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**SOCIAL PREFERENCES UNDER RISK:
MINIMIZING COLLECTIVE RISK VS.
REDUCING EX-POST INEQUALITY**

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Social Preferences under Risk*

Minimizing collective risk vs. reducing *ex-post* inequality

Alexia Gaudeul[†]

May 26, 2016

We refine the understanding of individual preferences across social lotteries, whereby the payoffs of a pair of subjects are exposed to random shocks. We find that aggregate behavior is *ex-post* and *ex-ante* inequality averse, but also that there is a wide variety of individual preferences and that the majority of subjects are indifferent to social concerns under risk. Furthermore, we determine whether subjects are averse to collective risk — the variability in the sum of payoffs of the pair. We do so by varying the presentation of payoffs. They are shown side by side in one treatment and added-up in the other. The first presentation draws attention to inequality in payoffs, the second to collective risk. We find that subjects dislike lotteries that lead to *ex-post* unequal distributions of payoffs in both cases and that emphasizing collective risk changes choice only marginally and not significantly, though in the direction of collective risk reduction. We conclude that *ex-post* inequality aversion is the primary concern in the evaluation of social lotteries while collective risk is only of secondary interest.

JEL Codes: C91, D63, D81

Keywords: Altruism, Collective Risk, Experimental Economics, Fairness, Inequality, Risk, Social Lotteries, Social Preferences.

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Like all the men of Babylon, I have been proconsul; like all, I have been a slave.

Borges, The Lottery in Babylon

The literature about social preferences under risk explores whether social considerations affect risk attitudes. Indeed, risk does not play out in a social vacuum. Taking risks exposes people to changes in their position in the hierarchy of wealth. Some risks are systematic, that is, they affect the collective outcomes of a community but not the distribution of wealth within it. Other risks are idiosyncratic as they affect only some agents while others remain safe. A final class of risks leads to a redistribution of wealth within a community without affecting that community's total welfare.

The experimental study of behavior under risk has been recently extended by outlining explicitly, when presenting a risky situation, how the risk affects not only the decision-maker's payoffs but also the payoffs of others. The literature explores whether people are more risk averse when a peer is not exposed to risk, whether they are more risk averse when deciding about the exposure to risk of others than when deciding about their own exposure, whether subjects tend to take more risk if that can allow them to catch-up with their peers, and whether subjects dislike risk that could affect their relative position *vs.* others.

This research line is of great interest to policy-makers, insurers and other risk managers and stakeholders. Questions to be answered include: Does widening inequality lead disadvantaged people to take more risk? Are risk managers taking too little risk when acting on behalf of others? Should we invest more in protection against risks that affect each individual independently or against risks that affect all the same way at the same time? Does conservative behavior by others encourage people to also avoid risk? ¹

Contribution This paper makes two main contributions. A first contribution is to refine established findings about social preferences under risk. We do so by contrasting average behavior, which is consistent with aversion to *ex-ante* and *ex-post* inequality, and individual behavior, whereby a majority of subjects are indifferent to either concern. This helps us reconcile contradictory findings. Some authors outline a lack of concern for the exposure to risk of others when one is exposed to risk. Other authors

¹Existing literature suggests answering yes to the first question, *cf.* section 1.2 and yes to the second section, *cf.* section 1.1. The first option in the third question is correct if indeed people dislike risks that increase *ex-post* inequality most, *cf.* section 1.3. The answer to the fourth question is unclear – people in groups tend to take more risks, *cf.* Gardner and Steinberg (2005), but it is unclear if this is due to imitating the more risky behaviors of others or simply to the fact of being in a group.

show that the perception of risk depends on one's relative position in terms of wealth and on the effect of risk on *ex-post* wealth distribution. We show that the minority of subjects who are sensitive to social concerns under risk is sufficiently averse to inequality to significantly affect aggregate statistics describing overall group behavior.

A second contribution of this paper is to consider whether people are averse to *collective risk*. Collective risk (Rohde and Rohde, 2015) is also sometime referred as aggregate, undiversifiable or systematic risk.² Much research has focused on whether people pay attention to *ex-ante* and *ex-post* inequality, but very little research considers whether people also try to reduce risk at the collective level by avoiding risks that make overall welfare more variable across contingencies.

The importance of collective risk Aversion to collective risk has been called “catastrophe avoidance”, for example in Fleurbaey (2010). People may want to avoid running risks that affect all in the same way at the same time because those types of risks affect the welfare of the group as a whole and thus carry special danger. To take an example, the potato blight led to the Great Irish Famine (1845-1852) in part because of over-reliance on potato for sustenance, so that there were only few substitutes available at any price when this crop failed. It might thus be that some individuals prefer risks that are spread across the group in such a way that a loss by one is compensated by a win by another.

From the point of view of evolutionary biology, populations with genes that are expressed in aversion to catastrophic risk are more likely to survive, along with their genes, over the long-term. Populations that do not carry such genes are more likely to become extinct. It would therefore be reasonable to expect individuals to dislike collective risk.³

From the point of view of a policy-maker, survival of the group is better guaranteed when collective risk is reduced. This is probably why overall stability is a major goal of public policy for many governments — equality of opportunity and of outcomes being another goal.

Issue with previous work A recent paper on this topic, Rohde and Rohde (2015), considers whether third-parties, who choose what risk other people face, take collective risk into account. Rohde and Rohde (2015) offer a menu of binary choices across lotteries that differ in terms of *ex-post*-inequality and level of collective risk. Regressions of

²This is not to be confused with *systemic* risk, which is the risk of collapse of a whole system.

³For some considerations on the relation between risk preferences and evolution, see Levy (2015). Schmidt et al. (2015) also use arguments from evolutionary biology to ground sex differences in attitudes to social risk.

choices on lottery characteristics lead them to assert that decision-makers seek collective risk and *ex-post* inequality. This finding is rather surprising, first because people generally dislike risk, so it is unclear why they would like it at the collective level, second because people generally dislike inequality, so it is rather unexpected that they would enjoy the prospect of more inequality.

The authors cannot identify their main effect with non-parametric tests. That is, they cannot decide between whether people are seeking both collective risk and *ex-post* inequality, or if they are averse to both. This is why they resort to parametric analysis. The issue with their regressions is that one cannot reduce *ex-post* inequality without increasing collective risk and *vice versa*. Indeed, indexes of *ex-post* inequality and collective risk that are used in their regressions are almost perfectly negatively correlated (Table 2 in Rohde and Rohde, 2015). In the first set of basic lotteries (a) for example, one measure goes from 0 to 2.36 and then 2.50, the other goes the other way, from 25 to 7.91 to 0. Inclusion of variations (b) and (c) on the basic lotteries only slightly alleviates the problem; the pattern is the same.⁴ Regression of the indexes of *ex-post* inequality on individual risk, collective risk and *ex-ante* inequality in their table 2 gives out a $R^2 = 0.97$. The authors transform their index values into their logarithm, which lowers the cross-correlation between their variables but does not solve the basic issue. Indeed, when replicating their main regression, we find that the average Variance Inflation Factor when all independent variables are included is 11.45 (values more than 10 are generally held to be worrisome). This indicates, as expected, that some variables are redundant.⁵

Table 6 in Rohde and Rohde (2015) reports the impact of changing the set of independent variables; we see there that the value of their coefficient estimates is very unstable, and indeed changes sign depending on the set of independent variables included in their regressions. This is because parameters in a logit regression must be estimated through a process of maximization of the log-likelihood. Because of multi-collinearity, if that process starts by putting weight on collective risk-seeking, it must reduce the weight on *ex-post* inequality aversion and *vice versa* as the index for both variables are almost perfectly negatively correlated. Starting conditions for the regressions may then determine which local maximum is reached (Myung, 2003).

Issues of multi-collinearity and convergence in Rohde and Rohde (2015) are further compounded by having only a small sample of 55 subjects who are required to make many choices between two risky alternatives. This is very difficult if we consider that

⁴The “common outcome” lottery in their menu is the only one where this pattern is broken (both independent variables take value 0). However, this lottery is also the only one with value 0 for “individual risk”, which is included as an independent variable in their regression.

⁵We thank the authors for providing us with their data.

experimental subjects are often unable to maintain consistency when choosing between one safe and one risky option. Finally, decision-makers in [Rohde and Rohde \(2015\)](#) have no strictly egoistic economic incentive to think carefully about their choice because they are paid a fixed fee independently of the decision they make. Indeed, [Rohde and Rohde \(2015\)](#) study the decision of third-parties who are unaffected by their own decisions — they are meant to represent social planners. We think that preferences of policy makers are of dubious interest. Policy makers ought to design and justify their risk policies so they correspond to the preferences of the affected population, not to their own preferences. It is also doubtful that social planners really are not affected by the consequences of their own decisions.

Overall, the method used in [Rohde and Rohde \(2015\)](#) does not achieve its stated aim. The issue with their paper is similar to the one already pointed out in [Engelmann \(2012\)](#): it is not possible to change the level of *ex-post* inequality without also affecting collective risk. Therefore, any attempt to disentangle both factors econometrically is doomed to fail. In our experiment, we use a more subtle approach whereby we vary the salience of collective risk across treatments. The reasoning is that if collective risk is a factor in decisions, then the behavior of individuals should differ across treatments.

Our method to isolate aversion to collective risk In our experiment, we contrast two types of social lotteries and two ways of presenting them to laboratory subjects. Consider positively correlated lotteries, which give the same payoff, either \$1 or \$0, to both individuals at the same time, and negatively correlated lotteries, which give either \$1 to one individual and \$0 to the other or the opposite (table 1).

Table 1: Negatively and positively correlated lotteries

	Head	Tail
Positive correlation	(1 for me, 1 for you)	(0 for me, 0 for you)
Negative correlation	(1 for me, 0 for you)	(0 for me, 1 for you)

Both type of lotteries are “fair processes of choice” ([Diamond, 1967](#)) but the positively correlated lottery is more risky at the level of the group (with probability half, the group gets \$2, else nothing), while the negatively correlated lottery minimizes risk at the social level. Preference for one lottery or the other reveals whether a subject cares more about collective risk or about *ex-post* inequality. The negatively correlated lottery is favored by a subject who cares most about reducing collective risk. He may do so to protect overall welfare, which is consistent with the literature about social preferences ([Charness and Rabin, 2002](#); [Güth et al., 2003](#); [Engelmann and Strobel, 2004](#); [Cappelen et al., 2015](#)). However, reducing collective risk can conflict with a

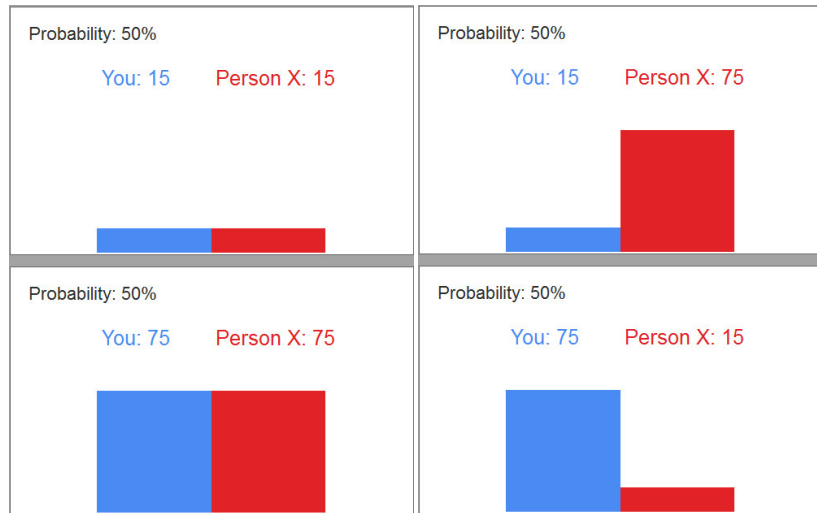
concern for maintaining equality (Fehr et al., 2006). The negatively correlated lottery generates envy *ex-post*, so that a subject who is prone to envy or who dislikes inequality may anticipate his *ex-post* feelings and prefer the positively correlated lottery instead. As mentioned in Fudenberg and Levine (2012, p.610), “misery likes company”.

Some previous social lottery experiments show that positively correlated lotteries are preferred to negatively correlated lotteries (Adam et al., 2014; López-Vargas, 2014). However, this only tells us that *ex-post* equality is important to subjects, not whether collective risk is also a concern. It could either be that subjects are insensitive to collective risk or that this concern is dominated by concern with *ex-post* inequality. The problem is that we observe only the end result of the combinations of those two forces in the choice of participants. If we observe choices that favor lotteries with equality *ex-post*, then this can either mean that people care only about reducing *ex-post* inequality, or that both forces play a role but inequality aversion dominates.

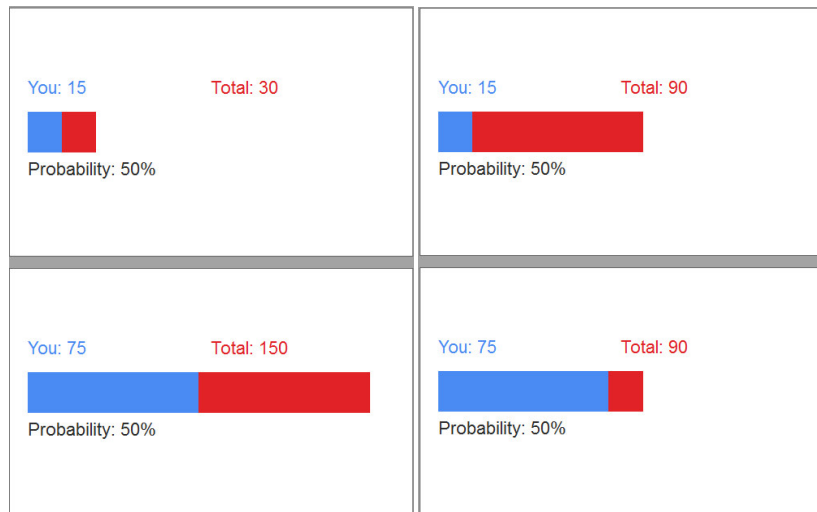
In order to know which of those alternatives holds in reality, we therefore run two treatments that vary the strength of those two forces: one treatment reinforces concern for inequality; the other treatment reinforces concern for collective risk. We do this by changing the way payoffs are presented. Previous experiments presented payoffs either in terms of numbers (payoffs for me, payoff for the peer), or in figures with columns of a height corresponding to each person’s payoffs shown side-by-side. This way of presenting payoffs is not conducive to considering risk at the level of the group. Indeed, the subject sees payoffs for himself and his peer and has to think further to compute the sum of payoffs for himself and his peer in each situation.

We therefore run a treatment where the distribution of payoffs is shown as a share of the total (the “collective” treatment) and compare results in that treatment with the usual treatment where the individual payoffs are shown side-by-side (the “inequality” treatment). Showing payoffs for oneself and the other side-by-side leads subjects to focus on individual payoffs comparisons rather than on collective payoff. Presenting payoffs added up leads subjects to pay more attention to collective welfare. If collective risk actually influences choice, then behavior should differ across treatments — while subjects would have more of a tendency to avoid *ex-post* and *ex-ante* inequality in the “inequality” treatment, they would have more of a tendency to avoid collective risk in the “collective” treatment. If collective risk is not important however, then behavior in the “collective” treatment would not be significantly less risky at the collective level than in the “inequality” treatment.

Figure 1 shows the way we presented payoffs for positively and negatively correlated lotteries in our “inequality” treatment, on top, and in our “collective” treatment, below.



(a) "Inequality" treatment (positive correlation on the left, negative correlation on the right)



(b) "Collective" treatment (positive correlation on the left, negative correlation on the right)

Figure 1: Graphical representation of payoffs in the experiment, examples

Changing the representation of social lotteries across treatments is a simple way for us to alter the way that subjects think about the social situation. Such "logically equivalent descriptions of a decision problem" should not affect behavior according to consequentialist theories of choice (Bardsley et al., 2010, p.23). However, a large body of research shows that such changes in framing do in fact affect behavior (Tversky and Kahneman, 1981; Nikiforakis, 2010; Dufwenberg et al., 2011). Varying how we visually represent a risk can therefore change how people feel and reason about a given social

risk.

While this manipulation is artificial, there are actual differences in how social risk is presented to people depending on the type of risk, who is presenting it, and the target audience. For example, insurance companies generally focus on making people aware of their own exposure to a given risk even when that risk would affect others equally – when advertising for flood protection for example. The State on the other hand may try to motivate investments in police and national security by drawing attention to the protection of the welfare of the population as a whole.

1. Literature review and hypotheses

Now that we introduced the motivation, contribution and method of this experiment, we are ready to go more into details about the experimental literature. Our experiment is most similar to [Bolton and Ockenfels \(2010\)](#) in its design. We also draw inspiration from the analysis in [Adam et al. \(2014\)](#), who divide subjects into types, those who are indifferent to the social context and those who respond to it. The literature has focused on three main issues: do people avoid imposing risk on others, are they sensitive to *ex-ante* inequality, and does *ex-post* distribution of payoffs matter?

Consider social lottery $L = ((m_1, y_1), p; (m_2, y_2), 1 - p)$ that obtains outcome m_1 for **me** (decision-maker) and y_1 for **you** (recipient) with probability p , and outcome m_2 for me and y_2 for you with complementary probability $1 - p$. The utility of this lottery can be decomposed as follows:

$$\begin{aligned}
 U(L) &= p \cdot u(m_1) + (1 - p) \cdot u(m_2) + \dots & (1) \\
 &\dots + \theta \cdot (p \cdot v(y_1) + (1 - p) \cdot v(y_2)) + \dots \\
 &\dots + \lambda \cdot (p \cdot V(m_1 - y_1) + (1 - p) \cdot V(m_2 - y_2)) + \dots \\
 &\dots + \gamma \cdot (p \cdot W(m_1 + y_1) + (1 - p) \cdot W(m_2 + y_2))
 \end{aligned}$$

whereby u, v, V, W are functions. [Expression 1](#) delineates some hypothesized drivers of behavior in social risk experiments. The first part of the expression is a standard individual expected utility function.

The second part, prefixed by θ , is the expected utility derived by the peer, with $v(\cdot)$ reflecting the belief of the decision-maker about the form of the utility of his counterpart. If $\theta > 0$ and $v(\cdot)$ concave, then the decision-maker prefers not letting his peer incur a risk – more precisely, the decision maker prefers the peer to obtain the expected value of a lottery rather than playing the lottery.

The third part of formula 1 is preceded by λ and is a function of the inequality in payoffs *ex-post*, with $V(\cdot)$ the decision-maker's sensitivity to inequality. We assume that $V(x) < 0$ for any $x > 0$, $V(0) = 0$ and $V(-x) = V(x)$. This implies that the decision-maker is as averse to advantageous as to disadvantageous inequality *ex-post*. If $\lambda > 0$, then the decision maker wants to minimizing inequality *ex-post*.

Finally, the fourth part, prefixed by γ , is the expected collective welfare. If $\gamma > 0$, then the decision maker wants to minimize collective risk. Our main idea is to determine whether $\gamma \neq 0$ by varying the presentation of payoffs so as to change the relative importance of γ across treatments and thus the decisions of our subjects. Without variation across treatments, then we would not be able to assess whether collective risks are a factor in decisions.

In the following, we adopt notations from Brennan et al. (2008) to help the exposition of our hypotheses:

- U is a lottery with equal chances of two possible outcomes, high payoff \bar{U} and low payoff \underline{U} .
- u is a safe payoff, chosen such that the average subject is about indifferent between u and U . u_H and u_L are a high and a low payoff such that $u_H > u > u_L$.
- uu denotes the event where both my peer and me receive u . Uu is the case where I play lottery U and my peer receives u . uU is the case where I receive u and my peer plays lottery U .
- UU is the case where we both play lottery U independently. UU^+ is the case where payoffs for my peer and for me are positively correlated (we get the same payoff after the random draw of the lottery) and UU^- is the case where payoff for my peer and for me is negatively correlated (we get opposite payoffs after the random draw of the lottery).

1.1. Altruism implies not imposing risk on others

A *first strand* in the literature focuses on whether altruism extend to the domain of risk by investigating whether experimental subjects are averse to imposing risk on others (Brennan et al., 2008; Güth et al., 2008, 2011; Koukoumelis et al., 2013). This is implied by $\theta > 0$ in formula 1 if subjects believe their peer is averse to risk. In this literature, subjects give their willingness to pay and/or willingness to accept sure payoffs rather than play social lotteries. The authors find that subjects prefer uu to uU (safe payoff for both rather than safe payoff for me and risk for the other) but are indifferent between Uu and UU (risky payoff for both rather than risky payoff for me and safe payoff for the other). In other words, $\theta > 0$ if the decision-maker is safe and $\theta = 0$ if the decision-maker is under risk. Their explanation is that subjects are not

able to process both risk for themselves and risk for the other. Since the first is more important than the other, they focus on the first and ignore the later. Concern for one’s own risk “crowds out” distaste for imposing risk on the other.

Hypothesis 1 (Crowding out). *Experimental subjects are indifferent to their peer’s risk exposure when they are themselves exposed to risk ($Uu \simeq UU$).*

A *second strand* of literature focuses on the slightly different comparison between individual risk attitudes and attitude to risk borne by the peer. Charness and Jackson (2009); Vieider et al. (2016); Bolton et al. (2015); Pahlke et al. (2015) find that subjects are more conservative in their risk taking when faced with either UU^+ or UU^- than when faced with U , so $U \succ UU^+$.⁶ This is interpreted as responsibility aversion (Charness, 2000), whereby subjects wish to avoid blame for a bad outcome. Other interpretations are that subjects take less risk when others are involved because they generally assume others are more risk averse than themselves, or because they were socialized to be more careful with the welfare of others than with their own.

Hypothesis 2 (Responsibility aversion). *Experimental subjects are more reluctant to take risk if their choice to take risk also exposes their peer to risk.*

1.2. Inequality in safe payoffs leads to more risk taking

In a *third strand* of literature, Linde and Sonnemans (2012); Schwerter (2013); Gamba et al. (2014) explore whether people are more ready to take risk if that gives them a chance to obtain as high a payoff as their peer. The payoff of the other acts as an aspiration point — in their experiments, the peer obtains the same payoff whether the decision maker takes a risk or not. We also explore the effect of inequality in safe payoffs but in our design, the decision maker also exposes his peer to risk if he takes a risk. In that case, altruism comes into play rather than aspiration points. If $\theta > 0$ in formula 1, then for u_L low enough, a subject may prefer Uu to uu_L even if he prefers uu to Uu . In other words, he is ready to sacrifice some individual utility by taking a risk so as to avoid imposing a low payoff on his peer. Similarly, such an altruistic subject may prefer uu_H even if he prefers Uu to uu .

An experiment reported in Bradler (2009) indicates that relative position does influence choice but subjects are generally ready to make a choice that improves the situation of their peer only if their peer is worse off than themselves and not otherwise. This implies taking a risk to avoid leaving a peer with only u_L , but not taking

⁶Charness and Jackson (2009); Vieider et al. (2016) consider only positively correlated lotteries while Bolton et al. (2015) consider both negatively and positively correlated lotteries. Pahlke et al. (2015) also consider lotteries with unequal probabilities of gains of losses.

less risk to let a peer obtain u_H . This type of social preference – benevolence towards the disadvantaged, malevolence towards the privileged – has been largely documented under the rubric of inequality aversion. In terms of our notations, this implies that θ takes a different sign depending on whether the peer obtains more or less than oneself in the safe alternative.

Hypothesis 3 (Ex-ante inequality aversion). *Subjects have competitive preferences if the peer is advantaged in the safe option and have altruistic preferences if the peer is disadvantaged in the safe option. Therefore, inequality in the safe alternative increases willingness to take risk.*

This hypothesis thus predicts that there is more risk taking if the peer receives more than oneself does in the safe option even though the peer would prefer the safe option, and there also is more risk taking if the peer receives less than oneself does in the safe option (because the peer would prefer the risky option).

1.3. The conflict between aversion for *ex-post* inequality and aversion for collective risk

A *fourth strand* of the experimental literature focuses on the role of procedural fairness in the evaluation of social lotteries (Krawczyk and Le Lec, 2010; Krawczyk, 2011; Brock et al., 2013; Andreozzi et al., 2013; Linde and Sonnemans, 2015). The main point of this literature is that we cannot directly infer preferences over social risks from social preferences over *ex-post* outcomes. Rather, subjects might care only or mostly about *ex-ante* equality, *i.e.* the utility of the expected outcomes rather than the expected utility of the outcomes. In this case, *ex-post* distribution of payoffs matters little to subjects as long as everyone has equal chances of obtaining each possible outcomes.

A related theoretical literature focuses on the conflict between *ex-ante* and *ex-post* inequality and underlines why concern for one is not compatible with concern for the other (Trautmann, 2009; Fudenberg and Levine, 2012; Saito, 2013). The social choice literature identified this problem long ago (Diamond, 1967; Broome, 1984; Machina, 1989). In the terms of equation 1, and if $\lambda = \gamma = 0$ then a subject is indifferent between UU^+ and UU^- . If $\lambda > 0$ and $\gamma = 0$ then a subject prefers UU^+ to UU^- . If $\lambda = 0$ and $\gamma > 0$ then the subject prefers UU^- to UU^+ as this implies less risk at the collective level. If $\lambda > 0$ and $\gamma > 0$ then UU^- is preferred to UU^+ if $\lambda \cdot V(\bar{U} - \underline{U}) + \gamma \cdot W(\bar{U} + \underline{U}) > \gamma \cdot (p \cdot W(2\bar{U}) + (1 - p) \cdot W(2\underline{U}))$.

Our first hypothesis is the null, *i.e.* $\lambda = \gamma = 0$, which implies $UU^+ \simeq UU^-$. Under that hypothesis, subjects do not care about the outcomes of a payoff allocation procedure as long as it is fair. Furthermore, they consider stochastic allocation procedures as fair if they lead to the same expected outcome for all.

Hypothesis 4 (Preference for procedural fairness). *Subjects are indifferent to differences in ex-post distribution of payoffs as long as both of them have the same opportunities*

Hypothesis 4 implies that decision-makers value negatively correlated lotteries (a good outcome for one means a good outcome for the other) the same as positively correlated lotteries (a good outcome for one means a good outcome for the other), as long as both lotteries do not differ in terms of *ex-ante* expected utility for one and for the other.

An alternative hypothesis is that of *ex-post* inequality aversion ($\lambda > 0$), which implies $UU^+ \succ UU^-$; subjects prefer stochastic allocations procedures that lead to equal outcomes for all.

Hypothesis 5 (Preference for distributive fairness (Ex-post inequality aversion)). *Subjects prefer lotteries that minimize ex-post differences in outcomes across decision-maker and recipient.*

The above hypothesis would seem to result directly from social preferences under certainty and the capacity of subjects to anticipate their own feelings *ex-post* (Loewenstein et al., 2001). There is some support in the literature for this “misery likes company” effect (Fudenberg and Levine, 2012, p.610). Indeed, Adam et al. (2014); López-Vargas (2014); Friedl et al. (2014) report dislike for negatively correlated lotteries. Bolton and Ockenfels (2010); Linde and Sonnemans (2015) find no evidence of *ex-post* inequality aversion. Krawczyk and Le Lec (2010) and Brock et al. (2013) state however that a mix of procedural (*ex-ante*) and distributive (*ex-post*) preferences is the best explanation for choices, thus allowing for a combination of hypotheses 4 and 5.

1.4. Attitudes to *ex-post* inequality depend on the presentation of payoffs

Our main, final and original hypothesis deals with the level of γ , which measures concern for collective risk. We argue that γ depends on how payoffs are represented:

Hypothesis 6 (Collective risk considerations). *Presenting information about payoffs for oneself and payoffs for the group, rather than about payoffs for oneself and payoffs for the peer, leads subjects to be more sensitive to social utility at the level of the group. Subjects are then more likely to choose lotteries that minimize risk at the group level.*

This hypothesis implies that negatively correlated lotteries are more likely to be chosen – and positively correlated lotteries less likely to be chosen – in the “collective” treatment than in the “inequality” treatment. In terms of our equation 1, $\gamma_{collective} > \gamma_{inequality}$.

Note that one could argue that differences in treatment could also affect choice even if $\gamma = 0$. This occurs if the “collective” treatment merely leads subjects to pay less attention to inequalities in payoffs, so $\lambda_{collective} < \lambda_{inequality}$. However, λ only affects lotteries for which there is inequality *ex-post* (see formula 1). If $\gamma = 0$ therefore, our treatment should not affect frequency of choices of positively correlated lotteries. If $\gamma \neq 0$ on the other hand, and the difference in treatment successfully leads to $\gamma_{collective} > \gamma_{inequality}$, then not only will negatively correlated lotteries be chosen more often chosen in the “collective” treatment, but positively correlated lotteries will also be less likely to be chosen, as they are the most risky in terms of joint payoffs.

2. Design of the experiment

We asked subjects in our experiment to make choices between pairs of lotteries, lottery A on the left and lottery B on the right. Subjects made their choice on their own, without consulting their peer. Lotteries specified outcomes for oneself (“decision-maker”) and for the peer (“recipient”). As in Bolton and Ockenfels (2010), our menu of lotteries included positively and negatively correlated lotteries, and we varied the relative wealth of the recipient in the safe option. However, we also include choices where the payoff of the peer is safe even if the decision-maker chooses a risky option. The risky lottery in this case is a mid-point between negatively positively correlated lotteries, with moderate *ex-post* inequality and collective risk. Furthermore, we obtain a more precise gradation of preferences across lotteries by asking subjects to make choices between decreasing safe amounts and a given lottery, keeping payoffs of the peer constant. We employ a variation of the multiple price list design (Andersen et al., 2006; Harrison and Rutström, 2008, p.50) whereby we did not present as usual the whole list of binary choices in a table, but rather presented the equivalent of each row of such a table one after the other on the screen, from the highest valued sure payoff to the lowest. As discussed, the representation of the two social lotteries depended on the treatment (figure 1).

Social lottery pairs are indexed as $l = \{Aa, Ab, \dots, Cc\}$ (table 2). Payoffs $X \in \{58, 53, 49, 46, 44, 42, 40, 38, 36, 34, 31, 27\}$ were shown one after the other in descending order. The risky option was a lottery with equal changes of 15 and 75 ECU for the decision maker, while payoff for the recipient was 40 ECU in case of no-correlation, 15 and 75 ECU in case of positive correlation and 75 and 15 ECU in case of negative correlation. As in Bolton and Ockenfels (2010), we also vary the payoff of the peer in the safe option. The recipient got 40 ECU in the “equality” situations, 30 ECU in the “advantage” situations and 50 ECU in the “disadvantage” situation. We chose 40 ECU because we

expected the average subject to be about indifferent between receiving that payoff or playing the lottery in the absence of their peer. They would thus not feel advantaged or disadvantaged in the “equality” treatment if they kept on switching from the safe to the risky option at that point.

Table 2: Menu of social lotteries

Label	Situation		Safe option (A)		Risky option (B)			
			Payoffs	Proba	Payoffs 1	Proba	Payoffs 2	Proba
Aa	Equality	No correlation	(X,40)	100%	(15,40)	50%	(75,40)	50%
Ab		Positive corr.	(X,40)	100%	(15,15)	50%	(75,75)	50%
Ac		Negative corr.	(X,40)	100%	(15,75)	50%	(75,15)	50%
Ba	Advantage	No correlation	(X,30)	100%	(15,40)	50%	(75,40)	50%
Bb		Positive corr.	(X,30)	100%	(15,15)	50%	(75,75)	50%
Bc		Negative corr.	(X,30)	100%	(15,75)	50%	(75,15)	50%
Ca	Disadvantage	No correlation	(X,50)	100%	(15,40)	50%	(75,40)	50%
Cb		Positive corr.	(X,50)	100%	(15,15)	50%	(75,75)	50%
Cc		Negative corr.	(X,50)	100%	(15,75)	50%	(75,15)	50%

Individual risk attitude was elicited similarly by presenting a succession of binary choices between descending payoffs X , with $X \in \{58, 53, 49, 46, 44, 42, 40, 38, 36, 34, 31, 27\}$, and a lottery with equal chances of 15 and 75 ECU.

Social value orientation was elicited by showing pairs of safe social outcomes (Table 3). Choice between option A and option B in this menu allows us to classify individuals as competitive, altruistic or egoists. For example, a subject who chooses B for choices S1-S5 and A for choices S1-S5 is an egoist (cares only about maximizing his own payoff), a subject who always chooses A is competitive (tries to minimize the difference between himself and the other), and a subject who always chooses B is an altruist or maximizes collective welfare.

Table 3: Menu of safe social outcome comparisons, with pattern of choice by an egoistic, a competitive and an altruistic subject

Label	Payoffs A	Payoffs B	egoist	competitive	altruist
S1	(40,40)	(42,45)	B	A	B
S2	(40,40)	(42,50)	B	A	B
S3	(40,40)	(42,55)	B	A	B
S4	(40,40)	(42,60)	B	A	B
S5	(40,40)	(42,65)	B	A	B
S6	(40,40)	(38,45)	A	A	B
S7	(40,40)	(38,50)	A	A	B
S8	(40,40)	(38,55)	A	A	B
S9	(40,40)	(38,60)	A	A	B
S10	(40,40)	(38,65)	A	A	B

As in Bolton et al. (2015) we “gradually increase the complexity of the task” by presenting first the individual choice under risk, then the social context under certainty and finally the social context under risk. In addition to this, subjects first had to practice with 5 decisions that were not incentivized, and we elicited choice in individual lotteries twice, first at the beginning of the menu of choice and then at the end, in order to account for a possible evolution of risk-preferences when subjects get more experience. We ran 9 sessions for each treatment (“inequality”, “collective”) in order to allow us to randomize the order of social lotteries across sessions. Each lottery was presented in a different order depending on the session, as per table 6 in appendix A. Overall, subjects had to make 147 binary choices, which took them 20 to 30 minutes.

We chose to ask subjects to make pairwise choices between lotteries rather than eliciting certainty equivalents because pairwise choice is more precise and less biased than other popular preference elicitation methods according to Hey et al. (2009). In adopting a variation of the multiple price list design, we were however aware of issues mentioned in Charness et al. (2013) and therefore employed the PRIor INCentive System (PRINCE) as per Johnson et al. (2014). The PRINCE system consists in giving to subjects closed envelopes at the beginning of the experiment and tell them that the decision that is going to determine their payoff is described in that envelope. This procedure alleviates the issue whereby subjects may not understand that only one of their decisions is going to determine their payoff. It reduces a potential problem whereby subjects “average” across choice situations (Holt, 1986).⁷⁸ We adapted this system for

⁷Note that Cubitt et al. (1998) does not anyway find evidence of cross task contamination effects associated with selecting one choice at random.

⁸We chosen not to ask subjects to state their certainty equivalent for the lottery as eliciting certainty equivalent for lotteries (willingness to pay, willingness to accept) is subject to reversal of preferences (Lichtenstein and Slovic, 1971; Grether and Plott, 1979). Furthermore, we would need to incentivize

our case where subjects could play different roles in the experiment and different tasks could be paid out.⁹

We followed Güth et al. (2008); Rohde and Rohde (2011); Linde and Sonnemans (2012); Gamba et al. (2014); Vieider et al. (2016) in delaying the revelation of what type, decision-maker or recipient, a subject is.¹⁰¹¹

We now explain how sessions were run and give some characteristics of our subject pool. We then go on to analyze data from the experiment.

3. Conduct of the experiment

We carried out the experiment in the experimental economics laboratory of the Friedrich Schiller University in Jena, Germany, from the 4th to the 13th of March 2015. Upon their arrival in the lab, we gave subjects some time to read printed out instructions while we played a recording of the instructions to ensure common knowledge. Instructions to participants are available in appendix G. Subjects then answered some control questions (appendix H) and we gave them the opportunity to ask questions individu-

this elicitation with the Becker-DeGroot-Marschak (“BDM”) incentive mechanism (Becker et al., 1964). This is problematic as expressing a price under that mechanism determines a lottery, so that the price may itself depend on attitude to risk. Finally, Horowitz (2006) raises some issues about incentive compatibility in the BDM mechanism. One last reason we did not want to use a BDM mechanism is that understanding the representation of social lotteries and what those imply in terms of payoffs is already quite difficult for subjects to process. Asking them to also process the explanations for the BDM mechanism would probably be too much to ask. The cost of this decision was that subjects had to make many binary choices simply for us to obtain an interval for their switching point between a safe payoff and the lottery. In practice, subjects quickly understood that only one decision mattered for each lottery, *i.e.* at what point to switch. They therefore chose very quickly across safe and risky lotteries, except for payoffs close to their switching point, when decision times increased substantially.

⁹There were 118 “decision-maker” envelopes that described one of the 9 times 12=108 social lotteries comparisons or one of the 10 safe social outcome comparisons. 2 times 12=24 envelopes described one of the individual lotteries comparisons. Before each session, and given that there were 12 subjects in each sessions, we drew 5 envelopes at random among the 118 “decision-maker” envelopes, 2 envelopes out of the 24 “individual lottery” envelopes, and added 5 envelopes assigning the subject who drew them to the role of recipient. At the end of each session, we asked subjects to open their envelopes and first called the 5 decision-makers in the social lotteries one after the other and implemented their decision in the situation described in their envelope. We then let the 5 recipients draw one of the decision-maker at random and gave them the payoff corresponding to the decision of their decision-makers. We finally called the 2 subjects who were assigned individual lotteries and implemented their decision.

¹⁰Andreoni and Miller (2002) give half of one’s payoff based on one’s decision and the other half based on the decision of the peer.

¹¹Krawczyk and Le Lec (2010) mention that if subjects care only about procedural fairness, then *ex-post* assignment of roles would make them more selfish because assignment to roles is random and therefore fair. However, the same argument also holds with *ex-ante* assignment to roles as a subject who was assigned the role of decider may reason that the recipient also had a fair chance to be a decider. We also note that reciprocal fairness can justify indifference to how one’s peer fares if one thinks the peer also chooses egoistically. This argument holds in the case of *ex-post* as well in the case of *ex-ante* assignment. We think that subjects differ in terms of whether they feel responsible for the recipient or not when assignment to roles is random.

ally. The experiment began only once all subjects had answered all control questions correctly. Subjects then went through the main part of the experiment as explained in Section 2.

We programmed and conducted the experiment with the software z-Tree (Fischbacher, 2007). Once participants were finished with both parts, we asked them to answer a short questionnaire about their decisions in the experiment (questions listed in appendix I.1, answers summarized in table 8). We also asked them some demographic information (age, gender, field of study..., see appendix I.2 for the questions, table 7 for a summary of answers) and asked them a few questions about their attitude to risk and fairness and their level of trust in others (appendix I.3, table 9).

We carried out recruitment with ORSEE (Greiner, 2004) on a subject pool that was mainly composed of undergraduate students at the Friedrich Schiller University in Jena. A total of 211 subjects took part over 18 experimental sessions, with 9 sessions for each treatment. There were 107 subjects in the “inequality” treatment and 104 subjects in the “collective” treatment. Age ranged from 19 to 62 with an average of 25. 35% of the subjects were male. Only 5% of the subjects reported knowing someone else in their session. Demographics were similar across both treatments (table 7). Subjects obtained €9.01 on average, ranging from €4.80 to €13.80, for an experiment that lasted about one hour on average.

4. Analysis of the data

We proceed to test hypotheses 1 to 5 in section 4.1, hypothesis 6 in section 4.2, and refine the test of hypotheses by looking at variations in individual responses in section 4.3. We start however by a general descriptive analysis of summary variables.

Across all choices between a safe and a risky outcome, the safe alternative was chosen 7.7 times out of 12. The average mid-point of the value interval between which subjects switched to the risky option, for those subjects who switched only once, was 37.7 ECU. As expected, the average subject is therefore about indifferent between u (40 ECU) and U (half a chance of 15 and of 75). Appendix E discusses subjects who never switched or switched more than once. Table 4 presents some summary statistics for the average number of choices of the safe option in the inequality and in the “collective” treatment, by type of lotteries.

Table 4: Number of choices of the safe option (mean, sd), by treatment and type of lottery

	“Inequality” treatment				“Collective” treatment		
	neg corr	no corr	pos corr		neg corr	no corr	pos corr
advantage	7.92 (3.20) 107	7.66 (2.97) 107	7.39 (3.39) 107	advantage	8.03 (2.96) 104	7.63 (3.14) 104	7.46 (3.07) 104
equality	8.35 (2.86) 107	8.16 (2.97) 107	7.69 (3.18) 107	equality	7.93 (2.93) 104	7.92 (2.79) 104	7.75 (2.90) 104
disadvantage	8.06 (3.02) 107	7.81 (2.95) 107	7.61 (3.13) 107	disadvantage	7.70 (2.93) 104	7.74 (2.90) 104	7.41 (3.01) 104
individual risk		7.50 (3.00) 214		individual risk		7.32 (2.96) 208	

We find that subjects prefer lotteries with positive correlation to lotteries with no correlation (they make fewer safe choices in the first case). Lotteries with no correlation are themselves preferred to lotteries with negative correlation.¹² Similarly, subjects consistently prefer safe payoffs of 40 to the recipient (“equality”) to safe payoffs with inequality, either to the advantage or to the disadvantage of the decision maker.¹³ Finally, we find that subjects are less risk averse when faced with individual lotteries than when faced with social lotteries (fewer safe choices).¹⁴

We explain and run a range of regressions to test the statistical significance of those results in the next section.

4.1. Overall regression

We test our hypotheses by using different specifications of the regression function. A first specification is based on a logit specification for choices; a second specification is based on the number of safe choices. A third type of specification compare switching point across lotteries. In doing this, we use three different indexes of risk aversion. A first is the mid-point of the interval between which a subject switched from the safe to the risky option, which we use as our estimate of the certainty equivalent CE_L of a lottery. A second measure is the “required rate of return” (ror), which is by how

¹²The only exception is the case where the safe payoff of the decision-maker is lower than that of the recipient (“disadvantage”) in the “collective” treatment, whereby negative correlation is preferred to no correlation (7.70 safe choices *vs.* 7.74).

¹³The one exception is for negative correlation in the “collective” treatment, where safe payoffs with an advantage are preferred to equality (8.03 safe choices *vs.* 7.93).

¹⁴There is one exception in the case of positive correlation with advantage in the inequality treatment, with 7.39 safe choices *vs.* 7.50 safe choice under individual risk.

much the certainty equivalent CE_L of the lottery L would need to increase to equal the expected value EV_L of the lottery: $ror = (EV_L - CE_L) / CE_L$. Measure ror is closely related to our third measure r in a CRRA utility function of the form $u(x) = \frac{x^{1-r}}{1-r}$. Graph 2 shows values of ror and r as a function of the elicited certainty equivalent of lottery $L = (15, \frac{1}{2}; 75, \frac{1}{2})$. We regress ror , r and CE on lottery characteristics.

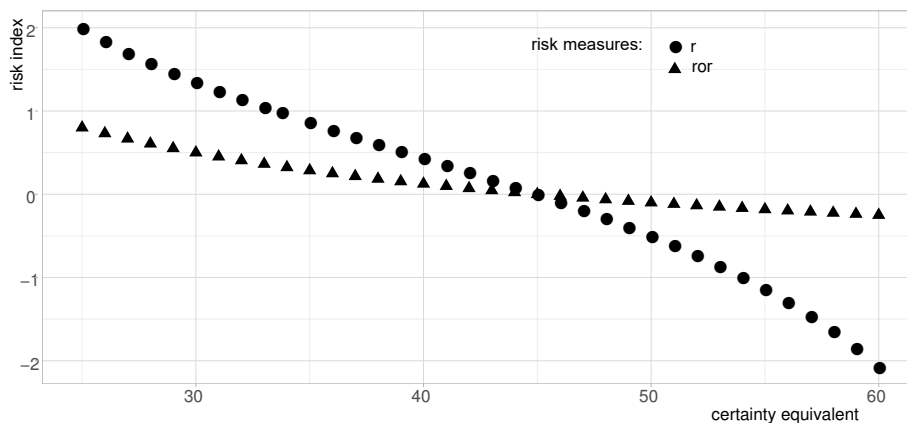


Figure 2: Two measures of risk based on certainty equivalents

The first and second specifications are robust to inconsistencies in choice patterns, while the others exclude some subjects whose choices are not consistent.

Fixed effect logit regressions are shown in column 1 of table 10 in appendix C. The regression equation is of the form:

$$\text{choice of } A = 1 \tag{2}$$

$$\text{if } \beta_0 + \beta_1 \cdot \text{value of } A + \alpha^+ \cdot UU^+ + \alpha^- \cdot UU^- + \beta_L \cdot u_L + \beta_H \cdot u_H + \alpha_R \cdot U + u_i + \epsilon_{ij} > 0$$

$$= 0 \tag{3}$$

else

with i the individual and j an index for the choice situation.¹⁵ UU^+ is a dummy taking value 1 if the social lottery is positively correlated. UU^- takes value 1 if the social lottery is negatively correlated. u_L takes value 1 if the peer receives u_L in lottery A. u_H takes value 1 if the peer receives u_H in lottery A. U takes value 1 if the subjects faces individual risk only. The base is therefore lottery Uu . We performed 100 bootstrap

¹⁵We also ran logit regressions with a dummy for each different payoffs. Results are the same except that the probability to choose the safe option increases linearly only up to safe payoff 53, beyond which it is flat.

replications to obtain normal-based 95% confidence intervals for our estimates. This is adequate for normal-approximation confidence intervals (Mooney and Duval, 1993).

Column 2 of table 10 shows estimates for a random effect panel logit regression. Age, nationality, education level, field of study, religiosity, political orientation as well as level and source of income do not influence overall risk taking. Social environment (living alone, size of town) and trust (index of trustfulness) also play no role. The only significant parameters are gender and general risk attitude (table 9). Men are less risk averse and people who report they are generally ready to take risk are indeed less likely to choose the safe option. Iterated elimination of parameters using the Bayesian Information Criterion results in only those two parameters being included in our regressions. A Hausman specification test rejects the hypothesis that a random-effects model adequately represents individual-level effects.

Column 3 of table 10 is a fixed effect regression of the number of safe choices on lottery characteristics. The regression specification is of the form:

$$\text{number of safe choices} = \beta_0 + \alpha^+ \cdot UU^+ + \alpha^- \cdot UU^- + \beta_L \cdot u_L + \beta_H \cdot u_H + \alpha_R \cdot U + u_i + \epsilon_{ij} \quad (4)$$

Column 4 shows the random-effect equivalent. A robust form of the Hausman specification test (Wooldridge, 2002, p. 291) rejects the hypothesis that regressors are uncorrelated with the group-specific error, so that only the fixed effect estimates are consistent.

Columns 5 to 10 show regressions of the same form as formula 4 but with dependent variables the certainty equivalent (CE), required rate of return (ror) and corresponding r parameter in a CRRA utility function, estimated at the middle of the interval between which a subject switched from the safe to the risky option if there was a unique switching point. Both a Hausman specification test and its robust version confirm that the random effect estimates are consistent for those regressions.

In presenting results, we focus first on the results of the logit regressions.

Result 1. *We find that $\beta_L = -0.25$ ($p < 5\%$, fixed effect regressions) and $\beta_H < -0.22$ ($p < 5\%$). This means that subjects are on average less likely to choose the safe option if the safe option gives the other more or less than 40 ECU.*

This result is consistent with *ex-ante* inequality aversion (hypothesis 3).

Result 2. *We find that $\alpha^+ = -0.24$, $p < 1\%$ and $\alpha^- = 0.16$, $p < 5\%$. This means that subjects are more likely to choose the safe option if lottery payoffs are negatively correlated, and more likely to choose the lottery if lottery payoffs are positively correlated.*

Those results are consistent with *ex-post* inequality aversion (hypothesis 5) but not with crowding out (hypothesis 1), and are also not compatible with subjects caring only about procedural fairness (hypothesis 4).

Result 3. We find that $\alpha^+ - \alpha_R = 0.28$, $p < 5\%$, so we can reject the hypothesis that $\alpha_R = \alpha^+$ (last row in table 10). This means that subjects are on average less risk averse in an individual setting than when facing positively correlated social lotteries.

Since UU^+ are the most preferred social lotteries overall, we can therefore confirm that subjects are more risk averse in a social context than in an individual setting. This result is consistent with hypothesis 2.

Results from the other specifications confirm the direction of the effects identified in the logit regressions. However, regressions based on switching points, which include fewer observations, do not evidence significant effects of negative correlation, and the effect of positive correlation is significant at the 5% level only in random effect regressions, which are however consistent (Hausman test).

Overall results are therefore not consistent with the hypothesis that subjects are indifferent to *ex-ante* or to *ex-post* inequality. The effects outlined above are not large however. The middle point of the confidence intervals for our parameter estimates correspond to the effect of changing safe payoffs by about 2 ECU, or increasing the number of choices of the safe option by one half, or increasing one's required rate of return by 2%. The two-sided 95% confidence interval for our parameter estimates indicate that the real effect of several aspects of the social context could be close to 0.

Robustness

Demographic variables We performed regressions to consider whether social risk preferences differed by demographic sub-groups: males (34% of the sample), students of social sciences (36%), those who lived most of their life in towns with more than 100,000 inhabitants (32%), those who indicated they were religious (22%), those who were politically on the left (36%), and those who reported living alone (32%). We find that demographic variables sometime affect estimates of our parameters (table 11). Students of social sciences are indifferent to advantageous inequality while other subjects dislike it ($\beta_L = 0$ vs. $\beta_L = 0.45$, difference significant at the 2% level, regression on number of safe choices). This is consistent with less concern for others. Subjects who identified politically on the left were indifferent to positive correlation in lotteries, while others liked it ($\alpha^+ = 0$ vs. $\alpha^+ = -0.42$, difference $p < 1\%$). A similar difference occurred for subjects who reported living with other people ($\alpha^+ = -0.12$ vs. $\alpha^+ = -0.59$, difference $p < 5\%$). This is consistent with more concern for overall welfare.

Feedback on decisions 52% of our subjects reported not taking their peer into account (question 7 of questionnaire I.1). Those subjects found the choice tasks easier to perform than those who reported that they took into account their peer (question 3 of questionnaire I.1, average 1.71 vs. 2.12, diff. $p < 1\%$). The difficulty of taking into account both risk and social concerns may therefore be a factor leading to social concerns being crowded out in the mind of some of our subjects (as per hypothesis 1).

Subjects who reported taking their peer into account were more averse to negative correlation in payoffs (table 12, $\alpha^- = 0.47$ vs. $\alpha^- = -0.09$, difference $p < 1\%$) and were keener on positive correlation ($\alpha^+ = -0.44$ vs. $\alpha^+ = -0.11$, difference $p < 5\%$). The behavior of subjects who reported not taking their peer into account was indeed not significantly affected by the payoffs of their peer or by correlation in payoffs, but they were more risk averse in social lotteries than in individual lotteries, so the social setting did affect their perception of risk like it did for other subjects.

Correcting choices for inattention, errors and indifference We ran the same regressions while correcting patterns of choice that indicate inattention, errors or indifference over a range of value (explanations in appendix E). Table 14 in the technical appendix F shows regressions with corrected choices. Results are very close to those in the original regressions and generally lead to more significant estimates of parameters.

Social risk aversion and social preferences We finally consider whether social preferences under risk are the same regardless of social preferences under certainty. Previous experiments show no obvious link between the two (Brennan et al., 2008; Bradler, 2009; Schwerter, 2013; Bolton et al., 2015; Linde and Sonnemans, 2015). We classify choices in the safe social payoff comparisons as per table 3 and find that 129 of our 211 subjects can be classified as either egoist, altruistic or competitive. Of those, 78% are egoists and 16% are altruistic. A broader definition of types allows us to classify 171 of our 211 subjects. This broader definition allows for one deviation from the choices of the “ideal type” (table 3) in the first five safe social outcome comparisons and one deviation in the last five safe social outcome comparisons.

We ran regressions of the number of safe choice for egoists and altruists under the enlarged definition of types (table 12). We find that altruists are more likely than other types to select the risky option if the safe option gives only 30 ECU to their peer. They are also those who react the most strongly to *ex-post* inequality in payoffs, being particularly averse to negatively correlated lotteries. It may be that altruists anticipate the negative emotions that their peer might experience if outcomes of the lottery are unequal and in favor of the decision-maker. Preferences of altruists under risk are therefore compatible to some extent with their preferences under certainty. On

the other hand, egoists favored positively correlated lotteries and they also preferred individual risk to social risk. This shows that egoism under certainty does not mean a subject does not care about the social context under risk. Finally, competitive subjects (not shown) were consistent in their preferences under risk, as they preferred the safe option if it gave a low payoff to their peer and were particularly likely to choose to take a risk rather than leave their peer with a high payoff.

This part shows that social preferences under certainty influence risk taking and that altruists and competitive subjects behave in a way that is consistent with their preferences under certainty. However, the social context of a decision under risk influences the choice of subjects who ignored payoffs for their peer under certainty. It may be that some subjects who are egoist out of principle in the safe condition do not know how to apply this principle under risk and therefore follow a more intuitive decision process.

4.2. Treatment effect

In this section, we test hypothesis 6 by comparing results in the inequality and in the “collective” treatment. We therefore re-run the regressions presented in table 10 with a dummy for treatments (table 13). One significant difference occurs in the logit regressions (columns 1 and 2), whereby sensitivity to own payoff is higher in the “inequality” treatment. This is probably because the “inequality” treatment focused attention on own payoff, while the “collective” treatment showed also the sum of payoffs. Lower sensitivity to own payoff in the “collective” treatment may thus be due to how the sum of payoff varies proportionally less than own payoffs.

Result 4. *Subjects in the “inequality” treatment are more likely than subjects in the “collective” treatment to avoid negative correlation in payoffs and more likely to like positive correlation in payoffs.*

Those effects are consistent with hypothesis 6 but none of the differences in parameters are significant.

Aversion to *ex-post* inequality in payoffs (negatively correlated lotteries) is consistently significantly different from 0 in the “inequality” treatment but not in the “collective” treatment. As per hypothesis 6, presenting payoffs added up may thus moderate the distaste of subjects for *ex-post* inequality in payoffs by underlining the benefits of having negatively correlated payoffs (less collective risk). Similarly, the preference of subjects for *ex-post* equality in payoffs was stronger in the “inequality” treatment than in the “collective” treatment. It may be that the “collective” treatment successfully underlined the costs of positively correlated payoffs (higher collective risk).

Those findings are confirmed when considering individual level results (section 4.3), whereby a greater number of subjects preferred negatively correlated lotteries in the “collective” treatment than in the “inequality” treatment.

Overall, while differences in the values of parameters are not significant across treatments, the evidence is consistent with hypothesis 6. Presenting payoffs added-up moderated the distaste for negatively correlated lotteries and the taste for positively correlated lotteries. However, it did not change the direction of preferences. Focusing the attention of subjects on collective payoffs did not lead to significant changes in parameter estimates. This allows us to conclude that considerations of collective risk affect the decisions of subjects in social lotteries only marginally.

4.3. Analysis of individual differences in behavior

We now analyze individual behavior by comparing the number of safe choices made by our subjects across social situations. Looking at behavior of our subjects on a case-by-case basis allows us to determine if the small but significant effects identified in the previous part are driven by moderate but general tendencies of all individuals, or by the strong preferences of a small portion of the population.

We identify individual behavior by running regressions of the number of safe choices on lottery characteristics, individual-by-individual (equation 4). Parameter estimates give us the average number of safe choices by the subject (constant term), how many more safe choices he made in the individual risk situation (α_R), how many more safe choices he made when faced with positively correlated social lotteries (α^+), *etc.* . .

We define a subject as being significantly affected by a given social situation (UU^+, UU^-, \dots) if the absolute value of the parameter for that situation ($\alpha^+, \alpha^-, \dots$) is greater or equal to 1. This indicates that the subjects made on average at least one more or less safe choice in that situation, on average, compared to his average number of safe choices, while controlling for other lottery characteristics.

Figure 3 in appendix D represents individual β_L and β_H in a scatterplot. Figure 4 represents individual α^+ and α^- . Individual α^+ and α_R are shown in figure 5. • Behavior consistent with hypothesis 1 is such that both $|\alpha^+|$ and $|\alpha^-|$ are strictly less than 1 (represented by points in the center square of figure 4). • Behavior consistent with hypothesis 2 is such that $\alpha^+ - \alpha_R \geq 1$ (represented by points above the bold line in figure 5). • Behavior consistent with the first part of hypothesis 3 is such that $\beta_H \leq -1$ (represented by points below the horizontal bold line in figure 3). • Behavior consistent with the second part of hypothesis 3 is such that $\beta_L \leq -1$ (represented by points to the left of the vertical bold line in figure 3). • Behavior consistent with hypothesis 4 is such that $|\alpha^+ - \alpha^-| < 1$ (represented by points between the two dotted diagonals

in figure 4). • Behavior consistent with hypothesis 5 is such that $\alpha^- - \alpha^+ \geq 1$ (point below the lower dotted diagonal in figure 4). Table 5 shows the count of subjects who exhibited behavior that fit each hypothesis, by treatment and overall.

Table 5: Classification of decision patterns, by individuals.

	“Inequality” treatment	“Collective” treatment	TOTAL
Hypothesis 1: no effect of risk on others if bear risk as well ($U_u \simeq UU^+ \simeq UU^-$)	65	46	111
Hypothesis 2: aversion to risk on other ($U \succ UU^+$)	30 (vs. 18 prefer risk on other),	35 (vs. 21 prefer risk on other)	65 (vs. 39 prefer risk on other)
Hypothesis 3: more risk taking if peer receives 50 ($U_{u_H} \succ U_u$)	21 (vs. 16 less risk taking)	30 (vs. 19 less risk taking)	51 (vs. 35 less risk taking)
Hypothesis 3: more risk taking if peer receives 30 ($U_{u_L} \succ U_u$)	30 (vs. 14 less risk taking)	30 (vs. 22 less risk taking)	60 (vs. 36 less risk taking)
Hypothesis 4: indifference to correlation in payoffs ($UU^+ \simeq UU^-$)	72	59	131
Hypothesis 5: aversion to <i>ex-post</i> inequality in lotteries ($UU^+ \succ UU^-$)	31 (vs. 4 prefer UU^-)	32 (vs. 13 prefer UU^-)	63 (vs. 17 prefer UU^-)
N	107	104	211

In order to assess the significance of the above results, we compute a statistic that depends on three numbers, (n_1, n_2, n_3) , with n_1 those who prefer A to B, n_2 those who are indifferent between A and B and n_3 those who prefer B to A. We test whether $n_1 > n_3$ by comparing n_1 and n_3 to $\frac{n_1+n_3}{2}$, which is the number of people who would be expected to be at the extremes if being at the extreme was simply the result of a symmetrically distributed random process. The χ^2 statistic for this test is $\frac{(n_1 - \frac{n_1+n_3}{2})^2}{\frac{n_1+n_3}{2}} + \frac{(n_2 - n_2)^2}{n_2} + \frac{(n_3 - \frac{n_1+n_3}{2})^2}{\frac{n_1+n_3}{2}} = \frac{(n_1 - n_3)^2}{n_1 + n_3}$. The critical value of this χ^2 test with 2 degrees of freedom and a p -value of 5% is 5.99.

We find that 60 subjects are averse to advantageous *ex-ante* inequality, 36 prefer it, 115 are indifferent, which gives out $\chi^2 = 6.00 > 5.99$. However, only 51 subjects are averse to disadvantageous *ex-ante* inequality, 35 prefer it and 125 are indifferent, which gives out a $\chi^2 = 2.97$. We can therefore refine result 1 as follows:

Result 5. *Hypothesis 3 is only partly supported at the individual level. A significant minority of subjects are averse to advantageous ex-ante inequality, while there is no significant minority of subjects that is averse to ex-post inequality.*

We find that 63 subjects prefer positively correlated lotteries, 17 prefer negatively correlated lotteries, and 131 are indifferent, which give out a $\chi^2 = 26.5$. We therefore refine result 2 as follows:

Result 6. *A significant minority of subjects take less risk if payoffs are negatively correlated. Hypothesis 5 is therefore supported at the individual level.*

However, hypothesis 4 holds for 131 of the 211 subjects, who are indifferent to *ex-post* distribution of payoffs as long as payoffs are equal in expectations *ex-ante*. We also find that 111 out of 211 subjects are indifferent to whether their peer bears risk, which is supportive of hypothesis 1. Therefore, a majority of subjects behave in ways that are consistent with those alternative hypotheses.

Finally, we find that 65 subjects are less risk averse when dealing with individual lotteries, while 39 are less risk averse in social lotteries. This gives out a $\chi^2 = 6.5$. We therefore refine result 3 as follows:

Result 7. *A significant minority of subjects exhibit lower risk aversion in an individual setting. This is supportive of hypothesis 2.*

The three above results change the meaning of the results observed in terms of average behavior (results from overall regressions). It appears that results 1 to 3 hold only because, of the minority of subjects who are sensitive to changes in the social context, a majority behaves in a way that fits those hypotheses rather than in a way that contradicts them. The weight of their behavior is sufficient to lead to a small although significant effect overall.

5. Discussion

Unlike many experiments in the literature, we did find that the social context had an impact on the choices of our subject at the aggregate level. While this impact was small, it was significant from a statistical point of view. Most subjects are indifferent to the social context; it is the behavior of a minority of subjects that drove aggregate effects in one direction. This confirms that research about preferences over social risk requires large samples¹⁶ as effects of the social setting are small and most people cannot or do not want to think of their decisions in terms of their own interest and that of their peer. This may be because there is no clear and established criterion for evaluating the relative desirability of different types of social risks. Many subjects may

¹⁶We were able to obtain significant results by having 211 subjects making a total of 142 binary choices each. To give an idea of the sample sizes required, Bolton and Ockenfels (2010) had 364 deciders, with each of them takes one decision in one social context only, Rohde and Rohde (2011); Linde and Sonnemans (2012) had 120 participants making about 40 choices each and each subject had half a chance to be a decider, Gamba et al. (2014) had 434 participants divided across four treatments (between-subject design), Bolton et al. (2015) used a between-subject design with 160 deciders divided across five treatments, Adam et al. (2014) used a within-subject design with 140 subjects making a total of 63 binary choices and Vieider et al. (2016) obtained 24 certainty equivalents from each of 200 subjects who were divided into two treatments, one with individual risk and the other with social risk.

then decide to act on the one thing they know about (their own interest) rather than considering variability of payoffs at the collective level or equality of payoffs *ex-post*.

The simple change in visual representation of payoffs across treatments in our experiment was a way for us to control perceptions of risk. It would be interesting to run experiments with alternative methods for influencing risk perceptions. One could for example present participants with different risk scenarios that elicit different types of concerns. Some risk scenarios would elicit concern for the welfare of a group as a whole (e.g. humanitarian disasters, such as after a tsunami or an earthquake), while some other risk scenarios would elicit concern only for the individual (e.g. taking exams, driving a car).

Another way the attention of subjects could be drawn towards different aspects of social risks could be to condition them by asking them to play a cooperative game with their peer before making choices among social lotteries, and compare choices in such a condition with choices made after competitive conditioning. One could also invite people who are partners in real life (couples, friends) or competitors (members of competing football clubs, for example). Those alternatives treatments are certainly good ideas for future experiments.

6. Conclusion

Our main goal in this paper was to determine whether consideration of collective risk play a role in the evaluation of social lotteries. We therefore varied the presentation of the social context across treatment. Our “inequality” treatment underlined inequalities in payoffs while our “collective” treatment underlined variations in joint payoffs and thus collective risk. Our hypothesis was that if some individuals are averse to collective risk, then behavior would differ across treatment, whereby choices would lead to less collective risk taking in the “collective” treatment.

By collecting a large number of decisions by a large number of participants, we were able to detect small but robust and significant preferences against lotteries that lead to *ex-post* inequality in payoffs. This effect was particularly strong in our “inequality” treatment but was more moderate in our “collective” treatment. Drawing attention to joint payoffs thus made subjects more inclined to reduce collective risk, and thus to moderate their dislike for negatively correlated payoffs in social lotteries. However, while differences across treatment were consistent with our hypothesis, the magnitude of those differences was not significantly different from 0.

Beyond our main result, further examination of individual behavior showed that the majority of subjects who reported not caring about the payoff of their peer were

also egoistic in their choices among different distributions of safe payoffs. Indifference to the social context may therefore not be a result of crowding out (hypothesis 1), but simply of egoism. Further showing a link between social concerns under risk and under certainty, we found that subjects who were altruistic when choosing among distribution of payoffs under certainty were also particularly likely to take risk to prevent their peer receiving a low payoff in the safe option. We would need more data to explore further the relation between social preferences under certainty and under risk; indeed, most subjects are egoistic which means that one must obtain a sample with many individuals in order to obtain a sufficient number of altruistic or competitive subjects.

Finally, we also confirmed that the majority of subjects were indifferent to the social context of their decision, as evoked in Adam et al. (2014). Our results that show a significant effect of the social context for some subjects and in the aggregate can therefore also be reconciled with papers that argue that risk crowds out social considerations (this is the case for most of our subjects) and with papers that argue that subjects care mostly about procedural fairness (most of our subjects are indifferent to correlation in social lottery payoffs). The social context has a significant effect in the aggregate only because, among the minority of subjects who respond to the social context, a majority dislikes *ex-post* and *ex-ante* inequality.

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A. Randomization of the order of lotteries

Table 6: Order of lottery presentation, by session, for each treatment.

Period	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	Session 8	Session 9
1-5	Practice								
6-17	Individual Risk								
18-27	Safe Social Outcomes								
28-39	Aa	Ab	Ac	Ba	Bb	Bc	Ca	Cb	Cc
40-51	Ab	Ac	Aa	Bb	Bc	Ba	Cb	Cc	Ca
52-63	Ac	Aa	Ab	Bc	Ba	Bb	Cc	Ca	Cb
64-75	Ba	Bb	Bc	Ca	Cb	Cc	Aa	Ab	Ac
76-87	Bb	Bc	Ba	Cb	Cc	Ca	Ab	Ac	Aa
88-99	Bc	Ba	Bb	Cc	Ca	Cb	Ac	Aa	Ab
100-111	Ca	Cb	Cc	Aa	Ab	Ac	Ba	Bb	Bc
112-123	Cb	Cc	Ca	Ab	Ac	Aa	Bb	Bc	Ba
124-135	Cc	Ca	Cb	Ac	Aa	Ab	Bc	Ba	Bb
136-147	Individual Risk								

B. Answers to the post-experimental questionnaire

Table 7: Demographics

Variable	Inequality treatment			Collective treatment			Min	Max
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.		
Age	107	24.7	5	104	25.1	4.1	19	62
Males	107	39%	0.5	104	29%	0.5	0	1
Germans	107	96%	0.2	104	92%	0.3	0	1
Education level	107			104				
High school degree (Abitur)		61%			47%			
University up to Bachelor		25%			31%			
Master, Diplom, PhD		9%			17%			
Other		5%			5%			
Field of study	107			104				
Social sciences		38%			35%			
Human sciences		17%			20%			
Natural sciences		14%			15%			
Size of town (Higher is smaller)	107	3.5	1.4	104	3.2	1.4	1	6
Religious	107	19%	0.4	104	26%	0.5	0	1
Political affiliation	107			104				
Left		16%			9%			
Social democrat		25%			22%			
Liberal		6%			3%			
Conservative		4%			13%			
Neutral / Moderate		32%			30%			
Revenue source	107			104				
Work (full time, part time)		20%			34%			
Parents		37%			34%			
Bursary / grants		26%			23%			
Credit		6%			2%			
Expenses per month ¹	107	1.9	1	104	2	1.1	1	6
Home alone (1 Yes)	107	36%	0.5	104	28%	0.5	0	1

¹ Expenses per month are coded as 1=less than 500€, 2=501-800€, 3=801-1200€, 4=1201-200€, 5=more than 2000€.

Table 8: About the experiment

Variable	Inequality treatment			Collective treatment			Min	Max
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.		
1. What was this experiment about in your opinion? (free field)								
2. Please briefly describe how you took your decisions. (free field)								
3. Decisions were easy to make (1 agree, 4 disagree)	107	1.8	.6	104	2	.6	1	4
4. Instructions were easy to understand (1 agree, 4 disagree)	107	1.8	.8	104	1.8	.7	1	4
5. I knew another participant (1 yes 0 no)	107	8%		104	2%	0.1	0	1
6. Payment is appropriate (1 yes 0 no)	107	62%		104	68%	0.5	0	1
7. I took peer into consideration (1 yes 0 no)	107	44%		104	52%	0.5	0	1
8.a) I consider only my own payoff (1 agree, 4 disagree)	107	1.7	.8	104	1.8	.8	1	4
8.b) I prefer no risk on peer (idem)	107	3	.9	104	2.7	.9	1	4
8.c) I prefer positively correlated payoffs (idem)	107	2.8	1	104	2.5	1	1	4
8.d) I maximized the sum of payoffs (idem)	107	2.2	1.1	104	2.2	1	1	4
8.e) I prefer risk on peer if risk on me (idem)	107	2.6	1	104	2.4	.9	1	4
8.f) Getting higher payoff than peer is important (idem)	107	3.2	.9	104	2.9	.9	1	4
8.g) I prefer not knowing payoff of peer (idem)	107	2.5	1	104	2.3	.9	1	4

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Two-sample Wilcoxon rank-sum (Mann-Whitney) test for differences in ordinal variables

Two-sample test of proportions for differences in binary variables

Table 9: Attitudes to risk, fairness and trust

Variable	Inequality treatment			Collective treatment			Min	Max
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.		
Risk attitude (Higher is less risk averse)	107	2.3	.6	104	2.3	.6	1	4
Equal pay is fairer (1 yes 0 no)	107	19%	.4	104	30%	.4	0	1
Trust questions								
One can trust in people (1=agree, 4=disagree)	107	2.3	.6	104	2.3	.7	1	4
One cannot rely on people (idem)	107	2.9	.8	104	2.8	.7	1	4
One should not trust unknown people (idem)	107	2.2	.8	104	2.1	.8	1	4
People try to be fair (1 yes 0 no)	107	61%	.5	104	64%	.5	0	1
People follow their own interest (1 yes 0 no)	107	62%	.5	104	58%	.5	0	1
Trustfulness index	107	0	4.6	104	0	5	-11.2	12.4

The last five questions are taken from the fairness, trust and helpfulness questions in the General Social Survey of the National Opinion Research Center at the University of Chicago. Answers to those questions are highly correlated (Cronbach's alpha is 78%). Rather than simply sum up the answers however, we compute an index of trustfulness from the answer to those questions by using a single-factor measurement model whereby answers are modeled as ordered logit. The index ranges from -11 (most trustful) to 12 (least trustful).

C. Regression tables

Table 10: Overall regressions, fixed and random effects

Dependent =	Choice Of Lottery A (Safe Option)		Number Of Safe Choices		Certainty Equivalent		ROR		R (CRRRA)	
	fixed effect	logit random effect	logit fixed effect	random effect	fixed effect	random effect	fixed effect	random effect	fixed effect	random effect
value safe payoff	0.30*** [0.28,0.33]	0.30*** [0.27,0.34]								
β_L (peer receives 30)	-0.25* [-0.46,-0.04]	-0.25** [-0.44,-0.07]	-0.29* [-0.52,-0.05]	-0.29* [-0.51,-0.06]	0.64** [0.22,1.05]	0.63* [0.14,1.11]	-0.02* [-0.03,-0.00]	-0.02* [-0.03,-0.00]	-0.06** [-0.10,-0.01]	-0.06* [-0.11,-0.01]
β_H (peer receives 50)	-0.22* [-0.38,-0.05]	-0.22** [-0.37,-0.07]	-0.24** [-0.42,-0.07]	-0.24** [-0.42,-0.07]	0.74** [0.28,1.20]	0.74** [0.30,1.19]	-0.02** [-0.04,-0.01]	-0.02** [-0.04,-0.01]	-0.07** [-0.11,-0.02]	-0.07** [-0.11,-0.02]
α^- (neg. corr.)	0.16* [0.03,0.28]	0.16** [0.04,0.27]	0.18* [0.01,0.34]	0.18* [0.00,0.35]	-0.28 [-0.68,0.12]	-0.28 [-0.68,0.12]	0.01 [-0.00,0.02]	0.01 [-0.00,0.02]	0.02 [-0.01,0.06]	0.02 [-0.01,0.06]
α^+ (pos. corr.)	-0.24*** [-0.36,-0.11]	-0.24*** [-0.37,-0.10]	-0.27** [-0.43,-0.11]	-0.27** [-0.43,-0.11]	0.39 [-0.11,0.89]	0.40* [0.03,0.77]	-0.01+ [-0.02,0.00]	-0.01+ [-0.02,0.00]	-0.04+ [-0.08,0.01]	-0.04* [-0.08,-0.00]
α_R (indiv. risk)	-0.51*** [-0.72,-0.31]	-0.51*** [-0.71,-0.32]	-0.59*** [-0.79,-0.39]	-0.59*** [-0.81,-0.37]	1.45*** [0.92,1.98]	1.43*** [0.87,2.00]	-0.04*** [-0.06,-0.03]	-0.04*** [-0.06,-0.03]	-0.13*** [-0.18,-0.08]	-0.13*** [-0.18,-0.07]
male	-1.44*** [-2.03,-0.84]	-1.44*** [-2.03,-0.84]	-1.58*** [-2.32,-0.85]	-1.58*** [-2.32,-0.85]	3.32*** [1.96,4.69]	3.32*** [1.96,4.69]	-0.12*** [-0.16,-0.07]	-0.12*** [-0.16,-0.07]	-0.30*** [-0.44,-0.16]	-0.30*** [-0.44,-0.16]
risk loving	-1.38*** [-1.95,-0.82]	-1.38*** [-1.95,-0.82]	-1.47*** [-1.98,-0.95]	-1.47*** [-1.98,-0.95]	2.85*** [1.65,4.05]	2.85*** [1.65,4.05]	-0.09*** [-0.13,-0.05]	-0.09*** [-0.13,-0.05]	-0.26*** [-0.39,-0.13]	-0.26*** [-0.39,-0.13]
Constant	-7.09*** [-8.72,-5.46]	-7.09*** [-8.72,-5.46]	8.00*** [7.58,8.42]	11.93*** [10.73,13.12]	37.06*** [36.23,37.89]	29.05*** [26.33,31.78]	0.24*** [0.22,0.27]	0.51*** [0.41,0.61]	0.70*** [0.62,0.77]	1.43*** [1.14,1.73]
N	26532	27852	2321	2321	1689	1689	1689	1689	1689	1689
Subjects	201	211	211	211	199	199	199	199	199	199
ll	-7854.99	-8820.86	-4223.71	-4223.71	-4279.12	1539.18	1539.18	1539.18	-307.91	-307.91
χ^2	615.22	435.50	51.81	117.22	41.38	141.99	46.91	126.15	36.72	131.17
$\alpha^+ - \alpha_R$	0.28* [0.06,0.50]	0.28** [0.08,0.48]	0.32** [0.10,0.53]	0.32* [0.07,0.57]	-1.06*** [-1.66,-0.46]	-1.03*** [-1.58,-0.48]	0.03*** [0.02,0.05]	0.03*** [0.02,0.05]	0.09*** [0.04,0.14]	0.09*** [0.04,0.13]

Normal-based 95% confidence intervals in brackets, 100 bootstrap replications.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Regressions for specific sub-groups, number of safe choices, fixed effects

	Males	Social Sciences	Big Town	Religious	Left Wing	Not Home Alone
β_L (peer receives 30)	-0.25 [-0.58,0.09]	-0.00 <i>[-0.31,0.31]</i>	-0.18 [-0.59,0.22]	0.07 [-0.49,0.63]	-0.22 [-0.55,0.12]	-0.24+ [-0.52,0.05]
β_H (peer receives 50)	-0.19 [-0.48,0.09]	-0.07 <i>[-0.29,0.14]</i>	-0.30* [-0.59,-0.00]	-0.05 [-0.47,0.37]	-0.32* [-0.57,-0.06]	-0.21+ [-0.44,0.03]
α^- (neg. corr.)	0.07 [-0.12,0.26]	0.03 [-0.20,0.27]	0.18 [-0.17,0.53]	0.41+ [-0.02,0.84]	0.08 [-0.18,0.34]	0.16+ [-0.01,0.34]
α^+ (pos. corr.)	-0.20 [-0.45,0.04]	-0.29* [-0.53,-0.05]	-0.44* [-0.81,-0.08]	-0.24 [-0.66,0.17]	0.00 <i>[-0.21,0.22]</i>	-0.12 <i>[-0.29,0.05]</i>
α_R (indiv. risk)	-0.58*** [-0.90,-0.27]	-0.58** [-0.93,-0.23]	-0.45+ [-0.91,0.01]	-0.42 [-0.96,0.12]	-0.53*** [-0.82,-0.24]	-0.51*** [-0.74,-0.29]
Constant	6.76*** [6.12,7.41]	8.03*** [7.44,8.62]	8.18*** [7.52,8.83]	8.09*** [7.35,8.84]	8.15*** [7.58,8.72]	8.07*** [7.66,8.48]
N	792.00	847.00	737.00	517.00	836.00	1584.00
Subjects	72.00	77.00	67.00	47.00	76.00	144.00
Π	-1354.37	-1456.71	-1417.93	-1034.59	-1470.22	-2857.04
χ^2	16.37	17.04	14.88	17.28	16.32	39.64

95% confidence intervals in brackets. Significant differences across sub-samples in italics.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Regressions by post-experimental feedback and social orientation in safe payoffs, number of safe choices, fixed effects

	Do Not Care	Care About Peer Payoff	Difference	Altruist	Egoist	Difference
β_L (peer receives 30)	-0.22* [-0.44,-0.01]	-0.35+ [-0.74,0.03]	-0.13 [-0.60,0.34]	-0.93** [-1.55,-0.31]	-0.23* [-0.46,-0.00]	0.70+ [-0.15,1.54]
β_H (peer receives 50)	-0.16 [-0.36,0.04]	-0.34* [-0.61,-0.07]	-0.18 [-0.53,0.16]	-0.02 [-0.52,0.47]	-0.24* [-0.45,-0.04]	-0.22 [-0.84,0.40]
α^- (neg. corr.)	-0.09 [-0.23,0.05]	0.47*** [0.19,0.74]	0.56*** [0.24,0.89]	0.51** [0.15,0.86]	0.02 [-0.11,0.16]	-0.48* [-0.91,-0.05]
α^+ (pos. corr.)	-0.12 [-0.26,0.03]	-0.44** [-0.76,-0.12]	-0.32* [-0.67,0.02]	-0.08 [-0.49,0.33]	-0.34*** [-0.54,-0.14]	-0.26 [-0.78,0.26]
α_R (indiv. risk)	-0.55*** [-0.76,-0.33]	-0.63** [-1.03,-0.24]	-0.08 [-0.50,0.32]	-0.67* [-1.24,-0.11]	-0.59*** [-0.83,-0.35]	0.08 [-0.63,0.80]
Constant	8.25*** [7.74,8.77]	7.72*** [7.21,8.24]		7.74*** [6.67,8.82]	8.26*** [7.84,8.69]	
N	1210.00	1111.00		319.00	1408.00	
Subjects	110.00	101.00		29.00	128.00	
ll	-1851.35	-2228.97		-599.75	-2349.17	
χ^2	32.64	44.45		22.76	29.83	

95% confidence intervals in brackets. Significant differences across sub-samples in italics.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Regressions by treatments, fixed effects

Dependent =	Choice Of Lottery A (Safe Option)	Number Of Safe Choices	R (CRRRA)
	Inequality	Collective	Collective
	Difference	Difference	Difference
value safe payoff	<i>0.32***</i> [0.30,0.34]	<i>0.26***</i> [0.22,0.30]	<i>-0.06***</i> [-0.10,-0.03]
β_L (peer receives 30)	-0.37* [-0.69,-0.05]	-0.12 [-0.36,0.12]	0.25 [-0.11,0.63]
β_H (peer receives 50)	-0.22+ [-0.45,0.01]	-0.19+ [-0.40,0.02]	0.03 [-0.24,0.31]
α^- (neg. corr.)	0.20* [0.03,0.39]	0.09 [-0.07,0.26]	-0.11 [-0.35,0.13]
α^+ (pos. corr.)	-0.28** [-0.47,-0.09]	-0.17+ [-0.37,0.02]	0.12 [-0.18,0.43]
α_R (indiv. risk)	-0.54*** [-0.79,-0.28]	-0.44** [-0.71,-0.18]	0.11 [-0.23,0.46]
Constant	8.09*** [7.61,8.58]	7.90*** [7.35,8.46]	0.67*** [0.57,0.77]
N	1332	13200	1177
Subjects	101	100	107
Π	-3373.12	-4419.63	-2067.15
χ^2	1085.23	177.69	28.34
		1144	907
		104	101
		-2146.00	-143.58
		22.98	27.17
			782
			98
			-162.42
			15.55

95% confidence intervals in brackets. Significant differences across sub-samples in italics.
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

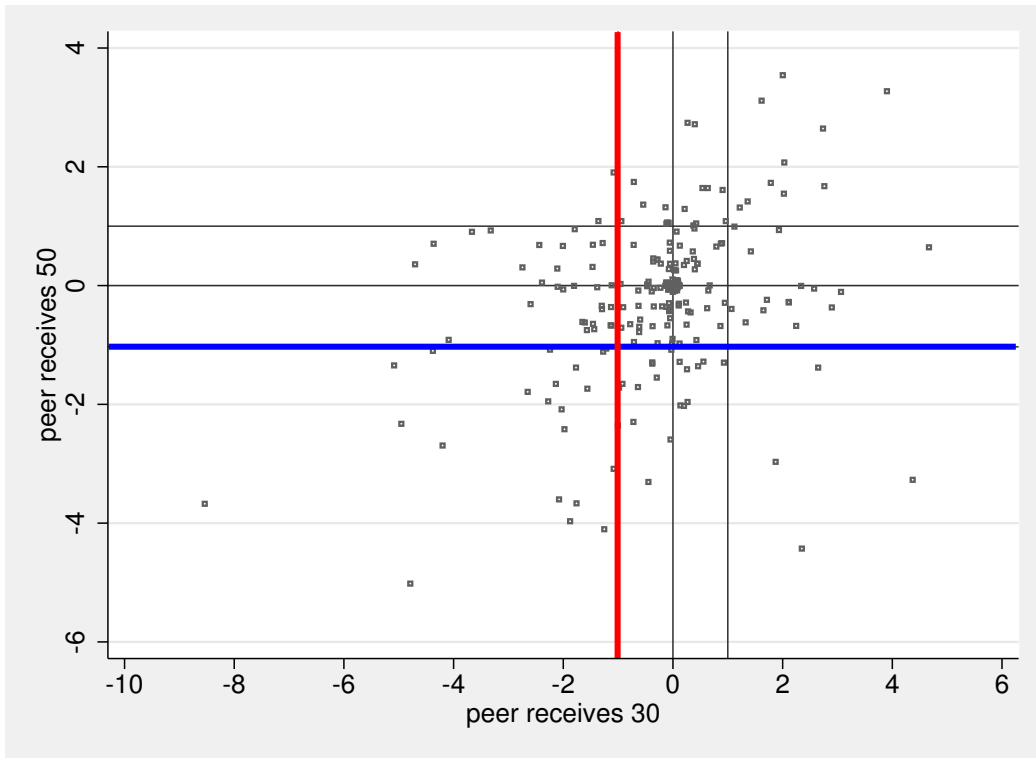


Figure 3: Individual aversion to ex-ante inequality in safe payoffs

β_{iH} in ordinate, β_{iL} in abscissa

Note: A small random noise was added to the coordinates of points in the graph to avoid overplotting (jittering).

D. Individual choices

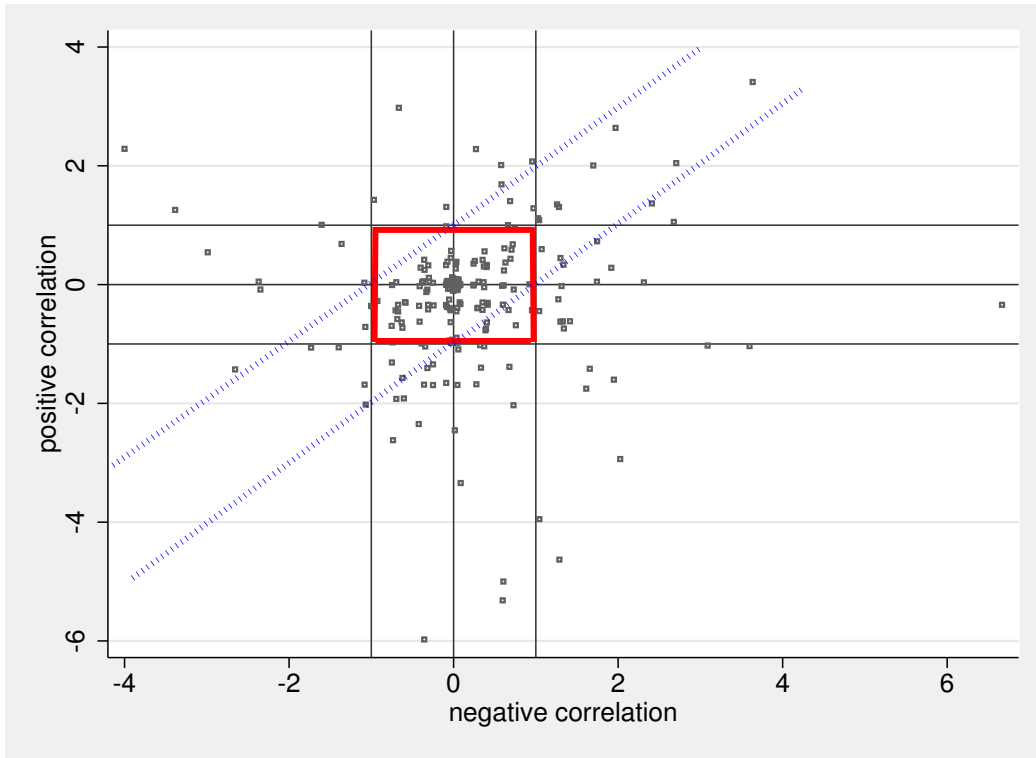


Figure 4: Individual aversion to ex-post inequality
 α_i^+ in ordinate, α_i^- in abscissa

Note: A small random noise was added to the coordinates of points in the graph to avoid overplotting (jittering).

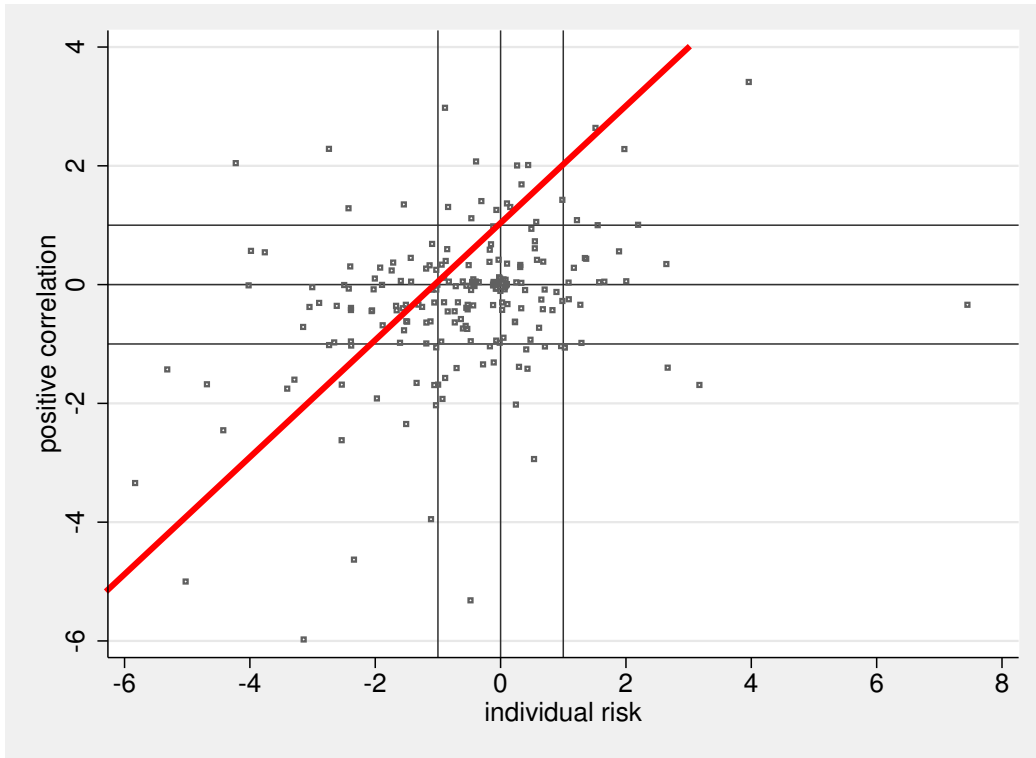


Figure 5: Individual aversion to social risk *vs.* individual risk
 α_i^+ in ordinate, α_{iR} in abscissa

Note: A small random noise was added to the coordinates of points in the graph to avoid overplotting (jittering).

Technical appendix

E. Switching behavior

73% of choices were such that a subject switched from the safe to the risky option only at one point, when the safe payoff became too low. In another 10% of cases, the subject always chose the safe option and in 2% of cases the subject always chose the risky option. 10 subjects chose the safe option systematically for all lotteries. A total of 84% of choice cases are thus consistent with monotonic preferences across lotteries. Of the remaining 16% other patterns of choices:

- 3% of cases were such that the subject chose lottery B when lottery A was 58 ECU and chose lottery A afterwards. This pattern can be attributed to inattention as a subject could keep on choosing lottery B mechanically without noticing that the situation has changed and the safe payoff was back up to the maximum.
- 5% of cases were “trembles” such that a subject interrupts a consistent series of choice for one option with *one* switch to the other option (e.g. AABAABBBB). Those choices can be attributed to mistakes or “slips of the mouse”.
- 2% of cases were “back-and-forth” such that a subject starts by choosing lottery A for high values of the safe option, then switches back and forth between A and B for a given interval, and ends up choosing B for low values of the safe option (e.g. AABAABBBB). Some of the “back and forth” can also be attributed to trembles (as in this last example), while some other cannot (e.g. AABABABBB). As discussed in [Andersen et al. \(2006\)](#) and [Charness et al. \(2013\)](#) and observed in [Harrison et al. \(2013\)](#), a back-and-forth pattern may be a sign that the subject is indifferent between the two lotteries for the range of payoffs over which back-and-forth switching is observed.
- 6% of cases are not accounted for by inattention, trembles or indifference. Such cases are concentrated among a relatively small subset of subjects. A subject who had an inconsistent choice pattern for one lottery often also displayed inconsistent choices in at least two or more other lotteries. This irreducible portion of cases may be due to improper understanding of the experiment, lack of motivation or confusion.

In correcting choices for additional regressions, we changed a unique choice of A between two choices of B to a choice of A, and conversely. We also changed choices of B when A is 58 ECU to A if A was subsequently chosen.

F. Regressions with corrected choices

Table 14: Overall regressions with corrected choices, fixed and random effects

dependent =	choice of lottery A (safe option)		number of safe choices		certainty equivalent		ror		r (crra)	
	fixed effect	logit random effect	fixed effect	random effect	fixed effect	random effect	fixed effect	random effect	fixed effect	random effect
value safe payoff	0.32*** [0.31,0.33]	0.36*** [0.32,0.40]								
β_L (peer receives 30)	-0.25** [-0.44,-0.07]	-0.28* [-0.52,-0.04]	-0.28* [-0.50,-0.06]	-0.28* [-0.51,-0.04]	0.62* [0.10,1.14]	0.60* [0.11,1.09]	-0.02+ [-0.04,0.00]	-0.02+ [-0.03,0.00]	-0.06* [-0.11,-0.01]	-0.06* [-0.10,-0.01]
β_H (peer receives 50)	-0.20** [-0.35,-0.05]	-0.22* [-0.41,-0.04]	-0.22* [-0.40,-0.05]	-0.22** [-0.39,-0.06]	0.71** [0.27,1.14]	0.70*** [0.29,1.11]	-0.02*** [-0.03,-0.01]	-0.02** [-0.04,-0.01]	-0.06*** [-0.10,-0.03]	-0.06** [-0.11,-0.02]
α^- (neg. corr.)	0.16* [0.02,0.30]	0.18* [0.02,0.34]	0.17* [0.02,0.33]	0.17+ [-0.01,0.36]	-0.36+ [-0.74,0.02]	-0.36+ [-0.78,0.06]	0.01* [0.00,0.02]	0.01* [0.00,0.02]	0.03+ [-0.00,0.07]	0.03+ [-0.00,0.07]
α^+ (pos. corr.)	-0.25*** [-0.40,-0.11]	-0.28*** [-0.44,-0.12]	-0.28*** [-0.44,-0.12]	-0.28*** [-0.45,-0.12]	0.35+ [-0.01,0.71]	0.33+ [-0.06,0.73]	-0.01+ [-0.02,0.00]	-0.01 [-0.02,0.00]	-0.03+ [-0.07,0.00]	-0.03+ [-0.07,0.00]
α_R (indiv. risk)	-0.55*** [-0.76,-0.34]	-0.61*** [-0.84,-0.39]	-0.61*** [-0.84,-0.39]	-0.61*** [-0.82,-0.41]	1.69*** [1.09,2.30]	1.67*** [1.00,2.33]	-0.05*** [-0.07,-0.03]	-0.05*** [-0.07,-0.03]	-0.15*** [-0.20,-0.10]	-0.15*** [-0.20,-0.10]
male	-1.63*** [-2.40,-0.86]	-1.63*** [-2.40,-0.86]	-1.58*** [-2.28,-0.88]	-1.58*** [-2.28,-0.88]	2.94*** [1.54,4.34]	2.94*** [1.54,4.34]	-0.10*** [-0.15,-0.05]	-0.10*** [-0.15,-0.05]	-0.27*** [-0.40,-0.14]	-0.27*** [-0.40,-0.14]
risk loving	-1.57*** [-2.14,-1.00]	-1.57*** [-2.14,-1.00]	-1.47*** [-1.97,-0.97]	-1.47*** [-1.97,-0.97]	2.81*** [1.71,3.92]	2.81*** [1.71,3.92]	-0.09*** [-0.13,-0.05]	-0.09*** [-0.13,-0.05]	-0.26*** [-0.35,-0.16]	-0.26*** [-0.35,-0.16]
Constant	-8.62*** [-10.46,-6.78]	-8.62*** [-10.46,-6.78]	8.04*** [7.64,8.44]	11.97*** [10.88,13.07]	37.28*** [36.50,38.06]	29.46*** [26.86,32.07]	0.24*** [0.21,0.26]	0.49*** [0.40,0.59]	0.68*** [0.60,0.75]	1.39*** [1.17,1.62]
N	26532.00	27852.00	2321.00	2321.00	1922.00	1922.00	1922.00	1922.00	1922.00	1922.00
Subjects	201.00	211.00	211.00	211.00	201.00	201.00	201.00	201.00	201.00	201.00
II	-6913.01	-7847.08	-4350.01	-5016.54	-5016.54	-5016.54	1608.24	1608.24	-491.75	-491.75
χ^2	8286.06	417.57	50.83	160.17	83.82	111.55	68.74	114.86	51.52	153.20
$\alpha^+ - \alpha_R$	0.30** [0.08,0.52]	0.33** [0.08,0.58]	0.33** [0.11,0.55]	0.33** [0.11,0.55]	-1.34*** [-1.95,-0.73]	-1.33*** [-1.91,-0.75]	0.04*** [0.02,0.06]	0.04*** [0.02,0.06]	0.12*** [0.06,0.17]	0.12*** [0.06,0.17]

95% confidence intervals in brackets

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

G. Instructions (translated from the German original)

Welcome and thank you for your participation! You can earn a sum of money in this experiment which depends on your decisions and those of another participant. It is therefore very important that you thoroughly and carefully read these instructions.

Please turn off your mobile phone now!

Communication with other participants is not allowed. If you have a question, please raise your hand. We will then come to you and answer your question.

You have drawn an envelope from a basket at the beginning of the experiment. PLEASE DO NOT OPEN IT. Only once the experiment is over and you have completed all the necessary tasks will we let you know that you can open the envelope. We will unfortunately have to exclude you from the experiment if you violate these rules.

You will make decisions during the experiment. The point is not to make the right or wrong decisions, but the ones you deem best. All results of the study will be kept strictly confidential and none of the other participants will learn what decisions you took.

Your earnings will be calculated in ECU (Experimental Currency Units). 1 ECU corresponds to 0.15€. At the end of today's session, your total earnings will be converted in euros and will be paid to you confidentially in cash. You will additionally receive a payment of 2.55€ for your participation (=17 ECU).

Running of the experiment

After you read the instructions completely, we will ask you some control questions to check your understanding of the experiment. The experiment does not begin until all participants have answered the control questions correctly. In the experiment, you will have to choose among several options that affect you and another person. Once the main part of the experiment is completed, we will ask you to complete a short questionnaire. This will be presented to you on your screen.

Explanation of the main part of the experiment

Each person in the room will be assigned to another person. We will call the person that will be assigned to you "person X". This assignment is done randomly and neither you nor person X will learn the identity of the other. You will have to make a series of decisions that determine what payment will be made to you and person X at the end of the experiment.

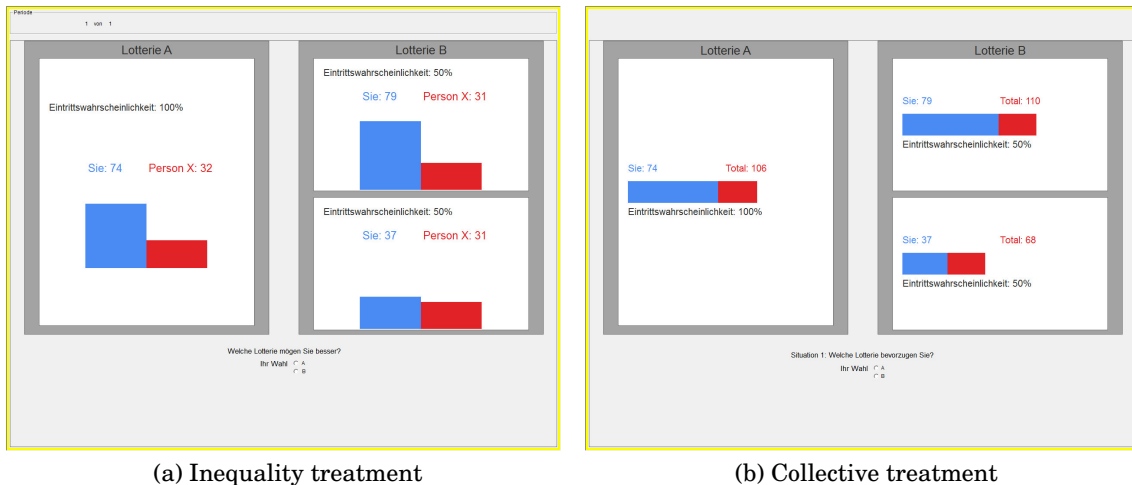


Figure 6: Screenshot

We discuss below the steps in a possible decision situation. There are two types of decision situations:

Situations of type 1

Top right you see an example of a decision situation of type 1 (see Figure 1). Please look at the graph carefully and read the supplemental explanations thoroughly.

In the illustration above you can see two lotteries: A and B. The payouts are shown above each bar. The payout on the left side of the bar graph is for you, the payout on the right side of the bar (“Inequality” treatment: is for person X) (“Collective” treatment: also includes the payout for person X).

“Inequality” treatment: Lottery A gives you as the decision maker 74 ECU and person X as the recipient 32 ECU. The payout in lottery B depends on chance. The probability that you get 79 ECU is 50% (person X then receives 31 ECU), otherwise you get 37 ECU (person X then receives 31 ECU).

“Collective” treatment: Lottery A gives you as the decision maker 74 ECU and person X as the recipient gets the rest of the 106 ECU. The payout in lottery B depends on chance. The probability that you get 79 ECU is 50% (person X gets the rest of the 110 ECU), otherwise you get 37 ECU (person X gets the rest of the 68 ECU).

Please enter your choice by clicking on A if you prefer A lottery and on B if you prefer lottery B. Please then click on "OK" to go to the next decision. Once you made your decision, a new decision situation with two new lotteries to compare will be shown

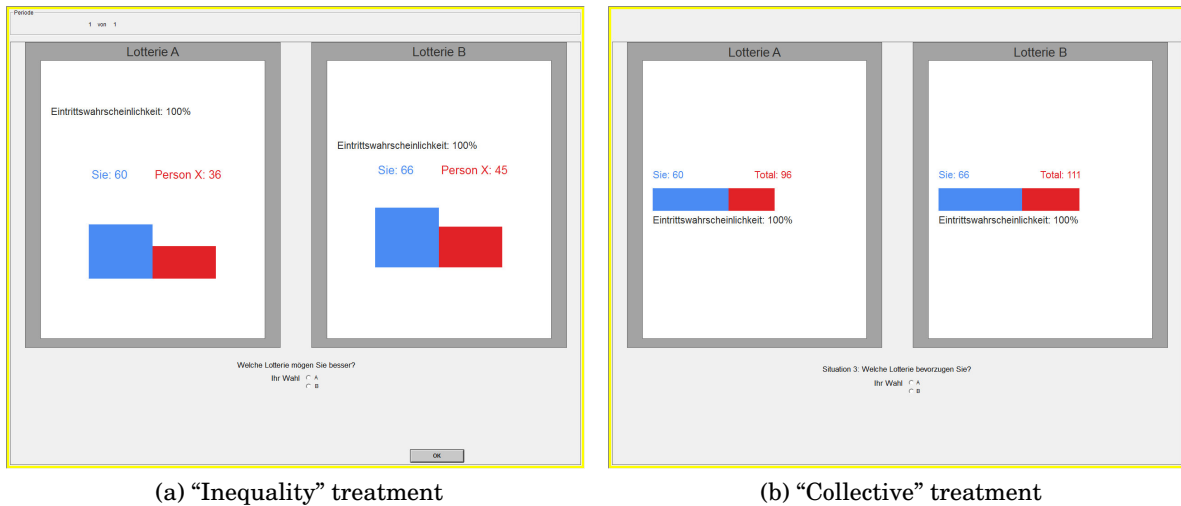


Figure 7: Screenshot

In some other decision situations of the type 1, both lotteries lead to a secure payment. Figure 2 shows the selection screen in this case. Please choose, as in the previous case, the lottery that you prefer.

Situations of type 2

You see below an example of a decision situation of the type 2 (see Figure 3). In a decision situation of the type 2, the payout for person X does not appear. In this case, the lottery determines only your own payout. Your decision does not affect payment for person X and you will not learn how much person X receives. Please choose as before the lottery that you prefer

You will go through a total of 147 rounds of decision situations as described above. The first five rounds are only for practice and are not paid. All decision rounds differ from each other and you should therefore pay careful attention to the payouts for yourself and person X.

Determination of payout

Before the experiment, we took 5 envelopes out of a basket with 118 envelopes, 5 envelopes out of a second basket with 5 envelopes and 2 envelopes from a third basket with 24 envelopes. This total of 12 envelopes was then placed in a basket and each of you was asked to draw an envelope from this basket, one after the other (see Figure 4).

You also pulled out another number from 1 to 12 from a deck of cards, which deter-

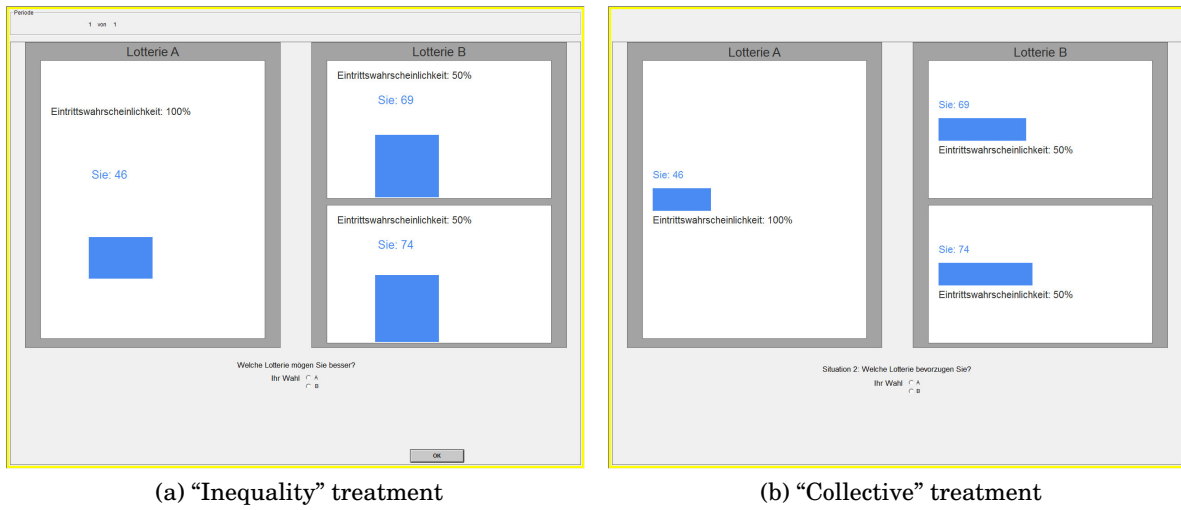


Figure 8: Screenshot

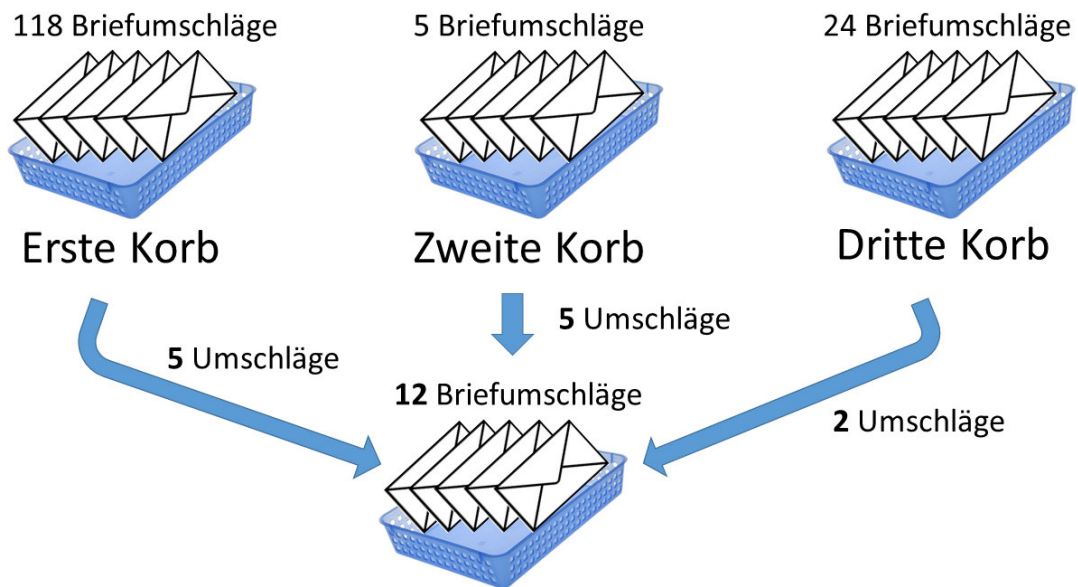


Figure 9: Procedure for the draw of envelopes

mined your booth in the laboratory.

You were asked to keep your envelope closed until the end of the experiment. At the end of the experiment, when you will have finished all the required tasks, we will ask you to open your envelope and read the paper inside.

Five of the papers say you are a decision-maker

Each envelope in the first basket describes a different decision situation of type 1. If the paper in your envelope says that you are a decision-maker, then your decision determines your payout and the payout of the person X. We will call decision-makers individually in turn in the order of their cabin number. If your cabin number is called and you are a decision-maker, you should get up and go forward to the experimenters (if your number is called and you are not a decision maker, then please keep seated). Below you can see an example of how your paper would look like if you were a decision-maker and the situation described there is as in Figure 1. The name of each decision situation is a unique combination of letters and a number. This name does not refer to the sequence of the situation and is used by us to identify more quickly which situation applies to you.

You are a decision-maker

The decision situation, which determines your payment is situation Qf5.

“Inequality” treatment: In decision situation Qf5 you had a choice of either 74 ECU (32 ECU for person X) in lottery A and an equal chance of either 79 ECU (31 ECU for person X) or 37 ECU (31 ECU for person X) in lottery B.

“Collective” treatment: In decision situation Qf5 you had a choice of either 74 ECU out of 106 ECU in lottery A and an equal chance of either 79 ECU out of 110 ECU or 37 ECU out of 68 ECU in lottery B.

When you come forward, we will take your cabin number and look on our computers which lottery (A or B) you chose in the situation that is described on the paper in your envelope.

You cannot change your decision at this time. We will only carry out the decision you have taken during the experiment. Please make sure, therefore, that your decisions during the experiment correspond to what you want to see carried out at the end of the experiment!

If you chose lottery B in this situation and the lottery B is as in Figure 1, then you will be asked to toss a coin. You get the top payoff in lottery B if the coin shows “head”. You get the lower payoff if the coin shows “tail”. If you chose lottery A in this situation, then you will get the payout of lottery A. In either case, you will also see how much person X will be paid.

Five of the papers say you are a recipient

Each envelope in the second basket says “You are a recipient”. If the sheet in your envelope says that you are a recipient, then we will call you AFTER all decision-makers have received their payments and left the room. The decision-makers left their cabin numbers with us and we put those in a basket. You will be asked to draw a number out of this basket. You will receive the payment which corresponds to the decision of the decision-maker whose number you have drawn. You will see what was the relevant situation for your decision, which lottery (A or B) was chosen by your decision-maker in this situation, and, if the situation called for it, the result of the coin toss (*i.e.* whether the decision maker tossed “head” or “tail”). Therefore, you will know how much your assigned decision-maker earned at the same time as you learn how much you get paid. For example, if your decision-maker opted for lottery A in the situation indicated on his sheet, then you will win the payout for person X in lottery A in this situation.

Below you can see how the sheet of paper would look like if you were a recipient:

You are a recipient

Two of the papers says you are neither a recipient nor a decision-maker

Each envelope in the third basket describes a different decision-making situation of the type 2. If the piece of paper in your envelope says that “you are neither a recipient nor a decision-maker”, then your payoff is determined from a decision situation of the type 2 (as shown in Figure 3). After all decision-makers and recipients have left the laboratory, we will ask you to come forward. Below you can see how your paper would look like in this case:

You are neither a recipient nor a decision-maker

The decision situation which determines your payment is situation Kb2.
--

In decision situation Kb2 you had a choice between 46 ECU (Lottery A) and an equal chance of either 69 ECU or 74 ECU (Lottery B).

When you come forward to us, we will check on our computer which lottery (A or B) you chose in the decision situation that is printed on the sheet of paper in your

envelope. If you chose lottery B, then you will be asked to toss a coin. If the coin shows “head”, then you will get the top payout (on the screen). If the coin shows “tail” then you will get the bottom payout (on the screen). If you chose lottery A, then you will get the payout for lottery A. You will not know what payment the other person who got the same type of envelope as you got.

Summary

1. You will be faced with a series of decision situations.
2. In every decision round you will be asked to choose between two lotteries (A or B).
3. It will take about 20 to 30 minutes for you to make your choices for all 147 decision situations.
4. Once all the decision rounds are over, we will ask you to complete a questionnaire.
5. Once you have completed the questionnaire, we will ask you to open your envelope. The sheet contained in the envelope indicates either that your decision in a given round determines your payment or that the decision of another participant determines your payment. Alternatively, your decision determines only your own payment.
6. Any decision that you made during the experiment could be that which is described in the envelope drawn by you and any participant in the laboratory could be your person X. The chance to be a decision-maker is the same as the chance that you are a recipient. You should therefore always make your decisions as if you will be a decision-maker and as if the decision you make will be the one that determines your payout.

H. Control questions

Please consult figure 5 to answer the control questions:

1. How many ECU does lottery A give you if you are the decision-maker? (Answer: 59 ECU)
2. How many ECU does person X get in lottery A if you are the decision-maker? (Answer: 49 ECU)
3. What is the probability that you get 35 ECU in lottery B if you are the decision-maker? (Answer: 50%)
4. Assume you are a decision maker: When do you get 73 ECU in lottery B? (Answer: If the coin shows “tail”.)

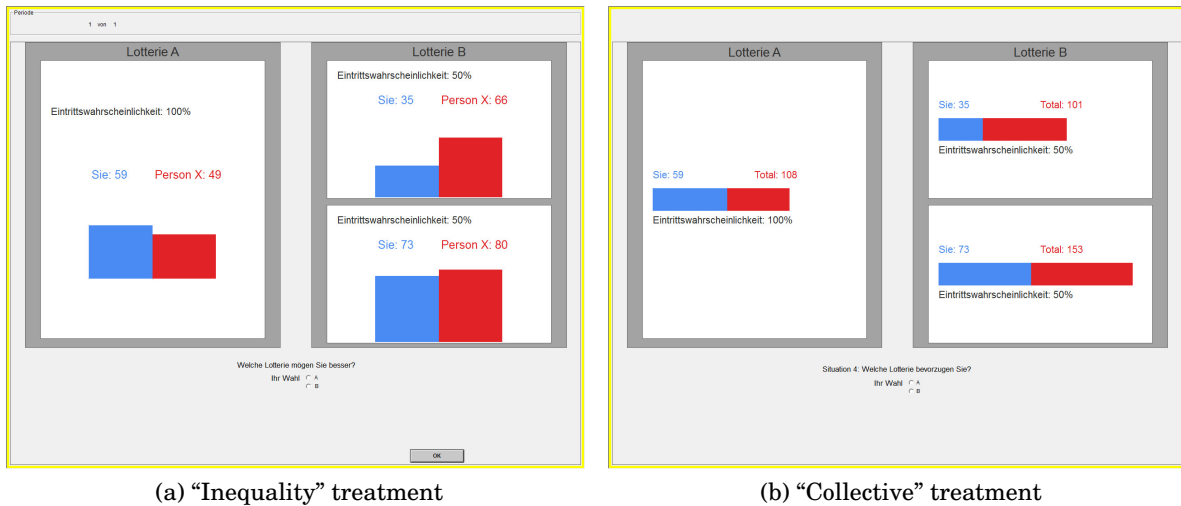


Figure 10: Screenshot

5. Suppose you win 60 ECU in the main part of the experiment. What does this amount correspond to in euros? (Answer: 9 Euros)
6. How likely is it that you are the decision maker if a situation of type 1 determines your payoff? (Answer: 50 percent)

I. Post experimental questionnaire (translated from the German original)

I.1. About the experiment

1. What was this experiment about in your opinion? (free field)
2. Please briefly describe how you took your decisions. (free field)
3. How difficult was it for you to make your decisions? (From 1 to 4, with very easy = 1, very difficult = 4)
4. How understandable were the instructions? (From 1 to 4, with easy to understand = 1, unintelligible = 4)
5. Did you know someone among the participants in this session? (Yes, No)
6. Is payment appropriate for this experiment? (Yes, No)
7. Did you take the payment for person X into account? (Yes, No)
8. Please give your level of agreement with the following propositions (From 1 to 4, with agree fully = 1, totally disagree = 4)
 - a) I chose based on my own payout only.
 - b) I prefer that person X not incur risk.

- c) I prefer that person X get the same payment as me in lottery B.
- d) I chose the option that maximizes payoff for me and person X.
- e) If I incur some risk then it is only fair that person X also incur risk.
- f) It was important for me to obtain a higher payoff than person X.
- g) I prefer not to know how much person X obtains.

I.2. Demographics

Finally, we would like to have a few more statistical informations about you.

1. What is your age?
2. What is your gender?
3. What is your nationality?
4. What is your highest qualification? (Abitur (High School), two-years University degree, Bachelor, Master, Diplom (=Master), PhD, Other)
5. In case you are studying, what are you studying? (Humanities, Social sciences, Natural sciences, Formal sciences, Other applied sciences, Not relevant)
6. Where have you been living most of your life?
 - a) 1. City with more than 1 million inhabitants 2. City with more than 100,000 inhabitants 3. City with more than 10,000 inhabitants 4. Town of less than 10,000 inhabitants 5. Village 6. Countryside.
7. Are you religious? (Yes, No, Unspecified)
8. How would you classify your political affiliation? (Left, social-democrat, liberal, conservative, neutral / moderate, none of the above)
9. What is the main source of income that allows you to fund your living expenses?
 - a) 1. Work (full-time) 2. Work (part-time) 3. Parents 4. Scholarship / BAFöG 5. Credit 6. Other
10. How much money do you spend in total over a month? (including food, clothing, rent, heating, water, education, entertainment, etc...)
 - a) 1. less than 500 € 2. 501 € - 800 € 3. 801 € -1200 € 4. 1201 € - 2000 € 5. More than 2000 € 6. Unspecified
11. Do you live alone? (Yes, No)

I.3. Risk, fairness and trust

1. Are you someone who is ready to take risk or do you try to avoid risk overall? (from 1 to 4, not at all ready to take risk, very ready to take risk)
2. Suppose that two people perform the same job in the same company. Both have the same qualifications, but Person A is more productive than person B. Is it fair that Person A get a higher salary? (Yes, No)

3. Do you agree with the following three statements (from 1 to 4, agree fully to disagree completely):
 - a) In general, one can trust people.
 - b) Nowadays, one cannot rely on anybody.
 - c) When dealing with strangers, it's better to be cautious before trusting them.
4. Would you say that most people...
 - a) would try to take advantage of you if given the opportunity...
 - b) or would try to be fair to you?
5. Would you say that most people...
 - a) try to be helpful...
 - b) or follow only their own interests?