Economic ties and social dilemmas*

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Abstract

Agents who are tied in a social dilemma situation oftentimes also engage in other economic activities that require (bilateral) cooperation. We develop an economic experiment to test whether the threat of being excluded from the benefits of cooperation in such an alternative economic activity can be an effective mechanism to deter free-riding in the social dilemma situation. Modelling the former as a gift-giving game and the latter as a Common Pool Resource game, we find that indeed resource extraction is closer to the socially optimal level if subjects interact with the same individuals in both activities, than if they do not. In addition, we find that sanctioning by means of selective exclusion from cooperation in the alternative activity is more effective the more profitable the alternative activity.

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村八分, mura hachi bu, is a Japanese expression for a traditional form of selective exclusion. The first ideogram means community, village, rural district and the likes. The second and third ideograms together mean 80%. Translated as "village 80%", the expression captures the system of peer enforcement applied by traditional Japanese communities: in case an individual does not conform to a particular code of conduct, he/she is excluded from 8 out of 10 main events in the village's social life.[1]

1 Introduction

Social dilemmas are very common in everyday life; there are many instances in which private and social objectives are not perfectly aligned. But although economic theory predicts that agents pursue their own private interests at the expense of those of the group as a whole, the real world is often not as dire. Even in the absence of formal intervention, people are observed to contribute to the public good (e.g., fulfilling team tasks in the workplace), or to mitigate the impact of their actions on the welfare of others in case of an economic bad (as is the case in many environmental issues).

In economic experiments, spontaneous emergence of cooperation in social dilemmas has been shown to arise if individuals can impose pecuniary sanctions on others. Reciprocal individuals are willing to punish free riders even if they themselves incur costs when doing so (Ostrom et al. [18], Fehr and Gächter [8]). And indeed there is evidence that self-regulation by means of pecuniary punishments occurs in the real world. For example, Brazilian fishermen in the Bahia region destroy the nets of fellow fishermen who do not respect the catch quotas (Cordell and McKean [5]).

However, whereas instances of self-regulation by means of pecuniary punishment are known, everyday experience suggests that it is not very common. Ordinary citizens do not usually have the right to destroy another person's property, nor do they have the authority to impose fines; it is the government that has, in most societies, the exclusive right of coercion. What citizens can do, however, is to cease interaction with individuals who free ride in the social dilemma situation, and refuse to cooperate with them in *other*

[1] We thank Yoshitsugu Yamamoto for drawing our attention to this expression.

social or economic circumstances in which they meet. Indeed, most behavior is embedded in a system of interpersonal relations (Granovetter [11]), and social dilemmas often occur in communities which are, by definition, characterized by the presence of multiple forms of interaction that require cooperation by two or more individuals (cf. Bowles and Gintis [4]). Ceasing cooperation in these other activities is a natural sanctioning device to discipline behavior of one's peers in the social dilemma situation. For example, Japanese villagers, Irish fishermen, and inhabitants of the Solomon Islands have in common that they cut contact with fellow villagers who free ride with respect to fishing, thus denying them the benefits of cooperation in other economic activities (McKean [16], Taylor [20], and Hviding and Baines [12]).

In this paper, we present experimental evidence on the behavior of participants in one particular social dilemma situation, the Common Pool Resource game, when these participants also interact in an additional economic activity which requires bilateral cooperation. This alternative activity is modelled in the form of what we label a "gift-giving" game, in which each participant decides whether or not to send a gift to each of the other participants he/she is interacting with. We investigate whether thus embedding the social dilemma in a wider economic environment sheds light on the emergence of cooperation. We hypothesize that linking the Common Pool Resource (CPR) game and the gift-giving game affects behavior in the former as subjects have the option to unilaterally cease cooperation in the gift-giving game in order to discipline the behavior of others in the CPR game. We will refer to this type of sanctioning as the selective exclusion mechanism.[2] If indeed selective exclusion arises naturally, we can conclude that communities will be better at solving social dilemmas than otherwise unconnected groups of individuals. And as cooperation usually unravels very fast in the Common Pool Resource game (Ostrom et al. [18], Vyrastekova and van Soest [21]), focusing on this particular social dilemma provides a strong challenge to this peer enforcement mechanism.

The design of our experiment is as follows. Subjects participate in a finitely repeated game. Its stage game consists of two games that are played sequentially, first the CPR

[2] Note that selective exclusion is with respect to (voluntary) cooperation in the alternative economic activity; it does not refer to denying individuals the right of access to the common pool resource, as this is very often not legal/feasible in practice (see McCarthy et al. [15]).

game and then the gift-giving game. The repeated game has only one subgame perfect Nash equilibrium: rational money-maximizing individuals always overharvest the CPR and never give a gift to any other individual. This prediction is independent of whether individuals interact with the same group of individuals in both constituent games, or not.

However, the presence of reciprocal individuals invalidates this prediction as these subjects may be willing to engage in bilateral gift-giving. Then, aggregate efficiency of CPR use may be higher if they interact with the same group of individuals in both activities (the community treatment, or Linked treatment), than if they do not (the disjoint groups treatment, or Unlinked treatment). Individuals in the Linked treatment have the option to refuse to give gifts to those who overharvest the CPR, whereas there is no such possibility in the Unlinked treatment. By comparing the Linked and Unlinked treatments, we can assess the viability of the selective exclusion mechanism and its effect on the efficiency of CPR use.

In some respects, the selective exclusion mechanism we study is similar to the pecuniary punishment mechanism discussed above. The most important similarity is that in order to be effective, both mechanisms require the presence of reciprocal individuals. In the latter mechanism, this is because it is not only costly to receive sanctions, it is also costly to impose them. That means that a subject imposing punishments actually provides a public good, and the Nash equilibrium prediction when all agents are assumed to be pure money maximizers, is that sanctioning will never take place. A similar line of reasoning holds for the selective exclusion mechanism, which requires the presence of reciprocal individuals to have a positive number of gifts being distributed; in the absence of gift-giving, there is no means to sanction other individuals' behavior either.

But selective exclusion differs from pecuniary punishment in two major respects. First, consistent with reality, we assume that giving gifts is costly. That means that when refusing to give a gift to a free rider in a particular round, the decision maker *reduces* his/her expenditures in that round, whereas sanctioning is costly in the pecuniary punishment mechanism. Second, pecuniary punishment is instantaneous and is not likely to be maintained over multiple periods unless the person punished persists in acting non-cooperatively with respect to CPR extraction. However, trust does play a role in the selective exclusion mechanism, and violating it may have persistent effects. If mutually beneficial cooperation in the gift-giving game is severed because one individual sanctions non-cooperative CPR extraction behavior by the other, it may prove difficult to re-establish the gift-giving relationship later on. Hence, we can hypothesize that the expected cost - in terms of gifts not received - of violating the norm is higher the more profitable is the gift-giving relationship.

However, the idea that peer enforcement by means of ceasing cooperation occurs naturally within a community is not self-evident, and neither is the statement with respect to the impact of profitability of the gift-giving relationship. A person imposing a sanction (by refusing to give gifts) may still incur costs if the punished individual views this refusal as being unfair, tries to deter future sanctioning, or is not aware of the link between his/her own actions in the CPR game and the number of gifts he/she receives. In these cases, the punished individual may retaliate and refuse to give gifts to the punisher in the next period, and cooperation in the gift-giving game may unravel. Therefore, potential norm enforcers may choose to refrain from imposing the sanction in order not to jeopardize the gift-giving relationship. From this perspective, punishing free riders in the social dilemma is a public good, as is the case in the pecuniary punishment experiments. In this light, it may actually be the case that ceasing cooperation is *less* likely to occur the more profitable is the alternative activity, because individuals are less willing to risk jeopardizing lucrative bilateral gift-giving opportunities to obtain relatively small efficiency gains in the social dilemma.

Thus, it depends on (the beliefs of others about) each subject's response to others' ceasing cooperation in the gift-giving game whether peer enforcement by selective exclusion takes place and hence whether or not the Linked treatment outperforms the Unlinked treatment in terms of efficiency of CPR use. And (the beliefs about) each subject's response to selective exclusion also determines whether or not higher returns in the gift-giving game render this mechanism more effective in increasing CPR efficiency. We sort out these issues in a 2x2 experimental design, the treatment variables being linking (whether or not the two constituent games are played with the same group of individuals), and the costs of providing gifts (which can be either high or low). As it is impossible to design payoff-equivalent games to compare our selective exclusion mechanism to the pecuniary punishment mechanism, we focus on the net efficiency gain associated with either mechanism. Ostrom et al. [18] find that the pecuniary punishment mechanism does increase the per-person return to extraction effort in the CPR game, but that *net* efficiency in the CPR game actually falls because of the deadweight loss associated with imposing punishments. Therefore, the question rises whether the selective exclusion mechanism is able to provide a pure efficiency gain, or not.

The selective exclusion mechanism is an alternative to the pecuniary punishment mechanism. Other alternative self-regulatory mechanisms that have been studied in the past include pecuniary rewards (rather than, or in addition to, pecuniary punishments; see Andreoni et al. [1]), non-monetary punishments (Masclet et al. [14]), and outright ostracism (Masclet [13]). Of these three, the paper by Masclet et al. [14] is most dissimilar from ours as our selective exclusion mechanism does have monetary implications, as is the case in Andreoni et al. [1] and in Masclet [13].

Our paper is close to the 'punishments and rewards' paper of Andreoni et al. [1], also because it is not ex ante obvious that the gift-giving game in our experiment will act as a punishment device (subjects always give gifts, unless the receiver acted non-cooperatively in the CPR game) or as a reward (subjects never give gifts, unless the receiver acted cooperatively in the CPR game). However, there are two main distinctions. First, whereas the second stage in the two-person Proposer-Responder game of Andreoni et al. is more easily identifiable as a sanctioning/reward stage, it is less obvious in our Linked treatments that the gift-giving game can play a similar role; the gift-giving game and the CPR game are presented as two separate games. Hence, if a link actually arises, it arises endogenously rather than that it is imposed by the experimenter. The second distinction is with respect to the dynamics of interaction among participants: Andreoni et al. use a stranger's treatment, whereas we use a partner's treatment. Therefore, in their paper rewarding and/or punishing cannot become a game in itself (resulting in positive reciprocity in rewards treatments, or retaliation in the punishment treatments), whereas it is a distinct possibility in our experiment.

The paper by Masclet [13] also uses a partner's treatment rather than a stranger's treatment when analyzing whether the possibility to ostracize fellow participants increases contributions in a public goods game. More specifically, he analyzes how the possibility to exclude individuals from one public goods game affects efficiency in another public goods game. Having observed all contributions in the public goods game that is played first, each subject can unilaterally block the participation of any other subject in the public goods game that is played next. Masclet finds that individuals who fail to contribute in the first game are excluded from the second game, and that the threat of this sanction raises contributions in the first game (but not in the second). Our paper differs from Masclet's because in our experiment selective exclusion itself refers to the decision with whom a subject wants to cooperate in the gift-giving game, but does not involve any - unilaterally imposed - restrictions on the set of individuals other subjects can interact with.[3] A second important difference is that Masclet [13] focuses on a public goods game, whereas we study the CPR game. Whereas free-riding in the public goods game only implies that the payoff of cooperative individuals is not enhanced, free-riding in our CPR game actually decreases the payoffs of those who are acting cooperatively. That means that maintaining cooperation is even more difficult in the CPR game than in the public goods game, and hence provides a stronger test for the mechanism studied.

The set-up of this paper is as follows. In section 2 we present the model, formulate the standard game theoretic predictions as well as our behavioral hypotheses, and briefly discuss the relevant details of the experiment's design. The data are analyzed in sections 3 and 4, and section 5 concludes.

2 The model, experiment design and hypotheses

2.1 The model

The basis of our experiment is a finitely repeated game with a stage game denoted by Γ^{CG}. In this stage game, two games are played sequentially, a standard static Common Pool Resource game (cf. Ostrom et al. [18]) and a gift-giving game. These constituent

[3]As is the case with pecuniary punishment, there are indeed instances in real life where individuals have the right to unilaterally decide whether or not another person is allowed to 'stay member of the club', but we think that the right not to cooperate is much more ubiquitous.

games are referred to with Γ^C and Γ^G, respectively. The novelty of our design is that rather than studying games Γ^C and Γ^G in isolation, we explore the consequences of linking the two.

The number of periods the stage game Γ^{CG} is played, T, is known to all experiment participants. Each participant plays both games Γ^C and Γ^G in a group of N players, but the group of players in game Γ^C, denoted A^C, is not necessarily the same as the group in game Γ^G, denoted A^G. Differences in group composition is, in fact, a treatment variable, as is the relative profitability of games Γ^C and Γ^G.

First, let us consider game Γ^C. In each period, each member of group A^C (referred to as 'user') is asked to divide a fixed endowment of effort, e, between CPR extraction and an alternative employment (the outside option). Extraction effort exerted by user i in period t is denoted $x_{i,t}$, and hence user i's effort devoted to the outside option is $(e - x_{i,t})$. The outside option yields a fixed per-unit wage rate, w. When exerting extraction effort, users incur costs that are linear in extraction effort; marginal cost are constant and equal to v. The group's revenues in period t, R_t, depend on the aggregate amount of extraction effort in that period, $X_t = \sum_{i=1}^{N} x_{i,t} \left(i \in A^C\right)$, according to the function $R(X_t) = AX_t - BX_t^2$. User i's share in these revenues is proportional to his/her share in aggregate extraction effort $(x_{i,t}/X_t)$. Hence, user i's payoff in game Γ^C in period t equals:

$$\pi_{i,t}^C(x_{i,t}, X_t) = w\left[e - x_{i,t}\right] + \frac{x_{i,t}}{X_t}\left[AX_t - BX_t^2\right] - vx_{i,t}, \tag{1}$$

with $A - v - w > 0$.

The socially optimal extraction effort level in game Γ^C is the one that maximizes the unweighted sum of the payoffs of all N users in the group as defined in (1). Transfers are not feasible and all subjects are homogenous. Therefore, the equitable socially optimal extraction effort level is $x^* = (A - v - w)/2NB$.

Assuming that subjects are rational and aim to maximize their own payoffs, user i's best response function can be determined by maximizing (1) with respect to $x_{i,t}$ while taking the aggregate extraction effort by all others ($X_{-i,t} = \sum_{j \neq i} x_{j,t}$ for $i, j \in A^C$) as given. Then, user i's best response function is $x_{i,t}(X_{-i,t}) = (A - v - w)/2B - X_{-i,t}/2$, and hence the unique symmetric Nash equilibrium extraction effort equals $x^{NE} = (A - v - w)/B(N+1)$. Because $x^{NE} > x^*$ if $N > 1$, the CPR game poses a social dilemma.

In the gift-giving game Γ^G, each subject makes $N-1$ binary choices whether to give a gift to each of his/her $N-1$ fellow group members, or not. Let $p_{ij,t}=1$ ($p_{ij,t}=0$) denote that individual i gives (does not give) a gift to individual j ($j \neq i$; $i, j \in A^G$) in period t. Giving gifts is costly to the person providing the gift, and it yields benefits to the gift recipient only. The costs of giving a gift to an additional subject are constant and equal to c ($c > 0$), and hence the total gift-giving costs in period t incurred by individual i are equal to $c\sum_{j\neq i} p_{ij,t}$. Individual i's benefits in the gift-giving game, b, are increasing and concave in the number of gifts received $\left(b(\sum_{j\neq i} p_{ji,t}) \text{ and } b'(.) > 0, b''(.) < 0\right)$. Individual i's payoff in the game Γ^G in period t thus equals:

$$\pi^G_{i,t}\left(\sum_{j\neq i} p_{ij,t}, \sum_{j\neq i} p_{ji,t}\right) = b\left(\sum_{j\neq i} p_{ji,t}\right) - c\sum_{j\neq i} p_{ij,t} \tag{2}$$

We assume that $b(0) = 0$ and impose that the gift-giving activity is efficiency-improving over the whole range of feasible gifts, $b'(.) \geq c$. In addition, we assume that $(N-1)c < b(1)$. This assumption selects a class of games where it is relatively cheap to search for a reciprocal partner in the gift-giving game. If one gives a gift to each of the $N-1$ other group members in a particular round, receiving one gift in return is sufficient to ensure a strictly positive payoff in that round.

Social welfare maximization in the gift-giving game implies maximizing the unweighted sum of the individual payoffs as defined in (2). Because $b'(.) \geq c$, social welfare is maximized if each individual sends a gift to all other members of the group, that is if $p^*_{ij} = 1$ for all $i, j \in A^G, i \neq j$. Denoting the socially optimal number of gifts given in a group by P^*, we have $P^* = \sum_{i=1}^{N}\sum_{j\neq i} p^*_{ij} = N(N-1)$. However, a pay-off maximizing individual acknowledges that giving gifts is costly and yields no direct benefit. Hence, the unique Nash equilibrium of this constituent game is that no gifts are being given: $p^{NE}_{ij} = 0$ for all $i, j \in A^G, i \neq j$.

The order of moves and information is as follows. In each round t, game Γ^C is played first. Each player $i \in A^C$ chooses her extraction effort $x_{i,t} \in [0, e]$. Then, the players in the group A^C are informed about the extraction effort decisions of the $N-1$ other participants in the CPR game ($x_{j,t}$; $j \neq i, i, j \in A^C$) and the resulting payoff $\pi^C_{i,t}$ for all $i \in A^C$. Next, each player participates in the gift-giving game, and again interacts with

Variable	Description	Game	Value
N	number of individuals per group	Γ^C, Γ^G	5
T	number of rounds of the stage game	Γ^{CG}	25
e	effort endowment	Γ^C	13
w	wage per unit of effort allocated to the outside option	Γ^C	0.5
A	parameter of the resource revenue function	Γ^C	11.5
B	parameter of the resource revenue function	Γ^C	0.15
v	per unit cost of effort in resource extraction	Γ^C	2
c	per unit cost of gifts	Γ^G	2 or 4
$b(0)$	benefits of receiving a gift from 0 individuals	Γ^G	0
$b(1)$	benefits of receiving a gift from 1 individual	Γ^G	20
$b(2)$	benefits of receiving a gift from 2 individuals	Γ^G	30
$b(3)$	benefits of receiving a gift from 3 individuals	Γ^G	36
$b(4)$	benefits of receiving a gift from 4 individuals	Γ^G	40

Table 1: Experiment parameterization.

$N-1$ players, referred to as group A^G, who may or may not be the same individuals she has interacted with in game Γ^C. Each player i chooses $p_{ij,t} \in \{0,1\}$ for all $j \neq i$ $(i, j \in A^G)$. Then he/she is informed about whether he/she received a gift of each of the other players in group A^G ($p_{ji,t}$; $j \neq i$, $i, j \in A^G$) as well as about the net payoff (π^G_{it}) obtained by each individual in group A^G. The parameter values that were used in the experiment are presented in table 1, and the associated unique Nash equilibria and social optima are presented in table 2.

2.2 The four treatments

We implement the experiment using a 2x2 design. One design variable is whether individuals interact with the *same* group of individuals in both the CPR and the gift-giving game *and* are able to monitor their fellow group members' actions in *both* games (the Linked treatments), or not (the Unlinked treatments). This is implemented as follows. In the Linked treatments, $A^C = A^G$, and each subject is assigned a unique identifier which is announced together with each action this subject takes in both games. In the Unlinked treatments, $A^C \neq A^G$, and each subject is assigned two different identifiers, one to identify his/her actions in the CPR game, and another one to identify his/her actions in the gift-giving game.

The second design variable is the cost of giving a gift, which is either high ($c = 4$, in

Variable	Description	Game	Value
x^*	symmetric socially optimal individual extraction effort	Γ^C	6
X^*	socially optimal group extraction effort	Γ^C	30
x^{NE}	symmetric Nash equilibrium individual extraction effort	Γ^C	10
X^{NE}	aggregate Nash equilibrium extraction effort	Γ^C	50
p_{ij}^*	socially optimal gift-giving decision	Γ^G	1
P^*	socially optimal number of gifts per group	Γ^G	20
p_{ij}^{NE}	Nash equilibrium gift-giving decision	Γ^G	0
P^{NE}	Nash equilibrium number of gifts per group	Γ^G	0
$\pi^{C,*}$	symmetric socially optimal payoff to CPR use	Γ^C	33.5
$\pi^{C,NE}$	symmetric Nash equilibrium payoff to CPR use	Γ^C	21.5
$\pi^{G,*}$	individual socially optimal payoff to receiving a gifts if $c = 2$	Γ^G	32
$\pi^{G,*}$	individual socially optimal payoff to receiving gifts if $c = 4$	Γ^G	24
$\pi^{G,NE}$	Nash equilibrium payoff to receiving gifts	Γ^G	0

Table 2: Socially optimal and Nash equilibrium levels of all variables of the stage game.

the High cost treatments) or low ($c = 2$, in the Low cost treatments), and which affects the relative profitability of the CPR and gift-giving games.

2.3 Hypotheses

Assuming that subjects behave as own payoff maximizing individuals, the stage game Γ^{CG} has a unique subgame perfect Nash equilibrium in all four treatments. Because the game is repeated a finite number of times, backward induction dictates that the Nash equilibria of the constituent games described above will apply in each single round of the repeated game. This is summarized in the following hypothesis:

Standard hypothesis Subjects behave as rational, own payoff maximizing players, and expect that others are also motivated exclusively by own material payoffs. They apply backward induction. Because the stage game consisting of the CPR game and the gift-giving game is repeated a finite number of times,

- subjects choose extraction effort level x^{NE} and give no gifts in all rounds of *both* the Linked and Unlinked treatments;
- the resulting efficiency in the CPR game as well as in the gift-giving game is equally low in all treatments; and

- the above predictions are independent of the costs of giving gifts.

So, the standard hypotheses predicts that $x_{i,t} = x^{NE}$ and $p_{ij,t} = 0$ for all $i = 1, .., N, i \neq j$ in all rounds of the experiment, and hence each individual's payoff is expected to be equal to $\pi_i^{NE} = \pi_i^C(x^{NE}, (N-1)x^{NE}) + \pi_i^H(0,0) = \pi_i^C(x^{NE}, (N-1)x^{NE})$ in all rounds of the experiment.

However, money maximization may not be an accurate description of individual preferences. Indeed, there is ample experimental evidence that a substantial part of humanity has reciprocal preferences (for a recent overview, see Fehr and Gächter [7]). When making decisions, a reciprocal individual chooses actions that increase (decrease) the payoffs of those who (are expected to) choose actions that increase (decrease) his/her payoff. Let us address how the presence of reciprocal individuals might make a difference in the finitely repeated game consisting of the CPR game and the gift-giving game.

First, consider the Unlinked treatment. Reciprocal individuals give a gift to any individual from whom they expect to receive a gift. When they receive a gift from an individual in one period they will send one back to that individual in the next. However, it is not just the truly reciprocal individuals who will return the gift; strategic money maximizers may do the same. Strategic money maximizers realize that establishing a gift-giving relationship is highly profitable in the medium run, but also that defection yields one-shot benefits. Hence, they may choose to imitate the reciprocal individuals' behavior in all but the last round, thus building a reputation for being cooperative (see Andreoni and Miller [2]). Therefore, only pure money maximizers who apply backward induction and do not consider the possibility of the presence of reciprocal individuals refuse to give gifts.

In our experiment, we choose parameters such that establishing bilateral gift-giving relationships is fairly easy. We impose that the benefits of receiving one gift are strictly larger than the total costs incurred when giving a gift to each of the $N-1$ other group members ($b(1) > c\,[N-1]$). Therefore, even though a subject does not know the preferences of his/her group members, it is sufficient if he/she believes that there is at least one other reciprocal individual in the group to expect a strictly positive payoff from 'testing the water' by sending a gift to all other group members in the first period of the game. So, in our experiment, gift-giving relationships are likely to arise among reciprocal individuals and strategic money maximizers who are not too pessimistic about the presence of other reciprocators in the group.

Whereas the gift-giving game allows for direct bilateral reciprocity, the CPR game does not; each individual can choose only one extraction effort level in each round. That means that pure money maximizers have a crucial impact on how the CPR game evolves (see Falk et al. [6]). Suppose that group A^C consists of $N-1$ reciprocal individuals, and one pure money maximizer. The reciprocal individuals start off selecting the socially optimal extraction effort level, and the pure money maximizer calculates his/her best-response level. Hence the pure money maximizer's payoff is larger than that of the reciprocal individuals. The only way reciprocal individuals can sanction the pure money maximizer's behavior is by increasing their extraction effort; they may behave even more aggressively than the pure money maximizer to force him/her to reduce his/her extraction effort. However, as soon as the reciprocal individuals reduce their extraction effort towards the socially optimal level, the pure money maximizer's best response is to again increase his/her extraction effort. The only equilibrium extraction level is the Nash equilibrium level, x^{NE}.

That means that our alternative hypothesis, which takes into account the presence of reciprocal individuals, is still dire with respect to the CPR game in the Unlinked treatment. However, in the Linked treatment, there is scope for bilateral reciprocity across the two games. Here, the decision whether or not to give a gift to another individual may not only depend on whether one expects that individual to give a gift in return, but also on that individual's extraction behavior in the CPR game. In other words, free-riding in the social dilemma situation can be punished by withholding gifts in the gift-giving game. If receiving gifts is sufficiently profitable, the threat of not receiving gifts may deter free-riding in the CPR game.

How seriously the threat of being sanctioned actually is, may depend on whether the costs of providing a gift are high, or low. Higher costs of providing gifts imply a larger direct cost saving when imposing a sanction (by withholding a gift). But higher costs also imply that the expected benefits from sending a gift falls, and hence may lead to lower incidences of bilateral gift-giving. This, in turn, dilutes the incentives for the strategic money-maximizers to imitate the reciprocators, and, in addition, obscures the connection between own extraction behavior and the number of gifts received. Is a fall in the number of gifts received a sanction on past excessive extraction behavior, or is it just that other players strategically defect? The reduced clarity of the motivation behind withholding gifts may decrease a sanctioned individual's willingness to incur costs to maintain cooperative behavior, both in terms of reducing extraction effort as well in terms of continuing sending gifts to others. Therefore, we predict that higher costs of sending a gift result in both lower efficiency in the gift-giving game (in both treatments) and lower efficiency in the CPR game (in the Linked treatment only).

Based on the above discussion, our alternative hypothesis is as follows:

Selective exclusion hypothesis: Reciprocal individuals are present and/or believed to be present in the subject pool. Therefore,

- efficiency of CPR use is higher than predicted by the Standard hypothesis in the Linked treatment, but equal to the predicted level in the Unlinked treatment;
- gifts are given in both the Linked and Unlinked treatments, resulting in higher efficiency in the gift-giving game than predicted by the Standard hypothesis;
- the higher the cost of giving a gift, the lower the efficiency in the gift-giving game in both the Linked and Unlinked treatments;
- the higher the cost of giving a gift, the lower the efficiency in the CPR game in the Linked treatment.

Thus, the Linked treatment allows subjects to condition their behavior in the gift-giving game on the behavior of others in the CPR game, and hence may result in higher efficiency of CPR use than predicted by the Standard hypothesis. Furthermore, the costs of giving a gift affect the extent to which the Linked treatment's efficiency of CPR use exceeds that of the Unlinked treatment.

2.4 Experimental design

In the Spring semester of 2003, we ran eight experimental sessions at Tilburg University, the Netherlands. In total, 160 subjects participated, and they were students in economics, law, or business. For each of the four treatments, we collected data on 8 groups of 5 subjects, resulting in 8 independent observations in each of the two Linked treatments, and 4 independent observations in each of the two Unlinked treatments. The language of the experiments was English. Upon arriving to the experiment the participants were randomly assigned to a computer terminal and were given a set of written instructions, a payoff table of the CPR game and computer screenshots. The experimenter read the instructions aloud. Subjects were asked to answer test questions using the payoff tables of the CPR game, and all participants solved the problems without major difficulty. The experiments were fully computerized; the software was programmed using z-Tree (Fischbacher [9]).[4]

All decisions in the experiment were formulated in a neutral language. We referred to the stage game as 'performing two tasks'. The 'first task' represents the CPR game, and was framed as the decision how to divide an endowment of 13 hypothetical experimental units called tokens between two options, option 1 in which one's payoff (measured in points) depends on one's own decision as well as on the decisions of the other group members (i.e., extraction from the common pool resource), and option 2 in which one's payoff depends purely on one's own decision (the outside option that pays a fixed wage rate; see section 2.1). We explicitly pointed out the symmetric socially optimal extraction level to allow the subjects to focus on the social dilemma aspect of the game rather than on searching for the social optimum.[5] The gift-giving game was referred to as the 'second

[4] All instructions, computer screenshots, and software are available upon request.

[5] The relevant part of the instructions reads as follows: "We would like to draw your attention to the fact that as a group, you and the other group members as a group can earn the maximum number of points if each group member puts 6 tokens in option 1. Note, however, that if every other group member puts 6 tokens in option 1 (that means that the others put together 4 times 6 = 24 tokens in option 1), it is best for you to put all your 13 tokens in option 1. Please, verify this in the table now. Therefore we remind you that you and the other group members can earn together the maximum possible number of points in any round by putting 6 tokens in option 1 and trusting that the others do the same."

This text was read to the participants in all four treatments, but the information provided did not induce participants to choose indiscriminatively the advertized socially optimal extraction effort level, as we show in the next section.

task', and was framed as the decision whether or not to send a fixed number of points (subtracted from the subject's cumulative earnings) to each of the other participants in the group. The history of each of the two games (the extraction effort and gift-giving decisions of the fellow participants a subject interacts with) was available on the computer screen. The experiment lasted about 2 hours, and participants earned on average 19.30 Euro (including 5 Euro participation fee).[6]

3 Data analysis

Figures **??** and **??** present the average group data with respect to CPR extraction effort and number of gifts given, respectively, over all 25 rounds of the game. In addition to the average aggregate group extraction effort in the four treatments, figure **??** also shows the average aggregate group extraction effort which materialized in a related experiment by Vyrastekova and van Soest [21], where the unregulated CPR game was played in isolation (i.e., not tied to another game) and with identical parameterization and instructions. Figure **??** shows that aggregate extraction effort in an average group in the Linked treatment is closer to the socially optimal level ($X^* = 30$) than in the Unlinked treatments as well as in Vyrastekova and van Soest's unregulated CPR game, where aggregate extraction effort level is very close to the subgame perfect Nash equilibrium level ($X^{NE} = 50$). Indeed, as shown on the LHS of table 3, a 2-sided Mann-Whitney U-test rejects the hypothesis

[6] To obtain insight into the other-regarding motives of our subject pool -to be able to infer whether there are significant differences in the groups of subjects playing each of the four treatments-, we followed the decomposed games approach developed by Messick and McClintock (1968). This was implemented as follows. Before participating in the experiment, each subject performed a social valuation task. This task consisted of selecting a payoff vector, determining how many points the decision maker herself would receive, and how many points an anonymous other participant would receive. There were 16 payoff vectors to choose from, only one of which maximizes the decision maker's payoff. In all other payoff vectors, the decision maker had to give up points in order to increase or decrease the number of points the other participant receives. Based on the chosen payoff vector, we label subjects as individualistic (maximizing their own payoff, giving zero points to the other person), pro-social (giving a positive number of points to the other person, at the expense of the number of points they receive themselves), or spiteful (giving a negative number of points to the other person, at the expense of the number of points they receive themselves). We find that the composition of our subject pools in the Linked and Unlinked treatments does not differ with respect to this measure of other-regarding behavior, and therefore all differences observed in the experiment can be attributed to the treatment variables rather than to subject sampling. The relevant proportions of individualistic, pro-social and spiteful individuals are 28% (29%), 61% (58%) and 11% (14%) in the Linked (Unlinked) treatments. These numbers are similar to the those found in other studies (e.g., Fischbacher et al. [10]).

of equal group extraction effort levels in the Linked and Unlinked treatments.[7] This part of the table also shows that in the Linked treatment, the efficiency improvement in CPR use associated with decreasing the costs of giving gifts is significant, albeit at the 9.3% level only (as determined on the basis of a similar Mann-Whitney U-test).[8]

Figure **??** shows that the average number of gifts provided per group is far above the Nash equilibrium prediction of zero gifts in all four treatments. In the Low cost treatments, this number is even fairly close to the socially optimal level ($P^* = 20$). Remarkably, the number of gifts given within a group does not depend on whether the CPR game and the gift-giving game are linked or not. Indeed, the Mann-Whitney U-tests presented on the RHS of table 3 do not allow us to reject the hypothesis of equal number of gifts given in Linked and Unlinked treatments, when keeping fixed the cost of giving a gift. In addition, the figure suggests that fewer gifts are being given if gifts are more costly in both the Linked and Unlinked treatments. This observation is supported only in case of the Unlinked treatments, as the p-value of the relevant Mann-Whitney U-test equals 0.021; in the Linked treatments, the p-value of 0.184 does not allow us to reject the hypothesis of equal number of gifts given. Note, however, that the pure cost effect on the number of gifts can be observed only in the Unlinked treatment as gift-giving in the Linked treatment may depend on play in the CPR game as well.

We summarize these findings in the following three observations:

Observation 1: The average group extraction effort in the CPR game is equal to (or even slightly higher than) the Nash equilibrium level in the Unlinked treatment, but

[7] In their unregulated CPR game, Vyrastekova and van Soest [21] find an average group extraction effort equal to 50.85, whereas these averages are 51.19 and 51.65 in this paper's Unlinked High and Low cost treatments, respectively. These differences in averages are not significant, as the p-value of the relevant Kruskal-Wallis test is 0.584 (the unit of observation being the average group extraction effort per independent observation). Hence, the play of the CPR game in the Unlinked treatments does not differ from the play of the same game in isolation. This result supports our conclusions about the absence of interdependency between the CPR game and the gift-giving game in the Unlinked treatment (see below).

[8] Figure 1 does suggest, however, that there may be an upward trend in aggregate extraction effort levels. When regressing current group extraction effort on that in the previous round and an intercept (using rounds 1-20), we find that the long-run aggregate extraction effort in the two Linked treatments is significantly below the Nash equilibrium level, but not so in the two Unlinked treatments. However, when including also the last five rounds of the experiment, only the Linked Low cost treatment results in a steady-state level below Nash. So, including the last five rounds does matter for the steady-state extraction effort level in the Linked High cost treatment, but not for the Linked Low cost treatment.

Group extraction effort			
	Low cost	High cost	
Linked	38.0	44.1	p=0.093
Unlinked	51.6	51.2	p=0.772
	p=0.011	p=0.042	

Number of gifts			
	Low cost	High cost	
Linked	15.2	12.4	p=0.184
Unlinked	15.8	12.3	p=0.021
	p=0.234	p=0.734	

Table 3: Average extraction effort and number of gifts per independent observation, with p-values for the relevant Mann-Whitney U-tests (rounds 1-25).

it is below the Nash equilibrium level in the Linked treatment.

Observation 2: The average number of gifts in the gift-giving game exceeds the subgame perfect Nash equilibrium level. The level of gift-giving remains high throughout the game except for the last few rounds. Furthermore, the more expensive the gifts are, the fewer are given.

Observation 3: The lower the cost of giving gifts, the lower the average group extraction effort in the CPR game in the Linked treatment.

All three observations are in conflict with the Standard hypothesis, but in line with the Selective Exclusion hypothesis that emphasizes the potential influence of reciprocal individuals on how the repeated game is played. So what behavioral evidence is available that reciprocal individuals are present in the subject pool? On the basis of binomial tests distinguishing reciprocal behavior from random gift-giving in the gift-giving game, we find that more than 90% of the subjects give gifts to those fellow group members from whom they received a gift in the previous round; only in the Unlinked High cost treatment this percentage is 80%. And similar tests show that the percentage of participants who refuse to give a gift to a person from whom they did not receive a gift in the previous period, ranges between 70 and 77% in three out of four treatments; in the Linked Low cost treatment, this percentage is only 45%.

Therefore, a substantial percentage of subjects indeed displays reciprocal behavior in the gift-giving game, but the relatively low percentage of negative reciprocal actions in the Linked Low cost treatment suggests that the decision to give a gift to another subject may not only depend on whether one received a gift from that subject in the previous period; behavior in the CPR game is likely to play a role as well. We provide three pieces of evidence for this conjecture.

First, when analyzing individual extraction effort in the first round, less effort is exerted in the Linked treatments than in the Unlinked treatments (and significantly so according to a 2-sided Mann-Whitney U-test, which yields $p = 0.000$ and $p = 0.024$ in the Low and High cost treatments, respectively). That means that it is sufficient to just *inform* the subjects that the two constituent games are played with the same individuals to induce lower extraction effort in the Linked treatments as compared to the Unlinked treatments.

Second, in the Linked treatments, the number of gifts given in the first period is not independent of the extraction effort level chosen earlier in that first round. If an individual put in more extraction effort than his/her group did on average, the likelihood of receiving a gift in that round is 45% and 41% in the Linked Low cost and Linked High cost treatments, respectively. If an individual's effort level is below the group's average, these shares are 88% and 77%, respectively, and these differences are significant with p-values at 0.000 for both treatments (based on a Mann-Whitney U-test, treating each individual gift-giving decision in round 1 as an independent observation).

The third piece of evidence that decisions in the two games are interconnected in the Linked treatment is obtained when plotting the relationship between a subject's deviation in extraction effort from the group's average (i.e., $x_{i,t} - \frac{1}{N-1}\sum_{j\neq i} x_{j,t}$) on the horizontal axis, and the average number of gifts received on the vertical axis (averaged over all 25 rounds of the game); see figure **??**. This figure suggests that putting in either more or less effort into CPR extraction than the group's average is correlated with fewer gifts received. Indeed, for extraction levels above the group average ($x_{i,t} > \frac{1}{N-1}\sum_{j\neq i} x_{j,t}$), the Spearman rank-based correlation coefficient for gifts received equals -0.886 ($p = 0.019$) and -0.771 ($p = 0.072$) in the Linked Low and Linked High cost treatments, respectively. However, for extraction levels below the group average ($x_{i,t} < \frac{1}{N-1}\sum_{j\neq i} x_{j,t}$, the respective correlation coefficients are -0.029 ($p = 0.957$) and 0.657 ($p = 0.156$).

Even though these correlations are not conditioned on past behavior (but see the next section), these three pieces of evidence together give rise to the following observation:

Observation 4: In the Linked treatment, overextraction (as compared to the group's

	Low cost treatment	High cost treatment
Nash equilibrium	573.5	573.5
Social optimum	1637.5	1437.5
Linked treatment	1442.7 (135.60)	1133.2 (202.72)
Unlinked treatment	1178.2 (121.41)	987.7 (110.00)
	p=0.000	p=0.003

Table 4: Average experiment earnings in points, 1 point=1 Eurocent (standard deviations in parenthesis; p-values for a 2-sided Mann-Whitney U test).

average) is correlated with fewer gifts received. In round 1, individuals overextracting the CPR relative to others in their group are only half as likely to receive gifts than those who do not overextract the CPR.

Hence, the group data suggest that embedding a social dilemma situation in a wider economic context (by adding the gift-giving game) gives rise to more cooperation in the social dilemma situation than predicted by economic theory. Moreover, whereas the pecuniary punishment mechanism results in a decrease in net efficiency (because of the 'deadweight loss' associated with the costs of imposing sanctions; see Ostrom et al. [18] and Ostrom et al. [19]: 176), the selective exclusion mechanism uncovered here results in a pure efficiency gain. Whereas aggregate extraction effort in the CPR game is closer to social optimum level in the Linked treatment than in the Unlinked treatment, the total number of gifts provided is identical (as it depends on the costs of gift-giving only). Linking the two games thus results in an unambiguous increase in the subjects' earnings, as can be viewed from table 4; subjects in the Linked treatments earned significantly more than those in the Unlinked treatments.

4 Analysis of individual behavior

Having observed that linking the CPR game and the gift-giving game results in higher efficiency in the CPR game without decreasing efficiency in the gift-giving game, we now turn to analyzing individual behavior to explain the underlying mechanism.

4.1 What determines the number of gifts received?

Let us first analyze the determinants of the number of gifts received by each subject, and let us denote this variable with $GR_{i,t}$ $(=\sum_{j\neq i} p_{ji,t})$. Is it determined exclusively by the number of gifts an individual sent to others in the previous period ($\sum_{j\neq i} p_{ij,t-1}$ which we will refer to with $GG_{i,t-1}$)? Or does it also depend on the individual's extraction effort in the CPR game in the current period, x_{it}? Obviously, whereas the former can be expected to play a role in both the Linked and the Unlinked treatments, the latter is relevant only in the Linked treatments.

We explore two ways of including extraction behavior in the regression equation explaining the number of gifts received. Specification L1 includes a dummy variable whether individual i's extraction effort exceeds the social optimal extraction level ($nv_{i,t} = 1$ if $x_{i,t} > 6$; zero otherwise), as well as a variable reflecting the extent of the norm violation ($exnv_{i,t} = (x_{i,t} - 6) * nv_{i,t}$). Specification L2 includes a simple measure of relative extraction effort, which is constructed as follows: $rx_{i,t} = x_{i,t} - \frac{1}{N-1}\sum_{j\neq i} x_{j,t}$.[9]

The regression results are presented in table 5. As the dependent variable is an integer number ranging from 0 to 4, we use a count model (quasi maximum likelihood); Huber/White standardized errors are presented in parenthesis. We find strong evidence for direct reciprocity within the gift-giving game, as the coefficient on $GG_{i,t-1}$ is positive and significant in all regressions (including U1, the regression for the Unlinked treatments). By interacting $GG_{i,t-1}$ with a dummy variable indicating the Low (High) cost treatment (with $LowCost = 1$ or 0, respectively), we can infer how the responsiveness to changes in gifts received depends on the cost parameter across treatments. Reducing the costs of giving gifts does not result in substantial changes in the response to the number of gifts given in the Unlinked treatments (as the coefficient on $GG_{i,t-1} * LowCost$ is small and significant at 10% only), but positive reciprocity in the Linked treatments is stronger if giving gifts is relatively cheap. This difference may be due to the fact that

[9] Note that this specification implies that if the coefficient on $rx_{i,t}$ turns out to be negative, those who relatively 'underexploit' the CPR receive *more* gifts than those who just put in the average extraction effort rather than less as suggested by figure **??**. However, when running a regression which allows for an asymmetric relationship (by including $rx_{i,t}$ as well as $|rx_{i,t}|$), we find that putting in more (less) than the group's average results (does not result) in fewer gifts received. As the loglikelihood of this regression is about equal to that of L2, we just present the results of the specification using $rx_{i,t}$.

	(U1)	(L1)	(L2)
Constant	0.282***	0.264***	0.258***
	(0.058)	(0.080)	(0.081)
$GG_{i,t-1}$	0.312***	0.189***	0.190***
	(0.019)	(0.014)	(0.014)
$GG_{i,t-1}*LowCost$	-0.043*	0.096***	0.096***
	(0.024)	(0.017)	(0.017)
$nv_{i,t}$		0.044	
		(0.076)	
$nv_{i,t}*LowCost$		-0.114	
		(0.086)	
$exnv_{i,t}$		-0.063***	
		(0.013)	
$exnv_{i,t}*LowCost$		-0.008	
		(0.018)	
$rx_{i,t}$			-0.064***
			(0.009)
$rx_{i,t} * LowCost$			-0.025*
			(0.014)
Group fixed effects	yes	yes	yes
Log likelihood	-3334.66	-3267.09	-3266.70
Number of observations	1520	1520	1520
*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.			

Table 5: Factors determining the number of gifts received in rounds 1 to 20 (Huber/White stadard errors presented in parenthesis).

in the Linked treatments there are two (rather than just one) opportunities to engage in reciprocal behavior; sanctions and rewards with respect to extraction effort decisions interact with reciprocal considerations with respect to giving gifts, whereas in the Unlinked treatments only the latter effect is present. But more importantly, both specifications L1 and L2 show that the number of gifts received depends negatively on own extraction effort. The fact that in L1 the absolute norm ($nv_{i,t}$) is not found to be significant whereas the extent of the norm violation ($exnv_{i,t}$) is, suggests that more excessive extraction is punished more severely. Regression L2 shows that the relative measure performs about equally well, as evidenced by the log likelihoods of specifications L1 and L2.

Therefore, we find evidence that in the Linked treatments, the number of gifts received depends not only on the number of gifts given, but also on the recipient's extraction effort.

Selective exclusion does arise naturally in this experiment.

4.2 What determines extraction effort behavior?

Let us now turn to the analysis of the *change* in extraction effort, $\Delta x_{i,t}(= x_{i,t} - x_{i,t-1})$.[10] Are adjustments in extraction effort determined exclusively by each individual subject's relative extraction effort in the previous period ($rx_{i,t-1}$; in all treatments)[11], or do they also depend on changes in the number of gifts received in the previous period ($\Delta GR_{i,t-1}$; in the Linked treatments only)? In other words, do individuals perceive a decrease in the number of gifts received in the previous period as a sanction, and do they adjust their extraction behavior accordingly?

Note that this analysis of the relationship between $\Delta x_{i,t}$ and $\Delta GR_{i,t-1}$ is not straightforward. Obviously, a decrease in the number of gifts received can be interpreted as a sanction and hence may induce a reduction in extraction effort. But one does not expect the amount of effort to increase if the number of gifts received goes up. We test whether the relationship between $\Delta x_{i,t}$ and $\Delta GR_{i,t-1}$ is indeed asymmetric by using as explanatory variables both the change in gifts received ($\Delta GR_{i,t-1}$) as well as the absolute change in gifts received ($|\Delta GR_{i,t-1}|$).

In table 6 we present the regression results explaining the change in extraction effort; the analysis is by means of ordinary least squares. In both the Unlinked and Linked treatments (U1 and L1) we find that individuals tend to adjust their extraction efforts towards the group's mean; if one's effort is above (below) the mean, one adjusts one's effort downward (upward). When not distinguishing between the Linked High and Linked Low cost treatments (L1), we do not find an asymmetric effect with respect to the number of gifts received as the coefficient on $|\Delta GR_{i,t-1}|$ fails to be significant.

However, the symmetry is lost when we run separate regressions for the two treatments,

[10] We focus on analyzing *changes* in the amount of effort allocated to CPR extraction rather than on *levels* of extraction effort. High levels of cooperation in the gift-giving game may be associated with high levels of cooperation in the CPR game, but cooperation in the former game may also be high if subjects do not wish to jeopardize profitable bilateral cooperation to obtain small private gains in the latter.

[11] An alternative explanatory variable would be the change in aggregate extraction effort by all other group members, $\Delta X_{i,t-1}$, reflecting myopic best response. However, as $rx_{i,t-1}$ outperforms $\Delta X_{i,t-1}$ in all regressions and the coefficients on all other explanatory variables are qualitatively similar, we only present the results of the regressions containing the former.

	(U1)	(L1)	(L1h)	(L1l)
Constant	-0.044	-0.021	-0.195	0.023
	(0.184)	(0.201)	(0.229)	(0.186)
$rx_{i,t-1}$	-0.647***	-0.471***	-0.445***	-0.488***
	(0.029)	(0.026)	(0.036)	(0.038)
$\Delta GR_{i,t-1}$		0.227***	0.190**	0.251***
		(0.057)	(0.091)	(0.072)
$\|\Delta GR_{i,t-1}\|$		-0.054	0.145	-0.177**
		(0.077)	(0.131)	(0.091)
Group fixed effects	yes	yes	yes	yes
adj R^2	0.248	0.201	0.188	0.221
Number of observations	1440	1440	720	720
*Significant at the 10% level, **Significant at 5%, ***Significant at 1%.				

Table 6: Factors determining the change in the extraction effort in rounds 1-20 (Huber/White standard errors presented in parenthesis).

as shown in L1h and L1l, respectively. We find that in the Linked High cost treatment, the relationship is symmetric (as $|\Delta GR_{i,t-1}|$ is not significant), but not so in the Linked Low cost treatment. If the number of gifts received in the previous period decreases ($\Delta GR_{i,t-1} < 0$), the marginal impact on extraction effort is -0.214 ($= 0.5 * (-0.251 - 0.177)$), which is significant at the 1% level.[12] If the number of gifts received in the previous period increases ($\Delta GR_{i,t-1} > 0$), the relevant coefficient equals 0.037 ($= 0.5 * (0.251 - 0.177)$), which is insignificant at all conventional levels. Therefore, in the Linked Low cost treatment, a decrease in the number of gifts received induces the decision maker to reduce extraction effort, whereas an increase does not result in a change in the amount of effort allocated to resource harvesting.[13]

Thus, we find that the subjects in both the Linked Low and High cost treatments reduce their extraction effort level if they are being sanctioned. But in the Linked High cost treatment the selective exclusion mechanism is less persistent as subjects tend to increase their extraction effort again if the sanction is lifted.

[12] Significancy is determined by regressing the dependent variable $\Delta x_{i,t}$ on $(\Delta GR_{i,t-1} + |\Delta GR_{i,t-1}|)$ and $(\Delta GR_{i,t-1} - |\Delta GR_{i,t-1}|)$, as well as on $rx_{i,t-1}$. The first (second) variable between brackets is positive (zero) if the number of gifts received increases, and the first (second) variable is zero (negative) in case the number of gifts received decreases.

[13] The same conclusions can be drawn when running the regressions using only those observations with $\Delta GR_{t-1} < 0$.

4.3 What determines the number of gifts provided?

Finally, let us analyze what determines an individual's decision to provide gifts. How does he/she react if he/she receives fewer gifts in period t (as compared to period $t-1$) if this can be interpreted as a sanction for his/her overextracting the CPR in period t? Does this individual accept the decrease in the number of gifts as a fair sanction for his/her excessive extraction behavior, or does he/she decide to retaliate by not sending gifts to the person imposing the sanction? In other words, does sanctioning potentially jeopardize cooperation in the gift-giving game, or not?

We answer this question by means of an ordered probit model with three possibilities: the subject decreases the number of gifts provided in the current period, keeps it unchanged or increases it ($\bar{G}\bar{G}_{i,t} = -1$, 0, or 1 if $\Delta GG_{i,t}$ is negative, zero or positive). The first factor that determines change in the number of gifts provided that we need to control for is the change in the aggregate extraction behavior by the other subjects (as measured by $\Delta X_{-i,t}$); the decision maker may decide to punish an increase in extraction, or reward a decrease.

But the analysis of the subject's response to a change in the number of gifts received ($\Delta GR_{i,t-1}$) is more interesting. Reciprocity implies that the coefficient on this variable is positive and significant, *unless* the subject under consideration increased his/her extraction effort in the previous period and views the subsequent reduction in the number of gifts received as a deserved sanction for him/her free-riding in the CPR game. To test this, we construct an indicator function $Deserved_{i,t}$, with $Deserved_{i,t} = 1$ if $\Delta x_{i,t} > 0$ *and* $\Delta GR_{i,t} < 0$, and zero otherwise. Direct reciprocity suggests that the coefficient on $(1 - Deserved_{i,t-1}) * \Delta GR_{i,t-1}$ is expected to be positive and significant. Selective exclusion does not cause the gift-giving relationship to unravel if the coefficient on $Deserved_{i,t-1} * \Delta GR_{i,t-1}$ fails to be significant. If it turns out to be positive and significant, though, sanctioning is a hazardous activity as refusing to give gifts to subject i induces him/her to retaliate.

The results of the regression analysis are presented in table 7. In both the Linked High and Linked Low cost treatments regressions (L1h and L1l, respectively), we find that the number of gifts provided is likely to increase the more others reduce their aggregate

	(L1h)	(L1l)
$\Delta GR_{i,t-1}*(1 - Deserved_{i,t-1})$	0.196***	0.248***
	(0.069)	(0.071)
$\Delta GR_{i,t-1}*Deserved_{i,t-1}$	0.467***	0.152
	(0.148)	(0.095)
$\Delta X_{-i,t}$	-0.047***	-0.073***
	(0.013)	(0.013)
Group fixed effects	yes	yes
Log likelihood	-607.29	-628.96
Number of observations	720	720
*Significant at the 10% level, **Significant at 5%, ***Significant at 1%.		

Table 7: Factors determining the change in the number of gifts provided in the Linked/high and Linked/low cost treatments in rounds 1-20 (Huber/White standard errors presented in parenthesis).

extraction effort; subjects reward that by sending more gifts. Also, direct reciprocity takes place: the positive coefficient on $\Delta GR_{i,t-1} * (1 - Deserved_{i,t-1})$ reflects that subject i decides to increase (decrease) the number of gifts she provides if she received more (fewer) gifts in the previous period, irrespective of the costs of gift-giving. But the fact that the coefficient on $\Delta GR_{i,t-1} * Deserved_{i,t-1}$ is also positive and significant in L1h but not significant in L1l suggests that sanctioning is hazardous in the Linked High cost treatment.

Thus, whereas subjects in the Linked Low cost treatment do not change the number of gifts they provide when confronted with a 'deserved' decrease in the number of gifts received, subjects in the Linked High cost treatment tend to decrease the number of gifts they give. Here, gift-giving unravels, whereas there is no evidence of unravelling when costs of gift-giving are low.

4.4 Summary of the analysis of individual behavior

The analysis of individual decision-making thus confirms that linking the CPR game to the gift-giving game results in higher efficiency in the CPR game because of selective exclusion. Individuals who exert high extraction effort levels (either relative to the socially optimal extraction effort level, or relative to the extraction effort of other members of their group) receive fewer gifts in the Linked treatments; free-riders are selectively excluded from the benefits of cooperation in the gift-giving game (see table 5).

Sanctioning by means of selective exclusion is effective because individuals respond by reducing their extraction effort level. However, the mechanism is more effective in the Linked Low cost treatment than in the Linked High cost treatment because of two reasons. First, the impact of a one-time selective exclusion on extraction effort is less persistent in the latter than in the former treatment; see table 6. In the Linked High cost treatment, we observe an increase of the extraction effort as soon as the sanction is removed, whereas the extraction effort level does not bounce back up in the Linked Low cost treatment. Second, imposing a sanction (by means of selective exclusion) is more hazardous in the Linked High cost treatment than in the Linked Low cost treatment (see table 7). Whereas a just sanction does not induce the punished person to cease giving a gift to the subject who imposed the sanction in the Low cost treatment, such retaliation does occur in the High cost treatment. Thus, selective exclusion is both less effective and more hazardous if the costs of giving a gift are high.

5 Conclusions

A substantial amount of experimental research has been undertaken to explain under what circumstances cooperation in social dilemmas can be sustained without centralized intervention. The self-regulatory institution that has been analyzed most extensively is that of decentralized pecuniary punishment, where subjects can impose costly punishment on free-riders. In this paper we explore the effectiveness of a more natural self-regulatory mechanism based on the observation that agents tied in a social dilemma game are often also dependent on (bilateral) cooperation in other economic activities. Selectively excluding individuals who free-ride in the social dilemma situation from the benefits of cooperation in these alternative economic activities may be used as a sanctioning device. We model the social dilemma game as a standard CPR game and the alternative type of economic activity as a two-sided gift-giving game.

Our experiments show that indeed selective exclusion occurs naturally if subjects interact with the same group of individuals in both activities, and is an effective mechanism in enforcing cooperation in the CPR game. In the community treatment (the Linked treatment), efficiency of the CPR game is significantly higher than in the Unlinked treatment (in which subjects are not able to selectively exclude CPR free-riders from the benefits of the gift-giving game), whereas the efficiency of the gift-giving game is identical across the two treatments. That means that, unlike the pecuniary punishment mechanism, aggregate efficiency unambiguously increases when linking the two games. Thus, our experiments suggest that strengthening community ties gives rise to powerful pro-social incentives with respect to cooperation in social dilemma situations and hence improves community welfare.

However, the magnitude of the efficiency gain crucially depends on the profitability of the alternative activity (the gift-giving game) as compared to the CPR game: the more profitable the gift-giving relationship, the larger the efficiency gains. Indeed, the gift-giving game is observed to unravel faster if the costs of providing gifts are high, because selective exclusion is less effective in inducing lower extraction effort levels as well as more hazardous for the person imposing the punishment in terms of the possibility of retaliation.

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