CEEL
Cognitive and Experimental Economics Laboratory

Luciano Andreozzi, Matteo Ploner and Ivan Soraperra

Justice among strangers. On altruism, inequality aversion and fairness

CEEL Working Paper 4-12

Cognitive and Experimental Economics Laboratory

Via Inama, 5 38122 Trento, Italy

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

Justice among strangers

On altruism, inequality aversion and fairness

Luciano Andreozzi*
DEM–University of Trento

Matteo Ploner
DEM–University of Trento

Ivan Soraperra
MPI of Economics, Jena

June 27, 2013

Abstract

We present an axiomatic model of choice involving two agents, motivated by the experimental evidence on non-selfish preferences. We distinguish two classes of social preferences, depending on whether they are or not separable. Altruism and spite (Andreoni & Miller, 2002; Cox *et al.*, 2007) are separable, while the various forms of inequality aversion are not (Fehr & Schmidt, 1999; Bolton & Ockenfels, 2000; Charness & Rabin, 2002). Separable and non-separable preferences give very close predictions when only sure outcomes are involved, but they make opposite predictions in choices involving lotteries. We show this by proposing a generalization of expected utility that accounts for preferences for "fair procedures", which violate the independence axiom. An experimental test of the model reveals little evidence of ex-post inequality aversion, even when non-expected utility preferences are accounted for.

*Corresponding author.
E–mail address: Luciano.Andreozzi[at]unitn.it

1 Introduction

We compare ourselves to our neighbors and peers. (Frank, 1987) We "keep up with the Jones". (Maccheroni *et al.*, 2008) Some become obsessed with their ranking among co-workers and acquaintances. No matter how strong it may be, however, this concern for social comparisons rarely extends outside a relatively small clique of friends and relatives. I may compare my car with my neighbor's, but I would hardly notice if a family living two blocks away has a brand new convertible.

Other social motives are less parochial. Take altruism, for example. We are happy to go through the small hassle of lending a tire iron to a stranger who needs it to change a tire. We donate money to victims of far-away disasters. One may say that in both cases we are concerned about the inequality between ourselves and some less fortunate stranger, but this would be wide of the mark. When we donate a few dollars (or a few minutes of our time) we reason that the benefit they give to somebody else largely outweigh the cost for us. Inequality plays little or no role.

After a long neglect, these deviations from pure egoism have been the focus of an intense theoretical and experimental research within economics (Sobel, 2005). In an early contribution to this literature, Fehr & Schmidt (1999) and Bolton & Ockenfels (2000) introduced the idea that in experimental settings subjects would show the same concern for social comparisons that we observe among neighbours, colleagues and friends. By contrast, Andreoni & Miller (2002) popularized the idea that the observed deviations from pure egoism reflect altruism (or spite), and hence are not primarily aimed at reducing (or enhancing) ex-post inequality.

This literature failed to produce an undisputed winner so far. An obvious reason is that these motives are difficult to tease apart. Pure distributional preferences are elicited by variants of the Dictator Game, in which all models which imply convex preferences make similar predictions (Cox & Sadiraj, 2010).[1]

Another, more subtle, problem is that there is no way to completely eliminate chance from experiments. To run a Dictator Game, roles need to be assigned, which is usually done randomly. *If* social preferences where in agreement with expected utility (as it was customary to assume in the early literature), this

[1] Much more attention has been devoted to the issue of non-monotonicity of social preferences. See for example Fisman *et al.* (2007), Blanco *et al.* (2011) and Cox & Friedman (2008)

would create no problem because subjects' preferences would be independent from the time in which uncertainty about roles is resolved. However, violations of expected utility are common when fairness is at stake (Diamond, 1967; Epstein & Segal, 1992; Karni & Safra, 2002; Machina, 1989). Outside of the lab, the toss of a coin is routinely used to combine two equally unfair outcomes into a fair lottery, which may induce violations of expected utility. (Bolton *et al.*, 2005). In these cases, the details of the way in which uncertainty is resolved become crucial (Myerson, 1981). Subjects may appear to be more concerned about inequality when their preferences are elicited after their position into an unfair allocation is decided then they are before.[2]

We address these issues proposing an axiomatic model that deals at the same time with preferences over sure outcomes and preferences over lotteries. We first provide a definition of altruism that distinguishes it form other preferences (like inequality aversion) in which social comparisons play a role. (See Dufwenberg *et al.* (2011) for a related approach to separability.) We then enlarge the preferences to include lotteries. This is done (in the spirit of Karni & Safra (2002)) by introducing a weaker version of the independence axiom, which accounts for the preference for "fair procedures". The preferences over lotteries are assumed to agree with the preferences over outcomes only when two lotteries that are equally fair are involved. Preferences over lotteries and preferences over outcomes are thus linked, although this link is weaker that it would be with the full independence axiom. We show that this weaker connection is sufficient to devise a very simple test to check the degree to which preferences are separable. The second part of the paper presents the results of an experiment which uses this test. We find that most subjects' preferences are indeed separable (or very close to be so), which speaks against the importance of social comparisons in experimental settings. In the light of what we said before, this is perhaps unsurprising, given the anonymous setting in which we run our experiment.

The paper is organized as follows. We devote Section 2 to an informal

[2] This is a common finding. Engelmann & Strobel (2004) present evidence that experimental subjects show little concern for inequality. In their reply, Bolton & Ockenfels (2006) notice that in that experiments subjects made their decisions before they new their position in the final distribution and that this type of "equal opportunity procedures can soften the tension between equality and efficiency" (1909). Similarly, Charness & Rabin (2002) (CR) and Falk *et al.* (2008) (FFF) find very remarkable differences in subjects' concern for inequality. In commenting these results, Cooper & Kagel (n.d.) notice that "It is hard to argue that the different results of FFF and CR are anything other than an artifact of how preferences are being elicited. One possible methodological cause is CR's use of an "equal opportunity" procedure whereby each subject got to choose as a B player knowing that their actual position as the A or the B player would be determined randomly at the end of the session."(16)

presentation of the main results of the paper and Section 3 to a review of the literature. Section 4 contains the technicalities of the model. In Section 5 we discuss our experimental evidence and Section 6 concludes. Longer proofs are collected in the Appendix.

2 Overview

We shall consider first situations in which a person (I) decides among monetary allocations between himself and another person (you). The choice is taken in a standard, ex-post Dictator Game setting: a fair coin has been tossed and I have been selected to choose among allocations like those in Table 1. I have preferences $\succeq_O$ over allocations of this type, that can be represented by a utility function $V_O(m, y)$, such that $V_O(x, x) = x$. Suppose that my choices reveal that

$$A \succ_O B \sim_O C \succ_O D \sim_O E$$

So, I prefer to divide 10$ equally between me and you rather than take them all to myself ($A \succ_O B$), which reveals that I am not perfectly selfish. But I am not perfectly altruistic either, because I prefer to keep the 10$ rather than give them to you ($B \succ_O D$).

Outcome	A	B	C	D	E
m	5	10	4	0	2
y	5	0	4	10	2

Table 1: Five outcomes

My choices in Table 1 also reveal that I have a preference for "equitable" outcomes. For example, indifference between B and C reveals that when I have 10$ and you nothing, I am willing to throw away 2$ in order to make your payoff equal to mine. While this preference may be attributed to an intrinsic dislike for unequal payoff distributions, this is not the only possibility. The obvious alternative is that the value I attach to an extra dollar to myself depends upon how many dollars I already have, although it does not depend upon how many dollars you have. If dollars have decreasing marginal utility (and I am not totally selfish), I will have strictly convex preferences even if I have no interest in equality *per se*.[3]

[3] This is a well researched topic in the social choice literature that was originated by

This difference is well illustrated by the following utility function, which is by far the most used functional form in the social preferences literature (see Section 3).

$$V_O(m, y) = ((1 - \theta^\star)m^\rho + \theta^\star y^\rho)^{\frac{1}{\rho}} \quad (1)$$

where $\theta^\star = \theta \in [0, 1]$ if $m \geq y$ and $\theta^\star = \theta - k$ with $k \geq 0$ if $y > m$. This is a parsimonious model in which each parameter captures one element of my preferences. θ represents the weight I put on your payoff, so that $\theta > 0$ implies that I am altruistic towards you at least when I get a larger payoff; k represents how much my altruism is reduced when your payoff is larger than mine. ρ captures diminishing marginal utility of money.

My choices in Table 1 can be rationalized either by setting $k > 0$ and $\rho = 1$ (in which case the convexity of my preferences is explained by my aversion to see you getting more money than me) or by setting $k = 0$ and $\rho < 1$, in which case my preferences are convex because I attach a decreasing value to an extra dollar to me or to you. Of course, any combination of these two will also do.

Although this is an important difference, it has received little attention in the literature on social preferences. In Section 4 we clarify this matter by providing a definition of *ordinally separable* preferences (Definition 4.1), which formalizes the idea that the value I attach to an extra dollar for me is independent from the dollars you have. Our first representation theorem (Proposition 4.1) proves that my preferences are ordinally separable if they admit an additively separable representation. We reserve the terms *altruism* and *spite* for preferences that are not egoistic, but are separable in this sense. The preferences represented by Equation 1 are separable provided that $k = 0$.[4]

The understanding of social preferences observed in laboratory settings would improve if a test could be devised to tell apart subjects whose choices are mostly motivated by the desire to reduce inequality from those whose preferences are better described as purely altruistic. Notice that such a test is bound to involve

---

Harsanyi's utilitarian theorem (Harsanyi (1955)). In the context of Harsanyi's theorem, it is a common statement that inequality aversion is simply a consequence of individuals having strictly concave utility functions for money (Harsanyi (1975) and Sen (1980) are a classical source for this debate. See Chambers (2012) for a recent contribution to this topic.) Broome (1995) contains a detailed discussion of Harsanyi's theorem, which to a large extent overlaps with the one we pursue here. More recent contributions to this debate are Fleurbaey (2010) and Fleurbaey & Zuber (2012).

[4] A value of k larger than zero implies that my indifference curves have a kink along the equal distribution line. This may seem to imply that failures of separability imply non differentiability of the utility function. This is in fact incorrect. Bolton & Ockenfels (2000) model inequality aversion by means of utility functions with smooth indifference curves.

more complex choices than the ones presented in Table 1. In fact, our discussion of separability in Section 4 will make it clear that, if one is bound to observe choices among sure outcomes, the required test is far too contrived to be used in a laboratory. The main tenet of this paper is that there is a way to single out my concern for ex-post inequality by observing the way I choose among lotteries.

Given what we said in the Introduction, this may sound paradoxical. A lottery can be seen as a procedure for allocating money between me and you that can be more or less fair. The value I attach to a lottery will thus depend upon my preferences over the outcomes it produces *and* the fairness of the lottery itself. To complicate matter, the value of a lottery will also depend upon my attitudes towards risk, which is particularly difficult to define in a context in which I decide over my and your payoff. The lotteries in Table 2 illustrate this point. (See Ben-Porath *et al.* (1997) and Fleurbaey (2010)).

Q

	H	T
m	5	5
y	5	5

R

	H	T
m	10	0
y	0	10

S

	H	T
m	10	0
y	10	0

T

	H	T
m	4	2
y	4	2

U

	H	T
m	10	10
y	0	0

Table 2: Five lotteries

Let $\succeq$ be my preferences over lotteries, and suppose that they must agree with my preferences over outcomes, including the independence axiom. It would then be the case that

$$Q \succ U \succ R \sim T$$

The preference $U \succ R$ appears to be questionable. It is true that in my ex-post choices I revealed that the outcome produced by U on Tail (10\$ for me and nothing for you) is better than the outcome produced by R (nothing for me and 10\$ for you). Since U and R produce the same outcome on Head, the independence axiom would imply that U is better than R. However, giving me and you an equal chance of getting 10\$ (R) is arguably more fair than appropriating the 10\$ myself (U). If my concern for the fairness of the lottery is sufficiently strong, I may disregard my preferences over outcomes and choose R rather than U. This example shows that there are cases in which the independence axiom is reasonable (for example when it implies that Q is better than T) and others in which it is not (when it implies that U is better than R). Also, it suggests that violations of the independence axiom are to be expected in situations in which a fair lottery like R is obtained by mixing two unfair outcomes like B and D in Table 1.

To make this intuition rigorous we need a definition of the fairness of a lottery. This is not an easy task. For example, it is not clear whether I am fairer if I give you one third of a given endowment, or one third of the probability of winning it. Luckily, we don't need to answer this question, as for our purposes a very mild notion of fairness is sufficient. Consider the lotteries Q, R and S. They may be viewed as three equally fair ways of allocating 10$ between myself and you. Q divides them equally between us, R flips a fair coin to adjudicate them, S flips a coin and award 10$ each on Head and nothing to each on Tail.

It seems plausible to assume that my preferences over these lotteries should reflect my concern for ex-post inequality (in comparing R to S) and my attitude towards risk (in comparing Q with S). However, they should not depend upon the relative importance I place on the ex-ante fairness of a lottery, as these lotteries are (we contend) equally fair.

To see how this intuition can be formalized, consider the following extension of the utility function in equation 1 to a lottery p in which a coin is flipped and a large prize x_H or a small prise x_L is awarded to me or to you. We shall call these *simple symmetric lotteries.* Assuming that $u(x) = x^\rho$

$$\begin{aligned} V(p) &= \frac{1}{2}u(V_O(x_H, x_L)) + \frac{1}{2}u(V_O(x_L, x_H)) + \kappa\frac{x_H + x_L}{2} \\ &= x_H^\rho + x_L^\rho - k(x_H^\rho - x_L^\rho) + \kappa(x_H + x_L) \end{aligned} \tag{2}$$

The utility of a lottery q which is obtained by mixing simple symmetric lotteries like p is the expected value of their utilities $V(p)$.

This utility function is a combination of an ex-post component which is the expected utility of the function $u(V_O(m, y))$ and an ex-ante component which is the expected monetary value of the lottery for me and for you. κ captures my departure from expected utility. When $\kappa = 0$ my choices agree with expected utility, so that no value is attached the coin flipping. In this case, the function

$u(V_O(x,x))$ will represent my preferences over lotteries that yield always the same ex-post monetary payoff x for me and for you. Larger values of κ imply that I tend to disregard my preferences for the ex-post outcomes and pay more attention to the ex-ante fairness of the lottery.

Notice however that varying the value of κ does not distort my preferences over lotteries that are symmetric and have the same expected value for me and for you. To see this, consider that my utility for two symmetric lotteries with the same expected value $\frac{x_H+x_L}{2}$ is simply a linear transformation of the expected value of $u(V_O(m,y))$. In this sense, my preferences over lotteries that are equally fair depend upon my preferences over outcomes (represented by $V_O(m,y)$) and my attitude towards risk (represented by the concavity of the function u) but not by my preferences concerning the fairness of the lottery (captured by κ).

Consider now my preferences over the lotteries R and S, that is for lotteries that only differ in the final correlation of our payoffs. We say that my preferences are *cardinally separable* if I am always indifferent among lotteries like these. It is a straightforward exercise to show that for any value of $\kappa \geq 0$, $V(R) = V(S)$ only if the concavity of my utility function is given by $\rho < 1$ and $k = 0$, that corresponds to ordinal separability. In this sense, preferences that make similar predictions in ex-post context do make opposite predictions in risky environments.

This result is intuitively appealing: indifference between R and S can only be taken as a proof that I have no concern for ex-post inequality, and hence that my preferences are indeed separable. In Section 4, when we provide a behavioral foundation for this class of models, we shall see that this is a general result. For any specification of my ex-post preferences $V_O(m,y)$, indifference between R and S reveals that they admit an additively separable representation.

This is the test we were looking for. When I choose between lotteries only differing in the correlation of our payoffs, I reveal my concern for ex-post inequality which is independent from other factors such as altruism, risk aversion or the preference for the ex-ante fairness of the lottery.

This result allows us a better understanding of the relationship between my ex-ante and ex-post choices as far as inequality is concerned. For any specification of my ex-post preferences $V_O(m,y)$ and my risk attitude represented by u, larger values of κ will make me prefer lotteries with larger expected payoff for me and for you, regardless of the final allocation of money. In this sense, it may appear that ex-ante I am less inequality averse than I am ex-post. Our model gives a more nuanced picture on this point. The real test for inequality aversion requires a comparison between lotteries that differ in payoff correlation. Indifference between these lotteries implies absence of ex-post inequality aversion. As a consequence, it would be improper to say that a larger concern for ex-ante equality reduces my concern for ex-post inequality. Roughly speaking, a consideration for the ex-ante fairness of the lottery ($\kappa > 0$) will reduce the concavity of my utility function. However, in our approach there is no relationship between concavity and inequality aversion. Aversion to inequality requires a degree of non-separability, which in equation 1 is captured by $k > 0$. As long as $k = 0$, my preferences are separable (and hence they do not reveal inequality aversion) both ex-ante and ex-post.

In the experimental part of the paper we study choices in simple symmetric lotteries and use equation 2 as a parametric model. Our data show that even if subjects' preferences fail to be separable, the parameter capturing non separability is very small. Moreover, a direct comparison of an inequity-aversion model a la Fehr & Schmidt and of an altruism model a la Cox *et al.* clearly shows that the latter better fits our data.

3 Literature Review

Most of the literature on social preferences has revolved around the functional form (1).

- Andreoni & Miller (2002), Cox *et al.* (2007), Fisman *et al.* (2007) assume that $\rho \leq 1$ and $k = 0$.
- Fehr & Schmidt (1999) assume that $\theta \geq 0$, $\rho = 1$ and $k > \theta$.
- Charness & Rabin (2002) and Engelmann & Strobel (2004) assume that $\theta \geq 0$, $\rho = 1$ and $k \in [0, \theta]$.

This literature has paid little attention to the issue of the separability. For example, Charness & Rabin (2002) present their model as an extension of Andreoni & Miller (2002), although the former is based on non-separable preferences and the latter on separable ones. Similarly, Cox *et al.* (2007) interpret the convexity of preferences (as captured by ρ) as a concern for relative payoffs, in analogy with inequality aversion. Our approach may help establish a more uniform terminology. It would be good to reserve, as we do here, the expression "inequality aversion" to those cases in which the difference between your and my monetary payoff enters my utility function and prevents it from having a additively separable representation.

Axiomatic versions of inequality aversion are presented by Neilson (2006) and Rohde (2010). The extension of inequality aversion to lotteries has been the focus of a small literature in the experimental field. Trautmann (2009) proposes a tractable model of ex-ante and ex-post inequality aversion. Saito (2012) provides a behavioural foundation for a utility function in which ex-post choices are in agreement with inequality aversion. Krawczyk & Le Lec (2010) and Brock *et al.* (2011) explore giving in Dictator Games in which instead of a fraction of the total pie, a subject can transfer a probability of winning. All these articles work in the framework of preferences for ex-post inequality as modelled by Fehr & Schmidt (1999). A consistent finding is that neither pure ex-ante, non pure ex-post concern for equality capture the observed behavior. The focus of these papers is orthogonal to our, in that they assume that subjects' ex-post preferences are best captured by inequality aversion and test to what extent "procedural fairness" reduces such concern.

Fudenberg & Levine (2012) discuss how to extend social preferences to lotteries in a spirit which is quite close to the one presented here. They derive an impossibility result which shows that several "properties" of preferences for ex-post outcomes and for lotteries cannot be satisfied together. Among them, they require that I should be willing to pay to correlate my winnings with yours for at least one lottery. This clearly conflicts with the approach we follow here, as we define cardinal separability as a global property of preferences over lotteries in which this property is violated. This is ultimately an empirical issue, and the evidence we present in the second part of this paper reveals that at least half of our subjects do have cardinally separable preferences.

4 Theory

4.1 Preferences over outcomes

An *outcome* is a pair $x = (m, y)$ where m is the money that goes to me and y is the money that goes to you. We say that an outcome is *symmetric* if it gives me and you the same amount of money. When there is no risk of confusion, we shall indicate with $x = (x, x)$ both the symmetric outcome and the money me and you get in it.

I have preferences $\succeq_O$ over outcomes that are complete, transitive and continuous. I am non selfish towards you, which means that there are at least two outcomes $x = (m, y)$ and $x' = (m', y')$ with $m' < m$ and $x' \succ x$. My preferences are *monotonic* if $(m, y) \succ_O (m', y')$ whenever $m > m'$ and $y > y'$. Also, we say that my preferences are *m-monotonic* if $(m, y) \succ_O (m', y')$ whenever $m > m'$ and are *symmetric-monotonic* if $x > x'$ implies that $(x, x) \succ_O (x', x')$. We shall follow the literature on social preferences in assuming that my preferences satisfy both m-monotonicity and symmetric monotonicity.

We shall indicate with $V_O(.)$ a numeric representation of these preferences such that $V_O(x, x) = x$. This representation is unique if preferences are monotonic. When preferences are not monotonic, $V_O(.)$ does not represent my preferences for the outcomes x such that $(0, 0) \succ_O x$. To avoid unnecessary complications, in what follows we shall restrict our attention to the set of outcomes S that are at least as good as $(0, 0)$, and for which the representation $V_O(.)$ is unique.

Definition 4.1 ***Ordinally separable preferences*** *Let $x = (m, y)$ and $x' = (m', y')$ be two outcomes such that $x \sim x'$. Let h_m and h_y be two numbers such that $(m + h_m, y) \sim (m', y' + h_y)$. The preferences $\succeq_O$ are ordinally separable if $(m + h_m, y') \sim_O (m, y' + h_y)$*

Figure 1 illustrates this definition. The preferences on the left are separable those on the right are not. In both cases I am indifferent between outcomes $x = (m, y)$ and $x' = (m', y')$. Indifference between a and b can be interpreted in the following way. Increasing my payoff of h_m in outcome x creates a new outcome (a) which is better than x and x'. h_y is the extra money you must receive in outcome x' to create another outcome (b), which is indifferent to a. One may interpret h_y as the value in terms of money for you in outcome x' of h_m dollars to myself in outcome x. Separability requires that this value should only depend on me getting m in x and you getting y' in x'. In turn, this requires that I am indifferent between c and c'. To see this, consider that in outcome d I get the same monetary payoff as in x, while you get the same monetary payoff as in x'. If I am indifferent between c and c', then I reveal that whenever I have x and you have y', I am willing to trade h_m extra dollars to me for h_y extra dollars for you.

What follows is our first representation theorem.

Proposition 4.1 *Preferences $\succeq_O$ are ordinally separable iff they admit an additive representation, that is if there are three functions $u(.)$, $u_m(.)$ and $u_y(.)$*

such that

$$u(V_O(m,y)) = u_m(m) + u_y(y)$$

This representation is unique up to a positive, linear transformation.

The if part is obvious. The only if part is a consequence of Debreu (1959) Theorem 3. It is easy to see that our definition 4.1 implies the so called Thomsen condition as illustrated by Figure 1. (For the Thomsen condition see Karni & Safra (1998) Wakker (1989))

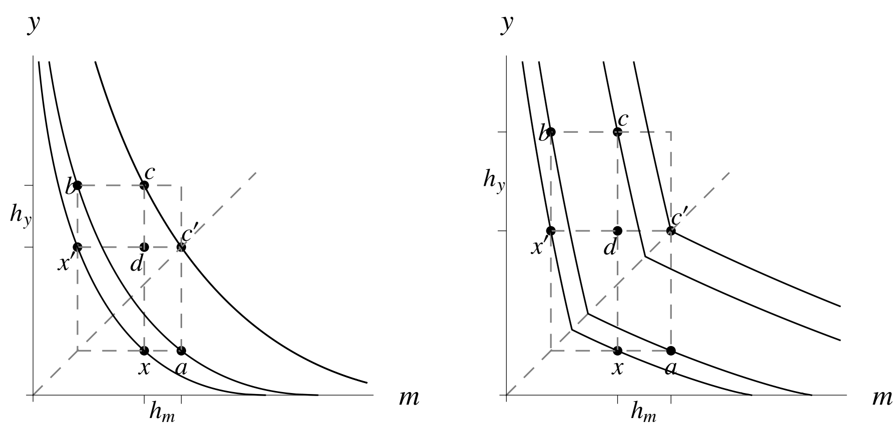


Figure 1: Separable (left) and non separable (right) preferences

If the preferences $\succeq_O$ are m-monotonic and symmetric monotonic, then $u_m(.)$ is strictly increasing. If $u_y(.)$ is also strictly increasing we say that I am *altruistic* towards you; if it is strictly decreasing I am *spiteful*.

4.2 Lotteries

Consider my preferences $\succeq$ over lotteries whose prizes are outcomes x. We shall indicate with $p = (x_1, p_1; \ldots; x_n, p_n)$ a generic lottery that yields outcome x_i with probability p_i. We shall also indicate with $p(x)$ the probability with which the outcome $x = (m, y)$ is obtained under p. $Supp(p)$ is the set of outcomes x such that $p(x) > 0$. For any outcome $x = (m, y)$ let $\bar{x} = (y, m)$ be the outcome in which the monetary payoffs are swapped between me and you. A simple symmetric lottery $(x, \frac{1}{2}; \bar{x}, \frac{1}{2})$ is an equal randomization between x and $\bar{x}$. We concentrate on generic symmetric lotteries, defined as follows.

Definition 4.2 *A lottery p is* ***symmetric*** *if for any outcome $x = (m, y) \in Supp(p)$ we have that for $\bar{x} = (y, m)$ $p(x) = p(\bar{x})$*

Notice that all symmetric outcomes $x = (x, x)$ for any $x \geq 0$ are also symmetric (degenerate) lotteries. Notice also that any symmetric lottery p can be decomposed as $p = ((x_1, \frac{1}{2}; \bar{x}_1, \frac{1}{2}), p_1; \ldots; (x_n, \frac{1}{2}; \bar{x}_n, \frac{1}{2}), p_n)$ where p_i is the probability with which the simple symmetric lottery $(x_i, \frac{1}{2}; \bar{x}_i, \frac{1}{2})$ obtains.

What follows is a standard technical axiom:

Axiom 4.1 *The preferences $\succeq$ are complete, transitive and continuous*

Our next axiom is a weaker form of the independence axiom, that only applies to symmetric lotteries.

Axiom 4.2 *Let p and q be two symmetric lotteries such that $p \succeq q$. For every $\alpha \in [0, 1]$ and for every symmetric lottery r, $(p, \alpha; r, (1-\alpha)) \succeq (q, \alpha; r, (1-\alpha))$*

What follows is a straightforward consequence of standard proofs in decision theory. (See for example Mas-Colell *et al.* (1995))

Fact 4.1 *Axioms 4.1 and 4.2 imply that preferences over lotteries $\succeq$ can be represented by a function $V(.)$. For any pair of symmetric lotteries p and q and for any $\alpha \in [0, 1]$,*

$$V(p, \alpha; q, (1-\alpha)) = \alpha V(p) + (1-\alpha) V(q)$$

.

Finally, let $v(x) = V((x, x))$. Then, for any lottery p involving only symmetric outcomes $x = (x, x)$

$$V(p) = \sum_{x \in supp(p)} p(x) v(x)$$

Our next axiom deals with the case of symmetric lotteries that are obtained by mixing unfair outcomes. Consider Figure 2. The thick lines represent the indifference curves corresponding to the preferences over outcomes $\succeq_O$ passing through outcomes x and $\bar{x}$. x^e and $\bar{x}^e$ are the symmetric outcomes that are indifferent to x and $\bar{x}$ resp. $\hat{x}^e_O$ is the symmetric outcome such that $\hat{x}^e_O \sim (x^e, \frac{1}{2}; \bar{x}^e, \frac{1}{2})$, while $\hat{x}^e$ is the outcome such that $\hat{x}^e \sim (x, \frac{1}{2}; \bar{x}, \frac{1}{2})$.[5]

[5]Notice that if the preferences $\succ_O$ fail to be monotonic, there may not be a symmetric outcome x^e that is indifferent to an outcome x. Consider however that we restricted our attention to the set S of outcomes that are at least as good as (0,0).

The independence axiom implies that $(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) \sim \hat{x}^e_O$ and hence that $\hat{x}^e_O = \hat{x}^e$. However, our weaker version of the independent axiom does not apply here, as x and $\bar{x}$ are not symmetric (degenerate) lotteries unless $x = \bar{x}$. So it is possible that an equal randomization between x and $\bar{x}$ is strictly preferred to an equal randomization between x^e and $\bar{x}^e$, although x is indifferent to x^e and $\bar{x}$ is indifferent to $\bar{x}^e$. Our next axiom establishes that randomizing between x and $\bar{x}$ is always at least as good as randomizing between x^e and $\bar{x}^e$ and hence $\hat{x}^e \geq \hat{x}^e_O$.

Axiom 4.3 *Let $x = (x_H, x_L)$ and $\bar{x} = (x_L, x_H)$ be two outcomes and let $x^e = (x^e, x^e) \sim x$ and $\bar{x}^e = (\bar{x}^e, \bar{x}^e)$. Then $(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) \succeq (x^e, \frac{1}{2}; \bar{x}^e, \frac{1}{2})$.*

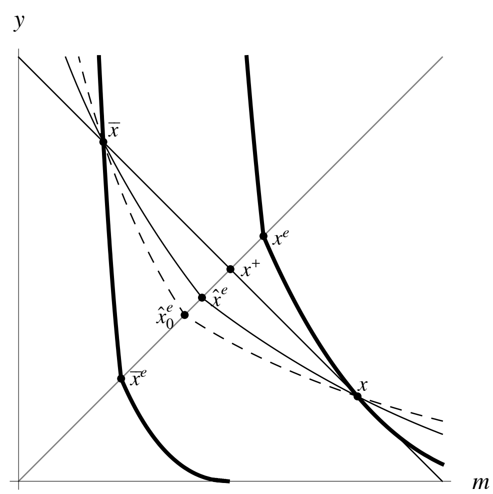


Figure 2: The weakening of the independence axiom

This axiom formalizes the idea that the mix of two unfair outcomes may be strictly preferred to any of them taken in isolation. It leads to our second representation theorem.

Proposition 4.2 *Let axioms 4.1, 4.2 and 4.3 hold true. Then for any symmetric lottery p*

$$V(p) \geq \sum_{x \in supp(p)} p(x) v(V_O(x)) \equiv v(V_O(p))$$

Notice that the model incorporates expected utility as a particular case in which the above inequality is in fact an equality for every lottery. With a slight abuse of notation we indicate with $v(V_O(p))$ the value the lottery p would have for a person who respects the independence axiom.

Our next axiom connects my preferences over outcomes and my preferences over lotteries. It imposes first that my preferences over lotteries agree with my preferences over outcomes in being monotonic for symmetric outcomes $x = (x, x)$. This clearly requires that $v(x)$ is strictly increasing. Second, it stipulates that in the choice between two symmetric lotteries in which me and you get the same expected amount of money, my preferences will only depend upon my ex-post preferences $V_O(m, y)$ and my risk preferences represented by $v(x)$.

Axiom 4.4 *(i) The function $v(x)$ is strictly increasing. (ii) Let p and q be two symmetric lotteries and let p^+ and q^+ be the expected monetary value of these lotteries for me and for you. If $p^+ = q^+$, then $V(p) \geq V(q)$ iff $v(V_O(p)) \geq v(V_O(q))$.*

We are now ready for our main result. We first define the notion of "cardinally separable" preferences. My preferences are cardinally separable if I am indifferent with respect to the correlation of our winnings.

Definition 4.3 *Preferences $\succeq$ are cardinally separable if for any outcome $x = (x_H, x_L)$*

$$V((x_H, x_L), \frac{1}{2}; (x_L, x_H), \frac{1}{2}) = V((x_H, x_H), \frac{1}{2}; (x_L, x_L), \frac{1}{2})$$

Proposition 4.3 *Let axioms 4.1, 4.2, 4.3 and 4.4 hold true. Preferences over lotteries $\succeq$ are cardinally separable only if the preferences over outcomes $\succeq_O$ are ordinally separable.*

In experiments it is useful to work with a parametric utility function. We shall consider a utility representation of preferences $\succeq$ which takes a simple additive form between the ex-post preferences over outcomes and the ex-ante evaluation of the lottery. The fairness of a lottery p is represented by a function $\Phi(p)$: two lotteries that are deemed to be equally fair have the same value of $\Phi(p)$. Preferences over outcomes are represented by an increasing function $u(.)$ and a scalar κ such that for a simple symmetric lottery p with outcomes

$x_H > x_L$

$$V(p) = \frac{1}{2}u(V_O(x_H, x_L) + \frac{1}{2}u(V_O(x_L, x_H))) + \kappa\Phi(p) \quad (3)$$

Our last proposition puts a restriction on the form that the function $\Phi(p)$ can take.

Proposition 4.4 *Let the preferences over symmetric lotteries be represented by the function 3. Then axioms 4.1, 4.2, 4.3 and 4.4 imply that for any simple lottery* $p = ((x_H, x_L), \frac{1}{2}; (x_L, x_H), \frac{1}{2})$, $\Phi(p) = \frac{x_H + x_L}{2}$.

This result provides a foundation for the use of equation 2 and sets the stage for the experiment we present in the next section.

5 The Experiment

5.1 Decision Setting

We test the parametric specification of preferences in equation 2. We test our model with three different tasks that are represented in Table 3. Subjects are randomly paired and roles are randomly assigned as subject A or B. Both subjects perform the same decision tasks, but only the choice made by subject A is implemented.[6]

In treatment *Equity (E)*, the subject decides between lotteries with correlated (Y) and anti-correlated winnings (X). The expected monetary payoff of the anti-correlated lottery is increasing, so that the choice measure a subject's willingness to pay to correlate his winning with his partner. Cardinal separability implies that lottery X are always preferred to lotteries Y (with the exception of the first, in which there is indifference).

In treatment *Risk (R)*, Option Y warrants a safe outcome of 10 while X yields a risky outcome which increases in its expected value moving from top to bottom. A subject characterized by a concave function $v(x)$ should switch from Option Y to Option X for $C > 6$.

In treatment *Equity and Risk (ER)* the lotteries have the same total monetary payoffs for the two subjects (20), but vary in the ex-post correlation of the payoffs. A risk-neutral and inequality averse subject would prefer always the

[6]In the experiment earnings were computed in Experimental Currency Units (ECU). The ECU to € exchange rate was equal to 1/2.

option Y, because it contains no ex-post inequality and has a constant expected value. A risk averse subject who is indifferent to ex-post inequality should instead always prefer option X.

Table 3: Treatments

	Option X				Option Y			
	p=1/2		p=1/2		p=1/2		p=1/2	
	H		T		H		T	
	x_A	x_B	x_A	x_B	x_A	x_B	y_A	y_B
				E				
1	20.00	0.00	0.00	20.00	20.00	20.00	0.00	0.00
2	21.00	0.00	0.00	21.00	20.00	20.00	0.00	0.00
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	28.00	0.00	0.00	28.00	20.00	20.00	0.00	0.00
10	29.00	0.00	0.00	29.00	20.00	20.00	0.00	0.00
				R				
1	15.00	15.00	1.00	1.00	10.00	10.00	10.00	10.00
2	15.00	15.00	2.00	2.00	10.00	10.00	10.00	10.00
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	15.00	15.00	9.00	9.00	10.00	10.00	10.00	10.00
10	15.00	15.00	10.00	10.00	10.00	10.00	10.00	10.00
				ER				
1	20.00	0.00	0.00	20.00	20.00	20.00	0.00	0.00
2	19.00	1.00	1.00	19.00	20.00	20.00	0.00	0.00
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
9	12.00	8.00	8.00	12.00	20.00	20.00	0.00	0.00
10	11.00	9.00	9.00	11.00	20.00	20.00	0.00	0.00

The three decision tasks summarized in Table 3, when jointly considered, provide us with an effective identification strategy of relevant parameters in equations 2. In treatment R only lotteries with symmetric outcomes are present and this allows us to identify parameters κ and ρ independently of k.[7] Choices

[7]In treatment R, a subject chooses X over Y at choice C iff $(15/2)^\rho + (C/2)^\rho + \kappa(15/2 + C/2) \geq (10/2)^\rho + (10/2)^\rho + \kappa(10/2 + 10/2)$

in treatment ER allow us to estimate parameters ρ and k. Within this treatment the expected value of the lotteries is kept constant and, as a consequence, ex-ante fairness does not differ across alternatives.[8]. However, choices in treatments R and ER allow us to estimate k and κ as a function of ρ. To obtain a full estimation of the relevant parameters, we need to take into account choices in treatment E. In this treatment, all relevant parameters play a role in shaping behavior. This is because of the tension between ex-post inequality aversion, that increases the utility of X, and risk aversion, captured both by ρ and by the level of ex-ante inequity aversion favoring symmetric lotteries with higher expected value.[9]

5.2 Participants and Procedures

A total of 116 Participants took part in 6 distinct experimental sessions conducted at the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento, Italy. The participants are undergraduate students of the University of Trento. Each participant took part only in one session. The computerized experiment was programmed and conducted using the Z-tree software (Fischbacher, 2007).

A show-up fee of €3 was given to each participant. The average earnings in the experiment were €8.37, show-up fee included. In the experiment earnings were computed in Experimental Currency Units (ECU) and at the end of the experiment 2 ECU were exchanged for €1.

Upon their arrival at the laboratory, participants were randomly allocated to a cubicle inhibiting interaction with other participants. Participants were left 5 minutes to read instructions individually and then instructions were read aloud by staff in the room. Participants were left free to privately ask for clarification and were asked to answer a questionnaire checking for their understanding of the instructions. After all had answered the questionnaire the experiment could begin.

The three treatments E, R, and ER were administered in a within-subject fashion over three distinct rounds. Thus, each participant took part in a total of 30 (10×3) decision tasks. The order of treatments was randomized at the

[8]In treatment ER, a subject chooses X over Y at choice C iff $\big((20-C+1)/2\big)^\rho + \big((C-1)/2\big)^\rho - k\Big(\big((20-C+1)/2\big)^\rho - \big((C-1)/2\big)^\rho\Big) \geq (20/2)^\rho$

[9]In treatment E, a subject chooses X over Y at choice C iff $\big((20-C+1)/2\big)^\rho - k\big((20+C-1)/2\big)^\rho + \kappa\big((20+C-1)/2\big) \geq (20/2)^\rho + \kappa(20/2)$

individual level, to control for ordering effects. Individuals were made aware of the fact that only one of the tasks would be randomly selected for payment at the end of the experiment. Specifically, the following procedure was adopted to define payments: first, one of the three rounds was randomly selected; second, one of the ten choices in this round was randomly picked; third, a uniform random drawn defined whether event H or T is realized; finally, the earnings of the two players were computed according to the choice made by subject A in correspondence to the decisions task thus selected.

5.3 Description of Choices

Figures 3 provides an analysis of participants' choices across experimental treatments. Bars' height captures the relative frequency of Option Y in each decision task C (see Table 3 for a description of choice tasks), both for Subjects 1 and Subjects 2. The dots and dashed lines represent the predicted probabilities of choosing Option Y, rather than Option X, as estimated by a mixed-effects logit regression controlling for repeated choices at the individual level.[10]

[Insert Figure 3 about here]

In treatment E, about 60% the participants choose Option Y for the choice task $C = 1$. However, the mixed-effects logit regression shows that the likelihoods of choosing Option Y and Option X are not statistically different for this choice task. As C increases, the likelihood of choosing Y becomes progressively smaller, with values approaching zero for $C > 5$. A likelihood ratio test shows that overall choices of Subjects A and Subjects B do not significantly differ (p-value=0.859).

In treatment R, almost all participants choose Option Y for $C < 6$, in accordance with risk aversion predictions. For $C \geq 6$, the participants switch to Option X, with a tiny fraction of participants choosing Option Y also for $C = 10$, when this is strictly dominated. However, the predicted probabilities of choosing B are very close to zero for $C > 7$ and reach zero for $C = 10$. A likelihood ratio test shows that choices of Subjects A and Subjects B are statistically different, but only marginally so (p-value=0.077).

In treatment ER, the majority of Subjects A chooses Option Y for $C \leq 4$, with a statistically significant effect for $C \leq 2$. The predicted likelihood of choosing this option is very close to zero for $C \geq 7$. A likelihood ratio test

[10]Indifference choices were omitted from the regression analysis. As a consequence, the number of observations ranges from 508 in treatment ER for Subjects 2 to 554 in treatment R for Subjects 1.

shows that choices of Subjects A and Subjects B do not statistically differ, overall (p-value=0.542).

Figure 3 reports on choices of all participants in the experiment. A relevant subset of choices is given by choices of rewarded participants (i.e, Subjects A) characterized by monotonic preferences.[11] The percentages of Subjects a meeting the monotonicity requirement are equal to 75.9%, 86.2%, and 74.1%, in treatment E, R, and ER, respectively. Overall, choices of this selected subsample are in line with the behavioral patterns displayed in Figure 3. In treatment E, the majority of participants with monotonic preferences (56.8%) chooses Option Y for $C = 1$, but a series of exact binomial tests restricted to choices of the participants who either choose Option X or Option Y does not detect any statistically significant difference in the propensity to choose Option X over Option Y for $C \leq 4$ (all p-values ≥ 0.096). For $C \geq 5$, choosing Option Y is statistically more likely than choosing Option X (all p-values ≤ 0.049). Choices of participants with monotonic preferences in treatment R strongly support the hypothesis of risk aversion among the participants. According to a series of exact binomial tests, choosing Option Y is statistically more likely than choosing Option X for $C \leq 6$ (all p-values ≤ 0.001). For $C \geq 8$, the likelihood of choosing Option X rather than Option Y is statistically higher (all p-values ≤ 0.006). In treatment ER, the majority of participants with monotonic preferences chooses Option B for $C < 4$. In particular, 62.8% choose Option B in $C = 1$ (Exact binomial test, p-value=0.008). However, for $2 \leq C \leq 4$, no statistically significant difference in the choice propensity is observed, while for $C \geq 5$ a statistically higher likelihood of choosing Option X over Option Y is observed (all p-values ≤ 0.028).

5.4 Model Estimation

In this section, we adopt a random utility approach to estimate a convenient parametric specification of our model. We assume that preferences over simple symmetric lotteries can be represented by equations 2. We also provide an estimation of the parameters in that equation, relying on the econometric specification described in Appendix B. In addition to the estimates of the parameters of the utility function, we also provide an account of alternative sources of error

[11] A subject has monotonic preferences if a single switch from one option to the other is observed. Moreover, an indifference choice should always be placed in between a choice of one option and of the other. If a subject starts with an indifference choice, no switches from one option to the other should be observed.

or indecisiveness in the decision making process. In particular, σ is the dispersion parameter of the Fechnerian error ϵ and w is a parameter measuring trembling in choices. Finally, parameter t measures the sensitivity in perceiving utility differences.

Table 4 reports the ML estimates of the parameters both for Subjects A (rewarded choices) and Subjects B (hypothetical choices).

Table 4: Estimates of the model in eq 5

Parameters	Subjects A		Subjects B	
	Coeff	Std. Error	Coeff	Std. Error
ρ	0.762	0.024	0.837	0.025
k	0.081	0.020	0.045	0.020
κ	0.000	0.012	0.000	0.013
w	0.000	0.087	0.126	0.048
σ	0.542	0.076	0.445	0.050
t	0.051	0.024	0.055	0.014
logLik	-1301.464		-1345.070	
AIC	2614.928		2702.141	

The estimates reported in Table 4 suggest that preferences are not additively separable. Indeed, k, although small in size, is significantly different from 0 in both the estimated models. Interpreting k in terms of the F&S model gives us an indication of the relevance of the estimated k. Within this model, inequality aversion requires that $k > \theta$. Hence, the value of k will imply a θ smaller than 0.081, a very low concern for the other's payoff. By contrast, the hypothesis that the convexity of preferences can be explained by decreasing marginal utility obtains strong support in our data. In fact, we reject the hypothesis that $\rho = 1$ in both the models.

The estimates of κ and w both hit the lower bound of the parameter space. This implies that we cannot reject the hypothesis that EUT holds and that paid subjects do not suffer from trembling, respectively. Interpreting the value of κ in terms of our model, we reject the hypothesis of a utility bonus for ex-ante equality. Because the estimates of κ and w lie on the boundary of the parameter space, the more parsimonious model obtained imposing $\kappa = 0$ and $w = 0$ provides exactly the same estimates and likelihood value and, thus, should be preferred to the full model.

Interestingly, hypothetical and paid choices deliver the same qualitative results, i.e., low concavity of indifference curves and a small preference shift moving from advantageous allocations to disadvantageous ones. The most interesting aspect emerging from the comparison is the presence of a positive estimate of trembling in case on hypothetical choices that is not observed when choices are payoff relevant.

The estimates reported in Table 4 do not allow us to dismiss one of our reference models in favor of the other. However, a direct comparison between F&S and Cox models can be obtained by imposing $\rho = 1$ and $k = 0$, respectively. Table 5 reports on the outcomes of these restricted estimations in which the parameters κ and w are dropped for the reasons stated above.

Table 5: Estimates of the F&S and Cox models (Subjects A)

Parameters	F&S		Cox	
	Coeff	Std. Error	Coeff	Std. Error
ρ	1.000	—	0.732	0.019
k	0.051	0.013	0.000	—
κ	—	—	—	—
w	—	—	—	—
σ	1.471	0.111	0.708	0.042
t	0.126	0.015	0.065	0.007
logLik	-1404.031		-1329.482	
AIC	2814.061		2664.964	

When comparing the fitting performance of the two models, the Akaike's Information Criteria (AIC) provides a clear advantage to the Cox model over the F&S model.

To summarize, we obtain strong evidence of convex other-regarding preferences ($\rho < 1$) and reject the hypothesis of additively separable preference ($k > 0$). The estimated degree of non separability, however, seems to be negligible when considering its economic relevance. Comparing the relative performance of the F&S and of the Cox model our results favor the altruism explanation over the inequity aversion explanation of choice behavior. Finally, we fail to reject the hypothesis of deviations from expected utility due to ex-ante inequity concerns.

6 Conclusions

Our result should be taken cautiously. First, the relative unimportance of inequality aversion, or any other type of preferences based on social comparisons, does not mean that subjects involved in experiments cannot show other social motives, altruism being the obvious alternative.

Also, while our experiment shows that inequality aversion is relatively unimportant in the anonymous environment in which experiments take place, it is silent on the force of this motive outside of the lab. In the face-to-face interactions that characterizes the real world, inequality aversion may be a much stronger force (with a larger economic impact) than any other social motive, including pure altruism. In this sense, inequality aversion should continue to play an important role in theoretical analysis, although its impact on the experimental literature may be more limited.

A Appendix

[Proof of Proposition 4.2] Consider a simple symmetric lottery $(x, \frac{1}{2}, \bar{x}, \frac{1}{2})$. Let $x^e \sim x$ and $\bar{x}^e \sim \bar{x}$ so that $V_O(x) = x^e$ and $V_O(\bar{x^e}) = \bar{x}^e$. Let $\hat{x}^e_O \sim \frac{1}{2}x^e + \frac{1}{2}\hat{x}^e$ be so that, because of Fact 4.1,

$$V(\hat{x}^e_O) = v(\hat{x}^e_O) = \frac{1}{2}v(x^e) + \frac{1}{2}v(\bar{x}^e) = \frac{1}{2}v(V_O(x)) + \frac{1}{2}v(V_O(\bar{x}))$$

Axiom 4.4 implies that $(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) \succeq (x^e, \frac{1}{2}; \bar{x}^e, \frac{1}{2})$, which in turn implies that

$$V((x, \frac{1}{2}; \bar{x}, \frac{1}{2})) \geq V((x^e, \frac{1}{2}; \bar{x}^e, \frac{1}{2})) = V(\hat{x}^e_O) = \frac{1}{2}v(V_O(x)) + \frac{1}{2}v(V_O(\bar{x}))$$

This can be extended to any symmetric lottery p by noticing that such a lottery can be decomposed as $p = ((x_1, \frac{1}{2}; \bar{x}_1, \frac{1}{2}), p_1; \ldots; (x_n, \frac{1}{2}; \bar{x}_n, \frac{1}{2}), p_n)$

$$V(p) = \sum_i p_i V((x_i, \frac{1}{2}; \bar{x}_i, \frac{1}{2})) \geq$$
$$\geq \sum_i p_i(\frac{1}{2}v(V_O(x_i)) + \frac{1}{2}v(V_O(\bar{x}_i))) = \sum_{x \in supp(p)} p(x)v(V_O(x))$$

[Proof of Proposition 4.3] For any pairs of monetary amounts $x_H > x_L$, the utilities associated to simple lotteries in which winnings are either correlated or uncorrelated are:

$$\begin{aligned} V(\frac{1}{2}, (x_H, x_H); \frac{1}{2}, (x_L, x_L)) &= \frac{1}{2}v(V_O(x_H, x_H)) + \frac{1}{2}v(V_O(x_L, x_L)) \\ &= \frac{1}{2}v(x_H) + \frac{1}{2}v(x_L) \\ V(\frac{1}{2}, (x_H, x_L); \frac{1}{2}, (x_L, x_H)) &\geq \frac{1}{2}v(V_O(x_H, x_L)) + \frac{1}{2}v(V_O(x_L, x_H)) \end{aligned}$$

Cardinal separability requires that

$$V(\frac{1}{2}, (x_H, x_L); \frac{1}{2}, (x_L, x_H)) = V((x_H, x_H), \frac{1}{2}; (x_L, x_L), \frac{1}{2})$$

and Axiom 4.4 requires that this is only true if

$$\frac{1}{2}v(x_H) + \frac{1}{2}v(x_L) = \frac{1}{2}v(V_O(x_H, x_L)) + \frac{1}{2}v(V_O(x_L, x_H)) \tag{4}$$

Define $v_m(x) = v(V_O(x, 0))$ and $v_y(x) = v(V_O(0, x))$ and notice that $v_m(0) =$

$v_y(0) = v(0) = 0$. Then

$$v(V_O(m, y)) = \frac{1}{2}v_m(m) + \frac{1}{2}v_y(y)$$

To see this, consider first that, from equation (4) above setting $x_H = x$ and $x_L = 0$ one gets that for any symmetric outcome

$$v(V_O(x, x)) = v(x) = \frac{1}{2}v(V_O(x, 0)) + \frac{1}{2}v(V_O(0, x)) = \frac{1}{2}v_m(x) + \frac{1}{2}v_y(x)$$

One can then rewrite equation 4 as

$$\frac{1}{2}v(V_O(x_H, x_L))+\frac{1}{2}v(V_O(x_L, x_H)) = \frac{1}{2}(\frac{1}{2}v_m(x_H)+\frac{1}{2}v_y(x_H))+\frac{1}{2}(\frac{1}{2}v_m(x_L)+\frac{1}{2}v_y(x_L))$$

$$= \frac{1}{2}(\frac{1}{2}v_m(x_H) + \frac{1}{2}v_y(x_L)) + \frac{1}{2}(\frac{1}{2}v_m(x_H) + \frac{1}{2}v_y(x_L))$$

which requires $v(V_O(x_H, x_L)) = \frac{1}{2}v_m(x_H) + \frac{1}{2}v_y(x_L)$ and $v(V_O(x_L, x_H)) = \frac{1}{2}v_m(x_L) + \frac{1}{2}v_y(x_H)$. It follows that $v(V(m, y))$ is an additively separable representation of preferences $\succeq_O$, and, because of Proposition 4.1, the preferences are ordinally separable.

[Proof of Proposition 4.4] For each symmetric outcome $x = (x, x)$ define $\phi(x) = \Phi(x)$. Fix two monetary amounts $x_L > x_H$ and define $x^+ = \frac{x_H+x_L}{2}$. Consider now the three lotteries $((x_H, x_L), \frac{1}{2}; (x_L, x_H), \frac{1}{2})$, $((x_H, x_H), \frac{1}{2}; (x_L, x_L), \frac{1}{2})$ and the symmetric outcome (x^+, x^+).

Consider an individual for whom $v(.) = \phi(.)$, so that $u(.) = v(.)$ as well and lets write the utility of these three lotteries.

$$\begin{aligned}
V(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) &= \frac{1}{2}v(V_O(x_H, x_L)) + \frac{1}{2}v(V_O(x_H, x_L)) + \kappa\Phi(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) \\
V(x^+) &= v(x^+) + \phi(x^+) \\
V((x_H, x_H), \frac{1}{2}; (x_L, x_L), \frac{1}{2}) &= \frac{1}{2}v(V_O(x_H, x_H)) + \kappa\Phi(x_H) + \frac{1}{2}v(V_O(x_L, x_L)) + \kappa\Phi(x_L) \\
&= \frac{1}{2}v(x_H) + \frac{1}{2}v(x_L) + \kappa(\frac{1}{2}\phi(x_H) + \frac{1}{2}\phi(x_L))
\end{aligned}$$

Axiom 4.4 requires that the orderings of the lhs should depend only on the ordering of the first terms of the rhs. This in turn requires that, for any $\kappa > 0$,

$$\Phi(x, \frac{1}{2}; \bar{x}, \frac{1}{2}) = \phi(x^+) = \frac{1}{2}(\phi(x_H) + \phi(x_L))$$

which in turn requires that $\phi(x) = x$.

B Econometric Specification

Our estimation strategy models the probability that subject i chooses either option B, A, or declares to be indifferent (I) in each of the choices he/she faces as function of the difference between the utility of the two lotteries (B and A) obtained by Equation 2. More precisely we assume that the choice process of agent i in choice n is the following: the agent computes the difference of utility of the two options $\Delta U_{BA} = V(B) - V(A)$ but he/she can make mistakes during the evaluation process that are captured by an additive error term $\epsilon \sim \mathcal{N}(0, \sigma^2)$ (Fechnerian error) so that the outcome of the evaluation becomes stochastic: $\Delta U_{BA} + \epsilon$. If the final value computed by the agent is greater than a threshold t, i.e., $\Delta U_{BA} + \epsilon \geq t$, then he/she chooses B; if instead the value is lower than $-t$, i.e., $\Delta U_{BA} + \epsilon \leq -t$, he/she chooses A; finally, if value falls between t and $-t$, i.e., $|\Delta U_{BA} + \epsilon| \leq t$ he/she declares to be indifferent between A and B. Besides the Fechnerian error term ϵ we consider also a second possible source of error. We allow agents to have momentary lapse of reason when choosing and, in such a case, they choose randomly, independently by the size of the difference in utilities (trembling error). Formally we assume that with probability w the agent does not follow the previously described choice rule, but declares A, B or I with probability ${}^1/_3$.

The probability that agent i chooses $X \in \{A, B, I\}$ in choice n is reported in equation 5.

$$
\begin{aligned}
P(y_{i,n} = X|\rho, k, \kappa, w, \sigma, t) = \\
(1-w)\left[\Phi\left(\frac{-t - \Delta U_{BA}(\rho,k,\kappa)}{\sigma}\right)^{\mathbb{1}\left(y_{i,n}=A\right)} \times \right. \\
\times \left(\Phi\left(\frac{t - \Delta U_{BA}(\rho,k,\kappa)}{\sigma}\right) - \Phi\left(\frac{-t - \Delta U_{BA}(\rho,k,\kappa)}{\sigma}\right)\right)^{\mathbb{1}\left(y_{i,n}=I\right)} \times \\
\left. \times \left(1 - \Phi\left(\frac{t - \Delta U_{BA}(\rho,k,\kappa)}{\sigma}\right)\right)^{\mathbb{1}\left(y_{i,n}=B\right)}\right] + \frac{w}{3}
\end{aligned}
\tag{5}
$$

Where Φ is the cdf of the standard normal distribution (i.e., a Probit link function), σ is the dispersion parameter of the Fechnerian error ϵ, and w is the trembling parameter. As usual, the Log Likelihood is obtained multiplying the choices over i and over n and taking the log. In all the estimated models parameters are box-constrained in the following way: $\kappa \geq 0$, $\sigma \geq 0$, $t \geq 0$, and $w \in [0, 1]$.

References

Andreoni, J., & Miller, J. 2002. Giving according to GARP: An experimental test of the consistency of preferences for altruism. *Econometrica*, **70**(2), 737–753.

Ben-Porath, Elchanan, Gilboa, Itzhak, & Schmeidler, David. 1997. On the Measurement of Inequality under Uncertainty. *Journal of Economic Theory*, **75**(1), 194 – 204.

Blanco, Mariana, Engelmann, Dirk, & Normann, Hans Theo. 2011. A within-subject analysis of other-regarding preferences. *Games and Economic Behavior*, **72**(2), 321–338.

Bolton, Gary E., & Ockenfels, Axel. 2006. Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments: Comment. *The American Economic Review*, **96**(5), 1906–1911.

Bolton, Gary E, Brandts, Jordi, & Ockenfels, Axel. 2005. Fair Procedures: Evidence from Games Involving Lotteries. *Economic Journal*, **115**(506), 1054–1076.

Bolton, G.E., & Ockenfels, A. 2000. ERC: A theory of equity, reciprocity, and competition. *American Economic Review*, 166–193.

Brock, J. Michelle, Lange, Andreas, & Ozbay, Erkut Y. 2011 (Dec.). *Dictating the risk - experimental evidence on giving in risky environments*. Working Papers 139. European Bank for Reconstruction and Development, Office of the Chief Economist.

Broome, J. 1995. *Weighing Goods: Equality, Uncertainty and Time*. Economics and Philosophy. Basil Blackwell.

Chambers, Christopher P. 2012. Inequality aversion and risk aversion. *Journal of Economic Theory*, **147**(4), 1642–1651.

Charness, G., & Rabin, M. 2002. Understanding Social Preferences with Simple Tests. *Quarterly journal of Economics*, **117**(3), 817–869.

Cooper, David J., & Kagel, John. Other Regarding Preferences: A Survey of Experimental Results. *In: The Handbook of Experimental Economics*.

Cox, James C., & Sadiraj, Vjollca. 2010. *Direct Tests of Models of Social Preferences and a New Model*. Experimental Economics Center Working Paper Series 2006-13. Experimental Economics Center, Andrew Young School of Policy Studies, Georgia State University.

Cox, JC, & Friedman, D. V. Sadiraj. 2008. Revealed altruism. *Econometrica*, **76**, 3169.

Cox, J.C., Friedman, D., & Gjerstad, S. 2007. A tractable model of reciprocity and fairness. *Games and Economic Behavior*, **59**(1), 17–45.

Debreu, Gerard. 1959. *Topological Methods in Cardinal Utility Theory*. Cowles Foundation Discussion Papers 76. Cowles Foundation for Research in Economics, Yale University.

Diamond, Peter A. 1967. Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparison of Utility: Comment. *Journal of Political Economy*, **75**(5), pp. 765–766.

Dufwenberg, Martin, Heidhues, Paul, Kirchsteiger, Georg, Riedel, Frank, & Sobel, Joel. 2011. Other-Regarding Preferences in General Equilibrium. *The Review of Economic Studies*, **78**(2), 613–639.

Engelmann, Dirk, & Strobel, Martin. 2004. Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments. *The American Economic Review*, **94**(4), 857–869.

Epstein, Larry G., & Segal, Uzi. 1992. Quadratic Social Welfare Functions. *The Journal of Political Economy*, **100**(4), 691–712.

Falk, A., Fehr, E., & Fischbacher, U. 2008. Testing theories of fairness?Intentions matter. *Games and Economic Behavior*, **62**(1), 287–303.

Fehr, E., & Schmidt, K.M. 1999. A theory of fairness, competition, and cooperation. *Quarterly journal of Economics*, **114**(3), 817–868.

Fischbacher, Urs. 2007. z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, **10**(2), 171–178.

Fisman, Raymond, Kariv, Shachar, & Markovits, Daniel. 2007. Individual Preferences for Giving. *The American Economic Review*, **97**(5), pp. 1858–1876.

Fleurbaey, Marc. 2010. Assessing Risky Social Situations. *Journal of Political Economy*, **118**(4), pp. 649–680.

Fleurbaey, Marc, & Zuber, Stphane. 2012. Inequality aversion and separability in social risk evaluation. *Economic Theory*, 1–18.

Frank, R.H. 1987. *Choosing the Right Pond: Human Behavior and the Quest for Status*. Oxford University Press.

Fudenberg, Drew, & Levine, David K. 2012. Fairness, risk preferences and independence: Impossibility theorems. *Journal of Economic Behavior & Organization*, **81**(2), 606 – 612.

Harsanyi, John C. 1955. Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility. *The Journal of Political Economy*, **63**(4), 309–321.

Harsanyi, John C. 1975. Nonlinear Social Welfare Functions. *Theory and Decision*, **6**(3), 311–332.

Karni, Edi, & Safra, Zvi. 1998. The Hexagon Condition and Additive Representation for Two Dimensions: An Algebraic Approach. *Journal of Mathematical Psychology*, **42**(4), 393 – 399.

Karni, Edi, & Safra, Zvi. 2002. Individual Sense of Justice: A Utility Representation. *Econometrica*, **70**(1), 263–284.

Krawczyk, Michal, & Le Lec, Fabrice. 2010. 'Give me a chance!' An experiment in social decision under risk. *Experimental Economics*, **13**, 500–511.

Maccheroni, Fabio, Marinacci, Massimo, & Rustichini, Aldo. 2008. *Social Decision Theory: Choosing within and between Groups*. Carlo Alberto Notebooks 71. Collegio Carlo Alberto.

Machina, Mark J. 1989. Dynamic Consistency and Non-Expected Utility Models of Choice Under Uncertainty. *Journal of Economic Literature*, **27**(4), 1622–1668.

Mas-Colell, Andreu, Whinston, Michael D., & Green, Jerry R. 1995. *Microeconomic theory*. Oxford University Press.

Myerson, Roger B. 1981. Utilitarianism, Egalitarianism, and the Timing Effect in Social Choice Problems. *Econometrica*, **49**(4), 883–897.

Neilson, William. 2006. Axiomatic reference-dependence in behavior toward others and toward risk. *Economic Theory*, **28**(3), 681–692.

Rohde, Kirsten. 2010. A preference foundation for Fehr and Schmidt's model of inequity aversion. *Social Choice and Welfare*, **34**(4).

Saito, Kota. 2012 (Mar.). *Social Preferences under Uncertainty: Equality of Opportunity vs. Equality of Outcome*. Levine's Working Paper Archive 786969000000000396. David K. Levine.

Sen, Amartya. 1980. Equality of What? *The Tanner Lecture on Human Values*, **I**, 197–220.

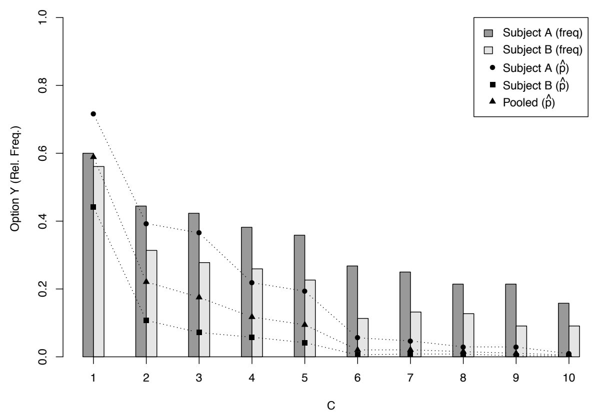
Sobel, J. 2005. Interdependent preferences and reciprocity. *Journal of Economic Literature*, **43**(2), 392–436.

Trautmann, Stefan T. 2009. A tractable model of process fairness under risk. *Journal of Economic Psychology*, **30**(5), 803–813.

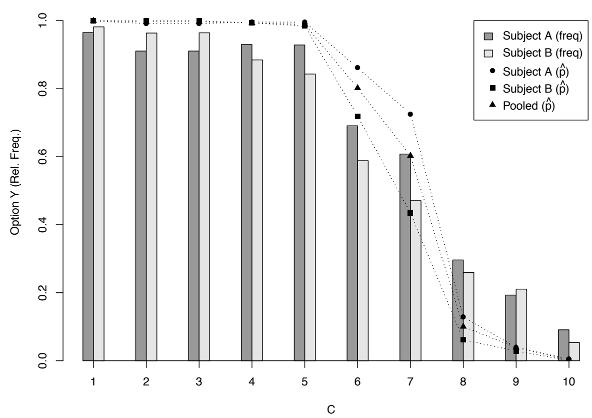
Wakker, P.P. 1989. *Additive representations of preferences: a new foundation of decision analysis*. Theory and decision library: Game theory, mathematical programming, and operations research. Kluwer Academic Publishers.

Figure 3: Choices of the Participants

Treatment E



Treatment R



Treatment ER