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Inequity and risk aversion in sequential public good games

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Abstract Behavioral hypotheses have recently been introduced into public-choice theory (Ostrom in American Political Science Review 92:1–22, 1998). Nevertheless, the individual intrinsic preferences which drive decisions in social dilemmas have not yet been empirically identified. This paper asks whether risk and inequity preferences are behind agents' behavior in a sequential public good game. The experimental results show that risk aversion is negatively correlated with the contribution decision of first movers. Second movers who are averse to advantageous inequity free-ride less and reciprocate more than do others. Our results emphasize the importance of strategic uncertainty for the correct understanding of which preferences influence cooperation in social dilemmas.

Keywords Inequity aversion · Risk aversion · Public good game · Conditional cooperation · Strategic uncertainty

JEL Classification C72 · C91 · D63 · D81 · H41

1 Introduction

Building on the hypothesis that the State's decisions consist of the behavior of agents who compose the government, the application of economic tools to political science introduced by Buchanan and Tullock (1962) and Olson (1965) has emphasized that collectively-optimal actions may not maximize individual utility. However, empirical evidence has shown that not all individuals act like *homo-œconomicus* agents (see for example Andreoni 1988; Berg et al. 1995; Camerer 2003; Forsythe et al. 1994; Isaac et al. 1984). Recent developments in public-choice theory have taken a behavioral approach to broaden the analysis of collective action. The introduction of social preferences, such as altruism, inequity aversion or trust, may mean that optimal collective choices are also optimal for individuals (Ahn et al. 2001, 2003; Ostrom 1998). However, empirical analysis is required to specify which types of social

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preference are relevant for public-choice theory. This kind of work is still only rare in the literature, even though it would greatly contribute to the development of a "behavioral theory of collective action" (introduced by Ostrom 1998), and thus to a better understanding of the resolution of social dilemmas.[1]

This paper proposes an experiment that arguably helps to fill this gap. We apply behavioral economics to public-choice theory to make a set of theoretical predictions. An experiment is then designed to identify and disentangle the individual preferences which effectively play a role in individuals' decisions in social dilemmas. One key feature of such social dilemmas is the presence of strategic uncertainty: individuals decide whether to cooperate without knowing what others have decided. This paper empirically specifies the individual preferences which matter in a particular social dilemma, a public good game, depending on the presence of strategic uncertainty. The sequential public good game allows us to distinguish between situations with and without strategic uncertainty. The experimental results shed light on the relevant behavioral hypotheses to be taken into account depending on the context, which here is the presence of strategic uncertainty. As such, these results contribute to the development and extension of public-choice theory.

Individual behavior in public good games has implications for a wide range of economic and political situations. Producers' and consumers' decisions regarding the protection of the environment, the choices of both Doctors and patients over health insurance, politicians' decisions faced with social dilemmas, etc. The work here analyzes agent behavior towards a public good based on individual preferences, and provides insights into the type of individuals who best serve the social interest and those to avoid in institutional settings. This distinction helps us to understand why, with the same incentives, the provision of public goods works better in some populations than in others. In addition, our use of a sequential public good game allows us to see whether reducing strategic uncertainty, i.e., communicating about others' contributions to a public good, is Pareto-improving. In standard economic theory, this type of information should be worthless. However, if individual preferences are not those of risk-neutral *homo-œconomicus*, the experimental results will reveal whether information that reduces strategic uncertainty affects individual behavior.

One of the key debates in public policy is how the efficiency of the market can be improved. This currently concerns environmentally-friendly behavior and public access to healthcare, for example. The sequential public good game allows efficiency to be tested in a way that is not possible in a simultaneous public good game. The sequentiality of the public good game is essential for the analysis of the role of communication about behavior or contributions to the public good. Knowing how many people invest in energy saving at the country or local level may induce environmentally-friendly behavior, and learning about the cooperativeness of some health-insurance companies could influence the behavior (price setting) of other health-insurance companies and so improve public access to healthcare.[2]

[1] For a discussion of the advantages of studying the psychological sources of different behaviors, see Camerer and Loewenstein (2004). As they note, "At the core of behavioral economics is the conviction that increasing the realism of the psychological underpinnings of economic analysis will improve economics *on its own terms*—generating theoretical insights, making better predictions of field phenomena, and suggesting better policy."

[2] Regarding the management of State health care expenditure, social norms have been found in the medical care Doctors provide to their patients. In some regions of the United States, Medicare spending per capita is twice as high as that in other regions (Orszag 2008). Announcing that some Doctors spend less money on medication with no difference in outcomes might persuade Doctors who spend a lot of money on treatment to reduce expenditure. Private communication, such as labels, may also help. Labels make environmentally- or socially-friendly actions more visible: for example, car constructors use environmental labels (ECOnetic

Moreover, in most situations, individuals make decisions with at least some knowledge of others' decisions (neighbors, colleagues, friends or relatives). The sequential public good game is thus more realistic than the simultaneous public good game, and arguably produces more useful conclusions for areas such as health and social policy. The work here considers these issues in the context of individuals' intrinsic preferences.

The public good game has been extensively used in experimental economics over the past 20 years. One robust result is that a considerable percentage of individuals voluntarily cooperate, even though the Nash equilibrium is to contribute nothing to the public good (see Anderson 2001 and Ledyard 1995, for reviews).[3] Once we drop the *homo-œconomicus* hypothesis, by assuming that either all agents have social preferences or agents are heterogeneous in these preferences, the free-riding equilibrium is not unique. In particular, cooperation, leading to more socially effective outcomes, is also an equilibrium behavior when some agents have social preferences. It has also been shown that risk aversion reduces agents' contributions when the contribution decision is made under strategic uncertainty (Bohnet and Zeckhauser 2004; Heinemann et al. 2009; Schechter 2007). Last, individual public-good contributions depend on both others' contributions in repeated (Croson 2007; Keser and van Winden 2000; Weimann 1994) and sequential public good games (Fischbacher and Gächter 2010; Fischbacher et al. 2001) and beliefs about these contributions (Croson 2007; Offerman 1997; Offerman et al. 1996, 2001; Orbell and Dawes 1991).[4] The question that then arises is whether the heterogeneity in contribution decisions in one-shot public good games reflects intrinsic preferences or rather others' contributions or beliefs about these contributions. The sequential public good game is one way of answering this question.

Our sequential public good game has two players. The first mover chooses her contribution to the public good under strategic uncertainty, as she does not now know what the second mover will decide. The second mover knows what the first mover has decided, and can choose to contribute either the same amount as the first mover or zero.[5] All of disadvantageous inequity aversion, risk aversion and beliefs should affect the first-mover's decisions, while only advantageous inequity aversion should play a role for the second mover's decision. As such, the contribution of advantageous inequity aversion, which has been theoretically identified as a source of cooperation in social dilemmas (Fehr and Schmidt 1999), can be isolated. Individual preferences are elicited via independent games and are then linked to behavior in the sequential public good game. We analyze the effect of inequity aversion as defined by Fehr and Schmidt (1999). The experimental measure of inequity aversion is still relatively rare; the games we use to elicit both advantageous and disadvantageous inequity aversion are based on those in Blanco et al. (2010). Advantageous inequity aversion is measured via a modified dictator game, and disadvantageous inequity aversion via the ultimatum game (Güth et al. 1982), using the strategy method (Selten 1967). Risk aversion

for Ford, eco^2 for Renault, or Bluetec for Mercedes), and the Swiss label Minergie is now fairly widespread in Europe for house building and renovation.

[3] The observation of non-selfish behavior has led to various theories of other-regarding preferences (see Sobel 2005, for a review). These fairness theories explain positive contributions in public good games by the inclusion of others' behavior or payoffs in the utility function. Some models include the distributive consequences of actions (Fehr and Schmidt 1999; Bolton and Ockenfels 2000) while others are based on fairness intentions (Rabin 1993; Dufwenberg and Kirchsteiger 2004). Falk and Fischbacher (2006) consider both intentions and outcome distributions as driving individuals' decisions situations of strategic interaction.

[4] Contributions may depend on beliefs about others' contributions in an environment with strategic uncertainty; however, this effect does not pertain in an environment without strategic uncertainty.

[5] This limited choice was imposed in order to make the game as simple as possible and to yield clear theoretical predictions depending on intrinsic preferences.

is measured using Holt and Laury's well-known lottery (2002), assuming constant relative risk aversion. Finally, beliefs about others' contributions to the public good are evaluated via a simple question.

Due to our simple design, the theoretical predictions are clear. Risk aversion and disadvantageous inequity aversion should negatively affect the contribution of the first mover while her beliefs about others' behavior should have a positive effect. The second mover should cooperate if she is sufficiently advantageous inequity averse. The results are mainly in line with these theoretical predictions. Our first result is that the contribution of the first mover is significantly negatively affected by risk aversion. Beliefs play a significant positive role while disadvantageous inequity aversion has no significant effect. The second result is that the second mover is significantly more likely to contribute the same amount as the first mover and less likely to free-ride if she is sufficiently advantageous inequity averse, as suggested by theory. Risk aversion and advantageous inequity aversion have no significant effect here.

It is not obvious in the literature whether inequity aversion theory helps to explain agents' contributions in a simultaneous public good game, i.e., under strategic uncertainty. Blanco et al. (2010) find that subjects' inequity aversion can explain their behavior in public good games, but only at the aggregate level, whereas Dannenberg et al. (2007), using the same games to measure agents' preferences, find a significant positive effect of advantageous inequity aversion on agents' contributions to the public good. Our result showing that advantageous inequity aversion is the main determinant of the second mover's conditional cooperation adds to this debate. This suggests that the presence or absence of uncertainty is key to the understanding of the effect of social preferences. We conclude that the predictions of Fehr and Schmidt (1999) mostly hold in our data when the situation is free of any uncertainty. Finally, our results also suggest that individuals' behavior is consistent between different experimental games.

The paper is organized as follows. Section 2 explains the game and the theoretical predictions, and Sect. 3 presents the experimental design. The results are analyzed in Sect. 4. Last, Sect. 5 concludes.

2 The game and the theoretical predictions

2.1 The sequential public good game

Suppose that two agents play a sequential public good game. The first mover, mover 1, decides whether and how much to contribute to the public good, with a contribution between zero and ten. We here consider the first mover's decision and the second mover's reaction to it. To keep the game as simple as possible, and to obtain clear predictions for the effects of both risk and inequity aversion, mover 2 chooses between contributing the same amount as the first mover or free-riding by contributing nothing. An additional advantage of this structure is that it allows us to separate advantageous from disadvantageous inequity aversion: the first mover's payoff is less than or equal to the second mover's payoff, while mover 2's payoff is greater than or equal to the first mover's payoff.

The payoff function is that of the basic public good game. The marginal return from the public good is $a \in [0, 1]$, and each agent's initial endowment is E. The payoff function R_{ik} of agent i as mover k, $k = 1$ for the first mover and $k = 2$ for the second mover, is defined as follows:

$$R_{ik} = E - x_{ik} + a\,(x_{ik} + x_{-k}) \tag{1}$$

with $k = 1, 2$, and $-k = 1$ if $k = 2$, $-k = 2$ if $k = 1$. The variables x_{ik} and x_{-k} are the contributions to the public good of subject i as mover k and mover $-k$, respectively. The contribution of the first mover is an integer $x_1 \in [0, 10]$ and that of the second mover takes one of the two values $x_2 \in \{0, x_1\}$.

2.2 Theoretical predictions

As noted in the Introduction, the experimental results from public good games do not line up with the predictions of standard economic theory. With *homo-œconomicus* agents, both first and second movers are predicted to contribute nothing to the public good. In this case, first movers face no strategic uncertainty as second movers never contribute anything. However, the experimental finding is that contributions represent between 40% to 60% of agents' endowments, i.e., of the social optimum (assuming that $a > \frac{1}{2}$), and are significantly different from zero (Ledyard 1995). The assumption of social preferences leads to multiple symmetric equilibria in public good games where positive contributions are also an equilibrium behavior, and so explain the experimental findings. If some agents have social preferences, the first movers in a sequential public good game face strategic uncertainty, as both free-riding and conditional cooperation by second movers are equilibria.

We here consider that agents feel inequity aversion, a type of social preference introduced by Fehr and Schmidt (1999) who define the inequity averse as "subjects who dislike inequitable outcomes" (Fehr and Schmidt 1999: 822). Specifically, subjects "experience inequity if they are worse off in material terms than the other players in the experiment, and they also feel inequity if they are better off" (Fehr and Schmidt 1999: 822). The advantage of this model is that the inequity aversion measured in one game can be applied to other games. This assumes that inequity aversion in one game is simply a monotonic transformation of the thresholds in another game. We can therefore measure inequity preferences in games that are independent of the public good game to infer inequity preferences. The utility function of player i depends on inequity as follows:

$$u_{ik}(X_{ik}) = X_{ik} - \alpha_i \max\{X_{-k} - X_{ik}, 0\} - \beta_i \max\{X_{ik} - X_{-k}, 0\} \tag{2}$$

Here α_i represents the disadvantageous inequity aversion of agent i while β_i corresponds to her advantageous inequity aversion. X_{ik} is the gain of agent i as mover k, where the gain is not necessarily monetary. According to Fehr and Schmidt (1999), $\alpha_i \geq 0$ and $0 \leq \beta_i < 1$. A selfish agent is one who does not take others' payoffs into account in her utility function, i.e., $\alpha_i = \beta_i = 0$. An inequity-averse agent may be negatively affected by having less than the other subject, $\alpha_i > 0$, or by having more, $\beta_i > 0$, or both. Subjects are heterogeneous in terms of their inequity aversion.

To derive the theoretical predictions, we solve the game by backward induction, determining first the optimal behavior of the second mover and then the optimal contribution of the first mover. The parameters in our experiment are such that $E = 10$ and $a = 0.8$.[6]

Second mover's choice The second mover maximizes utility by choosing $x_{i2} = 0$ or $x_{i2} = x_1$. As she either contributes nothing or the same amount as the first mover, the sec-

[6] The social marginal return to the public good is then 1.6, which is common in experiments. As there are two players, the individual marginal return to the public good is 0.8.

ond mover can never earn less than the first mover, $R_{i2} \geq R_1$. Therefore only advantageous inequity aversion is relevant for the second mover's utility, which can be written as:

$$u_{i2} = 10 - x_{i2} + 0.8\,(x_1 + x_{i2}) - \beta_i\,(x_1 - x_{i2}) \tag{3}$$

The second mover should contribute the same amount as the first mover to the public good if her degree of advantageous inequity aversion is such that $\beta_i \geq 0.2$. The equilibrium decision of the second mover is written as:

$$x_{i2}^* = \begin{cases} 0 & \text{if } \beta_i < 0.2 \\ x_1 & \text{if } \beta_i \geq 0.2 \end{cases} \tag{4}$$

Second movers with $\beta_i \geq 0.2$ are called conditional cooperators, as they will cooperate for the public good if the first mover cooperates.

First mover's choice Under standard economic assumptions, the first mover should never contribute, assuming that second movers always shirk. Nevertheless, if the first mover believes that some second movers have intrinsic preferences with $\beta \geq 0.2$, the optimal behavior of the first mover may be different from the standard economic prediction. Here the utility function of the first mover is subject to strategic uncertainty: the first mover is not sure whether she will be matched with a second mover with $\beta \geq 0.2$ or one with $\beta < 0.2$. The existence of some conditional cooperators, i.e., $\beta \geq 0.2$, introduces strategic uncertainty in our framework. Contributing more in the public good game is riskier than contributing less: the more the first mover contributes, the more she loses if the second mover contributes nothing instead of the same amount as her. The first mover's optimal public-good contribution depends on her beliefs regarding the share of second movers with $\beta \geq 0.2$, her risk aversion and her disadvantageous inequity aversion. Advantageous inequity aversion plays no role for first-movers' decisions as they cannot earn more than second movers.

We assume that risk aversion and inequity aversion are independent.[7] Therefore, the expected utility of agent i in the role of the first mover is the sum of her expected utility with respect to her own gain and her expected utility related to the second mover's gain:

$$EU_{i1} = Ev_{i1}(\tilde{X}_{i1}) + Ew_{i1}(\tilde{X}_2) \tag{5}$$

$$\Leftrightarrow \quad EU_{i1} = p_{i1}[v_{i1}(X'_{i1}) + w_{i1}(X'_2)] + (1 - p_{i1})[v_{i1}(X_{i1}) + w_{i1}(X_2)] \tag{6}$$

here $v_{i1}(\cdot)$ represents the utility from the first mover's own gain. We assume constant relative risk aversion for the function $v_{i1}(\cdot)$ to represent the risk preferences of agent i as mover 1:

$$v_i(\tilde{X}_{i1}) = \frac{\tilde{X}_{i1}^{1-r_i}}{1 - r_i} \tag{7}$$

Agent i is risk neutral if $r_i = 0$, risk averse if $r_i > 0$ and risk loving if $r_i < 0$.[8] Subjects are heterogeneous in terms of risk aversion.

The function $w_{i1}(\cdot)$ represents utility with respect to the gain of the second mover. Let p_i be agent i's belief regarding her probability of being matched to a second mover who is

[7] Dubois et al. (2009) and Traub et al. (2009) have recently shown that risk aversion is not significantly correlated with inequality aversion. This result is confirmed in our data.

[8] As in Holt and Laury (2002), the division by $(1 - r_i)$ is used to ensure that utility is increasing when $r_i > 1$. When $r_i = 1$, the natural logarithm is used.

not advantageous inequity averse, $\beta < 0.2$, and $1 - p_i$ her probability of being matched to a second mover with greater advantageous inequity aversion, $\beta \geq 0.2$.

We can rewrite the expected utility of the first mover as follows:

$$EU_{i1} = p_{i1}(v_{i1}(X_{i1}^*) + w_{i1}(X_2)) + (1 - p_{i1})(v_{i1}(X_{i1}) + w_{i1}(X_2)) \tag{8}$$

with X_{i1}^* being the certainty-equivalent of X_{i1}' through the utility function of Fehr and Schmidt (1999). As $w_{i1}(X_2)$ is the same in both states of nature, it will not affect agents' preferences. This specification avoids the question of how to include the first mover's risk aversion regarding the second mover's gains: whatever the shape of the utility function relative to the second mover's gain, the first mover's preferences remain unchanged.

The expected utility of the first mover is initially:

$$\begin{aligned} EU_{i1} = {} & p_{i1}\left(v_{i1}\left(10 - 0.2x_{i1}\right) + w_{i1}\left(10 + 0.8x_{i1}\right)\right) \\ & + (1 - p_{i1})\left(v_{i1}\left(10 + 0.6x_{i1}\right) + w_{i1}\left(10 + 0.6x_{i1}\right)\right) \end{aligned} \tag{9}$$

After the certainty-equivalent transformation via the utility function of Fehr and Schmidt (1999), this becomes:

$$\begin{aligned} EU_{i1}' = {} & p_{i1}\left(v_{i1}\left(10 - \frac{0.2x_{i1}(1 + 2\alpha_i)}{1 + \alpha_i}\right) + w_{i1}\left(10 + 0.6x_{i1}\right)\right) \\ & + (1 - p_{i1})\left(v_{i1}\left(10 + 0.6x_{i1}\right) + w_{i1}\left(10 + 0.6x_{i1}\right)\right) \end{aligned} \tag{10}$$

As the gain of the second mover is the same in both states of nature, it plays no role in the first mover's maximization problem. The first mover therefore maximizes the following expression to determine her optimal public-good contribution:

$$EU_{i1}' = \frac{p_{i1}(10 - \frac{0.2x_{i1}(1+2\alpha_i)}{1+\alpha_i})^{1-r_i} + (1 - p_{i1})(10 + 0.6x_{i1})^{1-r_i}}{1 - r_i} \tag{11}$$

The first mover's beliefs about the second mover's type, i.e., the second mover's β, and her risk aversion both affect the optimal contribution. Depending on the second mover's choice, the first mover may earn the same as or less than the second mover. Regarding inequity preferences, only the first mover's disadvantageous inequity aversion matters for her utility; advantageous inequity aversion has no effect.

Due to the complexity of the solution, the first mover's optimal contribution is depicted in Fig. 1. We show the optimal contribution as a function of disadvantageous inequity aversion and risk aversion for certain values of the first mover's beliefs about the second mover's type: $p_i = 0.1$, 0.5, 0.6 and 0.9.

It is clear from the figures that the first mover's optimal contribution is lower for agents with greater disadvantageous inequity aversion and risk aversion. The beliefs of the first mover about others play a significant role. The first mover's contribution rises with her beliefs about her chances of being matched to a second mover who will contribute the same amount as her (instead of free-riding). A first mover who thinks that her probability of being matched to a second mover who will contribute the same amount as her is 10%, will always contribute nothing to the public good whatever her intrinsic preferences. On the contrary, when this belief is 90%, she will always contribute ten.

To summarize, in addition to expectations about the other agent's behavior, disadvantageous inequity aversion and risk aversion should influence the first mover's decision. The

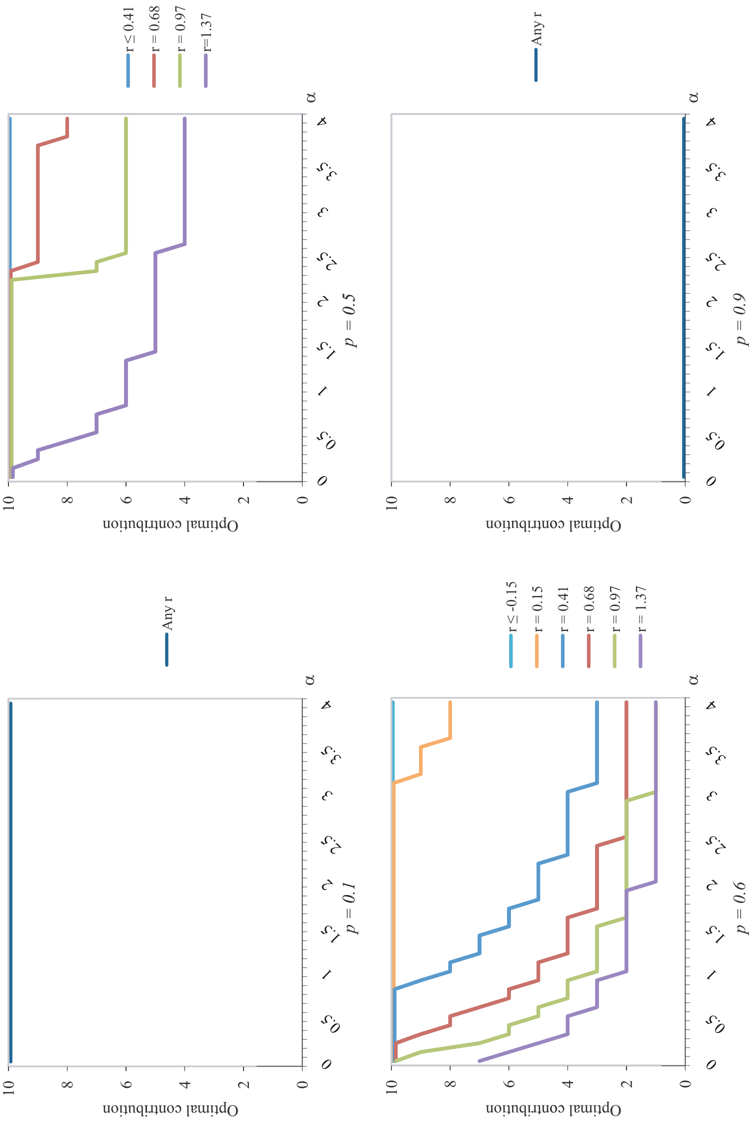

Fig. 1 Optimal contribution depending on α, r and p

Table 1 The predicted effect of intrinsic preferences on first and second movers' contributions

	1st mover	2nd mover
Disadvantageous inequity aversion	Negative	None
Advantageous inequity aversion ($\beta \geq 0.2$)	None	Positive
Risk aversion	Negative	None

second mover's choice should only be influenced by her advantageous inequity aversion. The theoretical predictions regarding the effect of agents' intrinsic preferences on their public-good contributions are summarized in Table 1.

These predictions based on intrinsic preferences are different for first and second movers due to strategic uncertainty. The second mover's behavior in addition allows us to see how much reciprocity is driven by advantageous inequity aversion when it is predicted to be the only determinant at stake. This represents an additional test of the model of inequity aversion of Fehr and Schmidt (1999) in the case with no uncertainty, and shows the pure effect of advantageous inequity aversion.[9] Although advantageous inequity aversion is not distinct from disadvantageous inequity aversion in Fehr and Schmidt's (1999) model, we need to understand exactly which intrinsic preferences play a role in agents' economic decisions. Previous attempts at determining the intrinsic preferences which matter in public good games without distinguishing the effect of strategic uncertainty from inequity aversion have produced mixed results: see Blanco et al. (2010) and Dannenberg et al. (2007).

3 Experimental design

The experiments were conducted at the GATE research center, Lyon, France. The experiment was computerized using the Regate software (Zeiliger 2000). We recruited 118 undergraduate students from three Business and Engineering schools using ORSEE software (Greiner 2004). Six experimental sessions were run. The instructions are provided in Appendix.

In each session, participants were randomly assigned to a computer. The instructions told participants that they would take part in four different games: (i) Holt and Laury's (2002) lottery, (ii) a modified dictator game, (iii) an ultimatum game, and (iv) the sequential public good game. Subjects did not know which type of game they were to play. They first played the three independent games to elicit preferences and then the one-shot sequential public good game. The subjects received no feedback during the session. We choose this order of games in the experiment as we think it is cognitively easier for subjects to start with the simpler Holt and Laury lottery and end with the more complex sequential public good game. This choice may allow us to restrict any errors that subjects make, and provides them with a logic of progression in the experiment. It may be asked whether this specific order of the games biases behavior in the sequential public good game. As subjects receive no feedback,

[9]Reciprocity is also found in trust games when considering the behavior of the second mover who decides how much of the amount received from the first mover to return to this first mover. It is commonly found that some people reciprocate to kind behavior, but no work has considered whether this behavior is directly linked to advantageous inequity aversion. Our approach could be replicated in the context of a trust game to see whether advantageous inequity aversion also drives second movers' reciprocity in this context.

either regarding the decisions of other subjects or their own payoffs, the games played before the sequential public good game should not affect their decisions in the latter.[10]

The strategy method (Selten 1967) was used for all games, where subjects make contingent decisions for all types of situations they could face, while the direct-response method asks subjects to make decisions only for the effective situation. The strategy method has two advantages. First, more observations are obtained, even regarding unlikely situations. Second, the experimentalist can estimate the full strategy of the subjects as defined in game theory to define their intrinsic preferences. In the sequential public good game, the observation of subjects' full strategies allows the precise identification of types. We can distinguish subjects by their frequency of free-riding or cooperation, and determine how their decisions vary with the first mover's choice. With the direct-response method, we would only see the subject's decision in specific situations.

There is little evidence that the strategy method induces different decisions from those in the direct-response method, as shown in a recent survey by Brandts and Charness (2009).[11] The strategy method may be criticized when subjects make decisions in various roles during the same game, but again the evidence reveals no differences in this respect. The strategy method produces similar results to the direct-response method even when subjects play different roles in the dictator (Cason and Mui 1998) and public good games (Fischbacher and Gächter 2010; Muller et al. 2008).[12]

The instructions for each game were distributed once the previous game was completed and were read aloud. Any questions were answered in private. Participants answered a series of questions for each game to check their understanding of the instructions. Each game started once all the participants had answered correctly. No communication was allowed.

The exchange rate was 4 points = €1. The presentation of the Holt and Laury (2002) lottery was directly in Euros. The payment consisted of the payoff in the lottery, plus the payoff in one of the other three games, selected randomly by the program, plus a €3 show-up fee. The sessions lasted for around 60 minutes, and average earnings were €8.14.[13]

3.1 Public good game

We organized a one-shot sequential public good game with two players using the strategy method. Our framework is close to Fischbacher and Gächter (2010). All subjects had two types of decision to make. First, every subject, as the first mover, was asked to decide how much of the ten points she wanted to contribute to the public good. All subjects then took

[10] From a practical point of view, to control for such order effects, we would have to organize 24 different treatments. To obtain sufficient data for each order, we would need at least 48 sessions. We therefore opted for a specific order of games with a logic of progression.

[11] The evidence is nevertheless not all one-way. There are differences between the two methods concerning punishment decisions: levels of punishment are lower in the strategy method. However, subjects make no punishment decisions in our experiments.

[12] For the ultimatum game, no evidence exists with subjects playing both roles. Nevertheless, Armentier (2004) tests the impact of the strategy compared to the direct-response method in the ultimatum game and finds no significant differences. Subjects first choose a minimum acceptable offer and have the opportunity to modify their decision once they learn the real offer of the sender. In fact, less than 6% of subjects revise their decision.

[13] Average earnings in this experiment are fairly low. This is because subjects who participated in this experiment came back to the lab one week later to participate in a following experiment and received additional payments. Subjects did not know anything about the following experiment when they participated in that described here.

decisions as the second mover concerning conditional contributions. Ten situations were presented to every subject, in which the contribution of the first mover was written. To keep the design as simple as possible and to test the theoretical predictions, the decision of the second mover was to contribute the same amount as the first mover or contribute nothing. For example, in decision 1, the second mover had to choose whether to contribute zero points or one point to the public good when the other subject had contributed one point. In decision 2, the choice was between contributing zero points or two points, given that the other agent had contributed two points, and so on up to decision 10.

The payoffs were determined as follows. Once all subjects had made their decisions as the first mover and the second mover, the software randomly selected half of the subjects to be first movers and the other half as second movers, and matched them. First movers were assigned their first-mover choice and second movers their second-mover choice for the actual contribution of the first mover. The payoffs were then calculated according to (1).

3.2 Elicitation of preferences

Three games, independent of the sequential public good game, were played to evaluate subjects' preferences over advantageous and disadvantageous inequity aversion and risk aversion.[14] The strategy method was also used here.

Advantageous inequity aversion The measure of advantageous inequity aversion is based on Blanco et al. (2010). Subjects were asked to participate in a series of dictator games, involving two roles: the *dictator* and the *receiver*. All subjects made their decisions under both roles before knowing which role they had actually been allocated for payment. At the end of the session, the program randomly allocated a role to each subject and payoffs were determined accordingly. Half of the subjects were dictators and the other half were receivers. All subjects were matched, with one dictator and one receiver in each pair.

The rules of the game were that the dictator chose between two options regarding the distribution of a pie between herself and the receiver. 21 decisions were presented to the subjects. The first option, option a, corresponds to the equal share for the dictator and the receiver: the distribution is (z_i, z_i), with $z_i = \{0, \dots, 20\}$. The second option, option b, is such that the dictator keeps 18 points for herself and gives two points to the receiver: the distribution $(18, 2)$. In decision 1, the dictator thus chooses between the distribution $(0, 0)$ (zero for herself and zero for the receiver) and the distribution $(18, 2)$ (18 for herself and two for the receiver); in decision 2, the choice is between $(1, 1)$ and $(18, 2)$, and so on until decision 21 where the choice is between $(20, 20)$ and $(18, 2)$. For the payment, one decision was randomly selected by the software. The dictator earned the amount she chose for herself in this decision.

Before playing as the dictator, subjects first made their decisions as the receiver. Every receiver was asked to decide to play the game or to opt out for a fixed payment (five points[15]). The choice of the outside option by the receiver did not affect the dictator's gains. When a dictator is matched with a receiver who had chosen the outside option, she still earns the

[14] Risk aversion and inequity aversion are independently elicited, as such preferences are supposed to be intrinsic to individuals. We here want to analyze the effect of such intrinsic preferences specifically in a sequential public good game. One idea for future research would be to analyze how risk aversion and inequity aversion interact in simple games to see whether one preference crowds out the other when risk- or inequity-aversion are sufficiently strong.

[15] Under the assumption that the dictator is selfish, the expected payoff of the receiver is around five points.

amount she chose for herself. This first step introduces a strategic dimension to the dictator game with the receiver not being entirely passive. The evaluation of advantageous inequity aversion is then more easily associated with behavior in games with strategic interactions.[16] Moreover, this limits the problem of over-estimating advantageous inequity aversion that might occur when dictators are obliged to be matched with a receiver.[17] All subjects knew the rules of the game when they made their decision as a receiver. The payment of the receiver was five if she opted out and the amount the dictator chose for her in the selected decision if she decided to play the game.

Agents' advantageous inequity aversion, β_i, was estimated through the subjects' choices as dictators. An individual who switches from the $(18, 2)$ unequal distribution to the (z_i', z_i') egalitarian distribution prefers $(18, 2)$ over $(z_i' - 1, z_i' - 1)$ but (z_i', z_i') over $(18, 2)$. The value z_i' represents the decision number minus one (as in decision 1, $z_i = 0$) of the first decision in which the agent chooses the egalitarian distribution. This individual is therefore indifferent between the $(18, 2)$ unequal distribution and the $(\tilde{z}_i, \tilde{z}_i)$ egalitarian distribution with $\tilde{z}_i \in [z_i' - 1, z_i']$ and $z_i' \in \{0, \dots, 20\}$. We have $u_i(\tilde{z}_i, \tilde{z}_i) = u_i(18, 2)$ with $u(\cdot)$ being the utility function defined by Fehr and Schmidt (1999) presented in (2). This gives $18 - 16\beta_i = \tilde{z}_i$. For our data analysis, we set $\tilde{z}_i = z_i' - 0.5$. The value of β_i is then:

$$\beta_i = \frac{18.5 - z_i'}{16} \tag{12}$$

Selfish agents are expected to switch from the unequal distribution to the egalitarian distribution at decision number 19. All agents switching before decision 16 have $\beta_i \geq 0.2$, all those switching at decision 16 or after have $\beta_i < 0.2$.

Disadvantageous inequity aversion Disadvantageous inequity aversion was measured as in Blanco et al. (2010) via an ultimatum game (Güth et al. 1982). The game involves two roles: the *sender* and the *responder*. All subjects made decisions under both roles before knowing the actual role they were assigned. At the end of the session, the program randomly allocated a role to each subject and payoffs were determined accordingly. Half of the subjects were allocated to be senders and half responders. All subjects were matched in pairs, with a sender and a responder in each pair.

As a sender, each subject received an endowment of 20 points. She was asked to split this amount between herself and the responder, knowing that the responder could either accept or reject this share. If the responder accepted the proposition, the distribution was implemented, but if she rejected it both the sender and the responder earned nothing. The responder then had to choose between two options for 21 decisions: option *a* is to accept the distribution and option *b* is to reject it. In decision 1, the responder chooses between accepting the distribution $(20, 0)$ (20 for the sender and zero for the responder) and rejecting it; in decision 2, the choice was between accepting $(19, 1)$ and rejecting it, and so on up to decision 21 where the choice was between accepting $(0, 20)$ and rejecting it.

The responder's decisions allow us to measure the degree of disadvantageous inequity aversion, α_i. We suppose that s_i' is the decision number minus one of the first decision in

[16] Fehr and Schmidt (1999) underline that the dictator game allows measurement of advantageous inequity aversion but is limited due to the non-strategic character of the game.

[17] Lazear et al. (2006) show that dictators give a higher amount to receivers when they are obliged to be matched with a receiver, compared to the situation where they can decide to be alone or to be matched with a receiver.

which the responder accepted the sender's distribution, so that $s_i' - 1$ is the decision number minus one of the last decision in which the responder rejected the distribution of the sender. This individual is therefore indifferent between receiving zero from a rejection and accepting some offer $\tilde{s}_i$ with $\tilde{s}_i \in \{s_i' - 1, s_i'\}$ and $s_i' \in \{0, \dots, 20\}$. We thus have $u_i(\tilde{s}_i, 21 - \tilde{s}_i) = u_i(0, 0)$ with $u(\cdot)$ being the utility function defined by Fehr and Schmidt (1999) presented in (2). This gives $\tilde{s}_i - \alpha_i(21 - 2\tilde{s}_i) = 0$. For our data analysis, we set $\tilde{s}_i = s_i' - 0.5$. The value of α_i is then:

$$\alpha_i = \frac{s_i' - 0.5}{21 - 2s_i'} \tag{13}$$

In the responder's role, selfish agents should accept any strictly-positive share. The later the agent switches from rejecting to accepting the distribution, the higher her value of α_i.

Risk aversion To elicit risk aversion, we appeal to the commonly-used lottery procedure of Holt and Laury (2002). Subjects filled in a questionnaire with ten decisions. Each decision consists of a choice between two paired lotteries, option a and option b. The payoffs for option a are either €2 or €1.60, whereas the riskier option b pays either €3.85 or €0.10. In the first decision, the probability of the high payoff for both options was 1/10. In the second decision, this probability rose to 2/10, and so on. When the probability of the higher payoff is large enough, subjects should switch from option a to option b.[18] Risk neutrality corresponds to switching at the fifth decision, while risk-loving subjects move earlier and risk-averse subjects later.

Beliefs We wanted to avoid any influence of the elicitation of beliefs on subjects' decisions in the public good game. Hence, we did not want to ask subjects directly whether they thought that the second mover would choose to contribute the same amount as them or to free-ride by contributing nothing. This question might have influenced their behavior. We therefore used a proxy, and asked each subject, after her decision as first mover and before her decision as second mover, "What amount do you think the other subject has chosen?". If the subject correctly guesses the other subject's contribution, she receives one additional point.[19] Beliefs have been shown to have significant effects on contributions in the literature (for example in Croson 2007; Offerman 1997; Offerman, et al. 1996, 2001; Orbell and Dawes 1991).

4 Results

In this section, we analyze how behavior in the public good game is related to intrinsic preferences, playing as first or second mover. We first present the distribution of inequity aversion and risk aversion among subjects.

[18] The number of safe choices corresponds to the number of decisions with option a, which is safer than option b. This number thus corresponds to the "risk aversion" variable in our econometric analysis.

[19] We chose to reward good predictions of the other's contribution by a very small prize to apply the standard rules used in experimental economics. This choice should not affect the results. Gächter and Renner (2010) show that, in a public good experiment, the distribution of individuals' beliefs and the relationship between contributions and beliefs are unaffected by incentives.

Fig. 2 The distribution of α and β

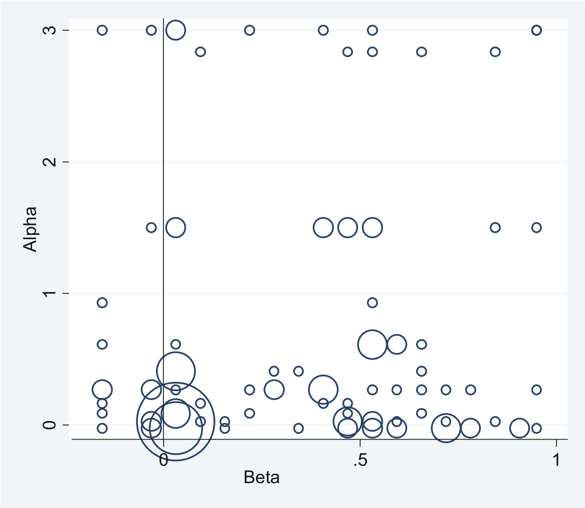

Table 2 The distribution of risk aversion

Number of safe choices	Range of risk aversion	Holt and Laury's classification	Frequency
0–1	$r < -0.95$	Highly Risk Lover	0.00
2	$-0.95 < r < -0.49$	Very Risk Lover	0.01
3	$-0.49 < r < -0.15$	Risk Lover	0.07
4	$-0.15 < r < 0.15$	Risk Neutral	0.18
5	$0.15 < r < 0.41$	Slightly Risk Averse	0.24
6	$0.41 < r < 0.68$	Risk Averse	0.27
7	$0.68 < r < 0.97$	Very Risk Averse	0.17
8	$0.97 < r < 1.37$	Highly Risk Averse	0.04
9–10	$1.37 < r$	Stay in Bed	0.03

4.1 Distribution of preferences

Subjects are heterogeneous in their degrees of inequity aversion: 17.8% of the 118 subjects are purely selfish ($\alpha = \beta = 0$) and 39.8% are averse to both advantageous and disadvantageous inequity ($\beta > 0$ and $\alpha > 0$). Advantageous and disadvantageous inequity aversion are not correlated (Spearman correlation test: $z = 0.0265$, $p = 0.7758$).[20] Figure 2 depicts the distribution of advantageous and disadvantageous inequity aversion.

The distribution of risk preferences, shown in Table 2, is similar to that in Holt and Laury (2002). Risk aversion is not significantly correlated with either advantageous inequity

[20]This is surprising with respect to the assumptions of Fehr and Schmidt (1999). However our results are in line with those in Blanco et al. (2010) and Dannenberg et al. (2007), who use the same games to measure inequity aversion.

Table 3 Distribution of contribution decisions

Contribution	Number of subjects	Frequency	Cumulative frequency
0	21	17.8%	17.8%
1	3	2.5%	20.3%
2	1	0.8%	21.2%
3	4	3.4%	24.6%
4	6	5.1%	29.7%
5	18	15.3%	44.9%
6	5	4.2%	49.2%
7	11	9.3%	58.5%
8	9	7.6%	66.1%
9	6	5.1%	71.2%
10	34	28.8%	100.0%

aversion (Spearman correlation test: $z = 0.0497$, $p = 0.5930$) or disadvantageous inequity aversion (Spearman correlation test: $z = 0.0467$, $p = 0.6157$).[21]

4.2 First mover's choice

The average contribution of first movers is 5.97. As shown in Table 3, three levels of contribution are the most popular. 18% of subjects contribute zero to the public good, 15% choose five and 29% choose ten. Overall, the results for first movers' decisions are consistent with previous work in experimental economics (among the many references summarized in Anderson 2001 and Ledyard 1995, see Andreoni 1988; Dorsey 1992; Isaac et al. 1984).

We now see how preferences, with respect to risk and inequity aversion, affect first movers' contribution decisions. We use a Tobit model as the contributions lie between zero and ten. The first model controls for risk aversion, disadvantageous inequity aversion and gender; in the second model, we add advantageous inequity aversion and subjects' beliefs. Table 4 presents the regression coefficients.

Although the first model is not overall significant, we see that risk aversion negatively affects first movers' contributions, as predicted by theory. Crossing over from the safer to the riskier option one decision later in the Holt and Laury lottery reduces contributions by 1. Theory predicted that disadvantageous inequity aversion should negatively affect contributions. However, disadvantageous inequity aversion has no significant effect, and the risk averse are no more affected by their disadvantageous inequity aversion than are the risk neutral or the risk loving.

In the second model, we take into account the effect of subjects' beliefs. As has previously been found, subjects who believe in others' contributions contribute more themselves. The introduction of beliefs renders the regression highly significant.

These findings are summarized in Result 1.

[21] Dubois et al. (2009) use a different method to that in Blanco et al. (2010) to measure inequity aversion. They use the procedure developed by Davidovitz and Kroll (2004) to link risk aversion and inequity aversion. Although they do not differentiate advantageous from disadvantageous inequity aversion, they also find no significant correlation between risk aversion and inequity aversion.

Table 4 Contribution decision regressions

	Dependent variable: public-good contribution	
	(1)	(2)
Gender	−0.193	0.751
	(1.237)	(0.947)
α	−0.339	0.093
	(0.782)	(0.568)
Risk aversion	-1.021^{**}	-0.730^{**}
	(0.493)	(0.368)
$\alpha \times$ Risk aversion	0.055	−0.024
	(0.139)	(0.102)
β		0.766
		(1.364)
Belief		1.138^{***}
		(0.147)
Constant	12.271^{***}	3.981^{*}
	(2.915)	(2.361)
No. observations	118	118
Left-censored	21	21
Right-censored	34	34
Prob > χ^2	0.3015	0.0000
Pseudo R^2	0.0094	0.1377

Note: Standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

Result 1 *As first mover, a subject with greater risk aversion contributes less to the public good than do others, while advantageous and disadvantageous inequity aversion have no significant effect. Beliefs about other's contributions are significantly and positively correlated with the first mover's contribution.*

When playing as first movers in a sequential public good game, subjects face strategic uncertainty due to their ignorance of the second mover's behavior. Therefore, as predicted, risk aversion affects public good contributions. Blanco et al. (2010) had previously shown that inequity aversion plays no role in a simultaneous public good game but had not measured risk aversion. We suggest that their finding is due to the strategic uncertainty in the simultaneous public good game, as players are uncertain about others' behavior. By analyzing the behavior of second movers in our simple design, we can see whether inequity aversion plays a role in the contribution decision when there is no strategic uncertainty.

4.3 Second mover's choice

When playing as second movers, subjects face no strategic uncertainty. Subjects contribute the same amount as the first mover or nothing. Beliefs about others and risk aversion play no role here.[22] The experimental design, asking second movers to choose between zero and the

[22] There is no uncertainty in each decision for second movers in our game, as they know the first mover's contribution. However, subjects might feel uncertainty with respect to whether they will be designated as

Table 5 Decisions of second movers for each choice of the first mover

	Dependent variable: Decision of the second mover to contribute the same amount as the first mover	
	(1)	(2)
Gender	−0.475	−0.481
	(0.425)	(0.426)
Risk aversion	0.204	0.205
	(0.149)	(0.150)
α	0.099	0.101
	(0.068)	(0.068)
β	3.495***	3.508***
	(0.637)	(0.638)
Contribution of the first mover		−0.040**
		(0.020)
No. observations	1180	1180
Prob > χ^2	0.0000	0.0000
Wald χ^2	48.51	52.26
Log Likelihood	439.69	437.63

Note: Standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

same contribution as the first mover, was chosen to keep the design simple and to identify types. Only advantageous inequity aversion should affect second movers' decisions.

The number of times that second movers match the public good contribution of the first mover instead of contributing zero is significantly correlated with their contribution decision as first mover (Spearman correlation test: $z = 0.3272$, $p < 0.001$). Those who contribute to the public good as first movers are therefore more likely to match a positive first mover contribution. Nevertheless, this observation provides no insights into the type of preferences, i.e., advantageous or disadvantageous inequity aversion or risk aversion, that drive second movers' behavior.

Table 5 presents the marginal effects of a panel probit regression with random effects (correcting for multiple observations per individual) of decisions of second movers to match the first mover's contribution to the public good.

The regressions show that the main driver of second-mover decisions is advantageous inequity aversion, as theory predicts. Risk aversion and disadvantageous inequity aversion play no role. We also see that subjects are less likely to contribute the same amount as the first mover as the first-mover's contribution increases.

A subject with $\beta < 0.2$ should always choose the zero contribution and those with $\beta \geq 0.2$ should always choose the same contribution as the first mover. As in previous work, different types of behavior are observed. Over the 118 participants, we identify five subject types. Some are "Free-riders" as they always contribute nothing to the public good, irrespective of the first mover's contribution. The second type is "Full reciprocators" who always contribute the same amount as the first mover. However, the behavior of other subjects violates the predictions of inequity-aversion theory: they sometimes contribute the same amount

first- or second-mover for the calculation of their earnings, and on the actual decision of the individual with whom they are matched. As a check, the second-movers' decision regressions control for risk aversion.

Table 6 Types of second-mover subjects

	Number of subjects	Frequency	Average β
Free-riders	47	39.8%	0.17
Full reciprocators	27	22.9%	0.55
Low reciprocators	22	18.6%	0.39
High reciprocators	16	13.6%	0.40
Others	6	5.1%	0.23

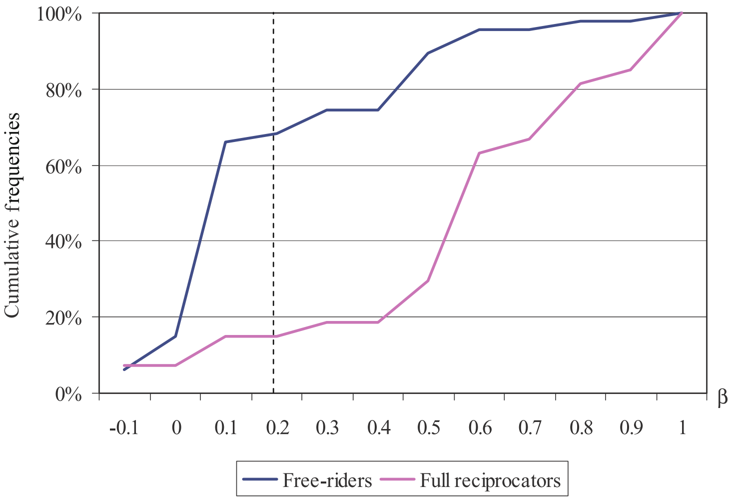

Fig. 3 Cumulative distribution of β for reciprocators and free-riders

as the first mover and sometimes zero. "Low reciprocators" match the first mover's contribution only if it is not too high; "High reciprocators" match when the first mover's contribution is high but free-ride otherwise. Six subjects are classified as "Others" because they do not follow any particular logic in switching from matching to free-riding. The distribution of subject types is given in Table 6.[23]

We focus our analysis on subjects who fit inequity-aversion theory by choosing always the same amount as the first mover or always zero. These subjects are in the majority (62.7% of all subjects).

The average advantageous inequity aversion of free-riders is 0.17 while that of reciprocators is 0.55. The difference is statistically significant (Mann-Whitney U-test: $z = 4.668$, $p < 0.001$). Those who reciprocate others' contributions are, on average, more advantageous-inequity averse than are those who free-ride. Figure 3 depicts the cumulative distribution of advantageous inequity aversion for reciprocators and free-riders.

Figure 3 clearly shows that the distribution of advantageous inequity aversion among reciprocators is very different from that among free-riders. Only 15% of reciprocators have $\beta < 0.2$ against 68% for free-riders. This difference is highly significant (Mann-Whitney

[23]More detail is found in the figure showing the frequency of contributing the same amount as the first mover for each contribution level at the end of Appendix.

Table 7 Reciprocal decision regressions

	Dependent variable: being a reciprocator			Dependent variable: being a free-rider		
	All	$\beta < 0.2$	$\beta \geq 0.2$	All	$\beta < 0.2$	$\beta \geq 0.2$
Gender	−0.031	0.010	0.046	0.193*	0.135	0.127
	(0.076)	(0.071)	(0.130)	(0.097)	(0.144)	(0.104)
$\beta \geq 0.2$	0.274***			−0.439***		
	(0.069)			(0.087)		
β		−0.516	0.702**		0.997	−0.375
		(0.399)	(0.332)		(0.920)	(0.266)
α	0.002	0.008	−0.028	−0.043**	−0.060*	−0.007
	(0.015)	(0.011)	(0.027)	(0.021)	(0.031)	(0.022)
Risk aversion	0.030	0.012	0.013	−0.049	−0.088*	0.004
	(0.027)	(0.023)	(0.045)	(0.035)	(0.051)	(0.038)
No. observations	118	51	67	118	51	67
Prob > χ^2	0.0068	0.4926	0.1942	0.0000	0.0372	0.2945
Pseudo R^2	0.1115	0.1214	0.0704	0.1854	0.1514	0.0692

Note: Standard errors in parentheses

*Significant at 10%

**Significant at 5%

***Significant at 1%

U-test, $z = 4.3848$, $p < 0.001$). This result supports the theoretical prediction that reciprocators should have $\beta \geq 0.2$ and free-riders should have $\beta < 0.2$. When playing as second movers, that is without any uncertainty about others' contributions, advantageous inequity aversion clearly drives the decision to reciprocate.

Econometric analysis will show whether the effect of advantageous inequity aversion on the second mover's choice remains significant, when we control for disadvantageous inequity aversion and risk aversion. Disadvantageous inequity aversion should have no effect, as the second mover earns either the same as the first mover or more, but never less. Equally, risk aversion should have no effect in the absence of strategic uncertainty. Table 7 presents the marginal effects from probit regressions of being a reciprocator and being a free-rider. We first consider all subjects, to determine the effect of the theoretical advantageous inequity aversion threshold (0.2), and then run separate analyses according to the value of β.[24]

The theoretical threshold has a large and significant effect: a subject with $\beta \geq 0.2$ is 27% more likely to be a reciprocator and 44% less likely to be a free-rider. The effect of advantageous inequity aversion as a continuous variable is positive and significant in the reciprocator regression only when $\beta \geq 0.2$. In the latter case, an increase in β of 0.1 raises the probability of being a reciprocator by 7%. In all of Table 7's other regressions, β is

[24] In these regressions, we include all of the previously-defined types of subjects. If we only consider reciprocators and free-riders, the effect of advantageous inequity aversion is even stronger and has greater explanatory power. As Fig. 3 already presents a clear picture for reciprocators and free-riders only, we here include all participants in the econometric regressions. We were careful to add the explanatory variables sequentially to control for collinearity. The marginal effects did not change with the introduction of the new variables, so we here only show the final specification.

insignificant. The effect of risk aversion or disadvantageous inequity aversion is insignificant or small. The following result summarizes our findings for second movers.

Result 2 *As second mover, the subject chooses between contributing the same amount as the first mover and contributing nothing to the public good mainly according to her advantageous inequity aversion. A subject with advantageous inequity aversion greater than* 0.2 *is more likely to reciprocate than others. Risk aversion and disadvantageous inequity aversion have only a very limited impact on this decision.*

Our results thus support the hypothesis of Fehr and Schmidt that those with high advantageous inequity aversion are more likely to cooperate and contribute in a public good game. For this hypothesis to be tested correctly, strategic uncertainty has to be removed from the public good game, so that we can focus on the pure effect of social preferences absent any effect of uncertainty. This corresponds to the second mover's behavior in the sequential public good game. In this case, of risk aversion and advantageous and disadvantageous inequity aversion, only advantageous inequity aversion has a strong significant effect. The individual preference behind contributions in a public good game without strategic uncertainty is therefore advantageous inequity aversion. Once we ensure that social preferences are the only source of variation, our results support Fehr and Schmidt's predictions.

5 Conclusion

The introduction of psychological variables into public-choice theory is necessary for its extension and the construction of more accurate models. Nevertheless, it is not clear which variables should be introduced to predict individual decisions in social dilemmas. Our experiment has attempted to fill this gap. We carried out a sequential public good game to disentangle the intrinsic preferences driving individual decisions, differentiating situations according to the presence of strategic uncertainty. The theoretical predictions are clear: first movers with higher risk aversion or disadvantageous inequity aversion should contribute less to the public good than others. Moreover, the higher the belief of first movers' regarding others' contributions, the higher her contribution. Second movers with a sufficiently high degree of advantageous inequity aversion should contribute more than others.

These theoretical predictions are mostly supported by the data. Greater risk aversion amongst first movers reduces the contribution to the public good. In addition to intrinsic preferences, first movers are also influenced by their beliefs about others' behavior. The main source of reciprocity for second movers is advantageous inequity aversion. Those who are sufficiently advantageous-inequity averse are more likely to reciprocate by contributing the same amount as the first mover and less likely to free-ride. Moreover, disadvantageous inequity aversion and risk aversion, as predicted, do not have any significant impact on second-movers' behavior. Our results thus suggest that public-choice theory should include individual risk preferences to predict decisions in social dilemmas when individuals are not aware of the behavior of others, i.e., under strategic uncertainty. The results also underline the predictive power of Fehr and Schmidt's (1999) model to explain reciprocity when there is no strategic uncertainty. Models should therefore include advantageous inequity aversion when others' behavior is perfectly observable, i.e., when there is no strategic uncertainty.

Our results have potential implications for economic policy and organizational management. They suggest that risk-averse individuals should not be leaders for decisions regarding the provision of public goods, while individuals who more easily trust others could play this role. Advantageous-inequity averse individuals serve the public interest as long as they can see that others have contributed to the public good as well. The results also suggest that it may be worth improving transparency or communication for risk-averse or advantageous-inequity averse individuals, in order to improve their cooperative behavior when other people cooperate too.[25] Therefore, greater transparency for some specific jobs or firms could be recommended. However, it may not be worth setting up costly communication activities when those receiving the information are selfish.

Another contribution of this study is more methodological. The results show that agents' behavior can be consistent between games even though the context differs. It then suggests the use of experimental within-subject analyses. Nevertheless, while it seems clear how risk aversion can be elicited in experiments, there is debate over the elicitation of social preferences. We do not know at present which games best elicit trust, reciprocity and inequity preferences independent of the context or, at least, which games produce the best measure for each type of context, if the contexts can be classified. This point seems crucial and warrants the attention of future research.

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Appendix: Instructions

You are about to participate in an experiment on decision-making organized for the GATE research institute. During this session, you can earn money. The amount of your earnings depends on your decisions and on the decisions of the participants you will have interacted with.

The experiment is composed of four independent sections. In every section, you will make one or several decisions. You will make your decisions without knowing the other participants' decisions in the previous sections. Note that the other participants do not know your decisions either.

The first section is in paper form. The result of the first section requires an individual random draw that will take place at the end of the session to determine your earnings.

Your final profit also depends on the three other sections. The section considered for your earnings calculation will be determined randomly by the computer software. Every section has the same probability of being selected. At the end of the session, the result of this draw will be individually announced, as well as your payoff in this section. Your total earnings

[25] Although it is not possible to observe individual preferences, we know that subjects self-select into different jobs or firms according to their risk aversion (Bellemare and Shearer 2010; Bonin et al. 2007; Grund and Sliwka 2010). No evidence on survey data is currently available on self-selection according to individuals' social preferences, but this is found in laboratory experiments (Cabrales et al. 2010; Dohmen and Falk 2010; Teyssier 2008).

will be individually announced and paid in cash in a separate room in order to preserve confidentiality. You will additionally receive a show-up fee of 3 Euros.

During the entirety of the session, you cannot communicate with other participants.

Thank you for your participation.

A.1 Section 1

The attached sheet of paper shows ten decisions. Each decision is a paired choice between "option a" and "option b". You will make ten choices and record these in the column on the right, but only one of them will be used in the end to determine your additional earnings. Let us explain how these choices will affect your earnings.

Here is a ten-sided die that will be used to determine this payoff. The faces are numbered from 1 to 10 (the "0" face of the die will serve as 10). When you come to the other office to receive your earnings at the end of the experiment next week, you will throw this die twice: once to select one of the ten decisions to be used and a second time to determine what your payoff is for the option you chose, a or b, for the particular decision selected.

Even though we ask you to make ten decisions, only one of these will end up affecting your earnings. However, you will not know in advance which decision will be used. Of course, each decision has an equal chance of being used in the end.

- Look at decision 1
  Option a pays €2 if the throw of the dice is 1, and pays €1.6 if the throw is 2-10.
  Option b yields €3.85 if the throw of the dice is 1 and pays €0.1 if the throw is 2-10.
- Look at decision 2
  Option a pays €2 if the throw of the dice is 1 or 2, and pays €1.6 if the throw is 3-10.
  Option b yields €3.85 if the throw of the dice is 1 or 2 and pays €0.1 if the throw is 3-10.
- The other decisions are similar, except that as you move down the table, the chances of a higher payoff for each option rise. In fact, for decision 10 in the bottom row, the dice will not be needed since each option pays the highest payoff for sure, so your choice here is between €2 and €3.85.

To summarize,

- You will make ten choices. For each decision row, you will have to choose between option a and option b. You may choose a for some decision rows and b for other rows. You may change your decisions and make them in any order.
- Next week, when you come to the other room to receive your earnings from the experiment, you will throw the ten-sided die to select which of the ten decisions will be used.
- Then, you will throw the die again to determine your money earnings for the option you chose for that decision.

The earnings for this choice will be added to your other earnings, and you will be paid all earnings in cash at the end of the experiment next week.

If you have any questions, please raise your hand. Your questions will be answered in private. Please do not talk with anyone.

PARTICIPANT NUMBER:
NAME OF YOUR COMPUTER :
DATE:

Please indicate for each of the following 10 decisions if you choose Option a or Option b.

	Your decision	
Decision 1		
Option a: 1/10 chance of 2€ and 9/10 chance of 1.6€	Option a	O
Option b: 1/10 chance of 3.85€ and 9/10 chance of 0.1€	Option b	O
Decision 2		
Option a: 2/10 chance of 2€ and 8/10 chance of 1.6€	Option a	O
Option b: 2/10 chance of 3.85€ and 8/10 chance of 0.1€	Option b	O
Decision 3		
Option a: 3/10 chance of 2€ and 7/10 chance of 1.6€	Option a	O
Option b: 3/10 chance of 3.85€ and 7/10 chance of 0.1€	Option b	O
Decision 4		
Option a: 4/10 chance of 2€ and 6/10 chance of 1.6€	Option a	O
Option b: 4/10 chance of 3.85€ and 6/10 chance of 0.1€	Option b	O
Decision 5		
Option a: 5/10 chance of 2€ and 5/10 chance of 1.6€	Option a	O
Option b: 5/10 chance of 3.85€ and 5/10 chance of 0.1€	Option b	O
Decision 6		
Option a: 6/10 chance of 2€ and 4/10 chance of 1.6€	Option a	O
Option b: 6/10 chance of 3.85€ and 4/10 chance of 0.1€	Option b	O
Decision 7		
Option a: 7/10 chance of 2€ and 3/10 chance of 1.6€	Option a	O
Option b: 7/10 chance of 3.85€ and 3/10 chance of 0.1€	Option b	O
Decision 8		
Option a: 8/10 chance of 2€ and 2/10 chance of 1.6€	Option a	O
Option b: 8/10 chance of 3.85€ and 2/10 chance of 0.1€	Option b	O
Decision 9		
Option a: 9/10 chance of 2€ and 1/10 chance of 1.6€	Option a	O
Option b: 9/10 chance of 3.85€ and 1/10 chance of 0.1€	Option b	O
Decision 10		
Option a: 10/10 chance of 2€ and 0/10 chance of 1.6€	Option a	O
Option b: 10/10 chance of 3.85€ and 0/10 chance of 0.1€	Option b	O

Sections 2, 3 and 4 are conducted via computer. Your earnings will be calculated in points,

4 points = 1 Euro

We remind you that one of the sections 2, 3 and 4 will be randomly selected by the computer software to determine your earnings. Each section has the same probability of being selected.

A.2 Section 2

This section is independent of the previous section.

In this section, the situation is the following:

- Person B will choose between two options: either to participate in the game whose rules are described below, or to receive 5 points and not to participate in the game.
- In the game, person A must choose between two earnings distributions between herself and person B in 21 different decision problems. Person B can only accept person A's decisions.
- You make your decisions under the role of the person A and under the role of the person B. The roles of the persons A and B will be randomly determined by the computer software once you have made your decisions.

The decision problems of the game will be presented in a table.

Example. Decision 7 is presented as follows:

Decision 7		
Option a: Your payoff is 7 pts and the payoff of person B is 7 pts	Option a	O
Option b: Your payoff is 18 pts and the payoff of person B is 2 pts	Option b	O

You make your decisions in the role of person A:

If you choose option a, you and person B will receive 7 points each. If you choose option b, you decide to keep 18 points for yourself and the payoff of person B will be 2 points.

The other decisions are similar, except that as you move down the table, the payoff of each person under option a is increased.

For example, decision 10 is presented as follows:

Decision 10		
Option a: Your payoff is 10 pts and the payoff of person B is 10 pts	Option a	O
Option b: Your payoff is 18 pts and the payoff of person B is 2 pts	Option b	O

You will choose an option (a or b) for each of the 21 lines you will see on the screen.

If this section is selected to determine your earnings, the computer software will match you randomly to another participant in the room once your choices have been made and will assign you a role. The matching and role attribution will remain anonymous.

The computer software will randomly select one of the decisions.

You make your decisions in the role of person A and also in the role of person B.

Your earnings are determined as follows:

- If you receive role B:
  - If you have chosen not to participate in the game, you will earn 5 points.
  - If you have chosen to participate in the game, you will earn the amount that person A with whom you are paired has chosen for person B in the decision selected by the computer software.
- If you receive role A, you will earn the amount you have chosen for yourself in the decision selected by the computer software.

Example of earnings calculation:

Decision 7 is the decision selected by the computer software.

If person B decides to participate in the game

- If person A has chosen option a
  Earnings of person A are: 7
  Earnings of person B are: 7
- If person A has chosen option b
  Earnings of person A are: 18
  Earnings of person B are: 2

If person B decides not to participate in the game

- If person A has chosen option a
  Earnings of person A are: 7
  Earnings of person B are: 5
- If person A has chosen option b
  Earnings of person A are: 18
  Earnings of person B are: 5

A.3 Section 3

This section is independent of the previous section.

In this section, the situation is the following:

- Person A will choose a distribution (only one) over the 21 payoff distributions available between herself and person B.
- Person B knows that person A has been asked to make this decision. B can either accept or reject the distribution chosen by A. If person B accepts the distribution proposed by person A, this payoff distribution is implemented. If person B rejects the offer, the two people, A and B, receive nothing.
- Person B chooses between accepting or rejecting the distribution proposed by person A for each of the 21 available distributions. Person B must choose an option (to accept the distribution or to reject the distribution) for each of the 21 lines on the screen.

If this section is selected to determine your earnings, the computer software will match you randomly with another participant in the room once your choices have been made and will assign you a role. The matching and role attribution will remain anonymous.

You will make your decisions in the role of person A and also in the role of person B.

- If you receive role A, you will earn the amount that you have chosen for yourself if the person B with whom you are matched accepts your offer. If person B rejects the offer, you and person B will earn nothing.
- If you receive role B, you will earn the amount that the person A with whom you are matched has chosen for B if you have accepted the offer. If you have rejected this offer, you and person A earn nothing.

A.4 Section 4

This section is independent of the previous section.

In this section, the situation is the following:

- Person A receives 10 points. In the following, we will call this amount the "endowment".
- Person A will decide how to use her endowment: A decides how much of the 10 points she wants to contribute to a project (from 0 to 10) and how much she wants to keep for herself.
- Person B receives an endowment of 10 points.
- For the ten different contributions of person A, Person B must choose between two possible contributions to the project.

The decision problems of person B will be presented in a table.

Example. Decision 7 is presented as follows:

Decision 7: A contributes 7 pts		
Option a: Your contribution is 7 pts	Option a	O
Option b: Your contribution is 0 pt	Option b	O

If in this specific decision problem you choose option a, this means that you decide to contribute the same amount as person A: you contribute 7 points when she contributes 7 points. If you choose option b, this means that you decide to contribute 0 points to the project when person A contributes 7 points.

The other decisions are similar, except that as you move down the table, the contribution of person A increases.

You choose an option (a or b) for each of the 11 lines on the screen.

If this section is selected to determine your earnings, the computer software will match you randomly with another participant in the room once your choices have been made and will assign you a role. The matching and role attribution will remain anonymous.

Payoffs of each participant are determined as follows:

Payoff $=10-$ your contribution to the project $+\ 0.8\times$ (your contribution to the project $+$ the other person's contribution to the project)

This formula shows that your payoff in this section consist of two parts: (1) the share of the endowment that you keep for yourself, and (2) the return from the project, that is 80% of the total contribution of the two persons who are matched together.

You will make your decisions in the role of person A and also in the role of person B.

- If you receive role A, your effective contribution to the project is the contribution decision you chose under role A.
- If you receive role B, your effective contribution to the project is the contribution you chose (option a or b) conditional on the contribution of the person A with whom you are matched.
- The earnings of person A and of person B are calculated according to the payoff formula described above.

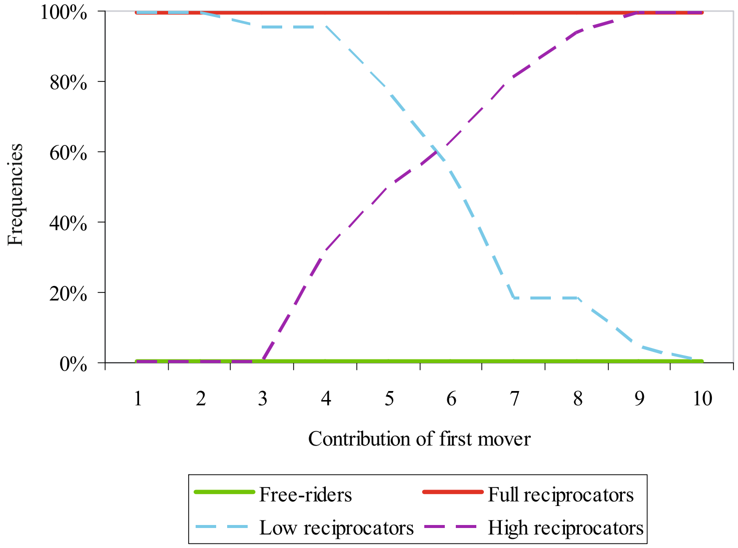
Examples:
Person A contributes 4 points to the project.

- If person B decides to contribute 0 points when A contributes 4 points:
  Earnings of person A $= 10 - 4 + 0.8 \times (4 + 0) = 9.2$
  Earnings of person B $= 10 - 0 + 0.8 \times (4 + 0) = 13.2$
- If person B decides to contribute 4 points when A contributes 4 points:
  Earnings of person A $= 10 - 4 + 0.8 \times (4 + 4) = 12.4$
  Earnings of person B $= 10 - 4 + 0.8 \times (4 + 4) = 12.4$

Person A contributes 9 points to the project.

- If person B decides to contribute 0 points when A contributes 9 points:
  Earnings of person A $= 10 - 9 + 0.8 \times (9 + 0) = 8.2$
  Earnings of person B $= 10 - 0 + 0.8 \times (9 + 0) = 17.2$
- If person B decides to contribute 9 points when A contributes 9 points:
  Earnings of person A $= 10 - 9 + 0.8 \times (9 + 9) = 15.4$
  Earnings of person B $= 10 - 9 + 0.8 \times (9 + 9) = 15.4$

Frequency of reciprocal decisions depending on the type of second mover:



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