

Choosing the Carrot or the Stick? – Endogenous Institutional Choice in Social Dilemma Situations[#]

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Abstract

We analyze an experimental public goods game in which group members can *endogenously* determine whether they want to supplement a standard voluntary contribution mechanism with the possibility of rewarding or punishing other group members. We find a significantly positive effect of endogenous institutional choice on the level of cooperation in comparison to the same exogenously implemented institutions. This suggests that participation rights enhance cooperation in groups. With endogenous choice, groups typically vote for the reward option, although punishment is even more effective in sustaining high levels of cooperation. Our results are evaluated against the predictions of social preference models.

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1 Introduction

In this paper we study cooperation in social dilemma situations using an experimental public goods game. In contrast to most of the previous work, we let subjects decide endogenously on the institutions governing their interactions. In particular, subjects can vote on whether they want to supplement a standard voluntary contribution mechanism (VCM) with the possibility of rewarding or punishing other subjects or whether they prefer to use the standard VCM. We find that the endogenous institutional choice has a positive effect on cooperation levels in the public goods game compared to a setting in which the same institutions have been determined exogenously (by the experimenter). This suggests that participation rights foster cooperation.

By varying the effectiveness of the available punishment or reward technology (defined as the ratio of monetary consequences of being punished or rewarded to the costs of punishing or rewarding), we can show that the reward option is chosen almost exclusively when reward or punishment are highly effective. However, the standard VCM is the preferred institution when the technology is less effective. The punishment option – though very effective in raising contributions – is only very rarely chosen endogenously, indicating that most subjects prefer an institutional environment without punishment.

We compare our results to predictions based on standard game theoretic analysis (under the assumptions of rationality and selfishness) and predictions derived from two prominent social preference models (Fehr and Schmidt, 1999, and Charness and Rabin, 2002). While the standard game theoretic model essentially fails to explain contributions and institutional choices, the models with social preferences are able to predict many, albeit not all, behavioral regularities in our experiment.

Our paper is related to a large number of studies dealing with the conditions and institutions that foster cooperation in social dilemma situations. Over the past decade, the effects of reward and punishment on cooperation in social dilemma games have received considerable attention, for instance in Fehr and Gächter (2000, 2002), Andreoni, Harbaugh and Vesterlund (2003), Masclet et al. (2003), or Sefton, Shupp and Walker (2007). These and most other papers discussed in the next section share the feature that the institution governing the interaction of subjects has been determined exogenously by the experimenters. Although the existing studies have provided illuminating and very important insights into the determinants of cooperation in groups, they are unable to answer two straightforward questions that are central to our paper: (1) Which institutions

do subjects actually prefer and choose themselves in a social dilemma? (2) How does the endogenous choice of rules affect group members' interaction and their level of cooperation? The answers to both questions are important in order to judge whether the inferences about the treatment effects of different – but exogenously imposed – institutions are reliable and can be generalized to situations where subjects can self-select or avoid certain institutions through an endogenous choice.

In real-life social dilemmas, groups often set the (explicit or implicit) rules that determine their interaction themselves. On a large-scale international level, for instance, one might think of the United Nations Framework Convention on Climate Change, the so-called Kyoto-protocol, or the United Nations Security Council. Representatives in these organizations establish rules – and possible sanctions in case of their violation – on how to provide the public good of carbon dioxide emission reduction or global security. Regarding small group interactions, work teams in companies or sports teams typically develop social norms on how to deal with 'rate busters' or on how to reward team members for contributions to the team success.

Seen from a broader perspective, our approach of endogenous institutional choice is linked to the question whether democratic participation rights have an influence on individual behavior. Frey (1994), Frey, Benz and Stutzer (2004), or Pommerehne and Weck-Hannemann (1996), for instance, have studied the effects of the degree of direct-democratic participation rights (as a form of endogenous institutional choice) on the level of cooperation among citizens and between citizens and the public sector. Their findings indicate that stronger direct-democratic participation rights increase cooperation and reduce, for example, tax evasion.¹ In our experiment we can examine how the decision to participate in the vote on the institution is linked to a subject's contribution level in the public goods game and to her punishing and rewarding behavior. Hence, we can establish a link between voting and economic decision making. We are also able to measure the economic benefit of an endogenous institutional choice by comparing contributions under the endogenous choice with contributions under identical, but exogenously determined,

¹ See also Feld and Tyran (2002). Alm, McClelland and Schulze (1999) analyze how voting on tax enforcement affects compliance behavior in a tax evasion experiment where taxes are used for providing public goods. They find that most voters do not support enforcement of penalties on tax evasion, which consequently drives down compliance rates.

institutions (a comparison that is hardly possible with field data). Our results provide clear evidence that endogenous institutional choice yields substantial benefits to cooperation.

The remainder of this paper is structured as follows. In Section 2 we give a brief overview of the related literature. Section 3 presents the public goods game and the different institutions that can be implemented in our setting. Section 4 describes our experimental design in detail, and in Section 5 we derive predictions on contribution levels and on voting behavior. Section 6 reports the experimental results, devoting one subsection to the issue of voting and potential selection of types into different institutions. Section 7 discusses our findings and concludes the paper.

2 A brief review of related literature

Our paper builds upon a considerable number of studies on the effects of *exogenously* imposed reward and punishment options in social dilemmas. Fehr and Gächter (2000, 2002) have analyzed the contributions to a public good when subjects can punish each other after having observed the other group members' contributions. Even though using the punishment option is at odds with selfish money-maximization in their experimental design, it is used rather frequently, thereby inducing very high levels of cooperation.²

One of the few papers on VCMs that take reward into account is Sefton et al. (2007). They have included a reward option in their public goods experiments. Like punishment, reward has been found to increase cooperation in comparison to the standard VCM-setting. Reward, however, seems to be less suitable for sustaining high levels of cooperation, as the decay of contributions over time is faster with the reward option than with the punishment option (see also Fehr and Gächter, 2003).

Decker, Stiehler and Strobel (2003) were the first to let subjects choose endogenously between different voting rules for executing punishment against group

² Masclet et al. (2003) have addressed the question whether the monetary consequences of punishment strengthen cooperation or whether the expression of disapproval of another subject's behavior through punishment is possibly equally or even more important. They have compared a public goods game with monetary sanctions to one with only symbolic, non-monetary sanctions. Cooperation remains higher with the monetary sanctions, but even the non-monetary sanctions raise cooperation levels above those in the standard VCM. Rege and Telle (2004) also report a positive effect of (non-monetary) social (dis)approval on cooperation in a public goods game.

members. They let group members propose their desired punishment intensity for each group member, and then they let subjects submit bids in a first-price auction regarding whether the execution of punishment shall require a simple majority or unanimity. It turns out that a unanimity rule is preferred (and receives higher bids). A related paper by Ertan, Page and Putterman (2009) shows that most groups rule out the possibility of punishing high contributors, but they implement an institution where the punishment of low contributors is possible. Kroll, Cherry and Shogren (2007) study the role of punishment in another context where group members can vote on non-binding minimum contributions to a public good. When failure to comply with the non-binding minimum can be punished, contributions increase significantly. Thus, it is not the outcome of the non-binding vote that is important for higher contributions in their setting, but the possibility of punishing defectors. Guillen et al. (2006) examine how the introduction of a (costly) central punishment agency affects contribution behavior in a threshold public goods game. They want to see if contributions to the public good are higher when subjects can actually decide by themselves whether or not the central punishment agency is needed. They find no effects of the vote, but all groups vote against the punishment agency, although the latter facilitates meeting the threshold considerably. Both Decker et al. (2003) and Ertan et al. (2009) do not compare their endogenous treatments with behavior under identical, but exogenously imposed institutions, as we will do. A further difference is that Decker et al. (2003) do not let groups choose whether they want to have a punishment option or not, while Kroll et al. (2007) and Guillen et al. (2006) allow groups to vote on punishment options. However, those two papers do neither consider a reward option, nor is the act of voting voluntary and costly in their designs. The latter feature will allow us to link voting and contribution behavior. Finally, none of these papers considers several levels of effectiveness of punishment and reward.³

Two papers are closest to the research questions in our paper. Botelho et al. (2005) extend the design of Fehr and Gächter (2000, 2002) by allowing subjects to choose directly whether they want to interact under a punishment institution or under a standard VCM. After subjects have experienced both the VCM and the VCM with the punishment option in a (partly perfect) stranger design, they can choose the governing institution for one final

³ Note that there is also a literature on endogenous group formation in social dilemmas (see Page, Putterman and Unel, 2005, or Charness and Yang, 2008, for instance). This literature does not directly address the issue of endogenous institutional choice, though.

round (with substantially increased salience). Botelho et al. (2005) find that almost none of their cohorts opt for the punishment institution. From an ex-post point of view, this choice is justified because the overall efficiency of interactions (including punishment costs) is significantly lower in the condition with punishment than without punishment. Compared to Botelho et al. (2005), our experiment considers not only a punishment, but also a reward institution, which will be shown to be rather attractive among groups when it is compared to the punishment institution. Furthermore, we use a partner design because we are mainly interested in the institutional choice of groups whose members will interact repeatedly after an initial decision on the governing institution. Finally, in contrast to Botelho et al. (2005) our subjects may abstain from participating in the vote. We are, therefore, able to draw inferences on the relationship between vote participation and behavior in the public goods game.

Güerker, Irlenbusch and Rockenbach (2006) study the *self-selection of individuals* into groups with an *exogenously given* institution. They find that subjects self-select into groups where they can both punish and reward other group members much more often than into groups with a standard VCM procedure only. Our approach is different in several aspects: First, we let *groups vote for the institution* that shall apply to their interaction. Therefore, our approach resembles a choice of rules within a fixed group in contrast to the voting by feet-approach of Güerker et al. (2006). Second, we compare the attractiveness of reward and punishment when they are equally effective and when subjects can choose directly between both institutions. In Güerker et al. (2006) punishment had much stronger consequences than reward. Separating punishment and reward – as we do in our paper – allows comparing the relative effects of both instruments. Third, in Güerker et al. (2006) subjects could switch between different institutions as often as they wished to without any costs. In our design, we implement small costs of voting in order to be able to assess potential effects of vote participation on cooperation as well as on sanctioning and rewarding behavior. Group members are not required to participate in this vote, but those abstaining are bound by the collective decision of voters in their group.⁴

⁴ Another contribution with endogenous institutional choice using a public goods game is Potters, Sefton and Vesterlund (2005). They examine endogenous sequencing in a voluntary contribution game with asymmetric information among players.

3 Our public goods setup

Let $I = \{1, 2, \dots, n\}$ denote a group of n subjects who interact in T periods. In each period $t \in \{1, 2, \dots, T\}$ individual $i \in I$ receives an endowment E which can be allocated either to a private good or a public good. The voluntary contribution of individual i to the public good in period t must satisfy $0 \leq c_{i,t} \leq E$. Let C_t denote the sum of all group members' contributions (i.e. $C_t = \sum_{j=1}^n c_{j,t}$). Individual member i 's payoff from her contribution in period t is given by

$$\pi_{i,t} = E - c_{i,t} + \gamma C_t \quad (1)$$

The marginal per capita return (MPCR) from investing into the public good is denoted as γ , which satisfies $0 < \gamma < 1 < n\gamma$, meaning that the self-interested choice and the socially optimal one are in conflict.

We consider three variants of this basic game: (i) the standard voluntary contribution mechanism (VCM) as it has just been described, (ii) the VCM with a punishment option, and (iii) the VCM with a reward option. In the standard VCM, all decisions are made simultaneously and each period has only one stage (the contribution stage). In the VCM with punishment (reward) each period has two stages, first the contribution stage and, thereafter, a punishment (reward) stage. In the second stage, group members receive information about the other members' contributions and can punish (reward) each of the other group members. Punishment is costly for the punisher and the punished subject. Reward is costly for the rewarding subject and beneficial for the rewarded subject.

We implement reward or punishment as a *binary* decision. Hence, a group member cannot choose between different intensities of reward or punishment. The effectiveness of reward or punishment, however, is exogenously varied. We use the term “leverage” and the symbol L to refer to different technologies. We consider $|L| = l$ or $|L| = h$, with $h > l$. A higher leverage means that the same choice of punishing or rewarding another subject has larger monetary consequences for the punished or rewarded subject (keeping constant the costs for the subject who punishes or rewards).⁵

⁵ The reason for choosing such a binary form of reward and punishment is that we wanted to keep the design simple so that subjects fully understood the available institutions in the endogenous treatments. Any more complicated reward or punishment technology would have made the choice task of the participants more difficult and would not have added important further insights.

Taking into account the monetary consequences of the second stage in each period yields the following payoff function for member i in the VCM with punishment or reward.

$$\pi_{i,t} = E - c_{i,t} + \gamma C_t + L \sum_{k \neq i} p_{ik,t} - \sum_{h \neq i} p_{hi,t} \quad (2)$$

where $p_{hk,t} = 1$ if member k has punished (rewarded) member h in period t and zero otherwise.⁶ The sign of the parameter L indicates whether punishment ($L < 0$) or reward ($L > 0$) applies. The absolute value of L captures the effectiveness of the punishment (reward) technology, with a larger $|L|$ indicating a stronger effect (a higher leverage) of one's own actions on the profits of others.⁷

4 Experimental design and procedure

Our experimental treatments were based on the public goods games introduced in the previous section. The parameters were set as follows: group size $n = 4$, endowment per period $E = 20$ ECU (experimental currency unit), MPCR $\gamma = 0.4$, and number of periods $T = 10$. We used a design that systematically varies the following three factors:

F1. The institution governing the provision of the public good: (i) the *standard VCM*, (ii) the VCM with *punishment*, or (iii) the VCM with *reward*.

F2. The leverage of punishment or reward: (i) $|L| = 1$ or (ii) $|L| = 3$.⁸

⁶ Normalizing the cost of punishment (reward) is always possible by an appropriate choice of L . Note that if the last two terms in equation (2) are dropped (or the punishment and reward option are not used), we are back in the standard VCM given by equation (1).

⁷ Needless to say, it is impossible to design a straightforward mechanism where punishment and reward are equivalent in terms of efficiency, unless the Nash equilibrium (assuming selfishness and common knowledge of rationality) is played. By nature, costly punishment makes everybody worse off if used, whereas costly reward has the potential of increasing overall efficiency (if $|L| > 1$). Since all real-world sanction and reward mechanisms have this feature, it seems natural to preserve it when studying the choice between reward and punishment in the laboratory.

⁸ Though one can find a wide range of technologies for the *punishment* option (ranging from a 1:1 ratio in Sefton et al., 2007, to a 1:5 ratio in Andreoni et al., 2003), the comparative statics of different technologies on contribution levels have only recently been examined systematically. See Anderson and Putterman (2006), Carpenter (2007), Egas and Riedl (2008), Masclet and Villeval (2008), Nikiforakis and Normann (2008), Casari and Luini (2009), or the survey in Casari (2005).

F3. The way in which the institution is determined: (i) *exogenously* by the experimenter or (ii) *endogenously* by the group itself through a voting procedure.

Table 1 summarizes our experimental treatments and the number of independent observations (i.e. groups) in each treatment. Note that we used a partner matching.

Table 1 about here

The first two factors of our design have been explained in the previous section. The way in which the institution is determined (factor F3) requires some additional explanation. In the exogenous treatments, the institutions were simply pre-determined by the experimenter. Participants in these sessions were informed in the experimental instructions about the institution under which they were playing the public goods game.

In the endogenous treatments, participants were introduced to all three possible institutions and could determine the institution prevailing in their group by the following procedure: First, subjects had to decide whether they wanted to participate in a costly vote on the institution. Voters incurred a small *one-time* fee of 10 ECU (equal to 5% of the sum of the individual endowment over the ten periods). Non-voters did not incur any costs, but were aware that the decision of voters in their group would be binding for them. The voting cost allows us to get rid of theoretical cases of indifference regarding voter turnout and to analyze connections between voter turnout and behavior in the public goods game. Then, the following approval voting protocol with simultaneous choices of all voters was applied: Each voter had to indicate for each available institution (*standard-VCM*, *punishment*, or *reward*) whether she was willing to accept this institution or not. It is important to note here that the endogenous choice was always restricted to a given leverage $|L|$. Hence, in one endogenous experimental treatment subjects could choose between the standard VCM, punishment with $|L| = 1$, or reward with $|L| = 1$. In the other endogenous experimental treatment, the leverage was always $|L| = 3$.

The voting outcome was determined as follows: If unanimous consent for any of the three institutions was not reached in the first ballot, the vote was repeated until unanimity (for at least one institution) was achieved.⁹ In the case of a unanimous consent of all voters

⁹ There was no upper limit on the number of voting rounds. In the results section we will show that most groups reached a consensus rather quickly. Remember that the costs of participating in the vote were one-

for exactly one institution, this institution was implemented in the public goods game for all ten periods. If more than one institution had received unanimous support, then the institution was determined by a random draw from the tied institutions. Finally, if none of the four group members had participated in the vote, then the institution was determined randomly in order to avoid creating a bias by imposing a default institution.

Voters were always informed about the total number of voters in their group, and after each voting round they were also informed about the number of votes each institution had received. Voting decisions were secret in the sense that they could not be linked to individual behavior in the consecutive public goods game.

One noteworthy feature of our design is that there was no play of the VCM before participants decided on whether to vote and what to vote for. While one might claim that this is a disadvantage of our design – because subjects had to make an institutional choice before having experienced a particular institution – we believe it is rather a strength, given that we are mainly interested in the kind of rules that subjects prefer when facing a social dilemma situation. As such, our focus is on the initial choice of rules and not on how the choice of rules depends on previous experience with different rules.¹⁰

In the punishment or reward stage that followed the contribution stage, subjects were informed about the contributions of all group members, and (if applicable) could decide on which members to punish or reward. It was possible to punish or reward any other member and also more than one group member. At the end of each period subjects were again informed about the other members' contributions, and about the decisions on punishment and reward (if applicable) and the resulting payoffs. Each member of a group had a unique ID. Contributions to the public good could be assigned to this ID throughout the experiment. However, decisions on reward and punishment as well as profits of other

time and, thus, independent of the number of voting rounds, and this was common knowledge. We do not argue that our voting mechanism is actually applied to real-world institutions for social dilemmas. We are confident, however, that its structure comes close to more or less tacit agreements on the implementation of sanctions and rewards in many small groups in real life and also to the decision making in institutional arrangements in larger international organizations, like in the context of the Kyoto protocol or World Trade Organization negotiation rounds (where unanimity is often required to implement an institution).

¹⁰ In order to check whether more experience with the game could lead to different results regarding the endogenous choice, we asked subjects in a post-experimental questionnaire whether they would stick to their institutional decision if the experiment had continued or whether they would then support another institution. The results (see Section 6.2.1) reinforce our conclusions based on initial choices.

players in one's group could not be linked to the ID. Hence, subjects could not identify other members' profits and which other group member had punished or rewarded them. This was done in order to avoid retaliation (of one member punishing another for having been punished by the other member in the past).¹¹

Notice that our binary punishment or reward technology is comparatively very weak. Given our experimental parameterization (see Section 4 for details) the monetary consequences of reward or punishment can account for at most 15% (with low effectiveness), respectively 45% of a subject's endowment (when reward and punishment are highly effective), which is much less than in all papers in the tradition of Fehr and Gächter (2000) where punishment could reach up to 100% of one's earnings per period. If we find positive effects of punishment and reward with our weak, binary technology, it seems reasonable to expect that a stronger technology with a broader range of intensities would also have positive (and perhaps even stronger) effects on contribution levels.

In the exogenous treatments we had in total 200 participants, yielding ten independent observations for each of the five different exogenous treatments (i.e. VCM, punishment with $L = -1$ or $L = -3$, and reward with $L = 1$ or $L = 3$). In the endogenous treatment we let 160 participants choose their desired institution when the leverage of reward or punishment was fixed at $|L| = 1$. Hence, we have 40 independent observations for the institutional choice with the low leverage. In addition, we had another 80 participants (i.e. 20 independent groups) choosing the institution under the high leverage $|L| = 3$.

In sum, 440 students drawn from the general undergraduate population at the University of Innsbruck participated in the computerized experiment (using z-Tree by Fischbacher, 2007). No subject was allowed to participate in more than one session and none of them had participated in a public goods experiment before.¹² Decisions were taken anonymously in cubicles and communication among participants was not permitted. The average session length was less than one hour, and subjects earned about 10 € on average.

¹¹ Such "counter-punishment" on the individual level is documented and analyzed in Denant-Boemont, Masclet and Noussair (2007) and Nikiforakis (2008), for instance. Of course, getting punished could also lead to unspecific retaliation by increasing a subject's general propensity to punish others.

¹² The experimental instructions for the endogenous choice treatment under $|L| = 3$ can be found in the online supplement (Appendix A). The instructions for the other treatments are analogous and available upon request.

5 Theoretical predictions

We derive theoretical predictions for three different models of subjects' preferences. The first model is the standard *homo oeconomicus*-model, which assumes that decision makers are rational and purely selfish. The two other models belong to the group of social preference models. The versions of the social preference models that we use are tractable for deriving clear predictions, in particular for the case of our vote on institutions. It is important to note that our experiment is by no means designed to deliver a rigorous test of the empirical validity of these models. Their application to our setting simply allows us to organize our theoretical predictions in a systematic way.

In our first model with social preferences, the model of inequity aversion by Fehr and Schmidt (1999), the utility of subject i in a set of n subjects depends on the vector of monetary payoffs $\pi = (\pi_1, \dots, \pi_n)$ in the following form:

$$U_i(\pi) = \pi_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{\pi_j - \pi_i, 0\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} \max\{\pi_i - \pi_j, 0\} \quad (3)$$

with $\beta_i \leq \alpha_i$ and $0 \leq \beta_i < 1$. The second term on the right-hand side of equation (3) captures the utility losses from disadvantageous inequality towards other group members (with weight α_i), and the third term the losses from advantageous inequality (with weight β_i). A desire to reduce inequality among group members may be one of the motivations for using instruments like punishment or reward.¹³

As our second model with social preferences we use the outcome-based version of the model by Charness and Rabin (2002), since the version of their model that takes intentions into account does not seem suitable to derive clear theoretical predictions for the institutional vote in our setup. The outcome-based model assumes that subjects care about social welfare, which includes the minimum payoff in the group and the sum of all group members' payoffs. More specifically, in their general model Charness and Rabin (2002, see their Appendix 1) define a subject's distributional preferences in a set of n subjects with $\pi = (\pi_1, \dots, \pi_n)$ as the vector of monetary payoffs in the following form:

$$U_i(\pi) = (1 - \lambda)\pi_i + \lambda[\delta \min(\pi_1, \dots, \pi_n) + (1 - \delta)(\pi_1 + \pi_2 + \dots + \pi_n)] \quad (4)$$

¹³ In fact, Fehr and Schmidt (1999) have applied their model to a public goods game with punishment. They have not used it for rewards, though, nor for a setting with endogenous choice between reward and punishment.

The weight a subject assigns to social welfare relative to the own payoff is measured by $\lambda \in [0,1]$. Note that setting $\lambda = 0$ captures the case of pure self-interest as in the *homo oeconomicus*-model. The weight $\delta \in [0,1]$ is attached to the “maximin”-aspect of social welfare, and the weight $1-\delta$ applies to total-surplus maximization. Since social welfare aspects seem particularly relevant for the reward institution with $L = 3$ we regard the distributional version of the model by Charness and Rabin (2002) as a valuable complement to the Fehr and Schmidt (1999)-model for deriving theoretical predictions.¹⁴

The main predictions from the three models are summarized in Table 2. They rely on the assumptions of common knowledge of rationality and risk neutrality. The finitely repeated game is solved through backward-induction. For the sake of succinctness, we discuss in this section only the main intuition for the theoretical results of Table 2. The interested reader is referred to the online supplement (Appendix B) for formal derivations, proofs and more information.

Table 2 about here

5.1 Predictions with standard preferences

A rational money-maximizing agent will abstain from costly punishment or reward. Hence, contributions do not depend on the availability of punishment or reward, irrespective of their leverage. Since free-riding is a dominant strategy due to $\gamma < 1$, all institutions will lead to zero contributions. As a consequence, subjects should be indifferent between the available institutions in the endogenous treatments and, thus, abstain from voting in order to save the voting costs (see the first column in Table 2).

5.2 Predictions with Fehr and Schmidt (1999)-preferences

Taking inequity aversion into account leads to the existence of equilibria with positive contributions in the standard VCM, because if a subject’s aversion against *advantageous* inequity is strong enough, she may refrain from free-riding (if $\gamma + \beta_i \geq 1$). However, if at least one group member satisfies $\gamma + \beta_i < 1$, positive contributions cannot be

¹⁴ There are several other suitable models of social preferences (such as Bolton and Ockenfels, 2000) and a large number of interesting intention-based models (e.g., Rabin, 1993; Falk and Fischbacher, 2006) that we cannot examine here.

sustained in equilibrium for our parameters (see [A] and [B] in the second column of Table 2).

The same equilibria [A] and [B] also prevail with punishment or reward under the low leverage $|L| = 1$, and even with reward under $L = 3$, since punishment with a low leverage does not constitute a credible threat to prevent free-riding and since the incentive to receive rewards is not sufficient to make free-riders contribute under both possible leverages.

Only with a high-leverage punishment option it is possible for cooperators (who satisfy $\gamma + \beta_i \geq 1$) to enforce positive contributions \bar{c} also from free-riders. Let n' denote the number of cooperators in a group, then $\bar{c} = n'L/(1-\gamma) > 0$ can be enforced from free-riders. Punishment is a credible threat in this case, because cooperators would be able to reduce the disadvantageous inequality caused by free-riding through punishment. In equilibrium, all group members thus contribute \bar{c} , and punishment is never used.

In summary, the predictions on contributions are the same for the standard VCM and punishment or reward with the low leverage $|L| = 1$ (see panel (B) in Table 2). Hence, subjects should abstain from the vote under $|L| = 1$. Since under punishment with $|L| = 3$ a positive contribution \bar{c} can be enforced, cooperators should vote for punishment then.

5.3 Predictions with Charness and Rabin (2002)-preferences

The distributional version of the Charness and Rabin (2002)-model predicts for the standard VCM that subjects who weigh social welfare at least as strongly as their own payoffs (requiring $\lambda_i \geq 0.5$) will contribute their full endowment (see the right-most column in Table 2). For all subjects with $\lambda_i < 0.5$, free-riding is a dominant strategy.

Adding a punishment option does not change any of these predictions, because relatively selfish group members (those with $\lambda_i < 0.5$) would contribute positive amounts only if the threat of getting punished for zero contributions was credible. The latter is not the case, though, since a punishing group member would reduce her own payoff and the group's total payoff and punishment would never increase the minimum payoff in the group.

The reward option is a useful tool to induce positive contributions, however. This is straightforward for the case of $L = 3$, where subjects who care much for social welfare (who satisfy $\lambda_i \geq 0.5$ and thus contribute $c_i = 20$; their number is denoted by n') can

enforce a positive contribution of $\bar{c} = n''L/(1-\gamma)$ even from subjects who care less for social welfare (with $\lambda_i < 0.5$). This enforcement rests on rewarding the latter subjects for contributing \bar{c} . For the case of $L = 1$, the same argument applies, but reward can only be part of an equilibrium strategy (and thus \bar{c} can only be enforced) if there are n'' subjects who care quite a lot for social welfare and largely disregard their own payoff (by satisfying $\lambda_i \geq 0.75$).

These predictions imply that subjects who care a lot for social welfare should participate in the vote in our endogenous treatments and support the reward option in order to be able to enforce positive contributions from subjects who care little for social welfare (and who do not participate in the vote).¹⁵

6 Experimental results

6.1 Behavior with exogenously determined institutions

Figure 1 displays the time trend of contributions in the treatments with exogenous institutions, and the upper panel [1] of Table 3 reports the overall averages. Contributions are lowest in the standard VCM-treatment, where subjects contribute on average 32.5% of their endowment (= 6.50 out of 20 ECU). This is clearly above the zero contribution level expected under the standard approach of common knowledge of rationality and selfishness, but it is not ruled out when taking into account social preferences. With the low leverage $|L| = 1$, the average contributions are only slightly higher with punishment (8.79) or with reward (6.62) than in the standard VCM. Contribution levels under the high leverage $|L| = 3$ are considerably higher, though, both with punishment (12.11) and reward (11.20).

Figure 1 and Tables 3 and 4 about here

Table 4 shows in column [1] the results of a panel tobit regression with random effects that studies the determinants of a subject's contributions in the exogenous treatments. Contributions in the standard VCM constitute the baseline. One can see that the variable *period* has a significantly negative effect, indicating the decay of contributions over time. Reward with the low leverage $|L| = 1$ does not increase contributions

¹⁵ This conclusion relies on the assumption that voting costs are small (see online Appendix B for details).

significantly (which is in line with the predictions based on Fehr and Schmidt (1999)-preferences and which is not ruled out using the Charness and Rabin (2002)-model either. Punishment has a significantly positive effect on contributions even with the low leverage, which cannot be rationalized by our social preference models. With the high leverage $|L| = 3$, both reward and punishment increase contributions significantly in comparison to the standard VCM, but also in comparison to the same institutions with the low leverage (Wald test, $p < 0.01$ both for punishment and reward).

Result 1. *When the institution is fixed exogenously and when $|L| = 1$, reward has no significant impact on contributions, while punishment has a small positive effect. When punishment or reward are highly effective ($|L| = 3$), both institutions trigger significantly higher contribution levels than the standard linear VCM and than the punishment and reward institutions under $|L| = 1$.*

Looking at profits in panel [1] of Table 3 it becomes evident that profits are not significantly different between the standard VCM and the VCM with punishment or reward under the low leverage $|L| = 1$.¹⁶ Concerning the high leverage $|L| = 3$ we see that the average profits are significantly higher under reward (29.37) than under both punishment (24.83) and the standard VCM (23.90). The underlying reason for this is that reward with high effectiveness is efficiency enhancing, while the high social costs of punishment (of 4 ECU per instance of punishment) consume the efficiency gains from higher contributions.

Turning to the frequency of using the punishment or the reward option in the exogenous treatments, we find that both are used more often in the high leverage condition $|L| = 3$ than in the low leverage condition. Rewards are assigned in 44% of all possible cases under $|L| = 3$ and only in 10% of cases under $|L| = 1$ ($p < 0.05$; Mann-Whitney U-test, $N = 20$). This is a clear indication that subjects exploit the potential efficiency gains under $|L| = 3$ to a large extent. The leverage has, however, no significant effect on the frequency of punishment, which is used in 20% of all cases under $|L| = 3$ and in 15% under $|L| = 1$.

¹⁶ All non-parametric tests reported in this paper are two-sided. Here, the overall average profit within a group of four subjects is treated as a single, statistically independent observation.

Result 2. *Regarding the frequency of using punishment or reward, subjects are much more responsive to a higher leverage in the reward institution than in the punishment institution, with significantly more rewards under $|L| = 3$ than under $|L| = 1$.*

Figures 2 and 3 about here

Figures 2 and 3 provide a more detailed picture of the patterns of reward and punishment, depending upon the leverage. They show the relative frequency with which a subject j is rewarded or punished by subject i , contingent on the absolute difference between subject i 's and subject j 's contribution. Concerning the frequency of punishment, we can discern from the left-most bar in Figure 2, for instance, that in 46% of the cases in which member j contributes 14 to 20 tokens less than member i punishment of member j by member i is observed. In general, there is a decrease in the relative frequency of punishment when moving from left to right in Figure 2. This means that members j are more frequently punished the less they contribute in comparison to member i .¹⁷

The picture shows a reverse trend for rewards (in Figure 3), where one is generally more likely to be rewarded the higher one's contribution in comparison to the contribution of the rewarding member. Under the high leverage, though, it seems that the subjects with high contributions reward each other, which leads to a peak in the central deviation range of $[-2, 2]$ between member i 's and j 's contributions.

Result 3. *The likelihood of getting punished is inversely related to a subject's contribution. Reward is most often granted for subjects that contribute at least as much as or more than the rewarding subject.*

¹⁷ Like Fehr and Gächter (2000), we also observe a positive, but relatively small number of low contributors that punish high contributors. Herrmann et al. (2008) use the term antisocial punishment for such cases, and they demonstrate that antisocial punishment is widespread around the world.

6.2 Behavior with endogenously determined institutions

6.2.1 Participation in the vote and institutional choice

Seventy one out of 160 subjects (44%) participate in the voting procedure in the low-leverage condition. In the high-leverage condition voter turnout is significantly higher with 48 out of 80 subjects (60%; $\chi^2 = 5.21, p < 0.05$), as qualitatively expected if subjects have social preferences of either the Fehr and Schmidt (1999)- or the Charness and Rabin (2002)-type. Obviously, the standard prediction of abstention from the vote fails.

Result 4. *Voter turnout is significantly higher when reward and punishment are more effective ($|L| = 3$) than when they are less effective ($|L| = 1$).*

In panels (A) and (B) of Table 5 we report the number of voting rounds until a unanimous agreement was reached, contingent upon the number of voters in a group.¹⁸ Of course, all groups with only one voter finish the procedure immediately because the single voter can implement her most desired institution. Across both leverage levels, 26 out of 37 groups with at least two voters reach an agreement within the first four voting rounds. In the low-leverage condition, the maximum number of voting rounds is 26, while in the high-leverage condition three groups need more than 50 voting rounds to reach an agreement, with a maximum of 103 voting rounds in one group (which finally settled – in less than 10 minutes – for the standard VCM).

Table 5 about here

Panel (C) of Table 5 reports the preferences of voters. More precisely, it shows the number of times each possible institution (VCM, punishment or reward) is supported in the very first voting round (where more than one institution could be supported, though). The standard VCM is most often supported when $|L| = 1$, whereas the VCM with reward is most preferred when $|L| = 3$, and the distribution of preferences is significantly different

¹⁸ Under $|L| = 1$, there were three groups in which none of the four members voted. Coincidentally, the random determination of the institution assigned one group each to the standard VCM, the punishment institution and the reward institution. Dropping these observations does not change our results in any respect.

between both leverages ($\chi^2 = 13.09, p < 0.01$). The rightmost column shows the frequency with which a voter's preference coincided with the actually chosen institution. We see that in total 97 out of 119 voters (i.e. 82%) experienced the very institution that they had supported in the first round of voting.

Table 1 provides details regarding the actually implemented institutions. With the low-leverage ($|L| = 1$), 25 out of 40 groups choose the standard VCM, five groups opt for the VCM with punishment and ten groups agree on the VCM with reward. The distribution of chosen institutions is significantly different from random and from the distribution in the high-leverage condition (χ^2 -tests, $p < 0.01$). With $|L| = 3$, 17 out of 20 groups choose the VCM with reward and the remaining three groups the standard VCM. No group opts for the VCM with punishment. The distribution of chosen institutions under the high leverage is at odds with the predictions from the Fehr and Schmidt (1999)-model, but fits the predictions from the Charness and Rabin (2002)-model.

Result 5. *The distribution of institutional choices depends significantly on the leverage of reward or punishment. Given a high leverage, 85% of groups endogenously choose the VCM with reward, whereas with a low leverage the majority of groups (63%) agree on the standard VCM.*

It seems noteworthy that given our results on institutional preferences, the many studies that have been conducted to examine exogenously imposed punishment institutions might have exaggerated the actual role of informal punishment in small-group interactions.

In order to check the robustness of our results regarding the endogenous institutional choice and subjects' satisfaction with their chosen roles, we asked them at the end of the experiment whether they would vote again and, if so, for which institution they would vote if the experiment were to be repeated. The data from this questionnaire reveal that 72% of voters (86 out of 119) would vote again for exactly the same institution. Only 13% of voters would abstain from voting, and 15% would switch to a different institution. The answers of non-voters are clearly different, because 74 out of 121 non-voters (61%) indicated that they would participate in the vote if the experiment were repeated. Most of them would have voted for punishment under $|L| = 1$ (27 out of 47) and for reward under $|L| = 3$ (22 out of 27). These results suggest that our results on the endogenously chosen

institutions would have been fairly similar and our conclusions corroborated if they had taken place after having gained experience with the game.

6.2.2 Contributions in the endogenous treatments

Figure 4 shows the time trend of contributions in the treatments with endogenous institutional choice, and panel [2] of Table 3 reports the overall averages. In the low-leverage condition ($|L| = 1$), contributions are lowest in the standard VCM (5.48), intermediate in the VCM with reward (8.53) and clearly highest in the VCM with punishment (16.13). In the high-leverage condition ($|L| = 3$), no group agreed on the punishment option. Groups with the reward institution contribute more (14.59) than groups in the standard VCM (9.17) or than those groups with the low-leverage reward (8.53).

Column [2] of Table 4 presents the results of a panel tobit regression. Again we find a significant downward trend over time. Punishment and reward increase contributions significantly. It is noteworthy that this holds also for reward under $|L| = 1$; an effect that was not significant with exogenous institutions (see column [1] of Table 4). The dummy variable “voter” has the value 1 if a group member decided to participate in the costly vote. Controlling for all other factors, it shows that voters contribute more to the public good than non-voters, but the effect is not always significant. There seems to be a weak link between the participation in the vote and behavior in the public goods game (as implied, for instance, by our prediction on vote participation according to Charness and Rabin-preferences; see Table 2 and online Appendix B). A model that adds an interaction variable of “voter” and period (not shown here) reveals that the effect of being a voter lasts for several periods, but ceases to be significantly different from zero from about half of the periods onwards. We will take up these findings again in Section 6.4. The “number of other voters” in a group has no additional impact on a subject’s contributions.¹⁹

Result 6. *When the institution is determined endogenously, we find for both leverages that reward is associated with higher contributions than the standard VCM. The same holds true for punishment with the low leverage (while for the high leverage there are no observations). Voters contribute more to the public good than non-voters.*

¹⁹ Using the total number of voters instead of the number of other voters yields basically the same results.

Figures 4 to 6 and Table 6 about here

Average profits per group member and period are shown in the lower part of panel [2] in Table 3. They are always significantly lower in the standard VCM than with punishment or reward. Under the low leverage, average profits are about 15% higher with punishment than with reward ($p < 0.05$; Mann-Whitney U-test; $N = 15$).

Figures 5 and 6 show the relative frequency of punishment and reward, depending on the difference in contributions of group members i and j . Since the patterns are very similar to the ones observed in Figures 2 and 3, we refer to the discussion of these figures in Section 6.1. Overall, the reward option is again more often used under $|L| = 3$ than under $|L| = 1$ (55% vs. 17%; $p < 0.05$; Mann-Whitney U-test, $N = 27$).

In Table 6 we examine the determinants of a member's decision to punish or reward. As independent variables in the panel probit regression we use member i being a voter, the number of voters in the group, the group's total contribution to the public good, and the difference between member i 's and member j 's contributions in a given period. We find that voters are more likely to reward other group members than non-voters both under $|L| = 1$ and $|L| = 3$. Voters do not have a higher probability than non-voters to punish other group members, though. The average contribution within a group has a significantly negative impact on the likelihood of punishment, and a significantly positive influence on the likelihood of reward. Furthermore, the likelihood of member i to punish (reward) member j is significantly decreasing (increasing) with the difference between member j 's and member i 's contribution.

Result 7. *Voters reward others more often than non-voters, but they do not punish more often than non-voters. The likelihood of member i to punish (reward) is increasing (decreasing) in the difference between member i 's and member j 's contribution.*

6.3 The effects of endogenous institutional choice on contributions

A comparison of the corresponding cells in panels [1] and [2] of Table 3 shows immediately that average contributions are higher in the endogenous treatments than in the corresponding exogenous treatments, especially in case of the reward and punishment options. The difference is most remarkable for the VCM with punishment under $|L| = 1$, where contributions are on average 16.13 in the endogenous case, but only 8.79 in the

exogenous case. The difference is smaller with reward, but still noteworthy (6.62 vs. 8.53 under $|L| = 1$; 11.20 vs. 14.59 under $|L| = 3$).

Therefore, we examine in column [3] of Table 4 the effects of endogenous institutional choice, holding the institutional factors constant. The most important result from the tobit panel regression is the significantly positive effect of the dummy variable “endogenous treatment”, with an estimated 1.7 ECU higher contributions when subjects participate in an endogenous treatment. The effects of reward and punishment are positive (and larger than the effects of the endogenous institutional choice), while contributions decline over periods. We also find a significant effect of being a voter. However, the number of other voters in a group does not influence the level of contributions.

Result 8. *For given institutions, endogenous institutional choice is associated with higher contributions than when an identical institution is implemented by an external authority.*

6.4 Is selection of types driving the effects of endogenous choice?²⁰

A straightforward question concerning the previous result is whether the positive effects of endogenous institutional choice are caused by (self-)selection effects of more cooperative subjects into allegedly more effective institutions (i.e., into the VCMs with reward or punishment). Remember that there are two interesting effects in this respect that were established in the previous analysis: First, voters are by and large more cooperative than non-voters, which is an indicator for such a selection effect. Second, the dummy variable for the endogenous choice is significantly positive even when controlling for the voting decision, which establishes an independent effect of the possibility to choose the institution on cooperation levels. Note further that the coefficients for the punishment and reward institutions under the endogenous choice are higher than under the exogenous choice (compare columns [1] and [2] in Table 4), i.e., they seem more effective. The latter effect could be driven both by the vote and by the above-mentioned selection effect.

In this subsection we address the issue of selection in two steps. In Subsection 6.4.1 we present incentivized data on the social orientation of participants in the original experiment. In Subsection 6.4.2 we introduce an additional control experiment which

²⁰ We thank an anonymous referee and Bruno Biais for encouraging us to add this section and for very valuable hints on possible identification strategies.

compares contributions under different institutions when chance determines whether subjects can endogenously choose their preferred institution or not. Dal Bó et al. (2009) address a very similar problem of identifying treatment and selection effects in a somewhat different environment (a prisoner's dilemma game with self-selection into a game in which both cooperation and defection is an equilibrium) and report that only 8% of the total effect is caused by self-selection of types, while 92% can be attributed to an endogenous treatment effect.²¹

6.4.1 Data on social orientation (ring test)

Our first approach to address the issue of self-selection of types relies on data on subjects' social value orientation. We rely on the so-called decomposed game technique, also known in the literature as the ring test.²² In this fully incentivized test, subjects have to make binary choices in 24 different allocation tasks (see Appendix C in the supplementary material for details). In each task, a subject has to choose among two allocations that allocate money to herself and another (anonymous) recipient.²³ The recipient stays the same in all 24 allocation tasks, and all 24 tasks are paid. Adding up the 24 decisions yields a total sum of money allocated to oneself (x -amount) and to the recipient (y -amount). From the ratio (x/y) one can calculate a subject's social orientation, indicated by the angle of a vector θ that results from the ratio x/y . Often θ is used to assign a subject to any of eight categories of social orientation (individualism, altruism, cooperation, competition, martyrdom, masochism, sadomasochism, and aggression; see Figure C1 in Appendix C). However, the assignment to categories is a cruder measure of social orientation than taking the angle of the vector θ itself. Hence, we will rely on θ in the following. It is also noteworthy that from the 24 choices one can construct a measure of a subject's consistency

²¹ The reader is referred to Dal Bó et al.'s (2009) excellent exposition of the identification strategy for further details.

²² See van Lange et al. (1997) for an extensive review of the psychological literature on the technique. In economics, the test has been used, for example, by Offerman, Sonnemans and Schram (1996), Park (2000), Brosig (2002) or van Dijk, Sonnemans and van Winden (2002).

²³ Note that a subject's recipient in the ring test was different from the other group members in the public goods games in the main experiment. This was made clear in the instructions. Each subject in the ring test was not only allocator, but also recipient.

in making allocation choices. We consider only subjects with a consistency measure of at least 50%.²⁴

The ring test constituted the second part of the experiment for subjects in all treatments. It was announced at the beginning of the experiment that there will be two independent parts, and instructions for the second part, the ring test, were handed out after the completion of the main part of the experiment (see Appendix C for details).

In the following, we, first, compare the average angle of the social orientation vector θ in our exogenous and endogenous treatments. In the exogenous treatment, 215 out of 240 participants meet our consistency threshold, and have an average θ of 15.327°. In the endogenous treatment, 185 out of 200 subjects are classified as consistent, with an average θ of 15.333°. Hence, participants in the endogenous and exogenous treatments do not differ in their social orientation ($p = 0.83$; Mann-Whitney U-test; $N = 400$). A different result would have been very disturbing.

Second, we concentrate on the endogenous treatments and examine whether there is a difference in the results of the ring test between voters and non-voters. Neither under $|L| = 1$ nor under $|L| = 3$ do we find a significant difference (14.59° of voters vs. 15.86° of non-voters under $|L| = 1$; $p = 0.45$, $N = 142$; 16.33° of voters vs. 13.87° of non-voters under $|L| = 3$; $p = 0.20$, $N = 73$). This indicates that voters do not differ from non-voters with respect to their social orientation. Furthermore, among voters we do not find any significant differences in the average θ with respect to a voter's most preferred institution in the very first voting round ($p = 0.79$ for $|L| = 1$, Kruskal-Wallis-test, $N = 59$; $p = 0.81$ for $|L| = 3$, Kruskal-Wallis-test, $N = 43$). This suggests that different institutions do not attract the support of different voters regarding their social orientation.

Third – since the result of the vote is also binding for non-voters – we check the distribution of social orientation in the groups that actually face different institutions. This measure is of course correlated with the preferences of voters in the first voting round. Again we find no significant differences in the social orientation vector θ , contingent on the implemented institution. Under $|L| = 1$, the average θ in groups with the standard VCM

²⁴ There is no standard practice of defining consistency in the ring test. Park (2000) considered subjects with less than 75% consistency as unclassifiable, while Brosig (2002) classified all subjects with at least 25% consistency. We have opted for an intermediate threshold. Note that changing the threshold (even taking *all* subjects, irrespective of their consistency measure) does not change any of the results (with respect to significance levels) reported in this subsection.

is 14.46° , in groups with reward (punishment) it is 16.49° (17.18°) ($p = 0.27$; Kruskal-Wallis-test; $N = 142$). Under $|L| = 3$, there are no groups with punishment. The average θ in groups with the standard VCM is 14.61° , while it is 15.46° in groups with reward ($p = 0.90$; Mann-Whitney U-test; $N = 73$).

In summary, the random assignment of subjects to the exogenous or endogenous treatments worked perfectly (with respect to their social orientation). We do neither find evidence for differences in social value orientation between voters and non-voters, nor for differences between voters supporting different institutions, nor for players facing different institutions. These results provide support against the conjecture that self-selection is an important driving force behind the positive effects of endogenous institutional choice.

6.4.2 A control experiment

The previous section suggests that being able to vote on one's preferred institution is the main factor that explains the higher contributions in the endogenous treatments. In this section we examine this finding further by conducting a control experiment. In the experiment the group's voting outcome is implemented for real only with a 50%-probability, while otherwise a non-preferred institution is implemented by chance. This allows us to examine experimentally whether a selection of types into specific institutions can explain the higher contributions in our endogenous treatment.

The control experiment closely follows the original experiments with endogenous institutional choice, including the same order of events, the same experimenters, the same experimental software and the same basic instructions. The only difference is that participants knew in advance – before they had to decide whether to vote or not – that a group's voting outcome would be preliminary and that the following rule applied: with a 50%-chance the outcome of the vote would be actually implemented for the 10 periods of the public goods game, while with 50% chance any of the two other available institutions would be randomly chosen for implementation.

In order to economize on subjects we have run the control experiment only with $|L| = 3$. We ran eight sessions with a total of 160 subjects (i.e. 40 independent groups). Participants were drawn from the general undergraduate population at the University of Innsbruck, excluding those who already had participated in the original experiment or in

any other public goods experiment before. No subject was allowed to participate in more than one session of the control experiment.

Table 7 shows the average contributions, depending on whether a group's vote was implemented or not (see column "Implementation") and on the institution that was actually valid. In 17 out of 40 groups (of which 36 had at least one voter), the vote outcome was actually implemented, and the overall voter turnout was 55%. We see that contributions are again higher with punishment or reward than with the standard VCM and that contributions are slightly (albeit insignificantly, as it will turn out) lower when the group's vote is not implemented, compared to a situation where the group's vote is confirmed.

Tables 7 and 8 about here

Column [1] in Table 8 shows the determinants of subjects' contributions in the control experiment. Reward and punishment increase contributions, and voters contribute more than non-voters. Importantly, the variable "vote implemented" is not significant. This means that the institutional rules drive behavior rather than whether a group got its preferred institution or not. However, a prerequisite of a selection effect to be important would be that there is a significant effect for the variable "vote implemented". If those subjects who vote for a specific institution (say, reward) are, on average, more cooperative types than others, then if reward is indeed implemented (i.e., the variable "vote implemented" takes the value one), these groups should be more cooperative than those groups that did not vote for reward in the first place (and should, thus, consist at least partly of less cooperative types according to the selection hypothesis). Hence, our control experiment provides further supportive evidence that it is not the self-selection into a specific institution which explains the higher contributions under endogenous institutional choice in our original experiment.

Column [2] of Table 8 adds another detail to our results. It considers both the data from the control experiment and all groups in the endogenous treatments where $|L| = 3$ applied in the original experiment. The dummy variable "control experiment" turns out to be significantly negative (while all other variables keep the expected signs and significance levels). The negative effect of the control experiment-dummy suggests that letting subjects vote is not sufficient for achieving higher contribution levels. It seems to be important that subjects know that the voting outcome will be implemented for sure. Thus, the control

experiment reveals that giving subjects the chance to vote but keeping it open whether the vote will really count is detrimental to cooperation in groups.

7 Conclusion

In this paper, we have been able to replicate the positive effects of reward and punishment on contributions in public goods games when the reward or punishment options are implemented exogenously. Most importantly, however, the main finding of our paper is the positive effect of an endogenous institutional choice on the level of cooperation in public goods games. Controlling for the institution, we have found higher contributions when a given institution has been determined by a group's vote than when it has been implemented exogenously. This is the pure effect of endogenous institutional choice that is independent of whether a sanctioning institution is implemented or not, meaning that the existence of a voting institution suffices to improve the outcome. However, it is especially strong for the punishment and the reward institutions, i.e., both become more effective in raising contributions when implemented endogenously. Our results from an incentivized test regarding social value orientation and a control experiment suggest that the positive effects of endogenous choice are not or only to a small extent driven by the self-selection of more cooperative subjects into institutions which support more cooperative behavior. Rather, it seems that the option of participating democratically in the choice of institutions makes the difference. This interpretation is consistent with findings reported in a recent paper by Dal Bó et al. (2009).

There might be different ways through which the democratic participation in the choice of institutions is transmitted to higher contribution levels. Voting in a small group, even if it is anonymous, by definition contains certain elements of signaling that might, for instance, update the beliefs of conditionally cooperative subjects (Fischbacher et al., 2001; Fischbacher and Gächter, 2009) on the level of cooperativeness of the other group members. One could also view voting in small groups as implicit communication that updates beliefs. It was not the purpose of this paper to distinguish between these different mechanisms, but this could be a very interesting route for further research.

Another important finding concerns the pattern of chosen institutions, depending on the effectiveness of reward or punishment. When reward and punishment have a high leverage, groups choose almost exclusively the reward option. A straightforward explanation for this choice behavior might be the intention to exploit the potentially large

efficiency gains through mutual rewards.²⁵ Another explanation for groups shying away from the punishment institution might be the fear of high efficiency costs if punishment is actually applied under $|L| = 3$. Furthermore, subjects could simply be myopic in the sense of overestimating the costs of being punished that usually accrue in the first periods of a public goods game and underestimating the potentially positive effects of the threat of punishment in raising contribution levels in the long run. When the leverage is low ($|L| = 1$), a clear majority of groups prefer the standard VCM over the reward or the punishment mechanism. The main reason for preferring the standard VCM might be the expectation of subjects that reward or punishment with $|L| = 1$ may have little or no effect at all, as basically predicted both with standard preferences as well as with social preferences. In fact, with exogenous choice and the low leverage, the influence of punishment or reward on contributions is relatively small, albeit significant for punishment. With endogenous choice, the effects are stronger, even with the low leverage, and total profits have been significantly higher both with punishment and with reward than with the standard VCM. Hence, from an ex-post perspective it would have paid off, on average, to vote for punishment or reward even with the low leverage.

Of course, it is important to bear some limitations of our results in mind. Obviously, they rely on the precise design of the sanctioning institutions in our experiments (remember that we implemented comparatively weak institutions) and on the implementation of the unanimity rule at the institutional implementation stage. Both issues might serve as interesting starting points for future research, for instance on the effects of different group decision making rules at the institutional implementation stage.

Our results can also be put into perspective by comparing them to the recent literature on endogenous institutional choice in public goods games. Neither Botelho et al. (2005), nor Ertan et al. (2009) nor Gülerk et al. (2006) have been able to address this issue in full depth because Botelho et al. (2005) and Ertan et al. (2009) considered only punishment and Gülerk et al. (2006) did not allow for a choice between reward and punishment (and because the leverages of reward and punishment were different in their experiment). Our results on the relative *unattractiveness* of punishment are basically in line

²⁵ In fact, under the high leverage ($|L| = 3$), the equilibrium in which each group members rewards every other group member is actually quite frequent with 21% of all cases in the endogenous treatments. Charness and Rabin (2002) also provide experimental evidence which shows that efficiency is an important concern in decision makers.

with the findings of Botelho et al. (2005), and they seem to be compatible with Ertan et al.'s (2009) finding that groups never allow punishment of high contributors. Botelho et al. (2005) argue that subjects opted for the standard VCM because subjects had experienced it as more efficient than the punishment institution. In our experiment, groups favored the reward institution over punishment possibly because of the higher efficiency of reward. Both findings should be considered complementary, indicating that subjects do not find the implementation of a punishment option attractive *if* they have an alternative. If they do not have any alternative – like in the exogenous case – the punishment option has a positive effect on contributions.

Regarding the fit of our theoretical predictions with the experimental data, it is not surprising that a model with purely selfish and rational agents and the prediction of zero contributions does not match our data. The models with social preferences fit our data much better. The Fehr and Schmidt (1999)-model is particularly suited to explain the effects of the punishment option under the high leverage, because highly efficient punishment can easily reduce inequity. The latter effect makes the threat of punishment credible and keeps contributions relatively high. However, the model largely fails to predict the observed behavior under the reward institution, since the model is not intended to consider efficiency concerns. This is much better captured by the model of Charness and Rabin (2002). In its outcome-based version it does not explain the use of punishment, because subjects who care for social welfare (but not inequity) will never execute the punishment option. The general model of Charness and Rabin (2002) that incorporates intentions and reciprocity would, in addition, be able to capture the effects of punishment. Since it would require quite some simplifying (and non-trivial) assumptions, we however decided not to derive predictions from this general version.

Of course, the outcome-based social preference-models that we have considered remain largely silent on the positive effects of the endogenous institutional choice. One explanation for this may be that the influence of intrinsic motivation fostered by democratic participation rights (Frey, 1997) or the emotional as well as physiological consequences of the act of punishing or rewarding (de Quervain et al., 2004; Casari and Luini, 2006; Brandts and Rivas, 2009) cannot be accounted for in outcome-based models.

8 References

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Tables and Figures

Table 1: Treatment characteristics and number of independent observations

| Determination of the institution | Leverage | Institution | | |
|----------------------------------|----------|--------------|------------|----------|
| | | Standard VCM | Punishment | Reward |
| Exogenous | $ L =1$ | $N = 10^*$ | $N = 10$ | $N = 10$ |
| | $ L =3$ | | $N = 10$ | $N = 10$ |
| Endogenous [#] | $ L =1$ | $N = 25$ | $N = 5$ | $N = 10$ |
| | $ L =3$ | $N = 3$ | – | $N = 17$ |

* There is no leverage in the standard VCM because there are no sanctions available.

The table indicates the actually chosen institutions in the endogenous treatments. In sum, we had 40 groups in the endogenous treatments with $|L|=1$, and 20 groups with $|L|=3$.

Table 2: Predictions for contributions and voting with different preference models

| Panel (A) – Contributions | Standard preferences: Selfish payoff- maximization | Fehr and Schmidt (1999)- preferences: Inequity aversion* | Charness and Rabin (2002)-preferences: Social welfare maximization [#] |
|---------------------------|--|--|---|
| Standard VCM | $c_i = 0 \forall i$ | [A] $c_i = 0 \forall i$ if $\exists j$ with $\beta_j < 0.6$, or [B] $c_i = c \in [0, 20]$ if $\beta_i \geq 0.6 \forall i$ [†] | $c_i = 0 \forall i$ with $\lambda_i < 0.5$ and $c_i = 20 \forall j$ with $\lambda_j \geq 0.5$ (and $\delta_j \leq 1 - 1/2\lambda_j$) |
| Punishment with $ L = 1$ | $c_i = 0 \forall i$ | Same as Standard VCM | Same as Standard VCM |
| Reward with $ L = 1$ | $c_i = 0 \forall i$ | Same as Standard VCM | $0 \leq c_i \leq \bar{c} = n''L/(1-\gamma)$, with $x = 0.75$, otherwise (if no member satisfies $\lambda_i \geq 0.75$) same as Standard VCM |
| Punishment with $ L = 3$ | $c_i = 0 \forall i$ | $0 \leq c_i \leq \bar{c} = n'L/(1-\gamma)$ | Same as Standard VCM |
| Reward with $ L = 3$ | $c_i = 0 \forall i$ | Same as Standard VCM | $0 \leq c_i \leq \bar{c} = n''L/(1-\gamma)$, with $x = 0.5$, otherwise (if no member satisfies $\lambda_i \geq 0.5$) same as Standard VCM |

| Panel (B) – Incentives for voting | | | |
|-----------------------------------|-----------------------|---|--|
| Endogenous choice with $ L = 1$ | No vote participation | No vote participation | Group members with $\lambda_i \geq 0.75$ have an incentive to participate in the vote and support <i>reward</i> [‡] |
| Endogenous choice with $ L = 3$ | No vote participation | Group members with $\beta_i \geq 0.6$ have an incentive to participate in the vote and support <i>punishment</i> [‡] | Group members with $\lambda_i \geq 0.5$ have an incentive to participate in the vote and support <i>reward</i> [‡] |

i Group member *i*, with four members in the group.

* The variable n' indicates the number of group members with $\beta_i \geq 0.6$. In the Fehr and Schmidt (1999)-model, the parameter β measures a subject's sensitivity to advantageous inequality.

[#] The variable n'' indicates the number of group members with $\lambda_i \geq x$ (where x constitutes a certain threshold). The parameter λ measures in the Charness and Rabin (2002)-model the weight a subject assigns to social welfare relative to own payoff (which receives weight $1 - \lambda$). "Social welfare" captures either a concern for the minimum payoff in the group (with weight δ) or a concern for the sum of all group members' payoffs (with weight $1 - \delta$).

[†] Taking for the purpose of illustration the distribution of parameter β reported in Fehr and Schmidt (1999, p. 844), the case of $\beta_i \geq 0.6 \forall i$ occurs in 2.6% of cases, whereas the case of at least one group member j satisfying $\beta_j < 0.6$ occurs in 97.4% of four-person groups.

[‡] Note that a coordination problem arises in the voting stage, since in equilibrium only one of the group members with an incentive to vote should actually vote because voting is costly.

Table 3: Average contributions and profits in the *exogenous* treatments

[1] Exogenous treatments

| | Leverage | Standard VCM | Punishment | Reward |
|---------------|----------|------------------|--------------------|---------------------|
| Contributions | L =1 | 6.50 (N = 10) | 8.79 (N = 10) | 6.62 (N = 10) |
| | L =3 | | 12.11 (N = 10) | 11.20 (N = 10) |
| Profits | L =1 | 23.90* | 24.37 | 23.97 |
| | L =3 | | 24.83 [§] | 29.37* [§] |

[2] Endogenous treatments

| | | | | |
|---------------|------|----------------------|----------------------|---------------------|
| Contributions | L =1 | 5.48 (N = 25) | 16.13 (N = 5) | 8.53 (N = 10) |
| | L =3 | 9.17 (N = 3) | - | 14.59 (N = 17) |
| Profits | L =1 | 23.29 ^{#,*} | 29.25 ^{#,§} | 25.12* [§] |
| | L =3 | 25.51* | - | 32.05* |

[#] Significant difference ($p < 0.05$) between standard VCM and punishment.

* Significant difference ($p < 0.05$) between standard VCM and reward.

[§] Significant difference ($p < 0.05$) between punishment and reward.

Two-sided Mann-Whitney U-tests.

Table 4: Determinants of contributions (censored tobit panel regressions)

| Independent variables | [1] Exogenous treatments | [2] Endogenous treatments | [3] Exogenous plus endogenous treatments |
|-------------------------|-----------------------------|------------------------------|---|
| Constant | 13.81** | 10.79** | 10.50** |
| Period | -1.33** | -1.16** | -1.24** |
| Punishment $ L = 1$ | 2.43* | 13.31** | 7.41** |
| Reward $ L = 1$ | 0.08 | 3.92** | 2.88** |
| Punishment $ L = 3$ | 5.51** | - | 8.41** |
| Reward $ L = 3$ | 5.35** | 10.26** | 8.70** |
| Voter | - | 1.19 | 1.22* |
| # other voters in group | - | 0.03 | 0.10 |
| Endogenous treatment | - | - | 1.71* |
| <i>N</i> | 2,000 | 2,400 | 4,400 |
| Log likelihood | -4,276.27 | -4,734.65 | -9,020.48 |

** Significant at 1% level; * significant at 5% level.

Marginal effects shown.

Table 5: Number of voting rounds and voting behavior in first round

| <i>Panel (A) – Voting rounds with $L =1$</i> | | | | | | | | | |
|---|--|---|---|---|---|----|----|----|----|
| Number of voters in a group (N = total number of groups) | Reaching an unanimous vote in voting round ... | | | | | | | | |
| | 1 | 2 | 4 | 7 | 9 | 10 | 11 | 13 | 26 |
| 1 ($N = 15$) | 15 | | | | | | | | |
| 2 ($N = 13$) | 9 | 1 | | 1 | | 1 | | 1 | |
| 3 ($N = 6$) | 3 | 1 | | | | | 1 | | 1 |
| 4 ($N = 3$) | | 1 | 1 | | 1 | | | | |

| <i>Panel (B) – Voting rounds with $L =3$</i> | | | | | | | | | |
|---|--|---|---|----|----|----|----|-----|---|
| Number of voters in a group (N = total number of groups) | Reaching an unanimous vote in voting round ... | | | | | | | | |
| | 1 | 2 | 3 | 11 | 13 | 51 | 61 | 103 | |
| 1 ($N = 5$) | 5 | | | | | | | | |
| 2 ($N = 6$) | 5 | | 1 | | | | | | |
| 3 ($N = 5$) | 2 | 1 | | | | 1 | | 1 | |
| 4 ($N = 4$) | | | 1 | 1 | | 1 | | | 1 |

| <i>Panel (C) – Voting behavior in first voting round</i> | | | | | | |
|--|------------------|------------------------------------|-----|------------|------------------------------|--------------------|
| Leverage | Number of voters | Support for ... | | | 1 st preference = | |
| | | Number (multiple support possible) | VCM | Punishment | Reward | actual institution |
| $ L =1$ | 71 | | 47 | 17 | 28 | 59 |
| $ L =3$ | 48 | | 18 | 8 | 38 | 38 |

Table 6: Punishing or rewarding behavior (panel probit-regression)

| Independent variables | Dependent variable: Decision to... | | |
|--|------------------------------------|-----------------------|-----------------------|
| | punish with $ L = 1$ | reward with $ L = 1$ | reward with $ L = 3$ |
| Voter (= 1) | -0.173 | 0.217* | 0.340** |
| Number of voters in group | 0.238* | 0.265** | -0.054 |
| Group contribution | -0.006** | 0.002** | 0.013** |
| Difference between other member's and own contribution | -0.098** | 0.035** | 0.022** |
| Observations | 600 | 1200 | 2040 |

** Significant at 1% level; * significant at 5% level.

Table 7: Average contributions in the *control* experiment

| | Implementation | Standard VCM | Punishment | Reward |
|---------|--|-------------------|-------------------|--------------------|
| $ L =3$ | By preference (vote implemented) | 5.53 ($N=6$) | - ($N=0$) | 9.81 ($N=11$) |
| | By chance move (non- preferred institution) | 3.53 ($N=3$) | 8.44 ($N=9$) | 7.42 ($N=11$) |

Table 8: Contributions in the *control* experiment (censored tobit panel regression)

| Independent variables | [1] Control experiment only | [2] Control experiment plus endogenous treatments with $ L = 3$ |
|---|-----------------------------|---|
| Constant | 4.81** | 10.24** |
| Period | -0.38** | -0.25** |
| Punishment $ L = 3$ | 1.89 [#] | 2.51** |
| Reward $ L = 3$ | 3.04** | 4.07** |
| Voter | 1.65** | 1.01* |
| # other voters in group | 1.06** | 0.55* |
| Vote implemented (1 = yes; 0 = non- preferred institution implemented by chance move) | 0.76 | - |
| Control experiment (1 = yes) | - | -5.32** |
| <i>N</i> | 1,600 | 2,400 |
| Log likelihood | -3,791.77 | -5,379.82 |

** Significant at 1% level; * significant at 5% level; [#] significant at 6% level.

Marginal effects shown.

Figure 1. Average contributions in the exogenous treatments

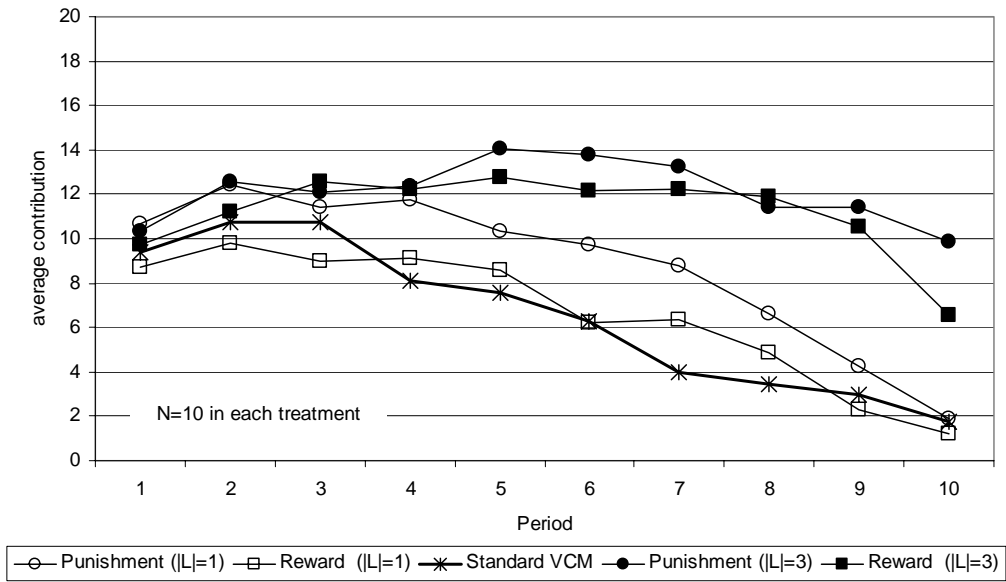
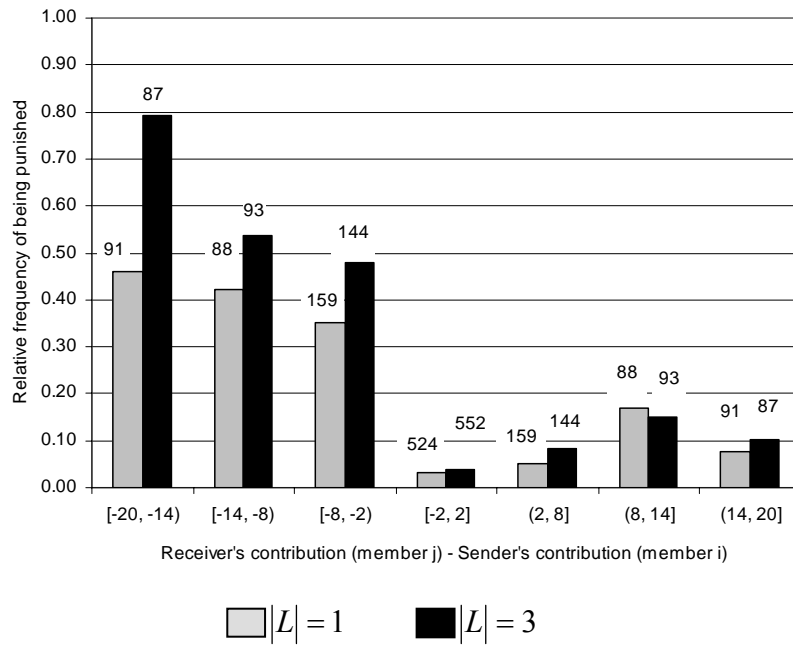
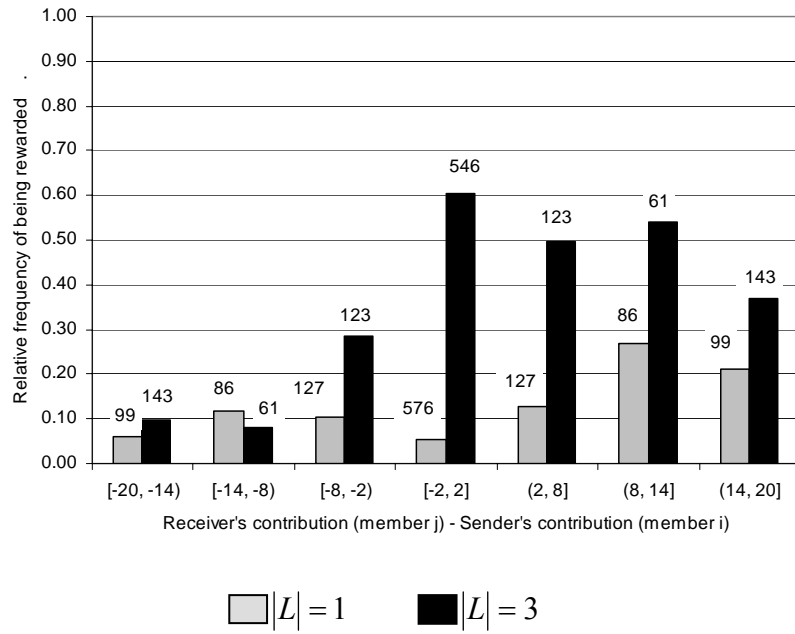


Figure 2. Punishment in the exogenous treatments



Numbers above bars indicate the number of observations.

Figure 3. Reward in the exogenous treatments



Numbers above bars indicate the number of observations.

Figure 4. Average contributions in the endogenous treatments

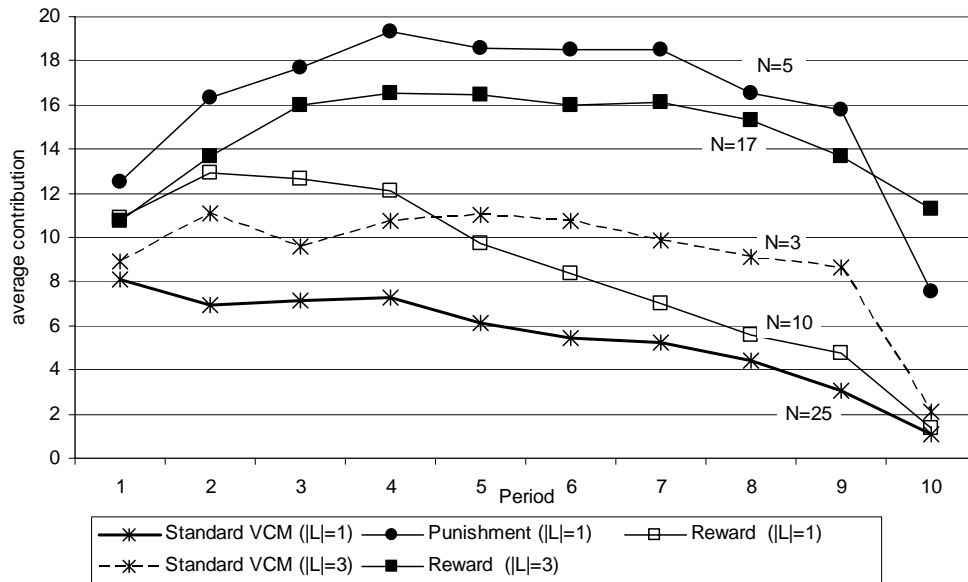
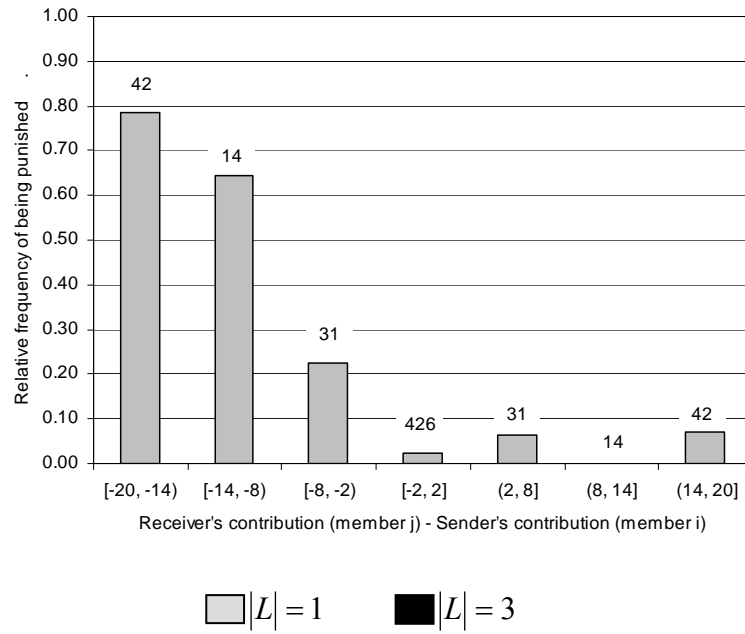


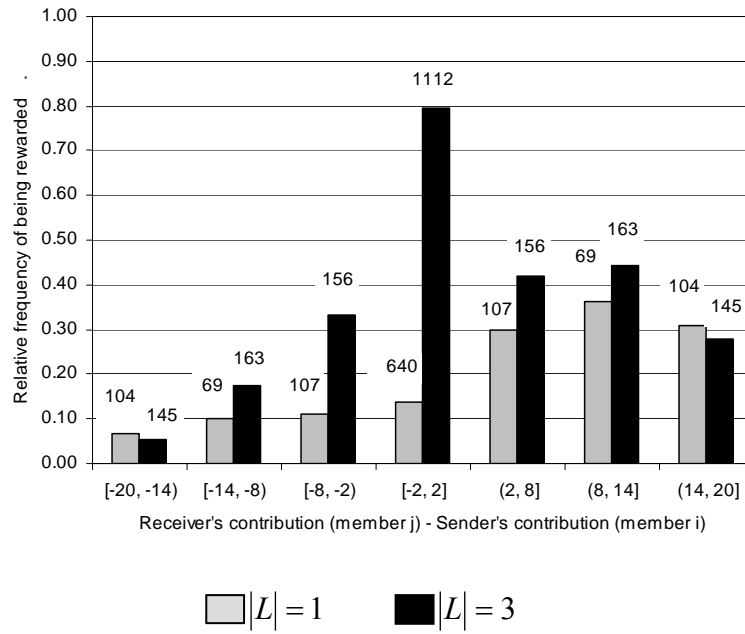
Figure 5. Punishment in the endogenous treatments



Numbers above bars indicate the number of observations.

Note: There are only data for $|L|=1$ because punishment was never chosen with $|L|=3$.

Figure 6. Reward in the endogenous treatments



Numbers above bars indicate the number of observations.