Investment in Risk Protection and Social Preferences
An Experimental Study

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Abstract

Individual decision making under uncertainty has been widely investigated in experimental economics, but only recently the literature has paid attention to risky choices having direct spillovers on others' welfare. We investigate how individuals access other's resources to protect themselves and how they access their own resources to protect others. Furthermore, we study behavior in a condition of delegated risky decision making, where incentives are not aligned. We assess behavior in the experiment against predictions obtained from a well-known social preferences model. In line with our predictions, we find that: i) individuals invest more of other's resources than of own resources to protect themselves; ii) individuals invest more of their resources in risk protection when risk is borne by themselves than when risk is borne by the other; iii) individuals invest more in risk protection when delegated to choose for others than when choosing for themselves. Our work contributes to the growing literature about choices in risky environments with social spillovers and sheds new light on the role of social preferences in risky environments.

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

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1 Introduction

In everyday life we are often offered proofs of how we care about each others. Simply think of how many people are willing to give up part of their time and resources in order to help who is need. Some examples can be children's sponsorship, volunteering works, humanitarian aids, or even just more simple actions we sometimes do to help someone. To a greater extent, this type of actions are not driven by any specific incentive or reward, but they depend mostly on our concerns for other individuals.

Socially oriented choices have been the focus of several previous studies that explain how people tend to make their decisions depending on how these will affect themselves and others. In other words, individuals usually decide according to certain social preferences (e.g., Fehr and Schmidt (1999)).

Nevertheless, as Saito (2013) points out, it would not be enough to simply rely on social preferences to understand people's decision making in everyday life. The reason is that often individuals know that they will be affecting others with their decisions, but they are not sure how; in fact, the consequences that an action can cause to others can be to some extent uncertain. This means that, when making decisions of this kind, people's choices may be driven by a component of risk that can determine the effects of their choices on other individuals.

Previous experimental studies have widely documented that people are characterized by certain preferences and attitudes toward risk. A relevant study by Andersen et al. (2006) demonstrates that subjects in the laboratory appear to be generally risk averse. Yamada et al. (2013) explain how humans may have inherited this attitude toward risk from evolutionary relatives; in fact, the authors find that also monkeys seem to be slightly risk averse and that their behavior, as in the case of humans, is highly depending on their wealth.

When enlarging the scope to encompass social preferences, it is not possible to just rely on findings collected in a social vacuum to make an analysis when the consequences of the choices made by the decision-maker also affect others. In fact, studies on individuals' risk preferences are helpful in predicting individuals' decision-making under risk, but this only leaving out the social dimension.

A wider analysis of decision making under risk should include both these aspects: risk preferences and social preferences. For this reason, many recent studies have been focusing on the field of *delegated decision making*. Specifically, this is a process in which an individual has to make risky decisions investing someone else's money. Although people have been proved being generally risk averse by nature, the emerged evidence about delegated decision making is mostly sparse and contradictory (Harrison et al. 2005, Baker et al. 2008).

One relevant study by Agranov et al. (2013) provides evidence of what the authors define as the "Other People's Money" effect. In more details, Agranov et al. utilize an experimental setting where delegated agents have to manage investors' money and both parties' incentives are aligned. Results show how other people's money is invested with much lower risk aversion than how it is done with agents' own one.

Also Chakravarty et al. (2011) conduct a study on delegated agents' behavior and find that individuals deciding over someone else's money are generally less risk averse, or even risk-loving, with respect to individuals making decisions for themselves. According to the authors, such a reduction in risk aversion on other people's money is connected to delegated agents' own preferences, but also to their believes about other people's preferences.

In order to provide a more clear explanation to this phenomenon, Chakravarty et al. encourage forthcoming studies to focus on two main hypotheses that have been already pointed out in the literature.

The first is that when individuals have to undertake risky decisions which have no direct payoff consequences, they tend to be less risk averse, as already shown in previous studies (Holt and Laury 2002, 2005; Harrison 2006). Experimental results provided by Chakravarty et al. seem to support this hypothesis. In fact, the authors observe that individuals are fairly risk averse when they bear directly the consequences of their actions, but when they have to decide for someone else they show a lower risk aversion.

The alternative hypothesis is related to individuals' decisions and their consequences on other people's money. Chakravarty et al. ask the subjects participating to their experiment to answer a questionnaire from which emerges how delegated decisions are not made in an attempt to predict other people's risk preferences. This means that it is not possible to exclude that subjects feel consequences of delegated decisions have social implications.

A piece of evidence which contradicts the higher propensity towards risk of those choosing for others is provided by Eriksen and Kvaløy. In their experiment, (2010) delegated agents' are more risk averse over others' money rather than over their own. Results are compatible with the concept of Myopic Loss Aversion (MLA) presented by Benartzi and Thaler (1993), but also with the existence of other regarding concerns are involved in the decisional process.

So far, studies on delegated decision making fail to provide consistent results in terms of delegated agents' risk aversion when managing others' money. Nevertheless, they show a general tendency: individuals decide differently when using others' money rather than their own. This, according to many of the authors, could be mostly related to the fact that when individuals are asked to manage other people's money they are moved by other regarding concerns and they make their choices according to their social preferences.

The role of social preferences in delegated decision-making has been addressed by some pioneering studies (Bolton et al. 2005, Brennan et al. 2008, Karni et al. 2008). Güth et al. (2008) provide evidence of how subjects show concerns for risk, even when this is borne by other individuals. Specifically, the study confirms that subjects approach risk differently depending on who has to bear it. Furthermore, the authors show that subjects are willing to pay in order to reduce the risk they have to bear. What is important to remark is that subjects characterized by socially-oriented behaviors take into consideration how risk may eventually affect consequences of their choices.

More recently, Krawczyck and LeLec (2010) conducted an experiment to investigate interactions between social and risk preferences. The authors investigate whether choices are better accounted for by a pure consequentialist model or by a procedural one. Krawczyck and LeLec's find that, even if the procedural model seem to perform better, neither this nor the purely procedural model can provide an adequate explanation to many choices made by subjects during the experiment. Thus, social and risk preferences cannot be analyzed together by simply utilizing one of these two models; indeed, these can be used as special cases, but in order to obtain a model able to completely describe individuals' behavior it is required a combination of the consequentialist and the procedural motives need to be combined. Furthermore, they show that individuals make choices that are generally socially and efficiency-oriented when these are in the domain of risk.

An additional contribution is provided by an experimentl study by Lahno and Serra-Garcia (2015). The authors explain how people affected by the presence of others tend to imitate others' decisions. This happens more frequently when the decision to imitate from others is to choose the safer option. Thus, results suggest that individuals show concerns for others' choices and pyoffs in risk taking, even if the general tendency is for subjects to prefer having an higher payoff with respect to others'.

The experimental study we present is aimed to contribute to the field of study on delegated decision making. In particular, our intent is to provide additional evidence about delegated agents' variations in risk preferences and to extend the study to a wider social dimension. Specifically, we use 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. The majority of studies in this field have focused on the changes in risk preferences when individuals make decisions on someone's behalf; the key point of these changes could be represented by social preferences, but this intuition has not been tested yet.

We find that subjects make delegated decisions with a higher risk aversion with respect to the one they show when using their own money, so our results are, from this perspective, in line with what found by Eriksen and Kvaløy (2010). 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 as subjects show a willingness to use their own wealth to buy protection for others. Although we provide a simple linear model, our results emphasize the importance of social preferences in the field of delegated decision-making.

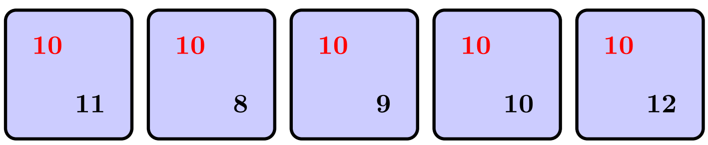
2 Methodology

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, and they have to choose the one they prefer to determine the payoff for themselves and for the recipient they are paired with. Each card delivers a payoff to the dictator and to the recipient. Knowledge about the payoffs is manipulated throughout the experiment.

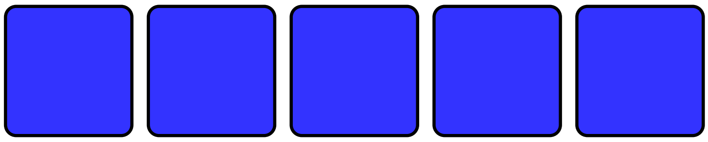
The experiment is divided into two parts. In part 1, the five cards are displayed face-up, each card reporting two outcomes in euro (see Figure 1). The value in the upper left corner of the card represents dictators' payoff (π_y), while the value in the lower right corner represents recipients' payoff (π_x). In part 1 , dictators' payoff is always equal to 10 euros, while recipients' 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 corresponding to the payoff allocation they prefer for themselves and the recipients they are paired with, and then proceed to the second part of the experiment.

Figure 1: Cards Face-up



In part 2, like in part 1, five cards delivering an outcome for the dictator and for the recipient are displayed. 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).

Figure 2: Cards Face-down



The joint outcomes for the two participants are experimentally manipulated in two treatments administered over two distinct rounds (see Section 2.2). In part 2, unlike in part 1, dictators face a genuine risk choice.

Nevertheless, before making a blind choice, dictators have the possibility to turn the five cards by participating to a lottery. This is implemented through a BDM procedure (Becker, DeGroot, and Marschak, 1964). Dictators make a monetary offer $0 \leq b \leq 6$; this value represents their willingness to pay to turn the cards. 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 ($r \leq b$), cards are turned and r is the price paid to turn the cards and solve uncertainty. If the random value drawn is higher than the value offered by subjects ($r > b$), 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 we experimentally manipulate, in a between-subjects fashion, is the individual bearing the cost of the bid made to turn the cards ($Cost$). 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 in a within-subjects fashion over two distinct rounds of part 2 is the 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 ($Risk.other$)). The recipient is the subject bearing the risk, while the dictator faces a safe payoff equal to the expected value of recipient's payoff. In the other round, recipient's payoff is always equal to 10 euros, while the dictator bears the risk of getting either 8, 9, 10, 11 or 12 euros. The order of the phases was administered to balance number of dictators and recipients bearing the risk in Phase 1, controlling thus 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 in the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento. Participants were recruited among undergraduate students, who subscribed for CEEL. The experiment was designed and administrated by using z-Tree (Fischbacher, 2007). We conducted eight experimental sessions and the total number of recruited subjects was equal to 163: 156 subjects took part in the experiment, while the other 7 were eventual replacements. Each subject received a 3.00 euros show-up fee, plus a sum that varied depending on their performance in the experiment. This was, on average, equal to 10.13 euros.

Upon their arrival, subjects are randomly assigned to a computer and receive instructions for the experiment[1]. Subjects have 5 minutes to read the general instructions and the ones related to the first part of the experiment, then these are read aloud by one of the experimenters. Once all the subjects are gone through a comprehension test, the experiment starts.

Choices are collected via a so-called vector strategy method. Initially, all the subjects are assigned to the role of dictator. The software randomly pairs subjects, but they do not know who they are paired with. Subjects all express their decisions as dictators and, only at the end of the experiment, before the determination of final payments, they are randomly divided into dictators and recipients. Note that decisions made by subjects that will be assigned the role of recipients do not affect the final payment.

In Part 1, dictators have to choose one of the five face-up cards displayed on their monitors to determine the payoff allocation for themselves and the

[1] An English translation is available in the appendix.

recipients they are paired with.

Once subjects complete the first part of the experiment, they are given two minutes to read the instructions for the second part. Then, an experimenter reads them out again and answers eventual questions. Subjects complete a short comprehension questionnaire at the computer, and the second part of the experiment starts.

Once subjects complete the second part of the experiment, they are randomly assigned the role of dictator or recipient, and they receive feedback about the three cards chosen during the experiment,one in part 1 and two in part 2, by either themselves or the dictator they are paired with. The software randomly draws one of the chosen cards to determine the final payment and the experiment ends.

Before being paid, subjects are asked to answer a few questions[2]. The first is composed of eight questions extracted from the Levenson's IPC (Internal, Powerful Others, and Chance) scale (1972) and produce a measurement of subjects' locus of control. The higher the score, the more subjects think events in their life depend on their own actions. This dimension can be considered important as experimental subjects are given the possibility to make an offer to buy the right to turn cards, but the random draw of a number highly influences the probability to obtain this right. Furthermore, subjects may want to have the more control they can over the possibility of obtaining or giving to another participant an unknown payment. Thus, subjects' locus of control may influence subjects when deciding how much they want to offer in the BDM procedure.

The second questionnaire is composed of seven questions extracted from the Domain-Specific Risk-Taking (DOSPERT) Scale (Weber et al. 2002), which measures subjects' risk attitudes. As risk is one of the key feature of our experimental design, we think it is appropriate to have some information about subjects' risk preferences.[3]

2.4 Behavioral Predictions

Choices in part 1, being risk-free, allow us to classify individuals in terms of their social preferences. At this aim, we rely on the following specification of the (12) model:

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

[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 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.

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. Depending on the payoff that dictators decide to give to recipients, they can be divided into 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 the CP types to choose the lowest outcome (i.e., $\pi_x = 8$). Strictly selfish types do not have any preference for as concerns other's payoff; thus, they are assumed to be distributed among the five outcomes.

Based on 1, we present here prediction about bid levels in alternative experimental conditions in part 2. 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 the individuals value more their own utility than the utility of the other, when being better off than the other. For the sake of simplicity, we adopt the original specification adopting a (piece-wise) linear 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 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 are going to post higher bids when the cost is borne by the other than when the cost is borne by themselves. Actually, when cost is borne by self we have that $b^* \leq 2.6$ and when cost is borne is borne by the other we have that $b > 2$.

Given our predictions, we are going to test the following two hypotheses that refer to the way decision makers manage the shifting of costs and risks between themselves and the other.

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

Hypothesis 2 *Cost borne by the Dictator.*
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 is borne by the other ($b^*_{CS/RS} > b^*_{CS/RO}$).

[4]Types are characterized by distinct parameters constellations. For welfare - enhancing iwe have that $1 \geq \rho \geq \sigma > 0$s; for competitive we have that ($\sigma \leq \rho \leq 0$; for difference averse we have that $\sigma < 0 < \rho < 1$; finally, for a selfish individual we have $\sigma = \rho = 0$.

Our model predicts that individuals are addressing risk differently when risk and costs are entirely born by self (CS/RS) and by the other (CO/RO) . Thus, our model provides us with a clear cut guidance to compare how individuals behave in a condition of delegated risky decision, when they choose for others with other's resources, and when they choose for themselves with their own money.

Hypothesis 3 *Delegated risky choice.*
Decision makers 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 ($b^*_{CO/RO} > b^*_{CS/RS}$*).*

For what concerns alternative social preference types, we obtain that for the same level of ρ, DA are predicted to post higher bids than WE in all conditions, but CS/RO. In this condition, b^* is decreasing for $\sigma < 0$ and increasing for $\sigma > 0$ and this complicates the comparison between the two types, being $\sigma < 0$ for the DA and $\sigma > 0$ for the WE. Furthermore, the difference in bids between condition CS/RS and conditions CO/RS, CO/RO is going to be larger for DA than for WE.

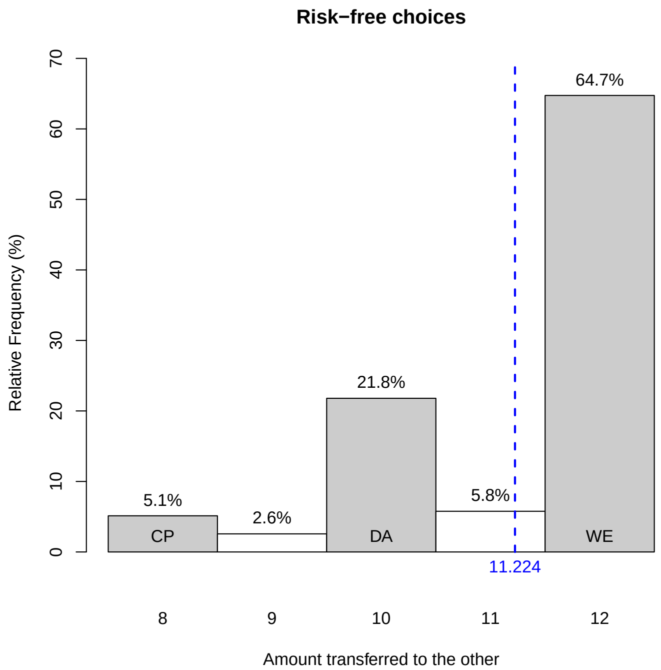
Hypothesis 4 *Risk protection and social types.*
Overall, DA types are going to buy more protection from risk than WE types ($b^*_{DA} > b^*_{WE}$*).*

3 Results

3.1 Classification of Social Types

Bars in Figure 3 show the distribution of choices in Phase 1, when cards are face up and there is no uncertainty. The darker part of the bar captures the share of participants that fall into a specific social type categorization, according the CR model presented above. Respectively, among those giving 8, 10, and 12 we can identify 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 very a high average transfer (11.2), close to the maximum of 12. The Figure reports also our classification in terms of social types, with the large majority classified as Welfare Enhancing (WE), followed by Difference Averse (DA), and Competitive (CP).

3.2 Investment in Risk Protection

Figure 4 provides us with a representation of the distribution of willingness to pay (WTP) choices in the four experimental conditions. 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 in correspondence to a given level of WTP. Crosses identify average choices.

Figure 4: Distribution of WTP across Conditions

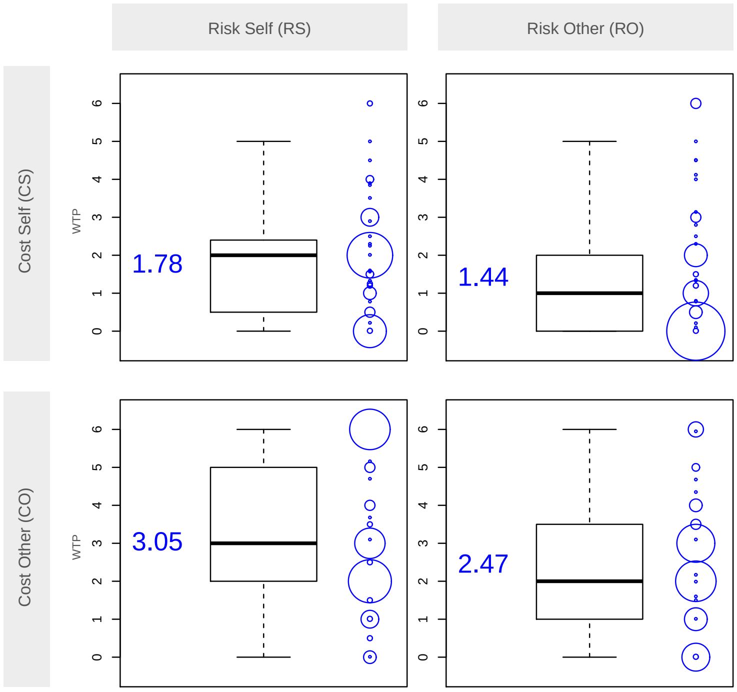


Figure 4 shows that the highest average (median) bid is observed in condition CO/RS and the lowest in condition CS/RO. The figure provides full support to the predictions of section 2.4, with bids in alternative conditions reflecting hypothesis obtain from the CR model : $b^*_{CO/RS} \geq b^*_{CO/RO}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

Behavioral predictions reported inform us that when cost is borne by the dictator, bids are expected to be lower or equal than 2.6. Non-parametric tests show that this is the case both in condition CS/RO and in condition CS/RS (Wilcoxon signed rank test, both p-values < 0.001). In contrast, when the cost is borne by the other bids should be above a lower bound of 2. Also in this case, non-parametric tests provide support to the predictions, both in condition CO/RO and in condition CO/RS (Wilcoxon signed rank test, both p-values < 0.037).

Choices in condition CO/RS show that participants use other's resources to protect themselves from risk, by choosing a positive WTP (WST, $p - value < 0.001$).[5] However, unlike predicted by selfishness 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 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 other's resources than of own resources in protection from risk affecting themselves.*

Choices in condition CS/RO inform us of the degree of concern for other's risk when own resources are at stake. In contrast to what predicted by pure selfishness, the average level of WTP in this condition is different than zero (WST, $p - value < 0.001$). An assessment of such altruistic concerns, relative to concerns for self, is obtained by comparing choices in condition CS/RO and in condition CS/RS . The negative difference between the two conditions is statistically significant (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 is borne by the other.*

The comparison between condition CS/RS and condition CO/RO suggests that our participants tend to attach higher 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 WTP in the latter are statistically higher than in the former (Wilcoxon Rank Sum tests, 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 on summary statistics about WTP choices in alternative experimental conditions and for the two most represented social types: inequity-averse (DA), and competitive (CP).[6]

As from Table 2, the highest average (median) bid is observed in condition CO/RS for the difference averse types, while the lowest average (median) bid is observed in condition CS/RO for the difference averse types. When comparing bids of the DA and 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, 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 other's resources in protection from risk than WE types.*

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 as WE (135 individuals). The dependent variable in the model is given by WTP, a direct measure of investment in risk protection. In 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 self 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 difference averse from the choice in the first task and equal to 0 when classified as welfare enhancing. The dummy variable $type.DA$ is also considered in interaction with treatment dummies. Finally, in Model 3 we add a few controls for demographics 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 ($CS = -1.026$).

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

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

In contrast, more protection is bought when risk affects the dictators 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 reported above in Result 3.

Model 2 takes into account the impact of treatment dummies, controlling for social preferences. As from the outcomes 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 is 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, as reported above in Result 4.

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

4 Discussion and Conclusions

We ran an experiment to investigate the role of social preferences in delegated risky decision making. With our results we contribute to the burgeoning literature on delegated risky decision by providing an additional analysis and we also shed new light on two fundamental questions: do individuals use more resources to offset risk when using other's money or when using own money? Do individuals use more resources to offset risk borne by themselves or risk borne by others?

In the first part of the experiment we categorized subjects according to their social preferences; this allowed us to focus our analysis on difference-averse and welfare enhancing types. In line with our predictions, we find that individuals tend to have self-centered risk attitudes when they can use others' money to exploit personal benefits. Specifically, during the experiment, subjects bought more protection against the risk they were bearing when they had the opportunity to pay for such a protection by using others' resources with respect to the case in which they had to pay with their own.

In addition to this, subjects invested more money to by protection from risk when they bear it with respect to the situation where the risk is borne by the other.

We also find, in accordance with previous studies, that individuals invest more in risk protection when they are making delegated choices rather than when they are choosing for themselves. In particular, difference averse types tend to invest more of other's resources when buying protection from risk than welfare-enhancing types.

The most important result we obtained is given by the accuracy in behavioral predictions provided by a model for social preferences. In fact, the majority of the studies in this field has been focusing on the role of risk preferences in delegated decision making; only recently, some authors have stressed that social preferences might have a role in such a decisional environment.

Evidence collected in our experiment may also have important implications for all agency problems involving choices with non-deterministic consequences.

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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.

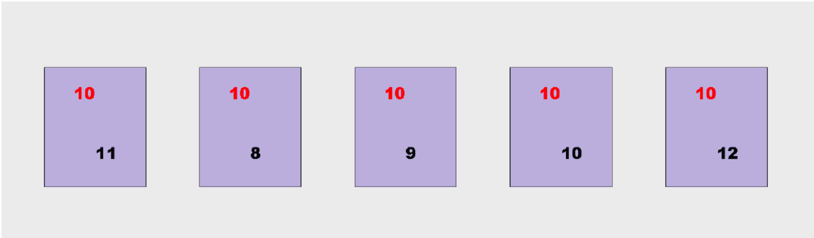
Following you will receive the instructions for the first part of the experiment. Once the first part will end, you will receive the instructions for the second part. We ask you to read the instructions carefully. Before the beginning of each part of the experiment you will have to answer some questions 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 aboout 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 $\pi^1, \ldots, \pi^5$ 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 (2002) (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

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

Possible outcomes are $\pi^1 = (8, 10)$, $\pi^2 = (9, 10)$, $\pi^3 = (10, 10)$, $\pi^4 = (11, 10)$, and $\pi^5 = (12, 10)$ and the price p is paid by the decision maker. Decision makers post a bid b that maximizes their expected utility, as measured by the CR model (equation 2) reported above. 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:

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

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, $b^* = 2$ 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 case the outcomes are the same as in the previous case but the price p is paid by the other player. 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)

Possible outcomes are $\pi^1 = (8, 10)$, $\pi^2 = (9, 10)$, $\pi^3 = (10, 10)$, $\pi^4 = (11, 10)$, and $\pi^5 = (12, 10)$ and the price p is paid by the decision maker. Accordingly, 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

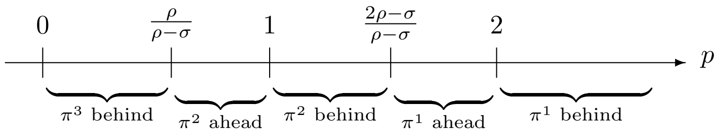
$$EU[b] = \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\sigma)(10-p) + \sigma 12\right]\mathrm{d}p \tag{8}$$

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.

As an example, 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 result 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 remains 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 behaviour 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 behaviour depends on the value of sigma. The behaviour 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)

The outcomes are the same as in CS/RO, but the price p is paid by the other player. 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

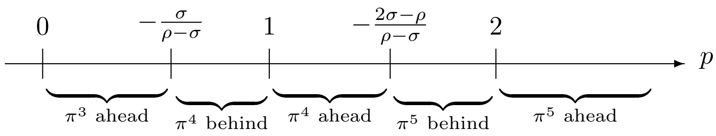
$$EU[b] = \begin{cases} \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^b \frac{1}{6}\left[(1-\sigma)10 + \sigma(12-p)\right]\mathrm{d}p & if \quad b < 2 \\ \left(1 - \frac{b}{6}\right)(50 - 3\rho + 3\sigma) + \int_0^2 \frac{1}{6}\left[(1-\sigma)(10) + \sigma(12-p)\right]\mathrm{d}p + \\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

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

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

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 $\sigma \ge 0$.

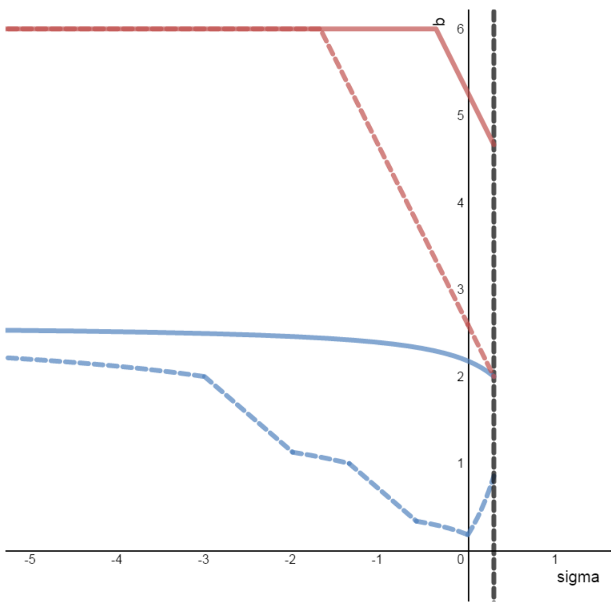
The optimal bid goes from $b^*=2$ when $\rho=\sigma$ to $b^*=6$ when $\sigma \le \frac{-17\rho}{3}$. Moreover, the optimal bid is decreasing in sigma while it is increasing in rho for $\sigma>0$ and decreasing in rho for $\sigma<0$. Thus, similar to what happens in CO/RS, a DA player posts higher bids 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 the optimal bids of agents across treatments. 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 the decision maker bears the risk ($\cdot/RS$) and the dashed lines conditions in which the other bears the risk ($\cdot/RO$); the blue lines identify conditions in which the decision maker bears the cost ($CS/\cdot$) and the red lines conditions in which the other bears the cost ($CO/\cdot$).

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



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

We start by comparing the bids b^* hen 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 him 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 n 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.