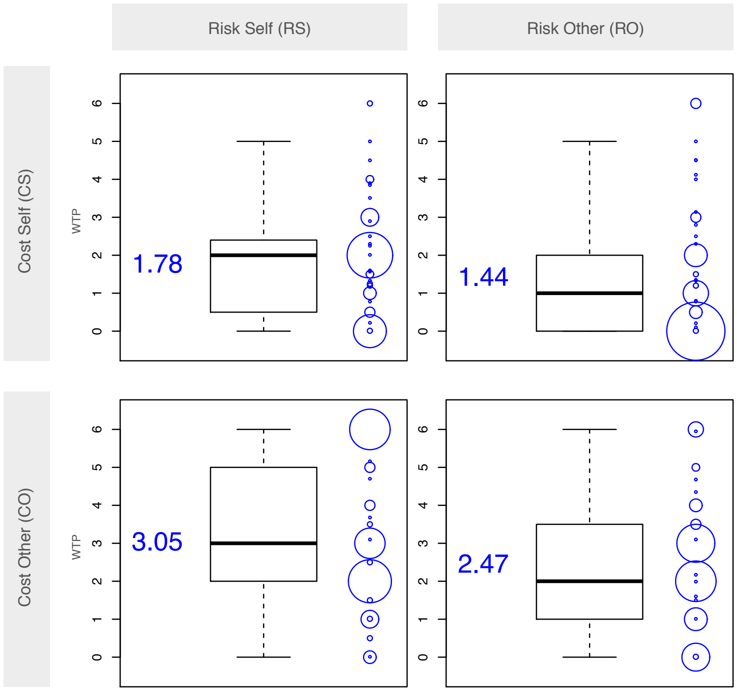


Figure 4 shows that the highest average (median) bid is observed in condition CO/RS and that the lowest is observed in condition CS/RO. The figure provides full support to the predictions of section 2.4, with bids in alternative conditions reflecting hypothesis obtain from the CR model : $b^*_{CO/RS} \geq b^*_{CO/RO} \geq b^*_{CS/RS} \geq b^*_{CS/RO}$.

The model also predicts that bids are going to be lower than or equal to 2.6, when the cost is borne by the dictator. Non-parametric tests show that this is the case both in condition CS/RO and in condition CS/RS (WST both p-values < 0.001).[5] In contrast, when the cost is borne by the other, bids should be above a lower bound of 2. Non-parametric tests again support the predictions, both in condition CO/RO and in condition CO/RS (WST, both p-values < 0.037).

Choices in condition CO/RS show that, when participants use the other's resources to protect themselves from risk, they choose a positive WTP (WST, p-value$<$ 0.001). However, in contrast to what selfishness would predict, the central tendency of the distribution is different from the maximum amount of 6 (WST, p-value$<$ 0.001).

[5] All tests reported are two-sided, when not specified. WRT stands for Wilcoxon Rank Sum Test. WST stands for Wilcoxon Signed Rank Test.

An interesting measure of the degree of "opportunism" shown by subjects is given by the difference between WTP in CO/RS and CS/RS. According to a non-parametric test, the positive difference between the two conditions is statistically significant (WRT, p-value$<$ 0.001).

Result 1 *The dictators invest more of the other's resources than of their own resources to protect themselves from risk.*

Choices in condition CS/RO inform us of the degree of concern for risk affecting the other when own resources are at stake. In contrast to what is predicted by pure selfishness, the average level of WTP in this condition is different from zero (WST, p-value$<$ 0.001). Nevertheless, individuals seem to value risk more when this affects themselves than when it affects the others, as confirmed by a non-parametric test (WST, p-value=0.008).

Result 2 *The dictators invest more of their resources in risk protection when risk is borne by themselves than when it is borne by the other.*

The comparison between condition CS/RS and condition CO/RO suggests that our participants tend to attach a higher negative value to risk when the cost of offsetting it and the consequences of choices are borne by others than when they are borne by themselves. Indeed, a comparison of the two conditions shows that the WTP in the latter is statistically higher than in the former (WRT, p.value=0.014).

Result 3 *The dictators invest more in risk protection when delegated to choose for others than when choosing for themselves.*

3.3 Risk Protection and Social Types

Table 2 reports summary statistics about WTP choices in alternative experimental conditions and for the two most common social types: difference-averse (DA) and welfare-enhancing (WE).[6]

As Table 2 shows, the highest average (median) bid is observed in condition CO/RS for the DA types, while the lowest average (median) bid is observed in condition CS/RO for the WE types. When comparing bids of the DA and the WE, the largest positive difference in average bids is observed in condition CO/RS. The smallest difference is registered in condition CS/RO. In line with predictions obtained above, the difference between the DA and WE in condition CS/RO is small and negative.

[6] In the analysis below we omit CP because of the low number of observations collected (i.e., 8) for this social type.

Table 2: Risk Protection and Social Types

	DA			WE		
	Mean	Median	SD	Mean	Median	SD
CS/RS	1.639	2.000	1.171	1.791	2.000	1.589
CS/RO	1.227	0.800	1.543	1.403	1.000	1.698
CO/RS	4.097	4.000	1.736	2.685	2.000	1.903
CO/RO	3.226	3.000	1.937	2.086	2.000	1.596

A series of non-parametric tests shows that no significant differences between the two types are observed in conditions in which the decision maker has to pay for protection from risk, CS/RS and CS/RO (WRT, both p-values $> .650$). In contrast, in the conditions in which the other pays for protection, i.e. CO/RS and CO/RO, the DA types tend to systematically buy more protection from risk (WRT, both p-values< 0.032)

Result 4 *DA types tend to invest more of the other's resources in protection from risk than WE types.*

Further insights about the consistency of behavior of alternative social types are gathered from the payoffs of those facing risk in part 2 when the bid is successful and cards are turned face-up. In such a condition, when the decision maker is a DA type the average payoffs are equal to 11.451 and 9.392 for the decision maker and the recipient, respectively (diff=2.059). When the decision maker is a WE type, the average payoffs are 11.406 and 10.864 for the decision maker and the recipient, respectively (diff=0.542). Non-parametric tests on individual averages show that the two types differ statistically in the payoffs of the recipients, but not in own payoffs (WRT, p-value=0.008 and p-value=0.836, respectively). As expected, a much wider gap in ex-post payoffs within a couple is registered when the decision maker is a DA type and this confirms the relevance of outcome-based considerations, even when the choice in part 2 is risk free.

3.4 Regression Analysis

Table 3 reports on the regression outcomes of a Linear Mixed Model estimation. The estimates are restricted to individuals classified as DA or WE (135 individuals). The dependent variable in the model is given by WTP, a direct measure of investment in risk protection. Model 1 controls for the impact of treatments on the decision to invest in risk protection. The treatment dummy CS is equal to 1 when cost of the investment is borne by subjects themselves

Table 3: WTP Determinants (LMM Regression)

	Model 1	Model 2	Model 3
(Intercept)	$2.387\ (0.203)^{***}$	$2.086\ (0.232)^{***}$	$4.397\ (1.765)^{*}$
CS	$-1.026\ (0.298)^{***}$	$-0.683\ (0.336)^{*}$	$-0.647\ (0.337)^{\circ}$
RS	$0.671\ (0.214)^{**}$	$0.599\ (0.251)^{*}$	$0.599\ (0.251)^{*}$
$CS : RS$	$-0.277\ (0.313)$	$-0.212\ (0.364)$	$-0.212\ (0.364)$
$type.DA$		$1.140\ (0.451)^{*}$	$1.087\ (0.462)^{*}$
$CS : type.DA$		$-1.316\ (0.672)^{\circ}$	$-1.430\ (0.676)^{*}$
$RS : type.DA$		$0.271\ (0.488)$	$0.271\ (0.488)$
$CS : RS : type.DA$		$-0.246\ (0.728)$	$-0.246\ (0.728)$
Age			$-0.018\ (0.052)$
$Econ$			$-0.455\ (0.261)^{\circ}$
$Female$			$0.060\ (0.267)$
$DOSPERT.score$			$-0.016\ (0.027)$
$LEVINSON.score$			$-0.042\ (0.034)$
AIC	1044.105	1039.642	1060.882
Num. obs.	270	270	270
Num. groups: ID	135	135	135

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\circ}p < 0.1$

and 0 when it is borne by the other. The treatment dummy RS is equal to 1 when risk is borne by self and 0 when it is borne by the other. The impact of the two variables is estimated both in isolation and in interaction. In Model 2, we add a control for social types and introduce the dummy variable $type.DA$, equal to 1 when an individual is classified as difference-averse, as deduced from choices in the first task, and equal to 0 when classified as welfare enhancing. The dummy variable $type.DA$ is also interacted with treatment dummies. Finally, in Model 3 we add additional controls for demographic characteristics (Age and $Female$), for field of study ($Econ$ is equal to 1 if students of Economics and 0 otherwise) and for self-reported measures in the DOSPERT questionnaire and in the Levenson's IPC scale. The Akaike's Information criteria (AIC) informs us that the most efficient specification is that of Model 2.

As the estimates of Model (1) show, dictators invest less in risk protection when the cost is borne by themselves rather than by the other ($CS = -1.026$). In contrast, more protection is bought when risk affects the dictator rather than the other ($RS = 0.671$). This pattern is consistent with Results 1 and 2 reported above. Furthermore, the linear hypothesis test $CS+RS+CS : RS = 0$ (Chisq=4.517, p-value=0.034) shows that participants tend to invest less in risk protection when choosing for themselves than when delegated to choose for others. This confirms what is reported above in Result 3.

Model 2 takes into account the impact of treatment dummies, controlling for social preferences. According to the results of Model 2, difference-averse types tend to invest more in risk protection than welfare-enhancing types ($type.DA = 1.140$), when cost and risk are borne by the other. Furthermore, the negative impact of CS on the investment is (marginally) stronger for the DA, as shown by the estimated coefficient for the interaction term $CS : type.DA$. Thus, DA types are more likely to exploit others' resources to invest in risk protection than WE types, in line with Result 4.

Estimates of Model 3 are, overall, in line with the results of Model 2. Among the control variables, only the field of study has a (weakly) significant effect on investment propensity, with students of economics investing lower amounts in risk protection than others.

4 Discussion and Conclusions

Outcomes from our experiment shed new light on three fundamental questions about risky decision-making involving social spillovers: i) do individuals use more resources to offset risk when accessing others' resources rather than own resources? ii) Do individuals use more resources to offset risk borne by themselves rather than by others? iii) Do individuals offset risk differently when choosing for themselves rather than when delegated to choose for others?

To answer these questions, we assess behavior in a simple experimental task against predictions obtained from a manageable and well-known model for social preferences. Results obtained provide strong support to the predictive ability of the model in the context under investigation. Specifically, we show that individuals buy more risk protection when another provides the resources (i) above), but are less likely to invest own resources to protect others than to protect themselves (ii). Furthermore, decision makers seem to invest more in risk protection when delegated to choose than when choosing for themselves (iii).

We show that differences in investment in risk protection across individuals are largely predicted by their social preference attitudes, with difference-averse types generally investing more resources in risk protection than welfare-enhancing types. This is mainly due to the fact that individuals endowed with inequity averse preferences dislike the perspective of lagging behind others (Linde and Sonnemans, 2012).

Our study highlights the importance of allocational considerations in risky choices involving others' welfare. In a typical delegated risky choice, the decision maker has no stakes in the choice. Thus, standard self-centered utility models do not provide clear guidance in predicting behavior. In addition to this, even allowing for other-regarding concerns, it would not be possible to define precisely what curvature of the utility function should be applied to the other. Here we neglect considerations about the curvature of the utility function and specifically focus on other-regarding concerns. This provides us with clear-cut predictions which are, overall, confirmed by the data gathered in the course of the experiment.

While there is scope for further research in this area to enrich the picture by modeling tastes for risk more explicitly, we feel that the evidence presented here nonetheless represents an important step along this research path.

References

Agranov, M., Bisin, A., and Schotter, A. (2014). An experimental study of the impact of competition for other people's money: the portfolio manager market. *Experimental Economics*, 17(4):564–585.

Andersen, S., Harrison, G. W., Lau, M. I., and Rutström, E. E. (2006). Elicitation using multiple price list formats. *Experimental Economics*, 9(4):383–405.

Andersson, O., Holm, H. J., Tyran, J.-R., and Wengström, E. (2014). Deciding for others reduces loss aversion. *Management Science*.

Becker, G. M., DeGroot, M. H., and Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral science*, 9(3):226–232.

Camerer, C. F. (2013). Experimental, cultural, and neural evidence of deliberate prosociality. *Trends in Cognitive Sciences*, 17(3):106 – 108.

Chakravarty, S., Harrison, G. W., Haruvy, E. E., and Rutström, E. E. (2011). Are you risk averse over other people's money? *Southern Economic Journal*, 77(4):901–913.

Charness, G. and Rabin, M. (2002). Understanding social preferences with simple tests. *Quarterly journal of Economics*, pages 817–869.

Engel, C. (2011). Dictator games: a meta study. *Experimental Economics*, 14(4):583–610.

Engelmann, D. and Strobel, M. (2004). Inequality aversion, efficiency, andmaximin preferences in simple distribution experiments. *The American Economic Review*, 94(4):857–869.

Eriksen, K. W. and Kvaløy, O. (2014). Myopic risk-taking in tournaments. *Journal of Economic Behavior & Organization*, 97:37–46.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *Quarterly journal of Economics*, pages 817–868.

Fischbacher, U. (1999). *Z-Tree 1.1. 0: Zurich Toolbox for Readymade Economic Experiments: Experimenter's Manual*. Institute for Empirical Research in Economics, University of Zurich.

Güth, W., Levati, M. V., and Ploner, M. (2008). On the social dimension of time and risk preferences: An experimental study. *Economic Inquiry*, 46(2):261–272.

Krawczyk, M. and Le Lec, F. (2010). 'give me a chance!'an experiment in social decision under risk. *Experimental economics*, 13(4):500–511.

Lahno, A. M. and Serra-Garcia, M. (2015). Peer effects in risk taking: Envy or conformity? *Journal of Risk and Uncertainty*, 50(1):73–95.

Levenson, H. (1972). Distinctions within the concept of internal-external control: Development of a new scale. In *Proceedings of the Annual Convention of the American Psychological Association*. American Psychological Association.

Linde, J. and Sonnemans, J. (2012). Social comparison and risky choices. *Journal of Risk and Uncertainty*, 44:45–72.

Pahlke, J., Strasser, S., and Vieider, F. M. (2015). Responsibility effects in decision making under risk. WP.

Trautmann, S. T. and Vieider, F. (2011). Social influences on risk attitudes: Applications in economics. In *Handbook of Risk Theory*. Springer.

Weber, E. U., Blais, A.-R., and Betz, N. E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of behavioral decision making*, 15:263–290.

A Experiment Instructions

Following we include an English translation of the experiment instructions. In order to match our experimental design, we had the need to produce four different version of the instructions (i.e. one for each treatment). General instructions and Instructions for the first part of the experiment were common for all the four treatments, while instructions for the second part were suitably edited.

As explained in the section on the experimental design, two treatments, i.e. the ones related to the risky component (*Risk*), are applied within subjects. This means that steps in the instructions referring to these treatments were common to the four versions. Nevertheless, we introduced a variation in the instruction to control for the order bias.

Here we present a version containing the edited parts. Every time we will be referring to one of these, there will always be a label between squared brackets indicating to what treatment the step refers to. Labels can either refer to the treatment related to the money used to buy the right to turn the cards, or to the order according to which participants, depending on their roles, bear the risk of receiving n unknown payment during the two phases in the second part of the experiment.

In the first case, if we refer to the treatment in which *Participant 2* has to be charged of the eventual cost of turning the cards you will read the label [*Cost.Oth*], while if we refer to the treatment in which *Participant 2* has to be charged of the eventual cost of turning the cards you will read the label [*Cost.Own*].

Similarly, when describing the two phases in the second part of the experiment, if *Participant 1* is the first to bear the risk of receiving an unknown payment you will read the label [$Risk.Own_first$], while if *Participant 2* is the first to bear the risk of receiving an unknown payment you will read the label [$Risk.Oth_first$]. These labels will be integrated with one of the label for the cost treatment. For instance, if the cost of turning the cards has to be borne by *Participant 2* and *Participant 1* is the first one to bear the risk of the unknown payment, you will find the label [$Cost.Oth/Risk.On_first$].

General Instructions

Welcome,

You are about to take part into an experiment on economic decisions. For being here on time, at the end of the experiment, you will receive 2.50 euros. May you have any doubt during the experiment, please raise your hand and ask a staff member. If you use the computer for activities not strictly related to the experiment, you will be excluded by the experiment and by any payment.

The experiment is divided into two independent parts. In the first part there is only one decisional phase, while in the second part there are two independent decisional phases. Thus, you will face a total of 3 decisional phases.

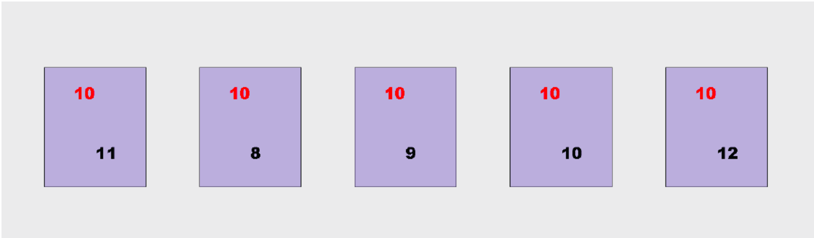
Following you will receive the instructions for the first part of the experiment. Once the first part will end, you will receive the instructions for the second part. We ask you to read the instructions carefully. Before the beginning of each part of the experiment you will have to answer some questions to verify your comprehension of the instructions.

During each phase of the experiment you will have the possibility to earn a sum of euros. This sum will not depend from the sum earned during another phase. Your final payment for the experiment will be defined at the end of the experiment by randomly drawing the earning from one of the three decisional phases.

During the experiment participants will have two roles: *Participant 1* and *Participant 2*. Initially, all the participants will be assigned the role of *Participant 1*, but they will know their actual role only at the end of the experiment. At the end of the experiment half of the participants will be randomly assigned the role of *Participant 1* and the other half the role of *Participant 2*. Every *Participant 1* will be randomly associated to only one *Participant 2*. Choices made by participants who will be assigned the role of *Participant 1* will define earnings for themselves and the *Participant 2* they are associated to, according to the rules that will follow. Thus, choices made by participants who will be assigned the role of *Participant 2* will not be relevant in determining experiment final payments.

Instructions - First Part

In this part of the experiment on your monitor you will be shown 5 cards, each one containing two sums in euros. The red sum in the upper left represents *Participant 1*'s earning, while the black sum in the lower right represents *Participant 2*'s earning. The following figure shows an example of a possible display condition of the cards (the order will be random and it may not correspond to the one in the screenshot below).



During this first phase, *Participant 1*'s earning is always equal to 10 euros. The earning assigned to *Participant 2* can vary depending on *Participant 1*'s choice and can assume an integer value between 8 euros and 12 euros. *Participant 1*'s task is to choose the combination of payments they prefer for themselves and *Participant 2* by clicking the button "I CHOOSE THIS ONE" below the desired card. In order to avoid eventual errors, participants will be asked to confirm their own choices after having made them. In case there would be an error in the choice it will be enough not to confirm it and to repeat the operation.

Instructions - Second Part

The second part of the experiment is composed of two phases. In both phases *Participant 1* will be shown 5 face-down cards (see screenshot below).

Each hole card has on its face two sums corresponding to the earnings for *Participant 1* and *Participant 2*. One of the two participants will always receive a payment equal to 10 euros, while the other participant will receive a payment that may correspond to 8, 9, 10, 11 or 12 euros, depending on the chosen card. In one phase the payment always equal to 10 euros will be given to *Participant 1*, while in the other phase the payment always equal to 10 euros will be given to *Participant 2*. More details about this are provided below.

As in the first phase, the red sum in the upper left represents *Participant 1*'s earning, while the black sum in the lower right represents *Participant 2*'s earning. It is possible to know the couple of earnings associated to each card only by turning the cards. Since the distribution of the cards is randomly determined in every phase, the order of the cards observed in one of the phases does not provide any information about their order in a different phase.

Participant 1 will be asked to make an offer to buy the possibility to turn simultaneously all the 5 cards. The offer will have to be between 0 and 6 euros (included) and it will have to be approximated to the second decimal number, by using a dot to separate integer and decimals.

The probability of turning the cards will depend on the offer made by *Participant 1* and will be defined by following this procedure:

- A value between 0 and 6 will be randomly drawn by the software so that all the values between 0 and 6 have the same probability of being extracted.
- If the randomly drawn value will be less or equal to *Participant 1*'s offer:
  - cards will be turned,
  - [$Cost.Oth$] the value randomly drawn by the software will be deducted from *Participant 2*'s payment indicated on the card chosen by *Participant 1*.
  - [$Cost.Own$] the value randomly drawn by the software will be deducted from *Participant 1*'s payment indicated on the card chosen by *Participant 1*.
- If the randomly drawn value will be higher than *Participant 1*'s offer:
  - cards will not be turned,
  - [$Cost.Oth$] the value randomly drawn by the software will not be deducted from *Participant 2*'s payment indicated on the card chosen by *Participant 1*.
  - [$Cost.Own$] the value randomly drawn by the software will not be deducted from *Participant 1*'s payment indicated on the card chosen by *Participant 1*.

[$Cost.Oth$] Based on this procedure, the best strategy for *Participant 1* is to make an offer corresponding to the maximum value they would like *Participant 2* to pay to turn all the cards.

[*Cost.Own*] Based on this procedure, the best strategy for *Participant 1* is to make an offer corresponding to the maximum value they would like to pay to turn all the cards.

Participant 1's task is to choose the card they prefer. If the combination between offer made and random draw allows to turn the cards, *Participant 1* will have the possibility to choose one of the face-up cards, otherwise they will have to choose one of the cards without knowing the consequences of their choice. In both cases, the choice is made by clicking the button "I CHOOSE THIS ONE" below the desired card.

Participant 1's choice define both *Participant 1* and *Participant 2*'s payments. If the choice is made upon a hole card, *Participant 1* will receive feedback about *Participant 2*'s payment only at the end of the second part.

[*Cost.Oth*] It is important to remember that, if cards are turned, *Participant 2*'s payment will be equal to the payment associated to the chosen card reduced of the value randomly drawn by the software.

[*Cost.Own*] It is important to remember that, if cards are turned, *Participant 1*'s payment will be equal to the payment associated to the chosen card reduced of the value randomly drawn by the software.

During the experiment the term "payment" will correspond to the value illustrated on the cards, while the term "earning" will correspond to the value illustrated on the chosen card reduced by the cost of turning the cards.

The described procedure will be common to the two phases in the second part of the experiment. The two phases will differ only in the distribution of the payments illustrated on the cards.

Phase 1

[$Cost.Oth/Risk.Oth_first$] *Participant 1*'s payment will be always equal to 10 euros. The payment assigned to *Participant 2* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 2*'s payment.

[$Cost.Own/Risk.Oth_first$] *Participant 1*'s payment will be always equal to 10 euros. The payment assigned to *Participant 2* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 1*'s payment.

[$Cost.Oth/Risk.Own_first$] *Participant 2*'s payment will be always equal to 10 euros. The payment assigned to *Participant 1* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 2*'s payment.

[$Cost.Own/Risk.Own_first$] *Participant 2*'s payment will be always equal to 10 euros. The payment assigned to *Participant 1* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 1*'s payment.

Phase 2

[$Cost.Oth/Risk.Oth_first$] *Participant 2*'s payment will be always equal to 10 euros. The payment assigned to *Participant 1* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 2*'s payment.

[$Cost.Own/Risk.Oth_first$] *Participant 2*'s payment will be always equal to 10 euros. The payment assigned to *Participant 1* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 1*'s payment.

[$Cost.Oth/Risk.Own_first$] *Participant 1*'s payment will be always equal to 10 euros. The payment assigned to *Participant 2* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 2*'s payment.

[$Cost.Own/Risk.Own_first$] *Participant 1*'s payment will be always equal to 10 euros. The payment assigned to *Participant 2* will vary depending on *Participant 1*'s choice and it will have one of the integer values between 8 euros and 12 euros. If cards are turned, the value randomly drawn by software will be deducted from *Participant 1*'s payment.

B Questionnaires

Following we include an English translation of the questionnaires our experimental subjects answered to at the end of the experiment. As explained in the section on the experimental design, our purpose is not to obtain validated psychological measures that can implement our analysis. In fact, we just are interested in gathering some information about possible factors of influence that could drive subjects' decisions during the experiment.

Levenson's Scale

We kindly ask you to answer the following questionnaire truthfully.

We ask you to indicate how much you agree with each of the following statements by using a scale of 6 values that goes from "I don't agree at all" to "I totally agree". Moving your choice on the radio button toward the right you increase your agreement with the statement on the scale that goes from "I don't agree at all" to "I totally agree".

1. To a great extent my life is controlled by accidental happenings.
2. When I make plans, I am almost certain to make them work.
3. Often there is no chance of protecting my personal interests from bad luck happenings.
4. When I get what I want, it's usually because I'm lucky.
5. I have often found that what is going to happen will happen.
6. It's not always wise for me to plan too far ahead because many things turn out to be a matter of good or bad fortune.
7. When I get what I want, it's usually because I worked hard for it.
8. My life is determined by my own actions.

Dospert

We kindly ask you to answer the following questionnaire truthfully.

We ask you to indicate the probability with which you would take the described action in the illustrated situation. You can judge by using the following scale: "Completely unlikely", "Mildly unlikely", "Quite unlikely", "Not sure", "Quite likely", "Mildly likely", "Completely likely".

1. To admit that your tastes differ from your friends'.
2. To bet your daily wage on a horse race.
3. To invest 5% of your annual wage on a high-risk financial product.
4. To bet your daily wage on the outcome of a sport event.
5. To invest 10% of your annual wage on a start-up.
6. To choose a career you like over a more stable one.
7. To give an unpopular opinion during a group discussion.

Demographic and Other Information

Please, fill the following fields.

1. Date of Birth:
2. Gender:
3. Field of Studies:
4. Number of experiment to which you have participated:

C Behavioral Predictions

Decisional Setting

We derive here the predictions about the size of the bid $b \in [0,6]$ that decision makers are paying to turn the cards and solve uncertainty. The individual facing uncertainty chooses over a lottery with five potential outcomes $\pi^1, \dots, \pi^5$ and each outcome $\pi^i = (\pi_x^i, \pi_y^i)$ gives a payoff of player X and Y. All π^i have the same probability $P(\pi^i) = 1/5$ to be picked when cards are face-down.

A random price $p \sim U(0,6)$ is drawn from a uniform distribution and cards are turned and uncertainty is solved when $b \geq p$. Depending on the treatment, the price p is paid either by the decision maker Y or by the player X and then the decision maker can freely choose the preferred card. When $p < b$, uncertainty is not solved and the decision maker picks one of the cards that are face-down.

Here we derive some behavioral predictions about the size of the bid conditional upon social types and experimental manipulations. We assume that subjects preferences follow the social utility function of Charness and Rabin (hereafter, CR)

$$CR_y(\pi_x, \pi_y) = \begin{cases} (1-\rho)\pi_y + \rho\pi_x & if \quad \pi_y \geq \pi_x \\ (1-\sigma)\pi_y + \sigma\pi_x & if \quad \pi_y < \pi_x \end{cases} \tag{2}$$

where CR_y is the utility of a player Y, ρ and σ capture other's welfare concerns, π_x and π_y are respectively player X and player Y's payoffs. Here we focus on two main social types, *Difference-Averse (DA)* and *Welfare Enhancing (WE)*. The latter are characterized by $1 > \rho \geq \sigma > 0$. The former are characterized by $\sigma < 0 < \rho < 1$. For the sake of tractability, we stick to the original model and assume that utility is (piece-wise) linear in monetary payoffs.

Concerning experimental manipulations, decision makers are facing four alternative conditions in which the risk may be borne by themselves or by the other and p may be paid by themselves or by the other.

		Risk	
		Self	Other
Cost	Self	CS/RS	CS/RO
	Other	CS/RO	CO/RO

In the following, we obtain predictions for each of the four alternative conditions.

Cost.Self/Risk.Self (CS/RS)

In this condition, outcomes are $\pi^1 = (8,10)$, $\pi^2 = (9,10)$, $\pi^3 = (10,10)$, $\pi^4 = (11,10)$, and $\pi^5 = (12,10)$. Decision makers post a bid b that maximizes their expected utility, as measured by the CR model reported above (equation 2). The expected utility of the decision maker is equal to

$$EU[b] = (1 - P_T(b))U_{NT} + \int_0^b \frac{1}{6} CR_y(\pi_x^*(p), \pi_y^*(p) - p)\mathrm{d}p \tag{3}$$

where $P_T(b) = \frac{b}{6}$ is the probability of turning the cards, $U_{NT} = \sum_{i=1}^{5} \frac{1}{5} CR_y(\pi_x^i, \pi_y^i)$ is the (expected) utility when cards are not turned, and $\pi^*(b) = (\pi_x^*(p), \pi_y^*(p))$ is the optimal choice given that cards are turned and price p is paid.

Since $CR_y(\pi_x, \pi_y)$ is increasing in π_y for all feasible ρ and σ, the optimal choice when cards are turned is $\pi^*(p) = \pi^5$ for all p. Then, expected utility becomes:

$$EU[b] = \begin{cases} \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\rho)(12-p) + \rho 10\right]\mathrm{d}p & if \quad b \leq 2 \\ \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^2 \frac{1}{6}\left[(1-\rho)(12-p) + \rho 10\right]\mathrm{d}p + & \\ \quad + \int_2^b \frac{1}{6}\left[(1-\sigma)(12-p) + \sigma 10\right]\mathrm{d}p & if \quad b > 2 \end{cases} \tag{4}$$

Note that: (i) the function is continuous—for $b = 2$ the two equations have the same value—and (ii) both equations are concave parabolae—$(1 - \rho)$ and $(1 - \sigma)$ are positive. So in order to find the optimal bid we only need to consider the position of the vertexes of the parabolae that are in $b = \frac{10-7\rho-3\sigma}{5(1-\rho)}$ and $b = \frac{10+3\rho-13\sigma}{5(1-\sigma)}$ respectively. In particular the maximum of the first parabola is in $b \leq 2$ only if $\sigma \geq \rho$ which is never the case, so the function $EU[b]$ is increasing for $b \leq 2$. Moreover the maximum of the second parabola is always in $b \geq 2$ hence the unique optimal bid is $b^* = \frac{10+3\rho-13\sigma}{5(1-\sigma)}$.

The optimal bid goes from $b^* = 2$ when $\sigma = \rho$ to $b^* = 2.6$ when $\sigma \to -\infty$. Moreover, b^* is decreasing is σ and increasing in ρ. This implies that a DA player posts higher bids than a WE player, for a given level of ρ.

Cost.Other/Risk.Self (CO/RS)

In this condition, outcomes are $\pi^1 = (8, 10)$, $\pi^2 = (9, 10)$, $\pi^3 = (10, 10)$, $\pi^4 = (11, 10)$, and $\pi^5 = (12, 10)$. Decision makers post a bid b that maximizes

$$EU[b] = (1 - P_T(b))U_{NT} + \int_0^b \frac{1}{6} CR_y(\pi_x^*(p) - p, \pi_y^*(p))\mathrm{d}p \tag{5}$$

Note that, since $CR_y(\pi_x, \pi_y)$ is increasing in π_y for all feasible ρ and σ, also in this case the optimal choice when cards are turned is $\pi^*(p) = \pi^5$ for all p.

Thus the expected utility becomes:

$$EU[b] = \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\rho)12 + \rho(10-p)\right]\mathrm{d}p \tag{6}$$

that is a concave parabola with a global maximum in $b^* = \frac{10-7\rho-3\sigma}{5\rho}$.

The optimal bid goes from $b^* = 0$ when $\rho = \sigma = 1$ to $b^* = 6$ when $\sigma \leq \frac{10-37\rho}{3}$. Moreover, the optimal bid is decreasing both in rho and sigma. This implies that a DA player posts higher bids than a WE player, for a given level of ρ.

Cost.Self/Risk.Oth (CS/RO)

In this condition, outcomes are $\pi^1 = (10, 8)$, $\pi^2 = (10, 9)$, $\pi^3 = (10, 10)$, $\pi^4 = (10, 11)$, and $\pi^5 = (10, 12)$. The expected utility is given by

$$EU[b] = (1 - P_T(b))U_{NT} + \int_0^b \frac{1}{6} CR_y(\pi_x^*(p), \pi_y^*(p) - p)\mathrm{d}p \tag{7}$$

Note that if $\sigma \geq 0$ the function $CR_y(\pi_x, \pi_y)$ is increasing in π_x and, hence, the optimal choice when cards are turned is $\pi^*(p) = \pi^5$ for all p. If instead $\sigma < 0$ the function is decreasing in π_x and hence the optimal choice when cards are turned and price p is paid changes with p. In the following we discuss separately the case of $\sigma \geq 0$ and $\sigma < 0$.

For $\sigma \geq 0$ the expected utility is

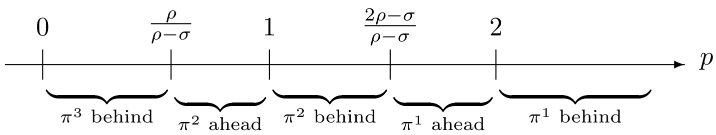
$$EU[b] = \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\sigma)(10-p) + \sigma 12\right]\mathrm{d}p \tag{8}$$

that is a concave parabola with a global maximum in $b^* = \frac{7\sigma+3\rho}{5(1-\sigma)}$.

For $\sigma < 0$, the optimal choice $\pi^*(p)$ is as follows:

$$\pi^*(p) = \begin{cases} \pi^3 = (10, 10) & if \quad p < \frac{\rho}{\rho-\sigma} \\ \pi^2 = (9, 10) & if \quad \frac{\rho}{\rho-\sigma} \leq p < \frac{2\rho-\sigma}{\rho-\sigma} \\ \pi^1 = (8, 10) & if \quad \frac{2\rho-\sigma}{\rho-\sigma} \leq p \end{cases} \tag{9}$$

Hence we need to take into consideration the following intervals when taking the integral over p.



The expected utility becomes

$$EU[b] = \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) +$$
$$+\begin{cases} \int_0^b \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 10\right] \mathrm{d}p & if \quad b < \frac{\rho}{\rho-\sigma} \\ \int_0^{\frac{\rho}{\rho-\sigma}} \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 10\right] \mathrm{d}p + \int_{\frac{\rho}{\rho-\sigma}}^b \frac{1}{6}\left[(1-\rho)(10-p)+\rho 9\right] \mathrm{d}p & if \quad \frac{\rho}{\rho-\sigma} \leq b \leq 1 \\ \int_0^{\frac{\rho}{\rho-\sigma}} \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 10\right] \mathrm{d}p + \ldots + \int_1^b \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 9\right] \mathrm{d}p & if \quad 1 < b < \frac{2\rho-\sigma}{\rho-\sigma} \\ \int_0^{\frac{\rho}{\rho-\sigma}} \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 10\right] \mathrm{d}p + \ldots + \int_{\frac{2\rho-\sigma}{\rho-\sigma}}^b \frac{1}{6}\left[(1-\rho)(10-p)+\rho 8\right] \mathrm{d}p & if \quad \frac{2\rho-\sigma}{\rho-\sigma} \leq b \leq 2 \\ \int_0^{\frac{\rho}{\rho-\sigma}} \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 10\right] \mathrm{d}p + \ldots + \int_2^b \frac{1}{6}\left[(1-\sigma)(10-p)+\sigma 8\right] \mathrm{d}p & if \quad 2 < b \end{cases} \tag{10}$$

Note that the function is continuous and each equation is a concave parabola.[7]

The maxima of the parabolae in b are equal to $\frac{3\rho-3\sigma}{5(1-\sigma)}$, $\frac{-2\rho-3\sigma}{5(1-\rho)}$, $\frac{3\rho-8\sigma}{5(1-\sigma)}$, $\frac{-7\rho-3\sigma}{5(1-\rho)}$, and $\frac{3\rho-13\sigma}{5(1-\sigma)}$, respectively.

Suppose that the maximum of the parabola defined in equation i is in the interval where equation i defines EU. Obviously, this point is also a local maximum of the EU over that interval. Moreover, it easy to check that equations $j < i$, i.e., the parabolae to the left of i, have their maximum to the right of their intervals; while equations $j > i$, i.e., parabolae to the right of i, have their maximum to the left of their intervals. This implies that EU is increasing over the domain of equations $j < i$ and decreasing over the domain of equations $j > i$ so the local maximum is the unique global maximum of EU. Given this, the optimal bid for $\sigma < 0$ is the following:

$$b^* = \begin{cases} \frac{3\rho-3\sigma}{5(1-\sigma)} & if \quad \frac{\rho-\sqrt{60\rho-35\rho^2}}{6} < \sigma < 0 \\ \frac{-2\rho-3\sigma}{5(1-\rho)} & if \quad \rho - \frac{5}{3} \leq \sigma \leq \frac{\rho-\sqrt{60\rho-35\rho^2}}{6} \\ \frac{3\rho-8\sigma}{5(1-\sigma)} & if \quad \frac{-5+\rho-\sqrt{25+110\rho-35\rho^2}}{6} < \sigma < \rho - \frac{5}{3} \\ \frac{-7\rho-3\sigma}{5(1-\rho)} & if \quad \rho - \frac{10}{3} \leq \sigma \leq \frac{-5+\rho-\sqrt{25+110\rho-35\rho^2}}{6} \\ \frac{3\rho-13\sigma}{5(1-\sigma)} & if \quad \sigma < \rho - \frac{10}{3} \end{cases} \tag{11}$$

Note that the optimal bid for $\sigma < 0$ is a continuous function and it is a continuous function also considering the optimal bids when $\sigma \geq 0$.[8] The optimal bid goes from $b^* = 0$ when $\rho = \sigma = 0$ to $b^* = 6$ when $\rho > 0.75$ and $\sigma \geq \frac{30-\rho}{37}$.

[7] In each equation, b is present only in the common part $\left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma)$ and in the last integral.

[8] It is easy to check that, at the interval boundaries, b^* has the same value when approaching from the left and from the right.

The behavior of the optimal bid with respect to ρ is not univocal. Indeed, while the bid is increasing in ρ on the "odd" intervals, on the "even" intervals its behavior depends on the value of sigma. The behavior of the optimal bid with respect to sigma is smoother: b^* is decreasing in σ on all the intervals for $\sigma < 0$, while it is increasing in σ for $\sigma > 0$. When comparing DA and WE, the ordering of b^* for the two types strictly depends on the level of σ, for a given ρ. Thus, no sharp predictions can be drawn in this condition for distinct types.

Cost.Oth/Risk.Oth (*CO*/*RO*)

In this condition, outcomes are $\pi^1 = (10, 8)$, $\pi^2 = (10, 9)$, $\pi^3 = (10, 10)$, $\pi^4 = (10, 11)$, and $\pi^5 = (10, 12)$. Decision makers post a bid b that maximizes

$$EU[b] = (1 - P_T(b))U_{NT} + \int_0^b \frac{1}{6} CR_y(\pi_x^*(p), \pi_y^*(p) - p)\mathrm{d}p \tag{12}$$

As before, since the CR function is increasing in π_x only if $\sigma \geq 0$, the optimal choice $\pi^*(p)$ is π^5 for $\sigma \geq 0$ and it changes with p for $\sigma < 0$.

In the first case, i.e., for $\sigma \geq 0$, the expected utility is

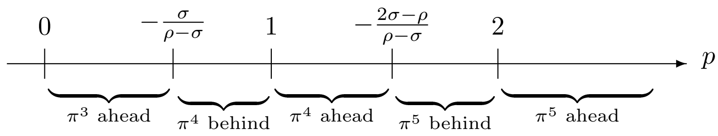
$$EU[b] = \begin{cases} \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\sigma)10 + \sigma(12 - p)\right] \mathrm{d}p & if \quad b < 2 \\ \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^2 \frac{1}{6}\left[(1-\sigma)(10) + \sigma(12 - p)\right] \mathrm{d}p + \\ \qquad + \int_2^b \frac{1}{6}\left[(1-\rho)10 + \rho(12 - p)\right] \mathrm{d}p & if \quad b \geq 2 \end{cases} \tag{13}$$

Note that the function is continuous and the two equations are a concave parabolae with maxima in $b = \frac{7\sigma + 3\rho}{5\sigma}$ and $b = \frac{-3\sigma + 13\rho}{5\rho}$ respectively. Note also that the maximum of the first parabola is in $b < 2$ only if $\sigma > \rho$ which is never the case. So expected utility is increasing in b for $b < 2$. Moreover, the maximum of the second parabola is always in $b \geq 2$ (recall $\sigma \leq \rho$) and hence there is a unique global maximum in $b^* = \frac{-3\sigma + 13\rho}{5\rho}$.

In the second case, i.e., for $\sigma < 0$, the optimal choice $\pi^*(p)$ is as follows:

$$\pi^*(p) = \begin{cases} \pi^3 = (10, 10) & if \quad p \leq -\frac{\sigma}{\rho - \sigma} \\ \pi^4 = (11, 10) & if \quad -\frac{\sigma}{\rho - \sigma} < p \leq -\frac{2\sigma - \rho}{\rho - \sigma} \\ \pi^5 = (12, 10) & if \quad -\frac{2\sigma - \rho}{\rho - \sigma} < p \end{cases} \tag{14}$$

Hence we need to take into consideration the following intervals when taking the integral over p.



The expected utility becomes

$$
\begin{aligned}
EU[b] = &\left(1-\frac{b}{6}\right)(50-3\rho+3\sigma)+ \\
&+\begin{cases}
\int_0^b \frac{1}{6}\left[(1-\rho)10+\rho(10-p)\right]\mathrm{d}p & if \quad b \leq -\frac{\sigma}{\rho-\sigma} \\
\int_0^{-\frac{\sigma}{\rho-\sigma}} \frac{1}{6}\left[(1-\rho)10+\rho(10-p)\right]\mathrm{d}p + \int_{-\frac{\sigma}{\rho-\sigma}}^b \frac{1}{6}\left[(1-\sigma)10+\sigma(11-p)\right]\mathrm{d}p & if \quad \frac{\rho}{\rho-\sigma} < b < 1 \\
\int_0^{-\frac{\sigma}{\rho-\sigma}} \frac{1}{6}\left[(1-\rho)10+\rho(10-p)\right]\mathrm{d}p + \ldots + \int_1^b \frac{1}{6}\left[(1-\rho)10+\rho(11-p)\right]\mathrm{d}p & if \quad 1 \leq b \leq -\frac{2\sigma-\rho}{\rho-\sigma} \\
\int_0^{-\frac{\sigma}{\rho-\sigma}} \frac{1}{6}\left[(1-\rho)10+\rho(10-p)\right]\mathrm{d}p + \ldots + \int_{-\frac{2\sigma-\rho}{\rho-\sigma}}^b \frac{1}{6}\left[(1-\sigma)10+\sigma(12-p)\right]\mathrm{d}p & if \quad -\frac{2\sigma-\rho}{\rho-\sigma} < b < 2 \\
\int_0^{-\frac{\sigma}{\rho-\sigma}} \frac{1}{6}\left[(1-\rho)10+\rho(10-p)\right]\mathrm{d}p + \ldots + \int_2^b \frac{1}{6}\left[(1-\rho)10+\rho(12-p)\right]\mathrm{d}p & if \quad 2 \leq b
\end{cases}
\end{aligned}
\tag{15}
$$

Note that, also in this case the function is continuous and each equation is a parabola. However, while the equations in the odd cases are concave parabolae, the equations in the even cases are convex parabolae.[9] This implies that there cannot be a maximum for b in the intervals $\left(-\frac{\sigma}{\rho-\sigma}, 1\right)$ and $\left(-\frac{2\sigma-\rho}{\rho-\sigma}, 2\right)$. The vertexes of the parabolae are, respectively in $\frac{3\rho-3\sigma}{5\rho}$, $\frac{3\rho+2\sigma}{5\sigma}$, $\frac{8\rho-3\sigma}{5\rho}$, $\frac{3\rho+7\sigma}{5\sigma}$, and $\frac{13\rho-3\sigma}{5\rho}$.

Moreover, note that for the feasible values of ρ and σ: (i) the vertex of the second parabola, which is in $\frac{3\rho+2\sigma}{5\sigma}$, is always to the left of $-\frac{\sigma}{\rho-\sigma}$; (ii) the vertex of the fourth parabola, which is in $\frac{3\rho+7\sigma}{5\sigma}$, is always to the left of $-\frac{2\sigma-\rho}{\rho-\sigma}$; (iii) the vertex of the first parabola, which is in $\frac{3\rho-3\sigma}{5\rho}$, is always to the right of $-\frac{\sigma}{\rho-\sigma}$; (iv) the vertex of the third parabola, which is in $\frac{8\rho-3\sigma}{5\rho}$, is always to the right of $-\frac{2\sigma-\rho}{\rho-\sigma}$. This implies that the EU function is increasing for b in the interval $[0, 2)$. Finally, the vertex of the fifth parabola—which is concave—is in $b = \frac{13\rho-3\sigma}{5\rho}$ that is bigger than 2 if $\rho > \sigma$ that is always the case. Hence, the unique global maximum is for $b^* = \frac{13\rho-3\sigma}{5\rho}$ that is the same optimal bid obtained for $\sigma \geq 0$.

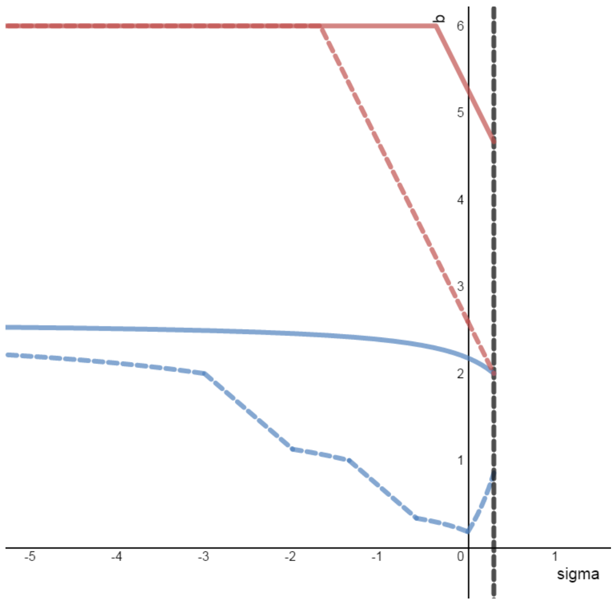
The optimal bid goes from $b^* = 2$ when $\rho = \sigma$ to $b^* = 6$ when $\sigma \leq \frac{-17\rho}{3}$. Moreover, the optimal bid is decreasing in sigma while it is increasing in rho for $\sigma > 0$ and decreasing in rho for $\sigma < 0$. Thus, similar to what happens in CO/RS, a DA player posts higher bids than a WE player, for a given ρ.

[9] This because in equation 2 and 4 the coefficient of b^2 is $-\frac{\sigma}{12}$ which is positive.

Comparison of optimal bids across treatments

Here we compare optimal bids across conditions. Figure 5 shows an example of the optimal bids as a function of σ in the four treatments. In the figure it is assumed that the agent has a $\rho = 0.3$. The continuous lines identify conditions in which risk is borne by the decision maker $(\cdot/RS)$ and the dashed lines conditions in which risk is borne by the other $(\cdot/RO)$; the blue lines identify conditions in which the cost is borne by the decision maker $(CS/\cdot)$ and the red lines conditions in which the cost is borne by the other $(CO/\cdot)$.

Figure 5: Optimal bids $b^*(\rho = .3)$



The blue solid line represents the optimal bid for CS/RS; the blue dashed line represents the optimal bid for CS/RO; the red solid line represents the optimal bid for CO/RS; the red dashed line represents the optimal bid for CO/RO.

We start by comparing the bids b^* when risk is shifted from the decision maker to the other agent. Thus, we compare i) $b^*_{CS/RS}$ and $b^*_{CS/RO}$ and ii) $b^*_{CO/RS}$ and $b^*_{CO/RO}$. We obtain that

- for $CO/\cdot$, we have that b^* when the risk is borne by the decision maker is bigger than b^* when the risk borne by the other when $\frac{10-7\rho-3\sigma}{5\rho} \geq \frac{13\rho-3\sigma}{5\rho}$, i.e., when $\rho \leq 0.5$.

- for $CS/\cdot$, we need to compare b^* when the risk is borne by the decision maker, i.e., $\frac{10+3\rho-13\sigma}{5(1-\sigma)}$ with all the cases of b^* when the risk is borne by the other.

  We start with $\sigma < 0$. In this case it is easy to check that, on the odd intervals, $\frac{10+3\rho-13\sigma}{5(1-\sigma)}$ is always bigger than b^* when the risk is borne by the other. Consider now the second interval, i.e., $\left[\rho - \frac{5}{3}, \frac{\rho-\sqrt{60\rho-35\rho^2}}{6}\right]$, and suppose that $\frac{10+3\rho-13\sigma}{5(1-\sigma)} < \frac{-2\rho-3\sigma}{5(1-\rho)}$. This implies that $\sigma < \frac{11\rho-10-\sqrt{85\rho^2-280\rho+220}}{6}$ but this quantity is smaller than $\rho - \frac{5}{3}$ so the optimal bid when the risk is borne by the decision maker is bigger than the optimal bid when risk is borne by the other player also on the second interval. Consider the fourth interval, i.e., $\left[\rho - \frac{10}{3}, \frac{-5+\rho-\sqrt{25+110\rho-35\rho^2}}{6}\right]$, and suppose $\frac{10+3\rho-13\sigma}{5(1-\sigma)} < \frac{-7\rho-3\sigma}{5(1-\rho)}$. This implies that $\sigma < \frac{6\rho-10-\sqrt{220-120\rho}}{6}$ but this contradicts $\sigma \geq \rho - \frac{10}{3}$ and, hence, also on the fourth interval the optimal bid when the risk is borne by the decision maker is bigger than the optimal bid when risk is borne by the other player.

  For $\sigma \geq 0$ we have that $\frac{10+3\rho-13\sigma}{5(1-\sigma)} \geq \frac{7\sigma+3\rho}{5(1-\sigma)}$ is satisfied when $\sigma \leq 0.5$. Given that $\sigma \leq \rho$ by assumption, $\rho \leq 0.5$ is a sufficient condition to ensure that the optimal bid when the risk is borne by the decision maker is bigger than the optimal bid when the risk is borne by the other player.

To summarize, any decision maker, irrespective of her social preferences, is going to bid higher when risk is borne by her than when risk is borne by the other, keeping fixed the subject paying to turn the cards. If we (reasonably) assume $\rho \leq 0.5$, we can completely rank the bids in the four experimental conditions by knowing that the optimal bid in CS/RS is always smaller than the optimal bid in CO/RO, i.e. $\frac{13\rho-3\sigma}{5\rho} \geq \frac{10+3\rho-13\sigma}{5(1-\sigma)}$ when $\sigma \leq \rho$ and $\rho \leq 0.5$. Then, for a given level of ρ, we predict the following rank in optimal bids: $b^*_{CO/RS} \geq b^*_{CO/RO} \geq b^*_{CS/RS} \geq b^*_{CS/RO}$. Moreover, in CO/RS and CO/RO we should observe $b^* \geq 2$, while in CS/RS and CS/RO we should observe $b^* \leq 2.6$. As shown also by Figure 5, this implies that the difference between optimal bids is more pronounced when shifting the cost from the decision maker to the other than when shifting the risk.