Conditional cooperation and the effect of punishment*

Oliver Kirchkamp[†] Wladislaw Mill[‡]

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We study how punishment influences conditional cooperation. We ask two questions: 1) how does conditional cooperation change if a subject can be punished and 2) how does conditional cooperation change if a subject has the power to punish others.

In particular, we disentangle the decision to be a conditional cooperator at all from the strength of conditional cooperation.

We find that the possibility of being punished increases the strength of conditional cooperation. At the same time the possibility of being punished increases the number of free riders. In our study the net effect on cooperation still is positive.

The possibility of punishing others has two effects: Substitution and responsibility. Players substitute conditional cooperation with punishment which leads to a decrease in conditional cooperation. The power to punish means more responsibility which leads to an increase in conditional cooperation. In our design the overall effect of responsibility is stronger than the effect of substitution.

We conclude that the threat of being punished and the power to punish changes conditional cooperation behavior in several, unexpected, ways.

Keywords: Punishment, Conditional Cooperation, Experiment, Substitution, Responsibility
JEL: C91; C72; H41.

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†University Jena, School of Economics, Carl-Zeiss-Str. 3, 07737 Jena, oliver@kirchkamp.de, Telefon +49 3641 943240, fax +49 3641 943242.

‡University of Mannheim, Department of Economics, L7 3-5, 68131 Mannheim, Germany. Email: mill@uni-mannheim.de, Telefon +49 621 181-1897. This reserach was mainly developed as a member of the IMPRS on Adapting Behavior in a Fundamentally Uncertain World in Jena.

1 Introduction

In this paper, we study how punishment influences conditional cooperation behavior. In particular, we ask how conditional cooperation changes (1) if a subject can be punished and (2) if a subject has the power to punish.

Social dilemmas, i.e. conflicts between self-interest and collective interest (Van Lange et al., 2014, Chaudhuri, 2010, Kollock, 1998), are a key issue in public economics. Social dilemmas can be found in many domains (e.g. environmental protection, overpopulation, team work). In many experiments we find that humans behave not only selfishly. At least to some degree, human behavior is also cooperative (see the seminal paper by Isaac et al., 1984).[1]

Conditional cooperation is one possible explanation for the existence of cooperation. Humans contribute and expect others to contribute as long as others contribute, too. Fischbacher et al. (2001) classify 50% of their participants as conditional cooperators while only 30% are found to be free riders. Similar findings has been replicated in different cultures (Herrmann and Thöni, 2009, Kocher et al., 2008). Conditional cooperation also plays a role in repeated games. Many studies in repeated games find cooperation decreasing over time (Isaac et al., 1984, Ledyard, 1994, Chaudhuri, 2010). Fischbacher and Gächter (2010) provide empirical evidence that conditional cooperation can explain the decline of cooperation in repeated public good games.[2] All in all, conditional behavior seems to be a very strong part of human behavior. Humans behave conditionally even when it is bad for the group. Abbink et al. (2010) find that subjects are punished if they do not contribute to a group conflict even if this results in an overall worse outcome. Furthermore, Abbink et al. (2017) show that subjects are punished if they do not engage in the destruction of a public good.

Punishment is another factor which is relevant to understanding cooperation. Punishment can increase and stabilize contribution in many settings, in particular in peer-punishment, third-party punishment and centralized punishment settings.[3] However, punishment can also crowd out intrinsic motivation: Gneezy and Rustichini (2000) study the effect of fines in day-care centers. They find that fining parents for picking up their children late increases, paradoxically, the number of parents which are late. Ellingsen and Johannesson (2008) argue that control systems may erode morale. Frey and Jegen (2001) and Gneezy et al. (2011) summarize several studies on crowding out of incentives through punishment.

Punishment may not only affect the behavior of the punished, i.e. the player which experiences a threat of punishment. Punishment may also affect the behavior of the punisher, i.e. the player with the power to punish.

In this paper we want to study how the threat of being punished and the power to punish

[1] See Chaudhuri (2010), Ledyard (1994) for two surveys of the literature.

[2] One alternative explanations for the decline in cooperation is given by Andreoni (1988) who argues that free riding is learned during a repeated game. Other authors relate a decline in cooperation in repeated games to other-regarding preferences (Houser and Kurzban, 2002, Goeree et al., 2002, Brandts and Schram, 2001, Palfrey and Prisbrey, 1997, Fischbacher et al., 2001).

[3] See Andreoni and Gee, 2012, Boyd et al., 2010, Cheung, 2014, De Silva et al., 2010, Dickson et al., 2015, Faillo et al., 2013a, Fehr and Gächter, 2000, Fehr and Gächter, 2002, Herrmann et al., 2008, Kamei, 2014, Kamijo et al., 2014, Nosenzo and Sefton, 2012, OGorman et al., 2009, Schoenmakers et al., 2014. For an overview see Chaudhuri, 2010, Balliet et al., 2011.

changes conditional cooperation. To our knowledge, there is no study investigating how punishment influences conditional cooperation.

Even though we know from the literature that the threat of punishment might increase cooperation, we do not know how punishment impacts conditional cooperation. We do not know whether punishment mainly affects the number of cooperators or whether punishment affects the strength of conditional cooperation. We do know from the literature that punishment is often directed towards the free riders (Cheung, 2014). We also know that participants do react to punishment and increase their cooperation levels (Nikiforakis et al., 2012) and that punishment increases overall cooperation (Nikiforakis and Normann, 2008). Albrecht et al. (2018) investigate how different types punish other players and how the composition of a group affects cooperation. However, what we still do not know from the previous literature, is how punishment influences conditional cooperation. More specifically, how punishment affects the conditional cooperation response of subjects classified as conditional cooperators. We also do not know how the power to punish interacts with conditional cooperation. In this paper, we explore several possible mechanisms. In particular, we study whether the power to punish is mitigated by substitution, responsibility, or entitlement.

Both punishment and conditional cooperation are conditional responses to the behavior of others. In this sense punishment and conditional cooperation can be seen as substitutes. A decision maker in a situation where both options, punishment and conditional cooperation, are available might choose smaller amounts of both as compared to a situation where only one of them is available.

Responsibility might be affected by the availability of punishment. Subjects with the power to punish might feel more responsible and act more as benevolent leaders, and hence might contribute more. A number of experiments[4] have shown that a position of power may lead to more prosocial behavior.

Entitlement is another mechanism which could affect conditional cooperation and punishment. In two recent studies Hoeft and Mill (2017a,b) show that subjects in a position of power use this power to enforce behavior which the enforcers themselves are not complying with. A decision maker with the power to punish might, hence, feel entitled to provide smaller contributions.[5] Such an entitlement can lead to antisocial punishment, i.e. punishment of contributions higher than the own (Faillo et al., 2013b, Herrmann et al., 2008).

To understand how punishment influences conditional cooperation we use three treatments. Treatment Base is a replication of Fischbacher et al. (2001). In this treatment all members of a group of four players have two tasks: One task is an unconditional contribution, the other task is a conditional contribution. Once players have made their decisions a random draw determines three players in the group for which the unconditional decision is implemented. Only for the one remaining player the conditional contribution (conditional on the average contribution of the others) is implemented.

In treatments CPun and UCPun, subjects still make an unconditional and a conditional decision. In addition and before the random draw, they make a punishment decision conditional on the contribution of others. In the treatment CPun only the punishment of the

[4]see Hamman et al. (2011), Grossman (2014), Brandts et al. (2015), Glöckner et al. (2011).

[5]Similarly, Ball et al. (2001) show that high-status subjects derive more rent in markets.

Table 1: Treatments

Treatment	Unconditional Contribution	Conditional Contribution	Punishment	Who punishes	Who is punished
Base	✓	✓	–	–	–
CPun	✓	✓	✓	Conditional decision maker	One of the unconditional decision makers
UCPun	✓	✓	✓	One of the unconditional decision makers	Conditional decision maker

conditional decision maker matters. One of the unconditional decision makers is punished. In the treatment UCPun a second random draw selects one of the unconditional decision makers. The punishment decision of this player is used to punish the conditional decision maker. Hence, UCPun represents a situation where a conditional decision maker experiences the threat of being punished. CPun represents a situation where a conditional decision maker has the power to punish others.

Anticipating our results, we find that the threat of punishment increases conditional cooperation for most participants. However, we also observe a negative effect of the threat of punishment: With punishment the number of free riders increases. Still, in our experiment, the total effect on conditional cooperation is positive.

Relating to the power of punishment we find that conditional cooperation and punishment are treated as substitutes. Such a substitution effect could mean that the availability of conditional punishment implies a decrease in conditional cooperation. This effect is, however, compensated by responsibility: Players with the power to punish seem to work harder for the common good.

In conclusion, this paper answers two questions:

1. How does conditional cooperation change if subjects can be punished?
    - The conditional cooperation increases
    - However, the number of free riders also increases
2. How does conditional cooperation change if subjects have the power to punish?
    - Conditional cooperation and punishment are treated as substitutes
    - But subjects with more power behave responsibly by contributing more to the common good.

The remainder of the paper is structured as follows: Section 2 will explain the design of the experiment. Section 3 presents our Hypotheses. In Section 4 we show the results of the experiment. Section 5 concludes.

2 Design

We implement three treatments in order to study the questions how conditional cooperation changes if 1) conditional cooperators might be punished and if 2) conditional cooperators have the power to punish (see Table 1).

In our Base treatment we try to be as close to the original paper of Fischbacher et al. (2001) as possible. Participants are matched in groups of four. They are instructed to divide 20 tokens between a private and public account (1 token = 0.30€). The public account (c_i) had a MPCR of 0.4, i.e. each group member receives 0.4 times the total contribution to the public account plus what they keep in the private account. Each participant i has, hence, the following payoff ϕ_i:

$$\phi_i = 20 - c_i + 0.4 \cdot \sum_{j \in \{1,\ldots,4\}} c_j \tag{1}$$

Instructions are provided on the computer. As in Fischbacher et al. (2001), participants answer 10 control questions before moving to the decision task.

To elicit choices, we use the strategy vector method (Selten, 1967). Participants make decisions for different situations. Only later they learn which choice is relevant. As in Fischbacher et al. (2001), participants can have one of two possible roles: In each group of four one randomly selected player is a conditional decision maker (CDM). The other three are unconditional decision makers (UDM). As in Fischbacher et al. (2001), players only learn which role they have after they have made all their decisions.

As in Fischbacher et al. (2001), subjects make two types of contribution decisions: First they make an "unconditional contribution", which is relevant if they have the role of an unconditional decision maker (see Figure 10 for the interface). Here they state how many of their 20 tokens they allocate to the public account.

Then they make a conditional contribution which is only relevant if their role is a CDM (see Figure 11 for the interface). Here they state their contribution to the public account for all the 21 possible average contributions (rounded to integers) of the other players.

In addition to the Base treatment two further treatments add a punishment stage. In the treatment UCPun the CDM can be punished by one of the UDMs. In the treatment CPun the CDM has the power to punish one of the UDMs (see Figure 12 for the interface). In the punishment stage, participants indicate by how many points another player should be punished conditional on the actual contribution of this player (0, 1, …, 20 tokens).[6] Each punishment point reduces the payoff of the punished player by one point. To avoid inequality concerns and welfare concerns punishment is costlessand limited to 10 tokens.[7] Thus, the overall maximal punishment a player can incur is 10 tokens.

[6]if the conditional decision maker is targeted for punishment (i.e. treatment UCPun) only the realized contribution is punished and not the full contribution strategy. Here punishment is only conditional on the contribution of a player, not, e.g. on the contribution of the others. We do this for three reasons: 1) it is easier to understand, 2) it is easier to implement, and most importantly 3) results are easier to interpret.

[7]Typically, the literature uses costly punishment with a 1:3 conversation rate (Tyran and Feld, 2006, Egas and Riedl, 2008, Nikiforakis and Normann, 2008), which often results in deterrent punishment. Limiting punishment to 10 tokens makes punishment non-deterrent for purely selfish players. Several studies have shown that using less effective punishment mechanisms has a limited improving effect on cooperation (Tyran and Feld, 2006, Egas and Riedl, 2008, Nikiforakis and Normann, 2008). Our results, hence, may even underestimate the impact of punishment. However, comparing the punishment behavior of subjects in our experiment to other experiments with costly punishment yields similar patterns (for example see Fehr and Gächter, 2002, Kamei, 2014).

Here the reader might ask whether our decision to make punishment costless might have undesirable consequences. If punishment is free, it might perhaps follow arbitrary patterns. The first argument against such a concern is that a switch from costless to costly punishment would only shift the level of punishment. Such a shift would not systematically change our results. Secondly, we do not observe random punishment in our experiment. Instead, our punishment patterns are very similar to the punishment observed in Fehr and Gächter (2002), who used costly punishment (see Figure 2 below). Most importantly, we think that we have a good reason why punishment must be costless in our experiment: Our goal is to compare the behavior – in particular the contribution behavior – of CDMs (conditional decision makers). Thus, all CDMs must be comparable across treatments. Specifically, the budget of all CDMs must be comparable. Costly punishment would change the CDMs' budget. If we introduced costly punishment and kept the endowment constant, then in CPun the CDMs had to balance expenditure for contribution and punishment. They wouldn't have to do this in Base and UCPun. If we introduced costly punishment and increased the endowment of the punisher, then the CDMs had a larger budget in the CPun treatment. We couldn't be sure that CDMs used this extra budget only for punishment. CDMs could use the extra budget to increase their own payoff or to increase their conditional contribution. No matter what we did, costly punishment makes it harder to compare CPun, Base, and UCPun. Hence, we think that for our design the benefits of costless punishment outweigh the potential costs.

CPun and UCPun differ in the direction of the punishment. In UCPun the CDM can be punished by one randomly selected UDM. In CPun the situation is reversed. Here the CDM has the power to punish one (randomly selected) UDM.

All treatments are administered between subjects. Subjects are randomly assigned to one of the three treatments. Subjects make each decision once in a fixed, predetermined order (see Fischbacher et al., 2001, see also Figures 10, 11, 12). Only when all subjects have completed all tasks they learn their role (conditional or unconditional cooperator) and (in the punishment treatments) whether their punishment is implemented. Subjects are also told the overall contribution of their group and the own payoff (see Figure 13).

After completing a socio-demographic questionnaire subjects are paid individually.

3 Hypotheses

In this paper we want to study how punishment influences conditional cooperation. In particular, we investigate 1) how the threat of punishment influences conditional cooperation and 2) how the possibility to punish others influences the own contribution behavior. Most of our hypotheses are, therefore, about conditional effects, i.e. about the slope of a reaction function, and not about average levels of contribution or average levels of punishment.

We suspect that the threat of being punished might work through different mechanisms. The fear of being punished could have a positive effect and could work as an incentive. At the same time, potential punishment increases uncertainty and insecurity which could lead to frustration and crowding-out. In this case the possibility of punishment could increase the number of free riders.

We also speculate that having the option to punish others affects conditional cooperation in a number of ways: Punishment is in itself conditional. Hence, punishment might become a substitute for conditional cooperation. In our study only one player has the right to punish. This player might feel a special responsibility or entitlement.

In the following, we start with the UCPun case, i.e. the case where the CDM can be punished by another player. We then continue with the CPun case, i.e. with the situation where the CDM has the power to punish another player.

3.1 Threat of punishment

In the UCPun treatment the CDM can be punished. As discussed above, several studies support the view that the possibility to be punished changes the behavior of decision makers. To avoid punishment, the CDM might try to fulfill the expectations of the punisher. If the CDM believes that most punishers expect conditional cooperation, then we should find either more conditional cooperation of the CDM in UCPun or more conditional cooperators in UCPun.

Hypothesis 1 (Punishment increases conditional cooperation)**.** *The CDM in UCPun (unconditional cooperator can punish conditional cooperator) shows more conditional cooperation than CDMs in* Base.

Hypotheses 1 refers to the slope of the conditional decision.

Hypothesis 2 (Punishment leads to more conditional cooperators)**.** *In* UCPun *more CDMs behave as conditional cooperators than in* Base.

Hypotheses 2 refers to the number of conditional cooperators and free riders.

Thus, we have two hypotheses on how the threat of being punished impacts cooperation behavior: Punishment either increases the slope of conditional cooperation or it just increases the number of conditional cooperators.

However, punishment might also backfire and crowd-out the incentives to cooperate, which is supported by the literature on crowding-out effects (Gneezy and Rustichini, 2000, Ellingsen and Johannesson, 2008, Frey and Jegen, 2001, Gneezy et al., 2011). Specifically, Bowles and Polania-Reyes (p. 418, 2012) argue that "the meaning of the fines or subsidies to the target of the incentives" account for crowding out. Thus, if the option of being punished suggests to subjects that free riding is a "permissible behavior"[8], then we would expect the opposite effect, and find less cooperation in UCPun. Thus, both Hypotheses 1 and 2 might be overturned by the crowding-out effect.

3.2 Power to punish

The power to punish can influence the conditional cooperation in several ways. We will discuss each of them in the following.

[8]Ibid., p. 390.

3.2.1 Substitution

In Fischbacher et al. (2001) and in our Base treatment conditional cooperation is the only possibility for the CDM to behave in a reciprocal way. In our UCPun (unconditional cooperator can punish conditional cooperator) treatment conditional punishment is the only possibility for the other three players to behave in a reciprocal way. In our CPun (conditional cooperator can punish unconditional cooperator) treatment the CDM has both options: The CDM can reciprocate through conditional cooperation. The CDM can also reciprocate through conditional punishment. These two options can be seen as substitutes. CDMs might choose a smaller amount of each single action when both are available.[9]

If conditional cooperation and conditional punishment are substitutes, we hypothesize the following:

Hypothesis 3 (Substituting conditional cooperation)**.** *We observe less conditional cooperation (a smaller slope) in* CPun *than in* Base*.*

Hypothesis 4 (Substituting punishment)**.** *We observe less conditional punishment (a smaller slope) in* CPun *than in* UCPun*.*

Both hypotheses refer to the amount of reciprocity, i.e. to the slopes of the conditional decision (see Equation (3) below), not to the absolute level. We should also note that the effect of substitution might be offset by responsibility.

3.2.2 Responsibility

Bolle and Vogel (2011) show that decision makers in a position of power act more responsibly. They act prosocially and not selfishly. We expect that also in our experiment power leads to more responsible behavior. The CDM in CPun has more power to reciprocate than the CDM in Base and UCPun. Therefore, we expect that the CDM in CPun behaves more responsibly than the CDMs in Base:

Hypothesis 5 (Responsibility increases cooperation)**.** *The CDM in* CPun *shows more conditional cooperation than CDMs in* Base*.*

Hypothesis 5 refers to the slope of the conditional decision. Hypothesis 5 predicts the opposite of Hypothesis 3.

3.2.3 Entitlement

Several papers[10] show that entitlement (and also social status) influences behavior of decision makers so that they behave in a less prosocial way.

[9] Obviously, it can also be argued that there are two types of reciprocity: a positive (cooperation) and a negative (punishment) one, and that these two types might not function as substitutes as they are unrelated (see Peysakhovich et al., 2014, for some evidence).

[10] Ball and Eckel (1998), Ball et al. (2001), Kimbrough and Sheremeta (2014), Hoffman et al. (1994), Hoeft and Mill (2017a,b), Falk (2017).

Table 2: Hypotheses

		Avg. Contr.	Contr. Slope	# of Cond.Coops	Pun. Slope
Threat of punishment	Hyp. 1	-	UCPun > Base	-	-
	Hyp. 2	-	-	UCPun > Base	-
Substitution	Hyp. 3	-	CPun <Base	-	-
	Hyp. 4	-	-	-	CPun < UCPun
Responsibility	Hyp. 5	-	CPun >Base	-	-
Entitlement	Hyp. 6	CPun <Base	-	-	-

In all our treatments the CDM can cooperate conditionally, but only in CPun the CDM can cooperate conditionally and punish conditionally. In CPun the CDM has, hence, more power. This extra power might not increase responsibility but instead increase entitlement. In this case the CDM would behave less prosocially.[11]

If the power to punish is perceived as an entitlement to behave in a less prosocial way, we hypothesize the following:

Hypothesis 6 (Entitlement reduces cooperation)**.** *The CDM in* CPun *cooperates less than the CDM in* Base*.*

Hypothesis 6 refers to the average amount of cooperation, i.e. the intercepts of the conditional decision. This is different from Hypotheses 1, 3 and 5, which refer to the strength of conditional cooperation, i.e. the slope of the reaction function of the CDM. For Hypothesis 6 we ask whether the CDM is entitled to a smaller contribution, regardless whether the other players contribute a large or a small amount. Since our estimation is based on demeaned data we can, indeed, interpret our treatment effects as effects on the average.

A summary of our hypotheses can be found in Table 2.

4 Results

4.1 Descriptives

4.1.1 Subjects

We conducted the experiments in February 2016 in the laboratory of the school of economics of the University of Jena (Germany). We recruited 144 participants (48 in each of the three treatments) in 9 sessions using the online recruiting platform ORSEE (Greiner, 2015). We implemented the experiment using z-Tree (Fischbacher, 2007). We are grateful to Fischbacher et al. (2001) for providing us with the z-Tree code and the instructions for the original experiment. We changed instructions, test-questions, and the program only where necessary

[11] Obviously, there are also arguments for why this effect might not occur. Among others, this effect might be fragile as the extra power is randomly assigned and is not made particularly salient. Nevertheless, several studies indicate that such effects might be observed and, hence, we list this effect as a hypothesis.

to implement our treatments CPun and UCPun. The entire experiment lasted for about 45 minutes. Participants earned on average 7.97€, which was at that time slightly above the minimum wage in Germany. We had 36% male and 64% female participants with a median age of 24. The average participant was in the third year of studying. As in Fischbacher et al. (2001), we did not invite any students who indicated to be studying economics or economics related topics (business, business-engineering etc.)

4.1.2 Classifying players

Fischbacher et al. (2001) suggest to divide subjects into four categories: *free riders* – subjects with a constant contribution of zero – *conditional cooperators* – subjects who cooperate conditionally on the contribution of others – *hump-shaped contributors* – subjects who conditionally contribute up to a certain point and reverse their conditional contribution from that point on forward – and *others* – subjects not classified in the three mentioned categories. In our paper we are less concerned with classification. Let us nevertheless briefly compare: If we follow the definition of Fischbacher et al. (2001) we find 78% conditional cooperators, 8% free riders, 3% hump-shaped contributors, as well as 10% *others*. This distribution of types seems to be similar to the distribution Kocher et al. (2008) find for the U.S.A. with 80.6% conditional cooperators, 8.3% free riders and 0% hump-shape contributors. Fischbacher et al. (2001) find fewer conditional cooperators (50%), more free riders (30%), and more hump-shaped contributors (14%). Comparing our results to a recently published review of conditional cooperation by Thöni and Volk (2018) we find that the percentage of conditional cooperators in our experiment is rather at the upper end of the distribution reported in that review.

Fischbacher et al. (2001) classify types separately from the estimation of conditional cooperation. Below (see Equation (2)) we propose to assess simultaneously the type of a player and, if this player is a conditional cooperator, the player's conditional cooperation function. To keep things simple we consider only two types (which are determined endogenously): Conditional cooperators (which seem to constitute the majority of our participants) and free riders. Anticipating our results, we find 79.9% conditional cooperators, 18.8% free riders, and 1.39% players which can't be perfectly classified.

Although we use a different classification of players, the behavior of conditional cooperators in our experiment is very similar to Fischbacher et al. (2001) (see Figure 1). As in several other studies (Fischbacher et al., 2001, Burlando and Guala, 2005, Herrmann and Thöni, 2009, Kocher et al., 2008, Hartig et al., 2015) conditional cooperators contribute slightly below perfect conditional cooperation.

4.1.3 Punishment

The pattern of punishment we find is similar to Fehr and Gächter (2002) (see Figure 2). Fehr and Gächter (2002) observe punishment in particular for players who contribute less than the mean contribution of the other group members. The fewer a player contributes to the public good compared to the average the more this player is punished. Similarly, we observe that our participants punish in particular those players who contribute less than the own unconditional contribution. The fewer a player contributes compared to the unconditional

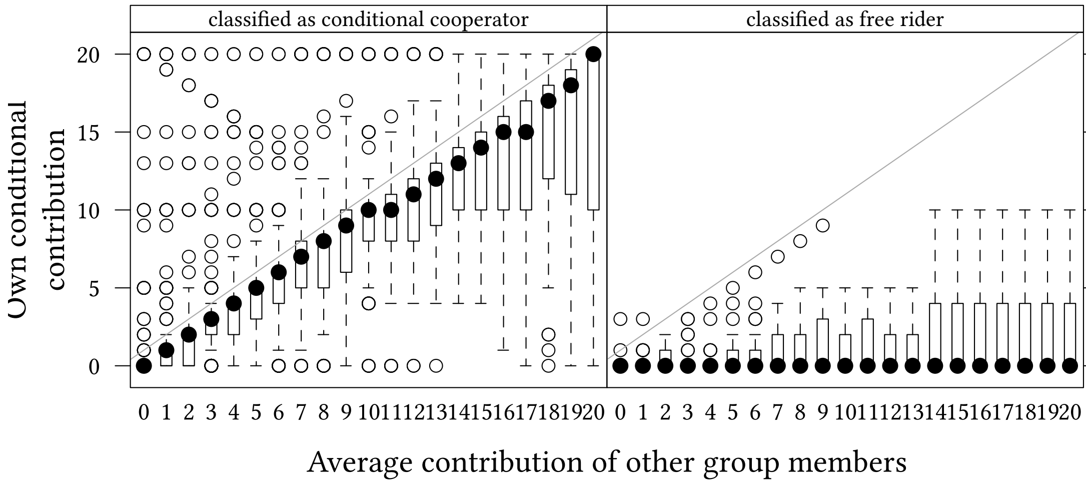


Figure 1: Boxplot of conditional contributions for conditional cooperators and free riders according to (2).

contribution of the punisher the more this player will be punished.

4.2 Estimation strategy:

To investigate the contribution behavior as well as the punishment behavior of subjects we use a hurdle model with random effects. We include random effects (for each individual participant) since we have repeated measures for each participant. We use a hurdle model to distinguish free riders from conditional decision makers. The hurdle model helps us distinguishing whether our treatments influence subjects' types (free rider or conditional) or their degree of conditional behavior. Our classification into only two types (free rider or conditional) is simpler than the one in Fischbacher et al. (2001) and Thöni and Volk (2018), and is purely data-driven.

We will use a Bayesian approach in the main part of the paper for its flexibility and ease of interpretation. Frequentist methods with simple non-hurdle models are shown in Appendix D of the paper.[12] All relevant results are robust to using Bayesian or frequentist methods.

In the following we estimate the influence of our treatments, Base, CPun and UCPun, on cooperation and on punishment. Dummies $\mathbb{1}_{\text{CPun}}$ and $\mathbb{1}_{\text{UCPun}}$, are one for treatments CPun and UCPun, respectively, and zero otherwise. In both hurdle models the (latent) variables $\mathbb{1}_{\text{CC},i}$ and $\mathbb{1}_{\text{CP},i}$ are one for participants i which are classified as conditional cooperators or conditional punishers, respectively, and zero for free riders.

[12]Note: the frequentist does not use a hurdle and hence all results have to be interpreted with caution as the cooperation slope of all types are aggregated. Thus, the results are prone to bias if not accounting for the types.

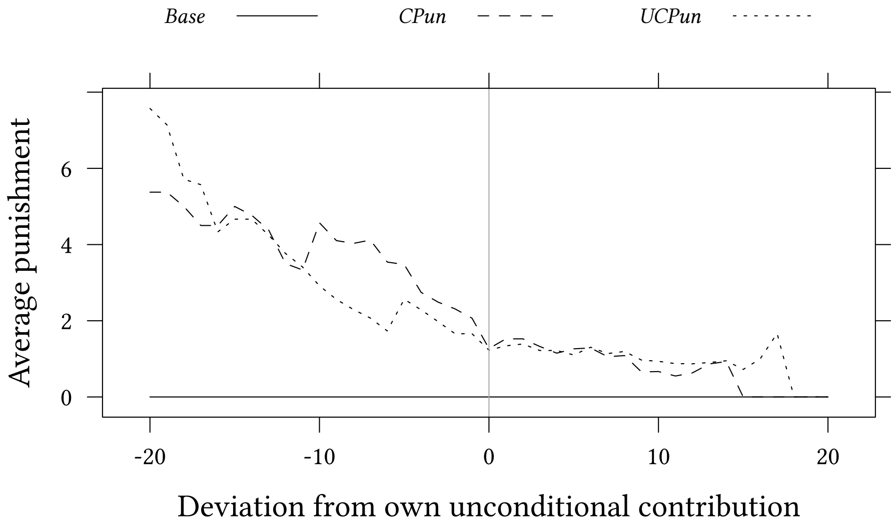


Figure 2: Punishment behavior

Contribution to the public good: The contribution to the public good is described by two equations: Equation (2) is the classification into free riders or conditional cooperators. Equation (3) is the actual contribution. We start with the classification, Equation (2). $\mathcal{L}$ denotes the logistic distribution. The probability that player i is a conditional cooperator (and not a free rider) is given by Equation (2):

$$\Pr(\mathbb{1}_{CC,i} = 1) = \mathcal{L}\left(\gamma_1^C + \gamma_{CPun}^C \mathbb{1}_{CPun} + \gamma_{UCPun}^C \mathbb{1}_{UCPun}\right) \quad (2)$$

Equation 2 estimates the baseline probability of a subject being a conditional cooperator ($\mathcal{L}(\gamma_1^C)$) and how this probability is affected by our treatments: either by the power to punish (γ_{CPun}^C) or the threat of being punished (γ_{UCPun}^C). Together with Equation (2) we estimate in Equation (3) the contribution $c_i(c_{-i})$ of player i conditional on the average contribution c_{-i} of the others:

$$\begin{aligned} c_i(c_{-i}) = \mathbb{1}_{CC,i} \cdot \big(\beta_1^C + \beta_{CPun}^C \mathbb{1}_{CPun} + \beta_{UCPun}^C \mathbb{1}_{UCPun} + \\ + (\beta_{c_{-i}}^C + \beta_{CPun \times c_{-i}}^C \mathbb{1}_{CPun} + \beta_{UCPun \times c_{-i}}^C \mathbb{1}_{UCPun}) \cdot c_{-i}\big) + \epsilon_i^{C\prime} + \epsilon_{i,c_{-i}}^C \end{aligned} \quad (3)$$

To account for repeated measurements we include a random effect $\epsilon^{C\prime}$.[13] The residual is $\epsilon_{i,c_{-i}}^C$.

Punishment: To model punishment, we, again, use a hurdle model with mixed effects. The model is described by Equations (4) and (5). Equation (4) is the classification into free riders or conditional punishers. Equation (5) is the actual punishment. Again, we start with

[13] We also estimate a model with two random effects: one for the intercept and one for the slope. Results are shown in Table 6 in the Appendix.

the classification, Equation (4). The probability that player i is a conditional punisher is given by (4):

$$\Pr(\mathbb{1}_{CP,i} = 1) = \mathcal{L}\left(\gamma_1^p + \gamma_{UCPun}^p \mathbb{1}_{UCPun}\right) \tag{4}$$

Equation (4) estimates the baseline probability of a subject being a conditional punisher ($\mathcal{L}(\gamma_1^p)$) and how this probability is affected by our treatments: whether the punishment decision is made by a conditional or an unconditional decision maker (γ_{UCPun}^p). Together with Equation (4) we estimate (5), the punishment $p_i(c_{-i})$ meted out by player i conditional on the contribution c_{-i} of an other subject:

$$p_i(c_{-i}) = \mathbb{1}_{CP,i} \cdot \left(\beta_1^p + \beta_{UCPun}^p \mathbb{1}_{UCPun} + (\beta_{c_{-i}}^p + \beta_{UCPun \times c_{-i}}^p \mathbb{1}_{UCPun}) \cdot c_{-i}\right) + \epsilon_i^{P\prime} + \epsilon_{i,c_{-i}}^P \tag{5}$$

To account for repeated measurements we include a random effect $\epsilon_i^{P\prime}$.[14] $\epsilon_{i,c_{-i}}^P$ is the residual.

We use a Bayesian approach for its flexibility and transparency.[15] We also estimate the standard mixed effects model (without a hurdle) using frequentist methods and Bayesian methods. All main results prevail under the frequentist approach. The technical details of the Bayesian estimation are provided in Appendix A. Detailed results for the Bayesian Model are reported in Appendix B in Table 5. Results for the frequentist model are reported in Appendix D in Table 10.

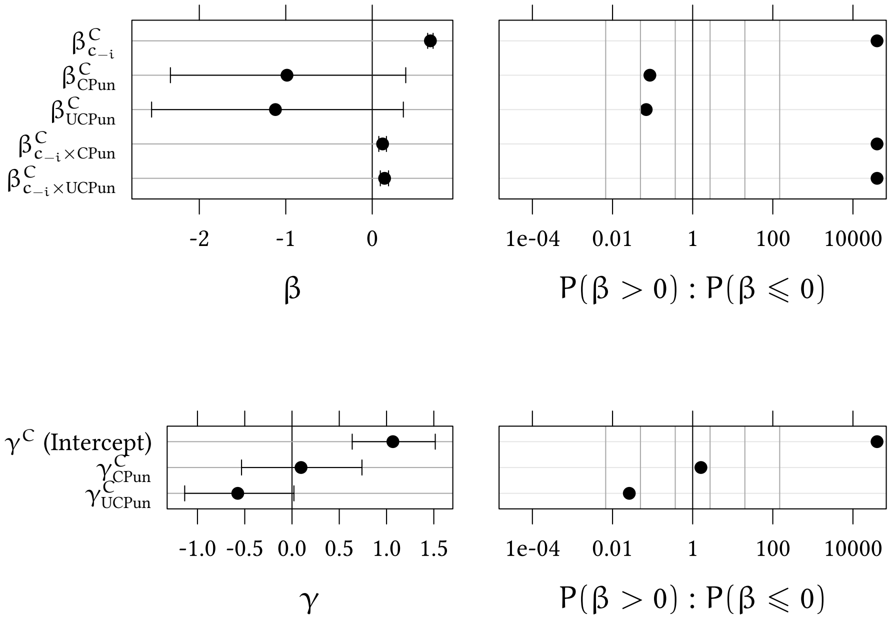
In our estimation strategy we solve two problems simultaneously. In Equations (2) and (4) we classify subjects as either conditional or unconditional decision makers (which is purely data driven). At the same time we estimate the degree of contribution or punishment for conditional decision makers in Equations (3) and (5). This simultaneous approach is different from first classifying subjects and only then estimating the contribution slope of these subjects. Such a two-step procedure could underestimate standard errors. Following the Bayesian approach allows us to straightforwardly and simultaneously estimate both decisions. Similarly, we estimate whether a subject is a conditional punisher and simultaneously we estimate punishment decision of those punishers.

4.3 Estimation results

Figure 3 shows estimation results for Equations (2) and (3). Detailed results are given in Table 4 in Appendix B. Table 5 in Appendix in Appendix B and Table 10 in Appendix D present

[14] As with cooperation we also estimate a hurdle model for punishment where we include two mixed effects: one mixed effect for the intercept and a second mixed effect for the slope. Results can be found in Table 9 in the Appendix.

[15] Looking for standard solutions to our estimation problem we found the R package `glmmADMB` which estimates the mixed effects hurdle model in a two-step procedure: First a linear mixed effects model for contributors is estimated, then a binomial logistic regression of contributing at all. In doing so, the estimation procedure does not control for dependencies and may, hence, underestimate standard errors. Clearly, we could implement our own ML estimator to solve the problem in a frequentist context. However, besides all limitations of ML we fear that such a program would be less transparent than a straightforward model in BUGS notation. The Bayesian approach allows us to transparently and simultaneously estimate the conditional as well as the binary decision.



The graphs show the 95%-credible intervals for the Bayesian estimated coefficients on the left hand side and the odds of the posterior to be larger than zero on the right hand side.
Detailed results are given in Table 4 in the Appendix.

Figure 3: Estimation results for Equations (3), (2)

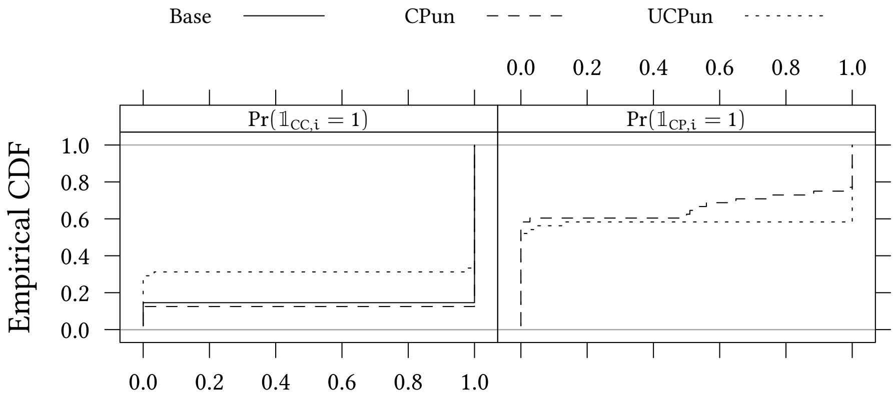


Figure 4: Classification of player types for Equation (2) and Equation (4).

results for a simpler model without a hurdle with a Bayesian approach and a frequentist estimation, respectively.[16]

The left part of Figure 4 shows the classification of contributors into 18.8% free riders ($\mathbb{1}_{CC,i} = 0$) and 79.9% conditional cooperators ($\mathbb{1}_{CC,i} = 1$) for Equation (2). 1.39% of our contributors cannot be classified with certainty, i.e. they follow both strategies with a positive probability. The right part of Figure 4 shows the classification of punishers into 54.2% unconditional punishers ($\mathbb{1}_{CP,i} = 0$) and 32.3% conditional punishers ($\mathbb{1}_{CP,i} = 1$) for Equation (4). 13.5% of our punishers cannot be classified with certainty.

Figure 5 shows estimation results for Equations (5) and (4). Detailed results are given in Table 7 in Appendix C. Table 8 resp. Table 11 present results for a simpler model without a hurdle with a Bayesian approach and a frequentist estimation, respectively.[17]

4.3.1 Threat of punishment

Punishment increases cooperation Hypotheses 1 and 2 predict a change in the cooperation behavior of CDMs in UCPun (unconditional cooperator can punish conditional cooperator) compared to Base (conditional cooperator, no punishment). Hypothesis 1 predicts a steeper slope of the conditional cooperation function in UCPun (unconditional cooperator can punish conditional cooperator) than in Base (conditional cooperator, no punishment). Hypothesis 2 predicts a higher probability to be a conditional cooperation in UCPun (unconditional cooperator can punish conditional cooperator) than in Base (conditional cooperator, no punishment).

We find that the odds that $\beta^{C}_{c_{-i}\times \text{UCPun}} > 0$ are 40000 : 1, i.e., we have very strong evidence in support of more cooperation in UCPun (unconditional cooperator can punish conditional

[16] Table 6 shows results for a model with hurdle and two random effects, one for the intercept and one for the slope.

[17] Table 9 shows results for a model with hurdle and two random effects, one for the intercept and one for the slope.

cooperator) than in Base (conditional cooperator, no punishment). Thus, we confirm Hypothesis 1.[18]

Turning to the probability to be a conditional cooperator, we find the odds that $\gamma^{C}_{UCPun} < 0$ are 38.1 : 1, i.e., we have strong evidence for a smaller (not larger) probability to be a conditional cooperator in UCPun. Thus, we reject Hypothesis 2 and show a converse relationship.

We see two opposing effects: When a CDM anticipates punishment in UCPun, the slope of conditional cooperation increases. At the same time the probability to be a conditional cooperator decreases. To determine which of the two effects dominates we estimate Equation (3) with $\mathbb{1}_{CC,i} = 1$, i.e. we assume that all participants belong to the group of conditional cooperators. Estimation results are shown in Table 5 in Appendix B. For this (simplified) model we find the odds that $\beta^{C}_{c_{-i} \times UCPun} > 0$ are 5.34 : 1, i.e., we have positive evidence[19] for an overall increase in conditional cooperation.

Result 1. *Threat of punishment increases the slope of conditional cooperators.*

Result 2. *Threat of punishment reduces the probability to be a conditional cooperator.*

4.3.2 Power to punish

Next, we come to the effect of being able to punish on conditional cooperation. We hypothesized that the option to punish others affects the decisions of a CDM in several ways.[20]

4.3.2.1 Substitution

Substituting conditional cooperation Hypothesis 3 predicts that the slope for conditional cooperation is smaller in CPun (conditional cooperator can punish unconditional cooperator) than in Base (conditional cooperator, no punishment). On the contrary, we find odds that $\beta^{C}_{c_{-i} \times CPun} > 0$ are 40000 : 1, i.e., we have very strong evidence for more, not less, conditional cooperation in CPun than in Base.

Result 3. *On the level of cooperation we find no substantial evidence for a substitution effect.*

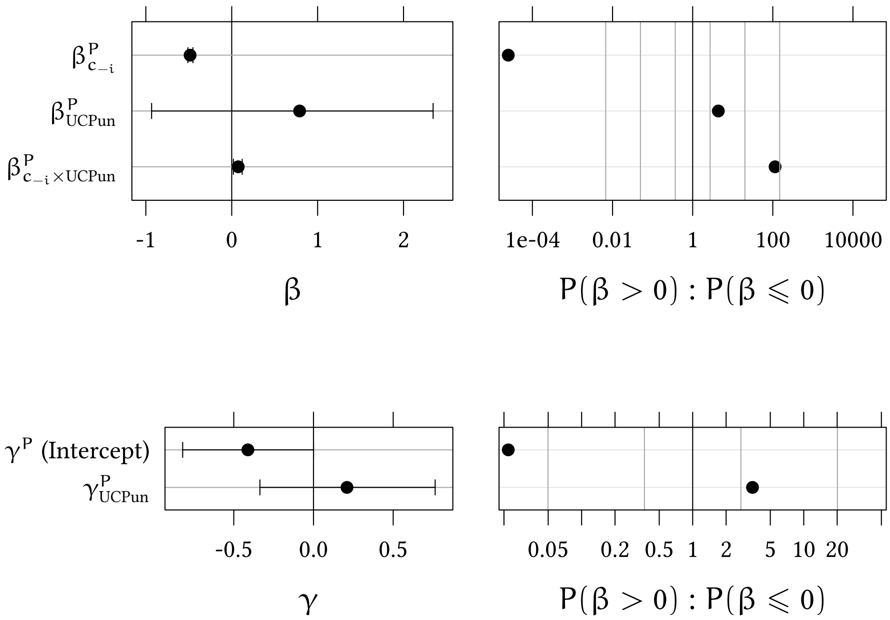
Substituting punishment Hypothesis 4 predicts a more sensitive reaction of punishment to contributions in UCPun, i.e. a higher slope of the punishment function. Indeed, we find the odds that $\beta^{P}_{c_{-i} \times UCPun} > 0$ are 114 : 1, i.e., we have strong evidence that punishment reacts more sensitively to contributions in UCPun than in CPun.

Result 4. *On the level of punishment we find strong evidence for a substitution effect.*

[18]We follow the terminology of Kass and Raftery (1995) to assess posterior odds.

[19]In line with Kass and Raftery (1995) we say that we have "positive" evidence if the Bayes factor is between e^1 and e^3. Between e^3 and e^5 we talk about "strong" evidence. For Bayes factors larger e^5 we talk about "very strong" evidence. For a discussion of the terminology and the differences between Bayes factors vs. non-bayesian significance testing, we refer the interested reader to Kass and Raftery (1995).

[20]Note, that all our hypotheses in this section are referring either to the slope or the average level. The hypotheses do not refer to the proportion of conditional cooperators and free riders. Thus, we also do not report these proportion here. However, the proportion still can be found in the respective tables and figures. It is evident that they do not change the results.



The graphs show the 95%-credible intervals for the Bayesian estimated coefficients on the left hand side and the odds of the posterior to be larger than zero on the right hand side.
Detailed results are given in Table 7 in the Appendix.

Figure 5: Estimation results for Equations (5), (4)

Table 3: Summary of tested hypotheses

		Avg. Contr.	Contr. Slope	# of Cond.Coops	Pun. Slope
Threat of punishment	Hyp. 1	-	UCPun > Base;$\Uparrow$ $*$; ✓	-	-
	Hyp. 2	-	-	UCPun > Base;$\Downarrow$ $*$; x	-
Substitution	Hyp. 3	-	CPun <Base ;$\Uparrow$ $*$; x	-	-
	Hyp. 4	-	-	-	CPun < UCPun;$\Uparrow$ $+$; ✓
Responsibility	Hyp. 5	-	CPun >Base;$\Uparrow$ $*$; ✓	-	-
Entitlement	Hyp. 6	CPun <Base;$\Downarrow$ $+$; ✓	-	-	-

$*$ denotes strong or very strong evidence. $+$ denotes positive evidence. $\Uparrow$ indicates a positive effect while $\Downarrow$ indicates a negative effect. ✓ indicates that the result goes in the anticipated direction and x indicates that the result goes in the opposite direction.

Hence, we do find evidence for a substitution effect, however only when substitution is not in conflict with responsibility, i.e. only for Hypothesis 4, and not for Hypothesis 3.

4.3.2.2 Responsibility

Responsibility increases cooperation Hypotheses 5 predicts more conditional cooperation in CPun than in Base, i.e. a steeper slope of the conditional cooperation function. Indeed – as we see in Result 3 – we find that the odds that $\beta^{C}_{c_{-i}\times CPun} > 0$ are 40000 : 1, i.e., we have very strong evidence in favour of more conditional cooperation (a steeper slope) in CPun than in Base.

Result 5. *We find very strong support for an effect of responsibility.*

4.3.2.3 Entitlement

Entitlement reduces cooperation Hypothesis 6 predicts less conditional cooperation in CPun than in Base, i.e. smaller average levels of cooperation (Equation (2)).

Since the estimation of Equation (2) is based on demeaned data, we can interpret our treatment effects as effects on the average. The odds that $\beta^{C}_{CPun} < 0$ are 11.7 : 1, i.e., we have positive evidence for less cooperation in CPun than in Base.

Result 6. *We find positive evidence for an entitlement effect.*

A summary of all the tested hypotheses and the corresponding results can be found in Table 3. It is worthwhile to point out that our results do depend to some extent on the assumption that types differ (i.e., using a hurdle model). One could also model participants as all following the same type (i.e., all conditionally cooperating a little bit). Using such a simplified model of human behavior might results in slightly changed results (see Table 10). By allowing for different types, one does get a slightly different (and arguably better) picture of the effects.[21]

[21] Thus, not all of the results are robust to different modeling assumptions. For example result 6 does not breed in significance in Table 10 where only one type is assumed.

5 Discussion and Conclusion

In our experiment, we study how punishment influences conditional cooperation behavior.

To do this, we compare in a one-shot public good game three different situations: one standard situation with no punishment and two situations with punishment. The two situations with punishment differ in who is punishing and who is punished. In treatment UCPun one of the unconditional decision makers punishes the conditional decision maker. In treatment CPun the conditional decision maker punishes one unconditional decision maker. The design allows us to better understand how punishment changes conditional cooperation (two of the most studied issues in cooperation literature). In particular, we can examine how the threat of punishment (in the UCPun treatment) and the power to punish (in the CPun treatment) changes the behavior of the conditional decision maker.

We hypothesize that the threat of punishment can change cooperation through two mechanisms. On the one hand, punishment might increase the number of conditional cooperators. Participants who, without punishment, behave as free riders might, with punishment, turn into cooperators. On the other hand, punishment might change the behavior of existing cooperators. They could behave in a more sensitive way and increase the slope of their conditional contribution. But not only the objects of punishment might change. The punisher might consider conditional cooperation and punishment as substitutes. The option to punish might lead to less conditional cooperation. Alternatively, the power to punish could trigger responsibility or entitlement. Responsibility would lead to more cooperation. Entitlement would lead to less cooperation.

In line with Fischbacher et al. (2001), we confirm that most subjects are conditional cooperators. As Fehr and Gächter (2000), we find that the threat of punishment increases cooperation. More specifically, we can see that it is conditional cooperation which increases with punishment.

However, punishment also has a negative effect: We find that the anticipation of punishment leads to a strong increase in the number of free riders. These could be decision makers who expect to be punished anyway and who try to make up for the lost earning by free riding. A possible explanation for this increase in free riders could be a crowding out effect (Bènabou and Tirole, 2006, Berg et al., 2017, Frey, 1997). The overall effect of punishment on cooperation is still positive.

In our experiment punishment could be seen as a substitute for contribution. A participant with the power to punish might reduce the own contribution and, instead, increase the punishment. At the same time the power to punish might increase responsibility and, thus, lead to an increase in contributions. When substitution and responsibility make opposite predictions, we find that responsibility has the stronger effect. When substitution is not in conflict with responsibility (as in our treatment UCPun) we have strong support for substitution.

Overall, we identify two positive and two negative effects of punishment: Positive is an increase in conditional cooperation. Positive is also an increase in responsibility. Negative is an increase in free riders. Negative is also a substitution of contribution with punishment. The total effect of punishment is, however, still positive in our experiment.

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A Technical details of the Bayesian estimates

For the Bayesian estimates we use JAGS 4.3.0 (2017). We demean data to improve convergence of the sampler. Demeaning also allows us to conveniently interpret our treatment effects as effects on the average. For each model, we use 4 MCMC chains. For each chain, we use a thinning interval of 10, we discard 5000 samples for adaptation and burnin and keep 10000 samples to estimate the posterior. With a thinning interval of 10 we calculate 10^5 samples for each chain. We then use thinning to keep the data manageable, keeping 10000 samples from each of the 4 MCMC chains. For each model we have, hence, 40000 samples (based on, actually, 4×10^5 samples before thinning).

We use (standard) vague priors as given by (6)-(10). For vague priors we use a normal distribution with a very small precision for regression coefficients (the variance is much larger than the estimated coefficients) and a Gamma distribution where mean and dispersion again follow a Gamma distribution (Kruschke, 2011).

$$\beta_{\{1,2,\ldots,5,6\}}^{\{C,P\}} \sim \mathcal{N}(0, 10^{-4}) \tag{6}$$

$$\gamma_{\{1,2,\ldots,3\}}^{\{C,P\}} \sim \mathcal{N}(0, 10^{-4}) \tag{7}$$

$$\epsilon_{\cdot}^{T} \sim \mathcal{N}(0, \tau^{T}) \tag{8}$$

$$\tau^{T} \sim \Gamma((m^{T})^{2}/(s^{T})^{2}, m^{T}/(s^{T})^{2}) \tag{9}$$

$$m^{T} \sim \text{Exp}(1) \text{ and } s^{T} \sim \text{Exp}(1) \text{ with } T \in \{C\prime, C, P\prime, P\} \tag{10}$$

B Estimation of Equations (2) and (3)

Table 4 reports the detailed results of the main model of contribution. Results for a standard mixed effects model (no hurdle) are reported in Table 5 and Figure 6. Table 6 and Figure 7 show results for a model with hurdle and two random effects, one for the intercept and one for the slope.

Tables show for each case the estimated median of the parameter, the 95%-credible interval ($Q_{.025}$, $Q_{.975}$), the odds that the parameter is larger than zero ($o(> 0)$), the effective sample size (SSeff), and the potential scale reduction factor (psrf).

C Estimation of Equations (4) and (5)

Table 7 show estimation results of the main model of the punishment behavior, Equation (4) and (5). We also estimate a standard mixed effects model which is reported in detail in Table 8 and Figure 8. A hurdle model with two random effects, one for the intercept and one for the slope is reported in Table 9 and Figure 9.

Table 4: Contribution: Results of the main model ((2), (3))

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^C_{c_{-i}}$	0.673	0.641	0.704	40000 : 1	40313	1.0000
β^C_{CPun}	-0.986	-2.334	0.388	1 : 11.7	39845	1.0000
β^C_{UCPun}	-1.120	-2.552	0.360	1 : 14.4	38669	1.0002
$\beta^C_{c_{-i}\times\text{CPun}}$	0.120	0.076	0.164	40000 : 1	42577	1.0000
$\beta^C_{c_{-i}\times\text{UCPun}}$	0.143	0.093	0.188	40000 : 1	31792	1.0004
γ^C (Intercept)	1.067	0.637	1.516	40000 : 1	32579	1.0000
γ^C_{CPun}	0.096	-0.534	0.740	1.61 : 1	35856	1.0001
γ^C_{UCPun}	-0.574	-1.135	0.020	1 : 38.1	33039	1.0000
τ_C	0.123	0.117	0.130		30332	1.0035
$\tau_{C'}$	0.118	0.091	0.148		34381	1.0005

A graph for the credible intervals and for odds is shown in Figure 3.

Table 5: Contribution: Standard mixed effects model (3) without hurdle ($\mathbb{1}_{CC,i} = 1$)

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^C_{c_{-i}}$	0.556	0.522	0.591	40000 : 1	40000	1.0000
β^C_{CPun}	-1.153	-2.845	0.566	1 : 10.2	39035	1.0000
β^C_{UCPun}	-1.132	-2.873	0.544	1 : 9.48	40343	1.0000
$\beta^C_{c_{-i}\times\text{CPun}}$	0.148	0.099	0.197	40000 : 1	39644	1.0001
$\beta^C_{c_{-i}\times\text{UCPun}}$	0.025	-0.023	0.074	5.34 : 1	40000	1.0000
τ_C	0.088	0.084	0.093		40000	1.0000

Figure 6: Contribution: Standard mixed effects model without hurdle

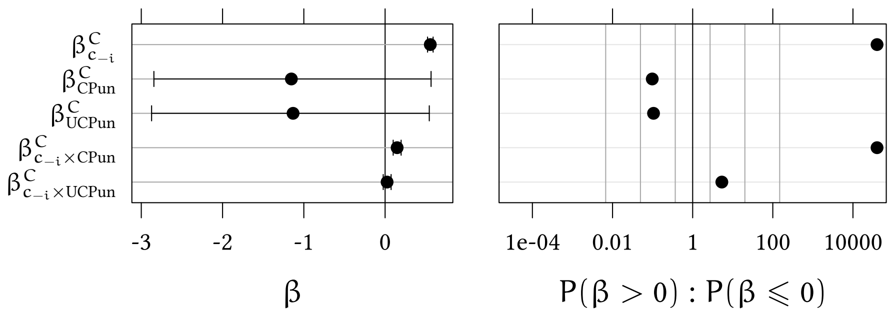

Table 6: Contribution: Mixed effects random slope hurdle model

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^C_{c_{-i}}$	0.638	0.504	0.764	40000 : 1	38884	1.0001
β^C_{CPun}	-1.311	-3.493	0.880	1 : 7.1	39569	1.0000
β^C_{UCPun}	-0.887	-3.257	1.375	1 : 3.41	40000	1.0000
$\beta^C_{c_{-i}\times\text{CPun}}$	0.154	-0.025	0.342	19.2 : 1	39514	1.0002
$\beta^C_{c_{-i}\times\text{UCPun}}$	0.124	-0.067	0.321	8.39 : 1	40000	1.0000
γ^C (Intercept)	1.160	0.716	1.631	40000 : 1	30723	1.0002
γ^C_{CPun}	-0.001	-0.651	0.647	1 : 1	33304	1.0001
γ^C_{UCPun}	-0.611	-1.216	-0.036	1 : 48.5	31278	1.0001
τ_C	0.250	0.237	0.263		40000	1.0000
$\tau_{C'}$	0.133	0.102	0.166		40472	1.0000
$\tau_{C''}$	5.674	4.225	7.249		38744	1.0000

Figure 7: Contribution: Mixed effects random slope hurdle model (Table 6)

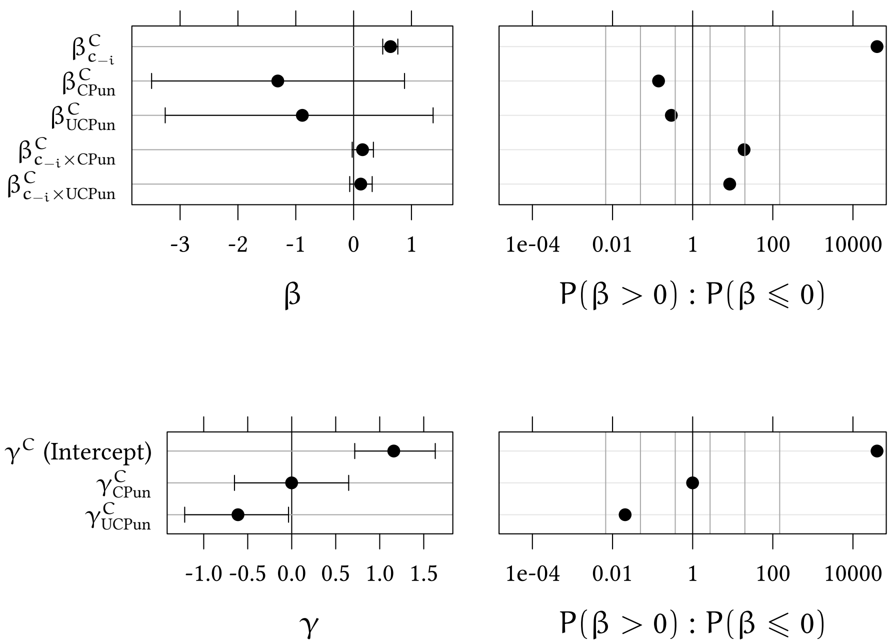

Table 7: Punishment: Results of the main model ((4), (5))

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^P_{c_{-i}}$	-0.485	-0.511	-0.452	1 : 40000	3881	1.0372
β^P_{UCPun}	0.790	-0.933	2.345	4.37 : 1	11805	1.4089
$\beta^P_{c_{-i}\times UCPun}$	0.076	0.020	0.122	114 : 1	1923	1.6251
γ^P (Intercept)	-0.411	-0.821	0.000	1 : 45.7	20552	1.1842
γ^P_{UCPun}	0.210	-0.336	0.763	3.46 : 1	19646	1.0983
τ_P	0.444	0.414	0.474		11314	1.0516
$\tau_{P'}$	0.275	0.193	0.364		16850	1.0500

A graph with credible intervals and odds ratios is shown in Figure 5.

Table 8: Punishment: Standard mixed effects model (5) without hurdle ($\mathbb{1}_{CC,i} = 1$).

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^P_{c_{-i}}$	-0.208	-0.228	-0.186	1 : 40000	40000	1.0000
β^P_{UCPun}	1.216	0.240	2.205	130 : 1	39027	1.0001
$\beta^P_{c_{-i}\times UCPun}$	0.081	0.051	0.110	40000 : 1	39461	1.0001
τ_P	0.244	0.228	0.259		39449	1.0000
$\tau_{P'}$	0.189	0.135	0.247		41245	1.0000

Figure 8: Punishment: Standard mixed effects model without hurdle (Table 8).

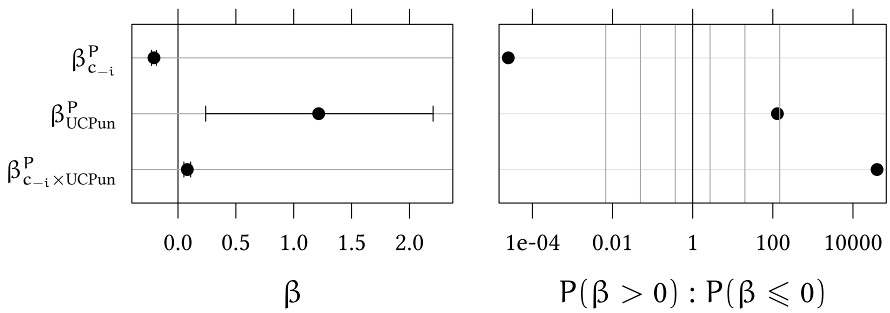

Table 9: Punishment: Mixed effects random slope hurdle model.

	Median	$Q_{.025}$	$Q_{.975}$	$o(>0)$	SSeff	psrf
$\beta^{P}_{c_{-i}}$	-0.341	-0.484	-0.202	1 : 20000	41105	1.0150
β^{P}_{UCPun}	1.492	-0.782	3.879	8.54 : 1	41191	1.0654
$\beta^{P}_{c_{-i}\times UCPun}$	0.124	-0.085	0.334	7.37 : 1	40378	1.0209
γ^{P} (Intercept)	-0.080	-0.487	0.334	1 : 1.81	39322	1.3188
γ^{P}_{UCPun}	0.224	-0.328	0.792	3.61 : 1	38392	1.2166
τ_{P}	0.667	0.611	0.722		39594	1.6549
$\tau_{P'}$	0.422	0.299	0.569		39106	1.1749
$\tau_{P''}$	7.806	4.617	11.523		33699	1.0224

Figure 9: Punishment: Mixed effects random slope hurdle model (Table 9).

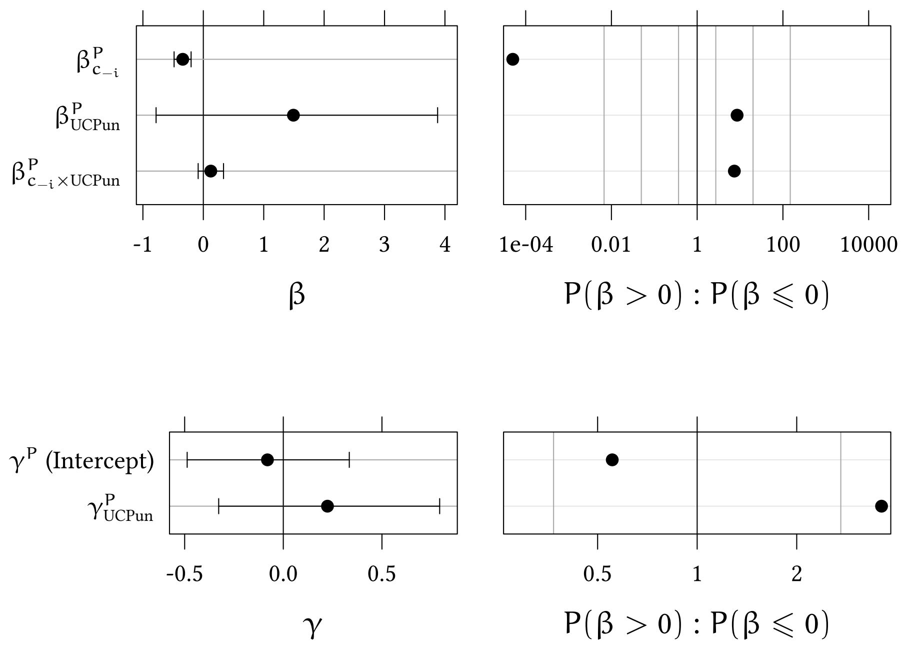

Table 10: Contribution: Frequentist estimation (no hurdle)

	Frequentist Mixed Effects Model
β^C (Intercept)	2.18*** (0.98, 3.38)
$\beta^C_{c_{-i}}$	0.56*** (0.52, 0.59)
β^C_{CPun}	−1.16 (−2.86, 0.54)
β^C_{UCPun}	−1.14 (−2.84, 0.56)
$\beta^C_{c_{-i}\times CPun}$	0.15*** (0.10, 0.20)
$\beta^C_{c_{-i}\times UCPun}$	0.03 (−0.02, 0.07)
Observations	3,024
Log Likelihood	−8,217.92
Akaike Inf. Crit.	16,451.84
Bayesian Inf. Crit.	16,499.95
Notes:	$p : *** < .001 ** < .01 * < .05$

D Frequentist results

We also estimate a frequentist mixed effects models for the contribution behavior, comparable to the estimation results presented in Table 5

Table 10 shows estimation results for Equation (3) using `lme4` (Bates et al., 2015) (version 1.1-19). All results from Section 4.3 are also present in this simple regression.

We also estimated a frequentist mixed effects models for the punishment behavior, comparable to the Bayesian model presented in Table 8.

Table 11 shows the estimation results of Equation (5) estimated in a frequentist context using `lme4`. Again the results are very similar to the results reported in 4.3.

Table 11: Punishment: Frequentist estimation (no hurdle)

	Frequentist Mixed Effects Model
β^C (Intercept)	4.33*** (3.63, 5.03)
$\beta^C_{c_{-i}}$	−0.21*** (−0.23, −0.19)
β^C_{UCPun}	−1.22* (−2.20, −0.23)
$\beta^C_{c_{-i} \times \text{UCPun}}$	0.08*** (0.05, 0.11)
Observations	2,016
Log Likelihood	−4,450.54
Akaike Inf. Crit.	8,913.07
Bayesian Inf. Crit.	8,946.72
Notes:	$p: *** < .001 ** < .01 * < .05$

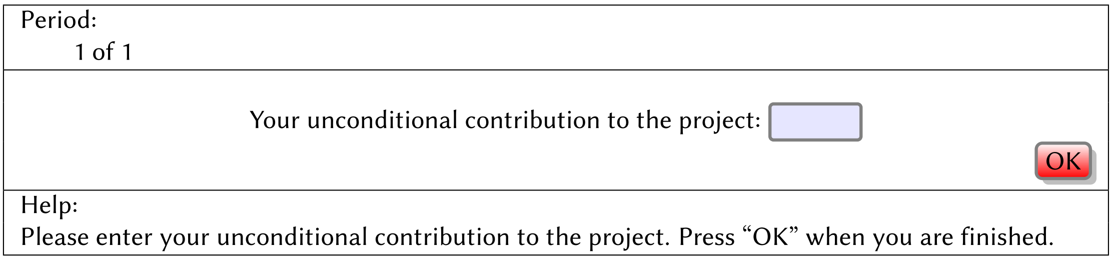
Period:
1 of 1
Your unconditional contribution to the project:
OK
Help:
Please enter your unconditional contribution to the project. Press “OK” when you are finished.

Figure 10: Unconditional contribution Decision

E Interface, data and methods

The experiment was conducted in German. A translation of the interface for the unconditional contribution, the conditional contribution, the conditional punishment and for the feedback can be found in Figures 10, 11, 12, 13.

Data and methods can be found at https://www.kirchkamp.de/research/condCoopPun.html

F Instructions

The experiment was conducted in German. All participants obtained the following handout (translated into English). Participants also read instructions on the computer screen (see F.2).

F.1 Handout

The decision situation You are a member of a group of size 4. Each member of this group has to decide how to spend 20 points. You can put the 20 points into a private account or

Period:
1 of 1

Your conditional contribution to the project (Contribution table)

0		7		14	
1		8		15	
2		9		16	
3		10		17	
4		11		18	
5		12		19	
6		13		20	

OK

Help:
In each field enter which contribution to the project you provide, if on average the others make a contribution to the project as denoted by the number to the left of each field.
When you have entered everything, press “OK”.

Figure 11: Conditional contribution Decision

Period:
1 of 1

Your conditional reduction of payment of one other player (Reduction table)

0		7		14	
1		8		15	
2		9		16	
3		10		17	
4		11		18	
5		12		19	
6		13		20	

OK

Help:
In each field enter by which amount your want to reduce the payoff of the other player when he contributes to the project an amount as denoted by the number to the left of each field.
The reduction is only implemented if you are randomly selected as a conditional player.
When you have entered everything, press “OK”.

Figure 12: Conditional punishment Decision

Period: 1 of 1	
Random number	2
Your number	1
For you the unconditional amount is relevant	
Your contribution to the project	10
Sum of all contributions	50
Income from the project	20.0
Income from private account	10.0
Reduction by player 2	5
Total income	25.0
Additional income from estimation	0

Figure 13: Feedback of unconditional decision maker

you can put all points or some of the points into a project. Each point not invested into the project goes automatically into the private account.

Total income You total income is the sum of your income from the private account plus the income from the project:

Income from private account (= 20—contribution to project) + income from project (= 0.4× sum of contributions to project
Total income

Each member of the group has to make two decisions: the unconditional contribution and the contribution table.

With the unconditional contribution, you state simply how many of the 20 points you invest into the project.

With the contribution table, you state, for each (rounded) average contribution of the others to the project, how much you want to contribute to the project.

Random choice Each member of the group has a membership number between 1 and 4. The participant in cubicle 1 will (with a four sided die) determine a random number between 1 and 4 and enter this number into the computer. If your number is chosen, then you are the randomly selected member.

For this randomly selected member, only the contribution table is relevant for the own contribution and for the payoff. For the other three members, who are not randomly selected members, only the unconditional contribution is relevant.

[[The following is only shown in CPun *and* UCPun*]]*:

Reduction decision In addition to the two contribution choices you also make a reduction decision. For this decision, you have to decide for each possible contribution of another player to the project by how many points the payoff of this player is reduced. This decision does not affect your own payoff.

[[in CPun*]]*
Only the reduction decision of the person whose contribution table is relevant for the decision will be implemented.

[[in UCPun*]]*
Only the reduction decision of one of the people whose contribution table is not relevant for the decision will be implemented.

I.e. if you are not a randomly selected member, i.e. if you unconditional contribution was relevant,

[[in CPun*]]*
then your reduction decision will not be implemented.
When you are a randomly selected member, i.e. your contribution table was relevant, then your reduction decision will be implemented.

[[in UCPun*]]*
then your reduction decision, or the decision of one of the other unconditional contributors, is implemented. Which of the three reduction tables of the three players who make an unconditional contribution is implemented, will be chosen by the computer. You will learn this choice at the end.
If you are a randomly selected member, i.e. your contribution table was relevant, then your reduction decision will not be implemented.

F.2 Screen Instructions

You are now taking part in an economic experiment. If you read the following instructions carefully, you can, depending on your decisions, earn a considerable amount of money. At the end of the experiment, your earned money will be added up and paid to you immediately in cash.

The instructions which we have distributed to you are solely for your private information. It is prohibited to communicate with the other participants during the experiment. Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments. If you have any questions please put your hand up. A member of the student team will come to you and answer your question privately.

During the experiment, we will not speak of Euros but rather of points. During the experiment, your entire earnings will be calculated in points. At the end of the experiment the total amount of points you have earned will be converted to Euros at the following rate:

1 point= 30 Eurocent

All participants will be divided into groups of four members. Except us, the experimenters, nobody knows who is in which group.

On the next pages, we will describe the exact procedure of the experiment.

The decision situation

You will learn later on how the experiment will be conducted. We first introduce you to the basic decision situation. At the end of the description of the decision, you will find control questions that help you to gain an understanding of the decision situation.

You will be a member of a group of 4 people. Each member has to decide on the division of 20 tokens. You can put these 20 tokens on a private account or you can invest them fully or partially into a project. Each token you do not invest into the project will automatically be transferred to your private account.

Your income from the private account:

For each token you put on your private account you will earn exactly one point. For example, if you put twenty tokens on your private account (which implies that you do not invest anything into the project) you will earn exactly twenty tokens from the private account. If you put 6 tokens into the private account, you will receive an income of 6 tokens from the private account. Nobody except you earns something from your private account.

Your income from the project

From the token amount you invest into the project, each group member will get the same payoff. Of course, you will also get a payoff from the tokens the other group members invest into the project. For each group member the income from the project will be determined as follows:

$$\text{Income from project} = \text{sum of contributions to the project} \times 0.4$$

For example, if the sum of all contributions to the project is 60 tokens, then you and all other group members will get a payoff of 60 $\times$ .4 = 24 points from the project. If the four group members together contribute 10 tokens to the project, you and all others will get a payoff of 10 $\times$ .4 = 4 points from the project.

Your total income:

Your total income results from the summation of your income from the private account and your income from the project.

Income from private account (= 20−contribution to project) + income from project (= 0.4× sum of contributions to project
Total income

The Experiment

The experiment contains the decision situation that we have just described to you. At the end of the experiment, you will get paid according to the decisions you make in this experiment. The experiment will only be conducted once.

As you know you will have 20 tokens at your disposal. You can put them into a private account or you can invest them into a project. In this experiment, each subject has to make two types of decisions. In the following, we will call them "unconditional contribution" and "contribution table".

- With the unconditional contribution to the project you have to decide how many of the 20 tokens you want to invest into the project. You will enter this amount into the following computer screen: *[[Insert Figure 10]]*

- Your second task is to fill out a "contribution table". In the contribution table, you have to indicate for each possible average contribution of the other group members (rounded to the next integer) how many tokens you want to contribute to the project. You can condition your contribution on the contribution of the other group members. This will be immediately clear to you if you take a look at the following screen. This screen will show up immediately after you have determined your unconditional contribution. *[[Insert Figure 11]]*

The numbers next to the input boxes are the possible (rounded) average contributions of the other group members to the project. You simply have to insert into each input box how many tokens you will contribute to the project - conditional on the indicated average contribution. You have to make an entry into each input box. For example, you will have to indicate how much you contribute to the project if the others contribute 0 tokens to the project, how much you contribute if the others contribute 1, 2, or 3 tokens etc. In each input box, you can insert all integer numbers from 0 to 20.

After all participants of the experiment have made an unconditional contribution and have filled out their contribution table, in each group a random mechanism will select a group member. For the randomly determined subject, only the contribution table will be the payoff-relevant decision. For the other three group members that are not selected by the random mechanism, only the unconditional contribution will be the payoff-relevant decision. When you make your unconditional contribution and when you fill out the contribution table you, of course, do not know whether you will be selected by the random mechanism. You will, therefore, have to think carefully about both types of decisions because both can become relevant for you. Two examples should make that clear.

Example 1: Assume that you have been selected by the random mechanism. This implies that your relevant decision will be your contribution table. For the other three group members, the unconditional contribution is the relevant decision. Assume they have made unconditional contributions of 0, 2, and 4 tokens. The average contribution of these three group members, therefore, is 2 tokens. If you have indicated in your contribution table that you will contribute 1 token if the others contribute 2 tokens on average, then the total contribution to the project is given by 0 + 2 + 4 + 1 = 7 tokens. All group members, therefore, earn .4 × 7 = 2.8 points from the project plus their respective income from the private account. If you have instead indicated in your contribution table that you will contribute 19 tokens if the others contribute two tokens on average, then the total contribution of the group to the project is given by 0 + 2 + 4 + 19 = 25. All group members, therefore, earn .4 × 25 = 10 points from the project plus their respective income from the private account.

Example 2: Assume that you have not been selected by the random mechanism which implies that for you and two other group members the unconditional contribution is taken as the payoff-relevant decision. Assume your unconditional contribution is 16 tokens and those of the other two group members is 18 and 20 tokens. The average unconditional contribution of you and the two other group members, therefore, is 18 tokens. If the group member who has been selected by the random mechanism indicates in her contribution table that she will contribute 1 token if the other three group members contribute on average 18 tokens, then the total contribution of the group to the project is given by 16 + 18 + 20 + 1 = 55 tokens. All group members will, therefore, earn .4 × 55 = 22 points from the project plus their respective income from the private account. If instead, the randomly selected group member indicates in her contribution table that she contributes 19 if the others contribute on average 18 tokens, then the total contribution of that group to the project is 16 + 18 + 20 + 19 = 73 tokens. All group members will, therefore, earn .4 × 73 = 29.2 points from the project plus their respective income from the private account.

[[The following is only shown in CPun *and* UCPun*]]*:

In addition to both contribution decisions, you have to make a reduction decision. In the reduction decision, you have to indicate for every possible contribution decision of a player to the project, by how many points you want to reduce the payoff of this player. Hence, you can decide how much you want to reduce the payoff of this other player conditional on his contribution.

This decision will not impact your payoff.

[[Insert Figure 12]]

The numbers next to the input boxes are the possible (rounded) contributions of another group member. You simply have to insert into each input box by how many tokens you want to reduce the payoff of another player- conditional on his indicated contribution. You have to make an entry into each input box. For example, you will have to indicate by how many points you want to reduce the payoff of another player if he contributes 0 tokens to the project, by how many tokes you want to reduce his payoff if he contributes 1, 2, or 3 tokens etc. In each input box, you can insert all integer numbers from 0 to 10.

[[in CPun*]]*
Only the reduction decision of the person whose contribution table is payoff relevant will be implemented. I.e. if you have not been randomly determined, i.e. the unconditional contribution is payoff-relevant for you, then your reduction decision will not be implemented. If you are the randomly determined subjects, i.e. the contribution table is payoff-relevant for you, then your reduction decision will be implemented.

[[in UCPun*]]*
Only the reduction decision of one of the persons, who were not randomly determined, will be implemented. I.e. if you have not been randomly determined, i.e. the unconditional contribution is payoff-relevant for you, then your reduction decision (or the reduction decision of one of the other unconditional contributors) will be implemented. Which of the three reduction decision, of the unconditional contributions, will be implemented, will be determined randomly by the computer and announced at the end of the experiment.
If you are the randomly determined subjects, i.e. the contribution table is payoff-relevant for you, then your reduction decision will not be implemented.

[[The following is only shown in CPun*]]*:

Example 1: Assume that you have been selected by the random mechanism. This implies that your relevant decision will be your contribution table. This also implies that your reduction decision will be implemented. For the other three group members the unconditional contribution is the relevant decision and hence, their reduction decision will not be implemented.

Assume they have made unconditional contributions of 0, 2, and 4 tokens.

If you have indicated in your reduction decision that the payoff of a subject will be reduced by 2 tokens, if this subjects contributed 0, and that the payoff of a subject will be reduced by 1 token, if this subjects contributed 2, and that the payoff of a subject will be reduced by 1 tokens, if this subjects contributed 4, then the payoff of the first subject (who happen to contribute 0) will be reduced by 2, the payoff of the second subject (who happen to contribute 2) will be reduced by 1, and the payoff of the third subject (who happen to contribute 4) will be reduced by 1.

If instead you have indicated in your reduction decision that the payoff of a subject will be reduced by 4 tokens, if this subjects contributed 0, and that the payoff of a subject will be reduced by 6 tokens, if this subjects contributed 2, and that the payoff of a subject will be reduced by 8 tokens, if this subjects contributed 4, then the payoff of the first subject (who happen to contribute 0) will be reduced by 4, the payoff of the second subject (who happen to contribute 2) will be reduced by 6, and the payoff of the third subject (who happen to contribute 4) will be reduced by 8.

Example 2: Assume that you have not been selected by the random mechanism which implies that for you and two other group members the unconditional contribution is taken as the payoff-relevant decision. Hence, your reduction decision will not be payoff-relevant.

Assume your unconditional contribution is 16.

If the randomly determined subject indicated that the payoff of a subject should be reduced by 2, if this subject contributed 16, then your payoff will be reduced by 2.

If instead, the randomly determined subject indicated that the payoff of a subject should be reduced by 0, if this subject contributed 16, then your payoff will be reduced by 0.

[[The following is only shown in UCPun*]]*:

Example 1: Assume that you have been selected by the random mechanism. This implies that your relevant decision will be your contribution table. This also implies that your reduction decision will not be implemented. For the other three group members the unconditional contribution is the relevant decision and hence, their reduction decision of one of the three members (determined randomly by the computer) will be implemented. This subject is reduction-relevant.

Assume your conditional contribution is 16.

If the reduction-relevant subject indicated in the reduction decision that the payoff of a subject should be reduced by 2, if this subject contributed 16, then your payoff will be reduced by 2.

If instead, the reduction-relevant subject indicated in the reduction decision that the payoff of a subject should be reduced by 0, if this subject contributed 16, then your payoff will be reduced by 0.

Example 2: Assume that you have not been selected by the random mechanism which implies that for you and two other group members the unconditional contribution is taken as the payoff-relevant decision. Assume that you are reduction-relevant.

Assume further that the unconditional contributions of the other two are given by 0 and 2 and the conditional contribution of the third subjects is 4 tokens.

If you have indicated in your reduction decision that the payoff of a subject will be reduced by 2 tokens, if this subjects contributed 0, and that the payoff of a subject will be reduced by 1 token, if this subjects contributed 2, and that the payoff of a subject will be reduced by 1 tokens, if this subjects contributed 4, then the payoff of the first subject (who happen to contribute 0) will be reduced by 2, the payoff of the second subject (who happen to contribute 2) will be reduced by 1, and the payoff of the third subject (who happen to contribute 4) will be reduced by 1.

If instead you have indicated in your reduction decision that the payoff of a subject will be reduced by 4 tokens, if this subjects contributed 0, and that the payoff of a subject will be reduced by 6 tokens, if this subjects contributed 2, and that the payoff of a subject will be reduced by 8 tokens, if this subjects contributed 4, then the payoff of the first subject (who happen to contribute 0) will be reduced by 4, the payoff of the second subject (who happen to contribute 2) will be reduced by 6, and the payoff of the third subject (who happen to contribute 4) will be reduced by 8.

[[The following is shown in all treatments]]:

The random selection of the participants will be implemented as follows. Each group member is assigned a number between 1 and 4. The participant in the first cubicle will, after all participants have made their unconditional contribution and have filled out their contribution table [In CPun and UCPun: and have filled out their reduction table], throw a 4-sided die. The number that shows up will be entered into the computer. If the thrown number equals the membership number that has been assigned to you, then for you your contribution table will be relevant [In CPun: and your reduction decision will be implemented] and for the other group members the unconditional contribution will be the payoff-relevant decision [In UCPun: and his reduction decision will be implemented]. Otherwise, your unconditional contribution is the relevant decision [In CPun: and your reduction decision will not be implemented] [In UCPun: and your reduction decision will be implemented, if you are randomly selected by the computer].

F.3 Control questions

1. Each group member has 20 tokens at his or her disposal. Assume that none of the four group members (including you) contributes anything to the project. What will your total income be? What is the total income of the other group members?

2. Each group member has 20 tokens at his or her disposal. Assume that you invest 20 tokens into the project and each of the other group members also invests 20 tokens. What will be your total income? What is the total income of the other group members?

3 Each group member has 20 tokens at his or her disposal. Assume that the other three group members together contribute 30 tokens to the project.
What is your total income if you - in addition to the 30 tokens - contribute 0 tokens to the project?
What is your income if you - in addition to the 30 tokens - contribute 8 tokens to the project?

What is your income if you - in addition to the 30 tokens - contribute 15 tokens to the project?

4 Each group member has 20 tokens at his or her disposal. Assume that you invest 8 tokens to the project.
What is your total income if the other group members - in addition to your 8 tokens - together contribute 7 tokens to the project?
What is your total income if the other group members - in addition to your 8 tokens - together contribute 12 tokens to the project?
What is your income if the other group members - in addition to your 8 tokens contribute 22 tokens to the project?