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Abstract

A usual explanation to low levels of contribution to public goods is the fear of getting the sucker's payoff (cooperation by the participant and defection by the other players). In order to disentangle the effect of this fear from other motives, we design a public good game where people have an insurance against getting the sucker's payoff. We show that contributions to the public good under this 'protective' design are significantly higher and interact with expectations on other individuals' contribution to the public good. Some policy implications and extensions are suggested.

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1. Introduction and motivation

Social dilemmas involve a conflict between a cooperative strategy, benefiting the group but potentially costly to the individual, and a defection strategy, detrimental to the group but benefiting the individual. A common social dilemma is the prisoner's dilemma involving four types of payoffs as indicated in figure 1 where T>R>P>S (Rapoport, 1967). Mutual cooperation brings a reward (R) payoff to each player; mutual defection leads to a punishment (P) payoff; when one player cooperates (resp. defects) while the other defects (resp. cooperates), he gets the sucker (S) payoff (resp. the temptation payoff).

Player i's strategy \ Player j's strategy	C	D
C	R,R	S,T
D	T,S	P,P

Figure 1. Typical prisoner's dilemma

Low levels of contribution are frequently reported in games with a prisoner's dilemma structure. Two main drivers are greed and fear (Ahn *et al.*, 2001). Out of greed, one player may defect to benefit from the good at the expense of the other player. Out of fear, individuals may prefer to defect to avoid the sucker payoff. The greed motivation is the classical opportunistic free-riding behavior. The fear motivation is an aversion to the sucker payoff. Even if the outcomes seem similar between greed and fear motivation –that is reduced contributions to public goods– the drivers are different. Indeed, greed leads to free riding behavior and is an opportunistic behavior where the individual seeks to consume more than his fair share of a public resource while defection out of fear is *a priori* non-opportunistic and results from the uncertainty concerning others' behaviors.

The aversion to the sucker's payoff has been notably introduced in the analysis of public goods with threshold effects. In this case, the agent does not contribute for the production of a public good because he fears that the good will not be produced because too many other players will defect. Given that the production of the public good requires a minimum level of contributions, if the contributions are insufficient, the good will not be produced and the individual will feel he squandered his contribution[1] (Sen, 1967; Runge, 1984; Schmidtz, 1991; Wiener and Doescher, 1991). For example, a driver can renounce purchasing an environmentally friendly car because he is convinced that his isolated contribution is too weak to induce a perceptible improvement in air quality, except if he is convinced that a sufficient number of other drivers will also contribute by purchasing an environmentally friendly car[2]. While the aversion to the sucker's payoff is exacerbated in the case of public goods with threshold effects, we contend that it remains an impediment to higher contributions, even when there is no threshold effect.

In a survey, Rapoport and Chammah (1965) showed that cooperation rates in prisoner's dilemmas increase when the 'sucker' payoff decreases. The '*strong* [emphasis added] desire to avoid being a sucker' is supported by an empirical regularity that 'when a manipulation (…) has the effect of increasing the likelihood that the group's goal will be achieved, subjects are more likely to cooperate' (Wiener and Doescher, 1991; see also Taschian *et al.*, 1984). Using experimental games, Fehr and Gachter (2000) demonstrate that people are willing to

[1] Sen (1967) defines this problem as the assurance problem.

[2] Another example can be related to the effects of seed money and refunds which increase significantly the contribution level of charitable giving (e.g., List and Lucking-Reiley, 2002).

punish free-riding –even if it is costly for them– in order to avoid getting the sucker's outcome.

Aversion to the sucker's payoff stems from many behavioral assumptions. Wilkinson-Ryan (2008) discusses what it is in the sucker payoff that deters from cooperation. The authors argue that to be a sucker, three conditions must be satisfied. First, the individual must "either give more than he gets or get less than he deserves". That points to fairness considerations. Second, "the victim must have evinced some kind of trust for his eventual antagonist, and then had that trust betrayed". That is linked to trust and betrayal. And finally, "each sucker has to some extent contributed to his own state" that is "it involves self-blame". Indeed, the dimensions involved in the sucker's payoff aversion are manifold. Obviously, we will not be able to deal with them all but we focus on the aversion to others contributing an overall amount of less than 75% of the individual's contribution (see next section).

In this article, we study an insurance mechanism to increase cooperation in the face of sucker's payoff aversion. Since sucker's payoff aversion stems from the uncertainty on other players' behavior rather than from opportunistic behavior, we investigate the impact of an insurance mechanism where players are insured against large losses in case they are the only contributors in the group. Rather than advocating for insurance schemes or contracts from a theoretical viewpoint (e.g., Schmidtz, 1991), we question their effectiveness to improve the funding of public goods. In order to disentangle the effect of the sucker's payoff aversion from other factors on the level of contributions, we design a public good game where participants are partially insured against defection by other players. The contribution level to public goods when a partial insurance mechanism is implemented has not been investigated in the literature. In other words, our paper answers to the following question: does the provision of an insurance mechanism lead to higher levels of contribution to public goods and to what extent? We report two main results. First, we corroborate that aversion to the sucker's payoff matters in overall contribution to public goods. The implementation of an insurance mechanism has a positive impact on the individual's contribution. Second, the insurance mechanism also affects the individual's expectations regarding the contributions of other participants. As all other agents also benefit from the same insurance mechanism, their incentive to defect is equally reduced. This effect simultaneously (i) reinforces the positive effect of the insurance mechanism at the individual's level as the probability to end up with the sucker's payoff is reduced, *ceteris paribus* but (ii) also decreases the overall individual's contribution because he expects that given that other players will contribute more, he can contribute less. Ultimately, the overall effect of implementing an insurance mechanism on the individual's contribution remains positive.

The remainder of the paper is organized as follows. Section 2 describes the experiment and stipulates the theoretical predictions. Section 3 presents and discusses the results. Section 4 concludes and provides some policy implications.

2. Experimental Design and Implementation

In this section we present the experimental design and the theoretical predictions given our treatments and our choice of parameters for the experiment.

2.1. Basic design

We use two treatments namely the *Reference* treatment that corresponds to a standard public good game and the *Insurance* treatment where we provide subjects with an insurance against the risk of getting the sucker's payoff. In the *Reference* treatment, subjects are endowed with 20 tokens they allocate between a private investment which earns one euro per token and a public investment which earns 0.4€ per token as in any standard public good experiment. Given other players' contribution c_{-i}, player i chooses the level of contribution c_i that maximizes the following payoff function:

$$u(c_i, c_{-i}) = 20 - c_i + 0.4\sum_{k=1}^{n} c_k = 20 - 0.6c_i + 0.4c_{-i}$$

In the *Reference* treatment, the Nash equilibrium is to contribute nothing and the social optimum to contribute all the endowment. The reason for low contributions may lie in greed (leading to free riding behavior) but also in fear (the aversion to the sucker's payoff). To distinguish these effects, we design a second treatment.

In the *Insurance* treatment, subjects have the same payoff function as in the *Reference* treatment except that another payoff function (alternative payoff) substitutes to the standard payoff if the other players in the group is too low. Given other players' contribution c_{-i}, player i chooses the level of contribution c_i that maximizes the following payoff function:

$$v(c_i, c_{-i}) = Max\ [(20 - 0.6c_i + 0.4c_{-i}); (20 - 0.3c_i)\ ]$$

The Nash equilibrium of this game is still to contribute nothing and the social optimum to contribute all. However, the worst payoff for player i that is to be the only one to contribute ("sucker's payoff") is now relatively better, $v(c_i, 0) = 20 - 0.3c_i$ (in the *Reference* treatment, this worst payoff was $u(c_i, 0) = 20 - 0.6c_i$). Note that the insurance mechanism insured against the case where the others give an overall contribution of less than 75% of the individual's contribution. The individual is indeed indifferent to the insurance mechanism when $c_{-i} = 3/4\, c_i$.

2.2. Predictions

Figure 2 displays (i) in plain lines, player i's payoff as a function of his own contribution and depending on the contribution of the three other players and (ii) in dotted lines, the player i's alternative payoff as a function of his own contribution.

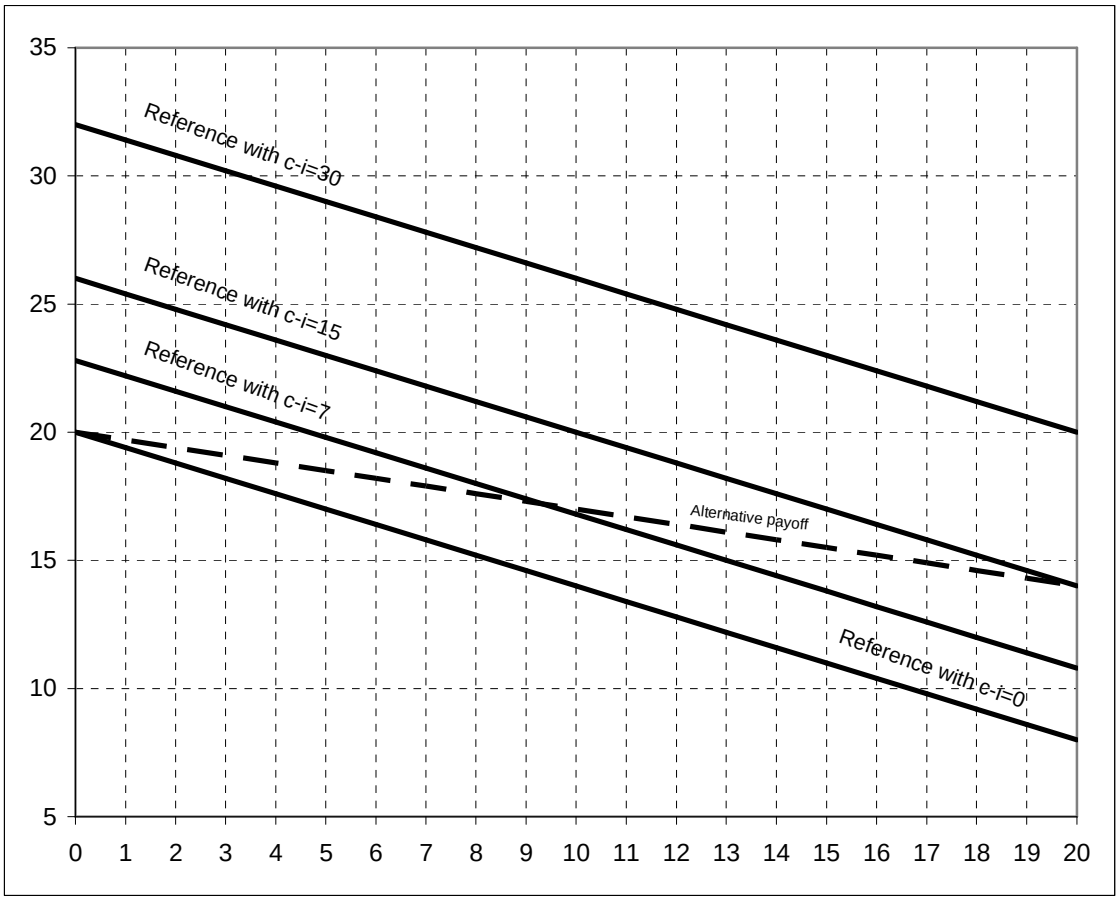

Figure 2. Player i's payoff as a function of his own contribution in the *Reference* treatment (with increasing levels of contribution of the three other players – plain lines) and in the alternative payment scheme (dotted line)

First, notice that all the payoffs functions in the *Reference* treatment have the same slope (-0.6) and are upward shifted with an increase of the other players' contributions. Second, notice that the alternative payoff scheme has a negative lower slope of -0.3 and is independent of the other players' contribution. In other words, it constitutes a partial and imperfect insurance mechanism against non or too weak contributions by other players. Third, in the *Reference* treatment, we clearly see the Nash equilibrium for player i: whatever the contribution of the other players, payoff is maximized for a zero individual contribution.

Several cases appear revealing player i's strategy in the *Insurance* treatment as compared to the *Reference* treatment:

(i) When $c_{-i} = 0$, the alternative payoff is always higher than the *Reference* payoff. If player *i* has an aversion to the sucker payoff, then contributions should be higher in the *Insurance* treatment as compared to the *Reference* treatment.

(ii) When $c_{-i} \geq 15$, the payoff of player *i* in the *Reference* treatment is always higher than the alternative payoff. Thus, whatever the contribution of the other players, player *i* should display the same type of strategy in the *Insurance* and *Reference* treatments.

(iii) When $0 < c_{-i} < 15$, the lines representing the *Reference* payoff and the alternative payoff cross each other. If player *i* is a relatively big contributor to the public good ($c_i > 4/3 c_{-i}$), then the *Insurance* treatment provides higher payoffs than the *Reference* treatment. However, if player *i* is a relatively small contributor ($c_i \leq 4/3 c_{-i}$), the *Insurance*

treatment is equivalent to the *Reference* treatment. In a pure 'homo economicus' model, the *Insurance* mechanism should play no role even when $0 < c_{-i} < 15$. Non contribution remains the dominant strategy. However, with other models of behavior where human beings are not 'pure egoists' (e.g., Croson, 2007), the *Insurance* mechanism will play a role. What behavior can we expect? By providing an insurance against the sucker payoff to all participants, the *Insurance* mechanism leads the individual to anticipate that others will contribute more. This anticipation can exert an influence in two opposite ways. On the one hand, if the individual exhibits reciprocal preferences, he will contribute more to match the higher contributions of other participants. On the other hand, if the individual exhibits altruistic preference that can be crowded out by expectations that other participants will contribute at higher levels, he will decrease his own contribution. In sum, in addition to the direct effect of the *Insurance* mechanism on the individual i, there is also an indeterminate indirect effect through the individual' expectations on the contribution levels of other participants.

3. Experimental results

We first present the sample and the sessions, then some summary statistics and finally the econometric results.

3.1. Sample and sessions

The experiment has been performed at the ENGREF (Nancy, France) and gathered a sample of 64 students (Table I). Subjects were randomly distributed among groups of four players. In each session, there were 4 groups. There were two sessions per treatment.

Table I. Organized sessions

Session	Treatment	Number of groups	Number of participants
1	*Reference*	4	16
2	*Reference*	4	16
3	*Insurance*	4	16
4	*Insurance*	4	16

3.2. Sample statistics

The average group contribution is 22.625 tokens (standard deviation: 18.226) for the *Reference* treatment and 27.863 (standard deviation: 15.532) for the *Insurance* treatment. Figure 3 gives a box plot representation of the average group contribution over the periods and reveals a higher median for the groups in the *Insurance* treatment. A two-sample Wilcoxon rank-sum test is performed to test for a difference of distribution of group contributions between the two treatments. The results suggests group contributions were higher in the *Insurance* treatment at a 1% significance level (z= -6.258).

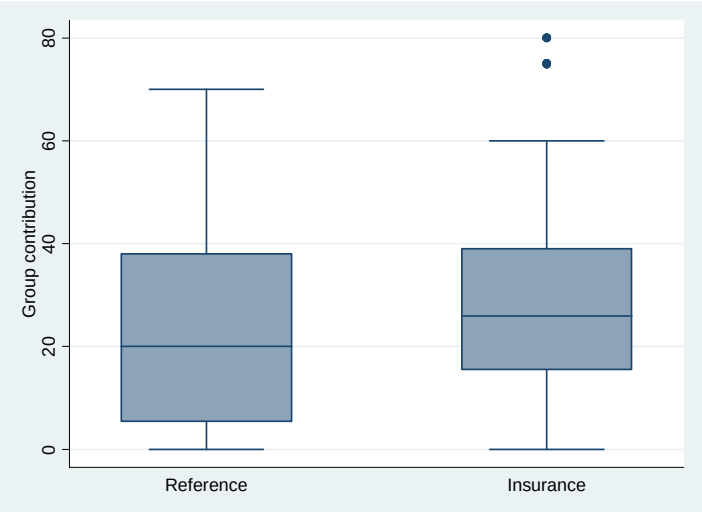

Figure 3: Box plot of average group contribution as a function of the treatment

The statistical analysis does not take into account the panel structure of the data. We take it into account in the econometric analysis.

3.3. Econometric results

Our data displays a panel structure and we are interested in time-invariant variables such as the treatment. The use of a random effect model that includes dummy variables for groups shows there is no individual specific effect. Thus, we use an ordinary least square model.

$$c_i = \alpha_0 + \alpha_1 Insurance + \alpha_2 E(c_{-i}) + \alpha_3 Period + \sum_{k \neq 1} \alpha_{4k} Group_k + e_i$$

The dependent variable is an individual i's contribution to the public good (c_i). Independent variables are the treatment dummy variable (*Insurance*) equal to one if the treatment is the *Insurance* treatment, an individual i's expectations on what the other three individuals in his group will contribute in the same period t ($E(c_{-i})$), the period number (*Period*), and an indicator variable for each group minus one (*Group*).

Individual i's expectations on others' behavior is unobservable. Thus, we used three proxies for the variable $E(c_{-i})$ (as in Cason and Gangadarhan, 2002 or in Croson, 2007). We consider that player i updates his beliefs on others' behavior on a period by period basis. In the actual computation method, we simply use the actual contribution of other players in the group as a proxy for individual i's expectations. In the myopic computation method, player i takes account only of the last period without considering the preceding periods. In the non-myopic computation method, player i updates his beliefs in period (N+1) by a weighted mean where the behavior of others in period (N-1) is projected on periods 1 to (N-2). The three computation methods yield the same results. In the article, we display only the actual computation method. Table II presents summary statistics for the dependent and independent variables.

Table II. Description and statistics of variables used in the regression analysis

Variable	Description	#Obs.	Mean (SD)
c_i	Individual i's contribution to the public good	1280	6.311 (6.732)
Insurance	Dummy (=1 if *Insurance* treatment and 0 otherwise)	1280	0.500 (0.500)
$E(c_{-i})$	Individual i's expectations on what the other three individuals in his group will contribute	1280	18.933 (13.856)

The econometric results for all individuals are presented in Table III. In line with the predictions in section 2.2., we have introduced an interaction effect between the treatment and the expectations.

Table III. OLS regression of individual i's contribution to the public good for all individuals

	Coefficient	SD	P>|t|
Insurance	2.160	0.949	0.023
Expectations	-0.136	0.028	0.000
Insurance X Expectations	0.068	0.032	0.034
Period	-0.401	0.033	0.000
Constant	6.905	0.776	0.000
(Dummies for group not reported here)			
Nb obs.	1280		
Adj-R2	0.2701		

From table III, we see that the *Period* has always a negative effect on individual contributions. It is a common result in experimental data. The data analysis shows a positive effect of the principal effect of *Insurance* treatment. The alternative payoff provides participants with an insurance against the risk of getting the sucker's payoff. Individuals are averse to the sucker's payoff. The principal effect of expectations is negative, although small. According to the analysis performed by Croson (2007), this negative correlation associated with positive levels of contributions reveals altruism on the part of participants. There is a crowding out effect. When participants expect high contributions from others in the group, they will decrease their contribution to the public good. Given such behavioral patterns, we predicted an increased negative effect of expectations in the *Insurance* treatment. However, the interaction effect between the *Insurance* treatment and the expectations is positive, although small. When the treatment has an insurance device against the sucker payoff, higher expectations will lead to higher contributions.

4. Conclusion

We examined the effect of the aversion to the sucker's payoff on contribution to public goods, using experimental games. Our results confirm that the aversion to the sucker's payoff plays a significant role in explaining contribution to public goods. Implementing an insurance mechanism plays a direct positive role on the individual's contribution and a positive indirect role through the individual's expectations on other's contribution. When the expected cooperation rate is relatively high, the insurance scheme reinforces the positive role of

expectations. A clear implication from our study is that public goods contribution schemes can increase the size of individual contributions thanks to refunding mechanisms in the event that the provision point is not reached. If people perceive their contribution as pivotal, that is, their contribution will 'make a difference'[3], they are more likely to contribute more.

Our study has limitations that give room for several extensions. For example, our insurance mechanism was partial and we do not investigate how different levels of insurance (from no insurance to full insurance) can impact on overall contribution to public goods with respect to the anticipated cooperation rate. An additional extension relates to the effect of heterogeneous agents (e.g. big and small contributors to public goods) on the functioning of insurance schemes. Moreover, in real life, insurance mechanisms can correspond to various devices that are likely to impact differently on contributions (e.g., List and Lucking-Reiley, 2002). We contend that people may, regardless from the end-outcome, extract 'procedural' utility from the way the insurance scheme is functioning (Benz *et al.*, 2004). For instance, the common knowledge of the presence of a sufficient portion of individuals willing to contribute to the public goods, regardless of others' contributions in the population can provide a natural 'insurance mechanism' preventing to some extent the aversion to the sucker's payoff in a different way when compared to a formal contract reimbursing people in case of insufficient overall contributions. This natural insurance mechanism may explain why ecolabelling schemes performs much better in some countries (e.g., Germany) compared to other countries (e.g. France).

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[3] Regarding a rewards-for-recycling program in the USA, some residents state that reward points matter less than seeing online 'how many trees and gallons of oil their recycling efforts have saved' (Jones, C., 2008, Residents reap rewards for recycling, USA Today, July, 9, http://www.usatoday.com/news/nation/environment/2008-07-08-recycle_N.htm).