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Abstract:

In this experiment, we endogenize the choice of which contribution scheme is implemented in a public good game. We investigate three rule-based contribution schemes and a voluntary contribution mechanism (*VCM*). The game is implemented either as a *Single-* or a *Multi-Phase Game*. In the *Single-Phase Game*, the contribution schemes are exogenously implemented. In the *Multi-Phase Game*, we let subjects vote on the rule-based contribution schemes. If a scheme gets a sufficient majority it is implemented. In case a sufficient majority is failed, subjects have to make their contributions to the public good using the *VCM*. We find that the endogenous choice of a contribution scheme has an impact on the level of contributions. In case of a rule-based contribution scheme which equalizes payoffs, contributions are higher if subjects chose the scheme for themselves than in case the scheme is implemented exogenously. The contrary holds for the *VCM*. Contributions are higher if the *VCM* is implemented exogenously than in case a sufficient majority is failed and, therefore, subjects have to play the *VCM*.

Keywords: public goods, endogenous institutions, minimum contribution rules, cooperation
JEL: C72, C92, H41

1. Introduction

The conditions and institutions which foster cooperation in social dilemma situations such as the private provision of public goods have been gained increasing attention in economics for the last two decades (e.g., Ledyard 1995). Inducing contributions to public goods remains an important endeavor and is particularly demanding when players are heterogeneous, e.g., with respect to their costs and benefits. Previous research has shown that exogenously implemented rule-based contribution schemes lead to substantial cooperation gains in public good games (e.g., Kesternich et al. 2012). Since a variety of rule-based contribution schemes is conceivable and an exogenous implementation is not always a feasible option, it is important to investigate if groups of heterogeneous agents are able to agree upon a common scheme and to which extent the endogenous choice of a contribution scheme affects their contribution behavior.

In this paper, we endogenize the choice of which contribution scheme is implemented in a public good game and explore the performance of rule-based contribution schemes for subjects who are heterogeneous regarding their initial wealth position. All rule-based contribution schemes are based on the principle of the "smallest common denominator" and include two steps. Firstly, all agents can propose a minimum contribution level to the public good that should be provided by the whole group. Then the minimum of all proposals is selected and allocated across the subjects according to some predetermined rule. This approach reflects many real world institutional arrangements for public goods that involve the choice of a provision goal and a burden sharing rule. For climate policy, for example, a pre-negotiated rule such as equal carbon reductions among countries (Barrett 2003) may particularly be beneficial in reducing negotiation costs when the total reduction target changes over time. Since each participating country needs to sign and ratify the agreement, the player with the smallest proposal is pivotal. Countries can, however, voluntarily go beyond their obligations.[1] Thinking about international climate negotiations a variety of pre-negotiated rules for carbon emissions reductions among participating countries is conceivable and it is participants' first challenge to agree upon a common rule. Our experimental design enables us to contribute to the following research questions: (i) which rule-based contribution schemes do subjects actually prefer, (ii) are subjects able to agree upon a common rule-based contribution scheme imposing different voting rules and (iii) to which extent does the

[1] First applications of the principle of the smallest common denominator in the context of environmental agreements can be found in Endres (1997) and Endres and Finus (1999).

endogenous choice of a contribution scheme affect the level of private contributions to the public good?

The 3-player repeated public good game is implemented either as a *Single*- or a *Multi-Phase Game*. Subjects in the *Multi-Phase Game* play a collective-choice and a contribution phase. In the *Single-Phase Game*, subjects play only the contribution phase and make their contributions to the public good according to an exogenously implemented contribution scheme. We investigate three rule-based contribution schemes and a voluntary contribution mechanism (*VCM*). The rule-based contribution schemes are inspired by different fairness norms and include equal contributions from all group members to the public good (*eqcont*), equal payoffs among all group members (*eqpay*) and proportional contributions to the public good (*propcont*). In the *Multi-Phase Game*, subjects first vote upon a joint distribution rule. Two forms of voting are investigated: majority and unanimity rule. If a rule-based contribution scheme gets a sufficient majority it is implemented in the contribution phase of the *Multi-Phase Game*. In case a sufficient majority is failed, subjects have to make their contributions to the public good using the *VCM*.

Our major finding is that the endogenous choice of contribution schemes does affect individual contributions to the public good. In case of the *eqpay* scheme, contributions are higher if subjects choose the scheme for themselves than in case the scheme is exogenously implemented. The contrary holds for the *VCM*. In the exogenously implemented *VCM* contributions are higher than in the case when subjects are not able to agree upon a rule-based contribution schemes and, therefore, have to play the *VCM*. Furthermore, our results confirm that rule-based contribution schemes are an effective means to increase contribution levels in public good games – even when subjects differ with respect to their initial endowment. Endogenously or exogenously implemented, rule-based contribution schemes counteract the characteristic downward trend in contributions to the public good observed in the *VCM*. With respect to subjects individually chosen mechanisms in the collective-choice phase we find that preferences for the different rule-based contribution schemes depend on their initial endowment. The higher subjects initial endowment the less (more) frequently they vote for the *eqpay* (*eqcont*) scheme. Nevertheless, we find subjects to recognize the potential efficiency gains such rule-based contribution schemes offer and to use the opportunity to agree upon a common scheme in the collective-choice phase of the *Multi-Phase Game*.

The reminder of the paper is organized as follows: Section 2 provides an overview of the related literature. Section 3 describes the experimental design and derives our theoretical predictions. We present the experimental results in Section 4 and Section 5 concludes the paper.

2. A Brief Review of Related Literature

Two strands of the experimental literature are highly relevant for our research questions. Firstly, there are a growing number of experiments on the effects of endogenous institutions in social dilemma situations. Experimental findings suggest that the endogenous choice of an institutional setting has a positive effect on the level of cooperation.[2] Walker et al. (2000) and Margreiter et al. (2005) investigate the effects of commonly established appropriation levels in comparison to independent and individual appropriation decisions in a common-pool resource experiment. In a homogeneous setting, Walker et al. (2000) examine a two stage common-pool resource game consisting of a collective-choice and an individual-contribution stage. In the collective-choice stage, each subject can propose appropriation levels for the common-pool resource for each group member, followed by the opportunity to vote anonymously on the proposals. If any proposal gets a sufficient majority, the proposal is implemented in the contribution stage of the game. In case a majority is failed, group members make their appropriation decision independently. They find that participants are more cooperative in case a proposal is adopted than in case the resource is appropriated individually. In a similar but heterogeneous setting, Margreiter et al. (2005) find that heterogeneity of participants makes it more difficult to achieve an agreement on a proposed appropriation level and – again – that the use of the common-pool resource is more efficient if a proposal is adopted by voting then if group members decide individually. In addition, our study focuses on the effect of endogenously implemented institutions in comparison to the same institutions implemented exogenously and is therefore more closely related to Sutter et al. (2010) and Balafoutas et al. (2013). Sutter et al. (2010) use a public good game in which each subject can decide whether to participate in a voluntary contribution mechanism with the possibility of rewarding or punishing other group members or

[2] For further experimental evidence see Kosfeld et al. (2009), Ertan et al. (2009), and Hamman et al. (2011). Kosfeld et al. (2009) investigate the endogenous formation of institutions in public good provision and conclude that institutions are formed and that they positively affects cooperation. Ertan et al. (2009) study a repeated public good game in which punishment may be allowed, depending on subjects' votes. They find an evolution towards allowing punishment of low contributions. In Hammen et al. (2011), each group selects an "allocator" at the beginning of each round of a repeated public good game. The allocator then chooses a vector of contributions. The result is that the delegation increases the contributions.

whether to participate in a standard voluntary contribution mechanism. They find that the endogenous choice of an institutional setting has a positive effect on the level of cooperation in the public good game compared to the situation in which the same institution has been implemented exogenously. The study most closely related to our experiment is the one by Balafoutas et al. (2013). They investigate the effect of endogenously implemented institutional settings within the framework of a public good game with the opportunity to redistribute the benefits from investing into the public good across all group members. Each period of the experiment has two stages: a collective-choice and a contribution stage. In the collective-choice stage participants determine the redistribution factor to be implemented in the contribution stage. The redistribution factor allocates the money invested into the public good across the group members and varies between equal payoffs for all group members and payoffs proportional to subjects' individual contributions to the public good. Subjects specify the value of the redistribution factor they favor at the beginning of each period and the median value among all group members is selected by the experimenter and implemented in the contribution stage. They find that subjects' preferences for the redistribution factor depend on their initial endowment. Subjects with a high and middle initial endowment mostly favor redistribution factors associated with payoffs proportional to individual contributions to the public good. In contrast, subjects with a low initial endowment favor redistribution factors associated with equal payoffs from investing into the public good. Finally, by comparing exogenously and endogenously implemented redistribution factors Balafoutas et al. (2013) find weak evidence that the opportunity to choose the redistribution factor for themselves makes subjects more cooperative compared to a situation with the same redistribution factor implemented exogenously. Similarly, Dal Bó et al. (2013) find that the effect of an institution on the level of cooperation in a prisoner dilemma is greater when it is chosen democratically by the subjects than when it is exogenously implemented. Furthermore, they show that this effect is due both to a selection effect and an endogeneity effect. The selection effect captures the fact that players who vote for a certain institution differ from those who do not. The endogeneity effect captures the fact that similar subjects facing the same situation behave differently depending on whether the situation was endogenously or exogenously imposed.

The second strand of literature relevant for our study refers to rule-based contribution schemes for public goods. In such a contribution scheme, players in a first step agree on a common group provision level using the principle of the smallest common denominator. In a second step, this group investment is allocated according to a specific rule to individual minimum contributions. Rule-based contribution schemes provide an effective way to solve the public goods' free-rider problem by transforming the social dilemma into a game with equilibria with positive contributions. Orzen (2008) shows rule-based contribution schemes to be effective in enhancing cooperation gains in homogeneous public good settings. Dannenberg et al. (2013) experimentally study the voluntary formation of coalitions to provide public goods. Participation and commitment in the coalition are either exogenously imposed or endogenously determined by the players themselves. They find larger voluntary participation rates when commitments in the coalition are endogenously determined using a minimum contribution rule rather than exogenously determined. In case of heterogeneous agents different specifications of those contribution schemes – inspired by different fairness norms – can be implemented. Kesternich et al. (2012) find that rule-based contribution schemes lead to substantial cooperation gains if agents differ in their benefits from the public good. They observe that a burden sharing rule that aims at equalizing payoffs by explicitly addressing redistribution among heterogeneous agents Pareto-dominates all other burden sharing mechanisms. We extent this literature by introducing heterogeneity with respect to the initial wealth position and the option of endogenous choice of the burden sharing rule.

3. Experimental Design and Theoretical Predictions

Participants in the *Multi-Phase Game* play a collective-choice phase and contribution phase. In the collective-choice phase, subjects themselves determine the contribution scheme to be implemented in the contribution phase of the game. Participants in *Single-Phase Game* play only the contribution phase whereby the different contribution schemes are exogenously implemented. Thereby, we assume that compliance is enforceable. In the *Multi-Phase Game,* we can, firstly, test the effects of endogenous institutional choice scheme by comparing contributions to the public good of groups which adopt a contribution scheme with contributions from groups which fail to agree on a scheme. Secondly, we can investigate the extent to which the endogenous choice of a contribution scheme has an impact on the level of cooperation by comparing endogenously implemented contribution schemes from the *Multi-Phase Game* with their exogenously implemented counterparts from the *Single-Phase Game*.[3]

[3] Details of the experimental design are summarized in Table 1.

3.1 *Single-Phase Game*

In the *Single-Phase Game,* subjects play only the contribution phase of the experiment. The contribution phase contains one of four different contribution schemes: three rule-based contribution schemes (*eqcont*, *eqpay* and *propcont*) and the standard voluntary contribution mechanism (*VCM*).

The payoff to player i, π_i, in all contribution schemes is determined by a linear public good game and given by

$$\pi_i = e_i - c * q_i + bQ$$

where e_i marks the initial endowment, q_i the individual contribution to the public good, b the marginal per capita return from the public good for player i and $Q = \sum_{j=1}^{n} q_j$ the aggregated provision level of the public good. Furthermore, players in our experiment differ with respect to their initial endowment. Each group of three players consists of one "low-type" player (*type20*) with an initial endowment of $e_{type20} = 20$, one "middle-type" player (*type30*) with $e_{type30} = 30$ and one "high-type" player (*type40*) with $e_{type40} = 40$. Thus, there is a total group endowment of $E = \sum_{i=1}^{n} e_i = 90$. Finally, we assume the marginal benefit from the public good to be $b = 0.6$ and the marginal costs for investing into the public good to be $c = 1$.

In the baseline *VCM*, agents simultaneously decide on their individual contributions to the public good, q_i. Since their marginal costs from investing into the public good exceeds their individual benefit standard theory predicts full free-riding and zero contributions for all players as well as individual payoffs of $\pi_{type20} = e_{type20}$, $\pi_{type30} = e_{type30}$ and $\pi_{type40} = e_{type40}$.

In the following, we consider rule-based contribution schemes that consist of two stages: In the first stage, the minimum stage, all players simultaneously suggest a minimum group provision level $Q_i^{min} \in [0,90]$.[4] The smallest suggested proposal then determines the lower level for the sum of individual contributions to the public good in the second stage, the individual contributions stage. Therefore, $Q^{min} = min_{j \in S} Q_j^{min}$ where S is the set of players in a group. In the individual contribution stage, the minimum individual contribution level, q_i^{min}, is derived from the binding group minimum provision level, Q^{min}, according to a specific predetermined rule-based contribution scheme, i.e., $q_i^{min}(Q^{min})$, whereby subjects have to contribute at least the

[4] In our experiment, for Q_i^{min} integer multiples of three are required.

minimum contribution level q^{min}, i.e., $q_i \geq q_i^{min}$. All in all we cover three different rule-based contribution schemes:

Equal-Contribution Scheme (eqcont)

In an egalitarian rule-based contribution scheme that requires equal contribution from all players (*eqcont*) to the public good, individual minimum contribution levels are given by

$$q_i^{min} = \frac{1}{n} Q^{min}.$$

Thus, the binding minimum proposal, Q^{min}, is equally distributed across all groups members. Note that in all rule-based contribution schemes, in the second stage of the contribution phase it is obligatory that the desired aggregated provision level Q^{min} is provided by the group and that $q_i^{min} \in [0, e_i]$. It follows that in the *eqcont* scheme minimum contributions of subjects with a comparably high initial endowment exceed those of subjects with a comparably low initial endowment if the equal contribution rule would require minimum contributions of low-type players to exceed their initial endowment. More formally, contributions of all group members are equal and given by $q_i^{min} = \frac{1}{n} Q^{min}$ if $Q^{min} \in [0,60]$. If $Q^{min} \in]60,80]$, minimum contributions of *type20* players are $q_{type20}^{min} = e_{type20}$ and therefore lower than those of *type30* and *type40* players, $q_{type30}^{min} = q_{type40}^{min} = \frac{1}{n-1}\left(Q^{min} - e_{type20}\right)$. If $Q^{min} \in]80,90]$, minimum contributions of *type20* and *type30* players are given by $q_{type20}^{min} = e_{type20}$ and $q_{type30}^{min} = e_{type30}$ and are lower than those of *type40* players, $q_{type40}^{min} = \frac{1}{n-2}\left(Q^{min} - e_{type20} - e_{type30}\right)$.

In the *eqcont* scheme, *type20* and *type30* players have a weakly dominant strategy to suggest $Q_i^{min} = E$. For them the marginal benefit from increasing the groups' binding minimum contribution level exceed its costs for all $Q_i^{min} \in [0, E]$. Choosing $Q^{min} < E$ would either reduce their own payoff (i) if they set the binding minimum or (ii) would not change the payoff if their minimum proposal is not pivotal. Following this intuition, *type40* players have a weakly dominant strategy to choose $Q_i^{min} = 78$, since their marginal payoff is positive only if $Q^{min} \leq 80$.[5] Since the smallest proposal is binding, a subgame perfect equilibrium in weakly dominant strategies is characterized by $Q^{min} = 78$ with $q_{type20}^{min} = 20$ and $q_{type30}^{min} = q_{type40}^{min} = 29$ which

[5] Mathematically, the weakly dominant strategy of *type40* players is to choose $Q_i^{min} = 80$, but the minimum group provision level has to be an integer multiple of three. Therefore, the weakly dominant strategy is to choose the greatest integer multiple of three below 80.

results in payoffs of $\pi_{type20} = 46.8$, $\pi_{type30} = 47.8$ and $\pi_{type40} = 57.8$, given that $q_i = q_i^{min}$ (see Table 2, Figure 1, and appendix for the analytical solution).

Equal-Payoff Scheme (eqpay)

If a rule-based contribution scheme aims to reach equality in payoffs among all group members (*eqpay*) and if all types of players have different initial endowments but the same marginal benefits from the public good, equating $\pi_{type20} = \pi_{type30} = \pi_{type40}$ and solving for q_i implies that

$$q_i^{min} = e_i - \frac{1}{n}\left(E - Q^{min}\right).$$

Note that in the *eqpay* scheme, the desired aggregated provision level Q^{min} may not entirely allow for payoff equalization since we do not allow for direct redistribution of initial endowments between group members and $q_i^{min} \in [0, e_i]$. This implies that payoff equalization among all group members could be achieved if $Q^{min} \in [30,90]$. If $Q^{min} < 30$ payoffs are as far as possible equalized. More formally, if $Q^{min} \in]9,30[$, $q_{type20}^{min} = 0$ and $q_{type30}^{min} = q_{type40}^{min} = e_j - \frac{1}{n-1}(e_{type40} + e_{type30} - Q^{min})$. If $Q^{min} \in [0,9]$, $q_{type20}^{min} = q_{type30}^{min} = 0$ and $q_{type40}^{min} = Q^{min}$. For instance, if $Q^{min} = 24$, this scheme would require $q_{type20}^{min} = 0$, $q_{type30}^{min} = 7$ and $q_{type40}^{min} = 17$ but nevertheless due to the endowment heterogeneity payoff equality is not reached. If $q_i = q_i^{min}$ individual payoffs are given by $\pi_{type20} = 34.4$, $\pi_{type30} = \pi_{type40} = 37.4$.

In the *eqpay* scheme, we expect all players to suggest full contribution levels i.e. $Q_i^{min} = E$ (see Table 2, Figure1, and appendix for the analytical solution). *type20* and *type30* players have a weakly dominant strategy to suggest $Q_i^{min} = E$ and also *type40* players maximize their payoff at $Q_i^{min} = E$. This allocation would lead to individual minimum contribution of $q_{type20}^{min} = e_{type20}$, $q_{type30}^{min} = e_{type30}$ and $q_{type40}^{min} = e_{type40}$ and given that $q_i = q_i^{min}$ equal payoffs for all group members of $\pi_{type20} = \pi_{type30} = \pi_{type40} = 54$.[6]

[6] type40 players payoff function is not monotonic increasing in Q^{min}. Therefore type40 players have, depending on their beliefs about the other players proposals a weakly dominant strategy to propose $Q_{type40}^{min} = 0$ or $Q_{type40}^{min} = E$. Since their payoff is maximized by $Q_{type40}^{min} = E$, we expect *type40* players to propose full contributions.

Proportional-Contribution Scheme (propcont)

If a rule-based contribution scheme requires individual contributions to be proportional to players' initial endowment (*propcont*), individual minimum contribution levels are given by

$$q_i^{min} = \frac{e_i}{E} Q^{min}.$$

Thus, the binding minimum proposal, Q^{min}, is distributed across group members according to their initial endowment, that implies, that individual minimum contributions increase with players' initial endowment. In this case, all players have a weakly dominant strategy to suggest full contribution levels, i.e., $Q^{min} = E$, since their marginal benefit from increasing the group's minimum contribution level exceeds its costs all $Q^{min} \in [0, E]$. This allocation is a subgame perfect equilibrium in weakly dominant strategies and would lead to individual minimum contribution of $q_{type20}^{min} = e_{type20}$, $q_{type30}^{min} = e_{type30}$ and $q_{type40}^{min} = e_{type40}$ and given that $q_i = q_i^{min}$ to payoffs of $\pi_{type20} = \pi_{type30} = \pi_{type40} = 54$ (see Table 2, Figure 1, and appendix for the analytical solution).

Thus, assuming that subjects behave according to standard theory and play their minimum contribution level, i.e. $q_i = q_i^{min}$, we can derive the following hypothesis regarding group's contribution levels

H1: Aggregate Contribution Level to the Public Good

$$Q_{eqpay} = Q_{propcont} > Q_{eqcont} > Q_{VCM}.$$

The theoretical predictions for all rule-based contribution schemes are summarized in Table 2 and graphically illustrated in Figure 1.

3.2 *Multi-Phase Game*

The *Multi-Phase Game* consists of two phases: a collective-choice phase and a contribution phase. It begins with the endogenous choice of a contribution scheme to be implemented in the contribution phase of the game. In the collective-choice phase, subjects vote anonymously on one of the proposed rule-based contribution schemes (*eqcont*, *eqpay* and *propcont*). We investigate two different voting mechanisms, majority and unanimity rule voting, each with three voting rounds. After each voting round all group members are informed about the numbers of votes for each proposed rule-based contribution scheme and if an agreement is reached. To be adopted, a rule-based contribution scheme must receive 2 out of 3 votes (majority rule voting) or 3 out of 3 votes (unanimity rule voting). If a rule-based contribution scheme gets the sufficient majority it is implemented in the contribution phase of the *Multi-Phase Game*. If a majority after the third voting round is failed, participants have to play a *VCM* in the contribution phase and to make their contribution decisions individually and independently.

Since the *VCM* is Pareto-dominated by all rule-based contribution schemes (see Table 2), we expect participants to agree upon a contribution scheme in the collective-choice phase of the *Multi-Phase Game*. Furthermore, under majority voting we expect participants to agree more frequently on the *eqpay* and *propcont* scheme compared to *eqcont*, since the equilibrium payoffs are higher in the *eqpay* and *propcont* scheme for *type20* and *type30* compared to *eqcont*. Selfish *type40* players are expected to vote for the *eqcont* scheme as under this scheme theses players have their highest equilibrium payoffs. Thus, we can expect that an agreement on a rule-based contribution scheme is more easily reached under majority than unanimity voting. Therefore, we can derive the following hypothesis

H2: Voting in the Collective-Choice Phase of the *Multi-Phase Game*

a) *Participants agree upon a rule-based contribution scheme in the collective-choice phase of the Multi-Phase Game. An agreement is more frequently observed under majority than under unanimity voting.*
b) *type20 and type30 participants vote more frequently on the eqpay and propcont schemes compared to the eqcont scheme.*
c) *type40 participants vote more frequently the eqcont scheme.*

Furthermore, in our experiment the form of collective choice itself becomes a treatment to distinguish whether a contribution scheme is implemented exogenously by the experimenter or endogenously by voting of the subjects. To distinguish exogenously and independently implemented contribution schemes, exogenously implemented contribution schemes get the prefix *ex-* (i.e., *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*) and endogenously implemented contribution schemes get the prefix *end-* (i.e., *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*). As standard theory is silent regarding the way how the institution has been developed, we do not expect any differences in behavior in exogenously and endogenously implemented contribution schemes. Thus, we can state the final hypothesis

H3: Endogenous and Exogenous Choice of Contribution Schemes

$$Q_{ex-i} = Q_{end-i} \text{ whereby } i = VCM, eqcont, eqpay, propcont$$

Nevertheless, previous studies have shown the choice of an institutional setting itself has a positive effect on the level of cooperation in social dilemma situations. [7] Therefore, we have reasonable doubts with respect to the validity of H3 and could expect that the opportunity to choose a rule-based contribution scheme for themselves make subjects more cooperative.

3.3 Laboratory Protocol

The experiment was run in July 2013 at the MaxLab laboratory of the University of Magdeburg in Germany. We used ORSEE (Greiner 2004) for recruiting participants and Z-Tree software (Fischbacher 2007) for programming. We recruited 363 students from different disciplines. Each student took part in one of 16 sessions with between 21 and 24 subjects.[8] On average, a session lasted about 60 minutes. At the beginning of each session, subjects were seated at separated linked computer terminals. In each session we randomly created up to 8 groups of 3 players with different initial endowments, one *type20*, *type30* and *type40*. Each player remained the same type and in the same group throughout the whole experiment (partner matching). During the collective-choice phase subjects got information on players' type and the outcome of the election within their group. During the contribution stage, information on individual contributions to the public good, payoffs and corresponding average values within the group was transmitted via screen. Participants were not aware of their exact partners and no direct communication between participants was allowed. Furthermore, only the 3 group members received detailed information on votes, offers, decisions and payoffs within their group on their screen. In a first stage of the experiment, participants received a set of experimental instructions which included verbal descriptions, numerical examples and control questions. Furthermore, participants received on their screen a simulator to verify the numerical examples, to answer control questions and to simulate different contribution decisions. [9] Thereby, the main objective of the simulator was to ensure that all subjects understood the payoff consequences of the rule-based contribution schemes. In a second step and after checking the understanding by means of control questions,

[7] See Section 2 for a brief review of the related literature.

[8] Initially, it was planned to conduct 16 sessions with 24 participants per session. Due to not appeared subjects we had to reduce the number of participants in seven sessions.

[9] We provide an example of instructions and screenshots in the appendix.

the experiment was started on the computer terminals. A session of the *Single-Phase Game* consist of 12 rounds of the public good game, the first two being practice rounds. A session of the *Multi-Phase Game* consist of a collective-choice phase with maximum 3 voting rounds and a contribution phase with 12 rounds of the public good game, the first two being practice rounds. At the end of each session, one non-practice round of the public good game was randomly chosen to determine individual earnings. The exchange rate between Euro and LabDollar (LD) was 1:3. On average, participants earned 14.70 Euro. No additional show-up fee was paid.

4. Experimental Results

4.1 Collective-Choice Phase

At first, we analyze subjects' voting behavior in the first phase of the *Multi-Phase Game*: the collective-choice phase. In this phase of the experiment, subjects vote anonymously on one of the three proposed rule-based contribution schemes (*eqcont*, *eqpay* and *propcont*). Our findings are summarized in Figure 2.

Figure 2: Individually Chosen Rule-Based Contribution Scheme by Types

Observation 1: Individually Chosen Rule-Based Contribution Scheme

Which rule-based contribution scheme subjects prefer depends on their initial endowment: The higher their initial endowment, the less (more) frequently they vote for the eqpay (eqcont) scheme. The propcont scheme is most frequently chosen by middle endowed players.

We find that the individually chosen rule-based contribution scheme depends on subjects' initial endowment. The frequency players vote for the *eqpay* scheme decreases with their initial endowment ($p<0.01$, Binomial Test, Table 3). *type20* players vote in 71% of all cases for the *eqpay* scheme, *type30* players in 46% and *type40* players in 20%. Furthermore, we find that *type40* players vote more frequently for the *eqcont* scheme than *type30* and *type20* players ($p<0.01$, Binomial Test, Table 3). *type40* players vote in 50% of all cases for the *eqcont* scheme, *type20* and *type30* players in 9% and 12%, respectively. The *propcont* scheme is most frequently chosen (42%) by *type30* players. This is significantly more frequent than by *type20* players (20%) and *type40* players (29%) ($p<0.05$, Binomial Test, Table 3).

Next, we analyze if groups are able to adopt a common rule-based contribution scheme in the collective-choice phase of the *Multi-Phase Game* and which scheme they chose for themselves. The results of the collective-choice phase are summarized in Table 4.

Table 4: Implemented Contribution Schemes in the *Multi-Phase Game*

Observations 2: Implemented Contribution Scheme in the *Multi-Phase Game*

The majority of all groups managed to agree upon a common rule-based contribution scheme in the collective-choice phase of the Multi-Phase Game. Furthermore, groups agree more easily under majority rule voting compared to unanimity rule voting. eqpay is the most frequently chosen rule-based contribution scheme.

We find that the majority of all groups in the *Multi-Phase Game* (77%) manage to agree upon a common rule-based contribution scheme in the collective-choice phase. In addition, groups agree more easily under majority rule (97%) compared to unanimity rule (58%) ($p<0.01$, χ^2-test and Fisher's exact test). Furthermore, we find that *eqpay* is the most frequently chosen rule-based contribution scheme under both voting rules ($p<0.01$, Binomial Test, Table 5). 47% of all groups in the *Multi-Phase Game* adopt the *eqpay* scheme to be implemented in the contribution phase. The *propcont* scheme is chosen by 22% of all groups and *eqcont* by 8% of all groups.

While at a first glance standard theory of rational and selfish behavior performs quite well regarding subjects' voting behavior, it remains noteworthy, however, that the *eqpay* scheme is selected with 62% under majority voting and still with 32% under unanimity voting (see Table 4). This observation cannot be explained by the standard theory. One plausible explanation is that a significant fraction of subjects (i) expects a group contribution below 90 tokens and (ii) is motivated by other regarding preferences. In particular, the behavior of *type40* players who vote for *eqpay* can be explained very plausibly by other-regarding preferences. One prominent theory of other-regarding preferences which in addition allows simple utility calculations is the inequality version model by Fehr and Schmidt (1999, F&S). They formalize the idea of inequality aversion by adding a disutility from disadvantageous inequality (weighted by parameter β_i) and a disutility from advantageous inequality (weighted by parameter α_i) to a standard linear utility function. F&S themselves present mean values $\bar{\beta} = 0.315$ and $\bar{\alpha} = 0.85$ for the inequality aversion parameters, which they derive from individual behavior in ultimatum games. Blanco et al. (2011) use modified ultimatum and dictator games to obtain similar inequality aversion parameters. In their distribution ($n = 61$), 56% of all subjects can be characterized by $\beta_i > 0.5$ and 33% have $\beta_i = 0.67$. In our case, for $\beta_i > 0.67$ a *type40* player prefers *eqpay* to the alternative rule-based contribution schemes. For *type30* and *type40* players with $\beta_i \geq 0$ and $\alpha \geq 0$, *eqpay* at least weakly dominates the alternatives. Thus, inequality aversion may explain the observed voting behavior.

Next, we analyze the dynamics of subjects' voting behavior over the three voting rounds in the collective-choice phase. Figure 3 summarizes participants voting behavior in the three rounds of the collective-choice phase.

Figure 3: Chosen Rule-Based Contribution Scheme by Rounds

Observation 3: Chosen Rule-Based Contribution Scheme by Rounds

Nearly half of the groups which agree upon a rule-based contribution scheme in the collective-choice phase of the game already agree in the first voting round. Participants of groups who do not agree on a common rule-based contribution scheme in the first place change their voting behavior over the rounds. They vote less (more) frequently for the eqpay (propcont) scheme.

At first, we find that with 21 groups (45%) nearly the half of all groups which manage to agree upon a common rule-based contribution scheme, already agree in the first round of the collective-choice phase. In the second round further 15 groups agree on a common rule-based contribution scheme and finally, further 10 groups in the last voting round. Next, we find that over the rounds participants vote less frequently for the *eqpay* scheme and more frequently for the *propcont* scheme (p<0.05, Binomial Test, Table 6). We do not find any significant changes regarding the voting behavior on the *eqcont* scheme.

4.2 Contribution Phase

4.2.1 Contributions to the Public Good

In this section, we analyze subjects' contributions to the public good in the contribution phase of the *Single*- and *Multi-Phase Game*. Table 7 reports average group contribution levels for each endogenously and exogenously implemented contribution scheme across all periods excluding trial periods.[10]

At first, we investigate average contributions to the public good in the contribution phase of the *Multi-Phase Game*. Average contributions per group in the different endogenously and exogenously implemented contribution schemes are summarized in Figure 4.

Figure 4: Average Contributions per Group in the Endogenously and Exogenously Implemented Contribution Schemes

Observation 4: Contributions in Endogenously Implemented Contribution Schemes

Average contributions are higher in case a rule-based contribution scheme is adopted in the collective-choice phase of the Multi-Phase Game than in case a sufficient majority is failed and contributions decisions are made via VCM. Finally, the downward trend in contributions disappears if a rule-based contribution scheme is adopted.

We find that contributions are higher in case a rule-based contribution scheme is adopted in the collective-choice phase of the *Multi-Phase Game* than in case no scheme is adopted and group members have to make their contribution to the public good individually via a *VCM* ($p<0.10$, U-test, Table 8). Averaged over all periods and subjects, contributions are lowest if subjects could not agree upon a common rule-based contribution scheme in the collective-choice phase and have to play a *VCM* (8.1 tokens) and highest if participants agreed upon the *eqpay* scheme (26.3 tokens). Average contributions in the endogenously implemented *eqcont* and *propcont* scheme are 20.3 and 22.5 tokens respectively (Table 7). Our regression results (see Table 14, Model 1) confirm these results. In Model 1 we only consider observations from participants in the *Multi-Phase Game* and find that the level of contributions to the public good is higher if groups adopt a

[10] We further provide results of nonparametric U-tests regarding the contributions in Table 8. Results of nonparametric Cuzick's test on time trends in contributions are given in Table 9. Further statistical evidence is given by a series of random effects regression models; see Table 14. A description of all dependent and independent variables entering our regression models is given in Table 13.

rule-based contribution scheme in the collective-choice phase. Groups who adopt the *eqcont*, *eqpay* or *propcont* scheme contribute significantly more than groups who do not adopt a rule-based contribution scheme and, therefore, have to play a *VCM*.

In addition, we find that contributions are higher in case the *eqpay* scheme is implemented by unanimity compared to majority (see Table 10 and Figure 5). All in all 28 groups agree on the *eqpay* scheme and among those 12 groups came to this decision unanimously.[11] Average contributions in the by unanimity implemented *eqpay* scheme are with 28.8 tokens significantly higher than those in the by majority implemented *eqpay* scheme with 24.4 tokens ($p<0.10$, U-test). Noteworthy is that in 12 out of the 16 groups in which the *eqpay* scheme is implemented by majority *type40* players are overruled. We find that in this case overruled *type40* players are comparatively uncooperative (see Figure 6). Averaged over all periods in the by majority implemented *eqpay* scheme overruled *type40* players contribute 33.1 tokens and *type40* players who could implement the *eqpay* scheme as their favored rule-based contribution scheme contribute on average 37.8 tokens.[12] Statistically significant at a conventional level is this result only in the last period of the contribution phase. Here overruled *type40* players contribute on average 34.9 tokens and not-overruled *type40* players 40 tokens ($p<0.01$, U-test).

Finally, we find that the agreement on a common rule-based contribution scheme counteracts downward trends in contributions over the periods. Contributions of groups who could not manage to agree upon a common scheme in the collective-choice phase of the *Multi-Phase Game* and therefore have to play a *VCM* decreased over periods ($p<0.01$, Cuzick's test, Table 9). In all rule-based contribution schemes there is no evidence for a negative time trend. On the contrary, in the endogenously implemented *eqpay* scheme, contributions even significantly increase over periods ($p<0.01$, Cuzick's test, Table 9).

In the next paragraph we turn our analysis towards the different contribution schemes given that they are implemented exogenously: the *Single-Phase Game*.

[11] Note that two groups agreed under majority rule voting per unanimity on the *eqpay* rule-based contribution scheme.

[12] We could not observe this behavior in the *eqcont* and *propcont* rule-based contribution scheme. On reason could be the small number of groups that agreed in the collective-choice phase of the *Multi-Phase Game* on the *eqcont* or *propcont* rule-based contribution scheme.

Observation 5: Contributions in Exogenously Implemented Contribution Schemes

Given that the contribution schemes are implemented exogenously, the level of cooperation is higher in rule-based contribution schemes compared to the VCM. Again, rule-based contribution schemes counteract the downward trend in contributions.

If the rule-based contribution schemes are exogenously implemented, the average contributions are higher are higher in those schemes (*eqpay*, *eqcont* and *propcont*) than in the exogenously implemented *VCM* (see Table 7). Averaged over all periods and agents, contributions in the *propcont* scheme are with 24.3 tokens the highest and significantly higher than those in the *VCM* (17.5 tokens) ($p<0.05$, U-test, Table 8). In the *eqpay* and *eqcont* scheme average contributions are 21.5 tokens and 21.2 tokens, respectively but not statistically significant different from average contributions in the *VCM* at a conventional level. These observations are confirmed by our regression results (see Table 14, Model 2). By considering only exogenously implemented contribution schemes we find that the different contribution schemes (*eqpay*, *eqcont* and *propcont*) have a significantly positive impact on subjects' contributions to the public good compared to the *VCM*: the *eqpay* scheme at a significance level of 1%, the other two rule-based contribution schemes at the 10%-level. Finally, we find that also the exogenously given schemes prevent contributions from declining. Given that a *VCM* is exogenously implemented in the *Single-Phase Game* average contributions significantly decline over periods ($p<0.01$, Cuzick's test, Table 9). In contrast, there is no evidence that the average contributions decline in the exogenous implemented rule-based contribution schemes and in the *eqcont* scheme average contributions increase significantly over the periods ($p<0.1$, Cuzick's test, Table 9).

Next, we turn our analysis towards the comparison of contributions to the public good in endogenously chosen contribution schemes (*Multi-Phase Game*) and their exogenously implemented counterparts (*Single-Phase Game*).

Observation 6: Contributions in Endogenously and Exogenously Implemented Contribution Schemes

a) *Considering the eqpay scheme, contributions are higher if this scheme is implemented by voting compared to if it is implemented exogenously.*

b) *Considering the VCM, subjects who could not manage to agree upon a common rule-based contribution scheme and, hence, choose to play the VCM contribute less compared to participants in the exogenously implemented VCM.*

We find that the opportunity to choose a rule-based contribution scheme by voting has an effect on the level of contributions to the public good. If participants manage to agree upon the *eqpay* scheme, contributions are higher compared to the exogenous implemented *eqpay* scheme ($p<0.05$, U-test, Table 8). Averaged over all periods and agents, contributions in the exogenously implemented *eqpay* scheme are 21.5 tokens, if, however, the *eqpay* scheme is implemented endogenously average contributions are 26.4 tokens (see Table 7). In contrast, we find that average contributions are lower if participants do not managed to agree upon a common rule-based contribution scheme and, therefore, have to play a *VCM* compared to the situation in which a *VCM* is implemented exogenously by the experimenter ($p<0.05$, U-test, Table 8). Averaged over all periods and agents, contributions in an exogenously implemented *VCM* are 17.5 tokens and 8.1 tokens if participants failed to agree upon a common rule-based contribution scheme in the voting stage of the experiment (see Table 7). These results are confirmed by our regression results (see Table 14, Model 3-6). We only consider observations from the same exogenously or endogenously implemented contribution scheme (*VCM*, *eqcont*, *eqpay* and *propcont*). We find that contributions are significantly lower in the endogenously compared to the exogenously implemented *VCM* (see Table 14, Model 3). In contrast, contributions in the endogenously implemented *eqpay* scheme are significantly higher than in the exogenously implemented *eqpay* scheme (see Table 14, Model 5). With respect to the *eqcont* and *propcont* schemes we cannot find an effect of endogenous choice on the level of cooperation.

It could be argued that the differences in subjects' contributions to the public good between endogenously and exogenously implemented contribution schemes are driven by a sample selection effect à la Dal Bó et al. (2013).[13] By assuming that cooperative subjects are willing to give up their initial position in the collective-choice phase in order to guarantee that their group agrees at least on any rule-based contribution scheme, the collective-choice phase could select cooperative subjects form uncooperative subjects. Therefore, we could expect higher contribution in groups that managed to agree on a common rule-based contribution scheme at the end of the collective-choice phase compared to participants in the endogenously implemented *VCM*. We

[13] See Section 2 for a brief review.

cannot completely rule out a possible sample selection effect, but following this logic a sample selection effect should be relatively weak if groups already agreed in the first round of the collective-choice phase on a common scheme. By considering only groups that agreed already in the first voting round of the collective-choice phase in the *Multi-Phase Game* on the *eqpay* scheme we find that the opportunity to vote has still a positive impact on subjects' contributions to the public good (see Figure 7). Average over all periods and agents, contributions in groups that agree in the first voting round on the *eqpay* scheme are with 25.47 tokens significantly higher than in the exogenously implemented *eqpay* scheme with 21.45 tokens ($p<0.01$, U-test).

4.2.2 Payoffs

In this section we analyze participants' payoffs in the contribution phase of the *Single*- and *Multi-Phase Game*. Table 7 reports payoffs for each endogenously and exogenously implemented contribution scheme across all periods excluding trial periods.[14] At first, we investigate payoffs of participants in the contribution phase of the *Multi-Phase Game*. Our findings are summarized in Figure 8.

Figure 8: Average Payoffs per Group in the Endogenously and Exogenously Implemented Contribution Schemes

Observation 7: Payoffs in Endogenously Implemented Contribution Schemes

Average payoffs are higher in case a rule-based contribution scheme is adopted in the collective-choice phase of the Multi-Phase Game than in case a sufficient majority is failed. Finally, the downward trend in payoffs disappears if a rule-based contribution scheme is adopted.

We find that payoffs are significantly higher in case a rule-based contribution scheme is adopted in the collective-choice phase of the *Multi-Phase Game* than in case no scheme is adopted ($p<0.10$, U-test, Table 11). Averaged over all periods and players, payoffs are lowest if participants could not agree upon a common rule-based contribution scheme in the collective-

[14] We further provide results of nonparametric U-test regarding the profits in Table 11. Results of nonparametric Cuzick's test on time trends in contributions are given in Table 12. Further statistical evidence is given by a series of random effects regression models; see Table 15. A description of all dependent and independent variables entering our regression models is given in Table 13.

choice phase and have to play a *VCM* (36.5 tokens) and highest if participants agree upon the *eqpay* scheme (51.2 tokens). Furthermore, average payoffs are 48 and 46.3 tokens in the endogenously implemented *propcont* and *eqcont* scheme (see Table 7). Finally, we find that the agreement on a common rule-based contribution scheme counteracts downwards trend in profits over the periods (see Table 12).

In the next paragraph we turn our analysis towards the different contribution schemes given that they are implemented exogenously: the *Singe-Phase Game*.

Observation 8: Payoffs in Exogenously Implemented Contribution Schemes

Given that the contribution schemes are implemented exogenously, payoffs are higher in rule-based contribution schemes compared to the VCM. Again, rule-based contribution schemes counteract the downward trend in payoffs.

If the rule-based contribution schemes are exogenously implemented, payoffs in those schemes (*eqpay*, *eqcont* and *propcont*) are higher than in the exogenously implemented *VCM* (see Table 7). Averaged over all periods and agents, payoffs are the lowest in the *VCM* (44 tokens) and highest in the *propcont* scheme (49.4 tokens). Furthermore, payoffs in the *propcont* scheme are higher than those in the *eqpay* scheme (47.2 tokens). According to a U-test only average profits in the propcont scheme are significantly different from those in the VCM ($p<0.05$, U-test, Table 11). According to our regression results (see Table 15, Model 2) all the rule-based contribution schemes (*eqpay*, *eqcont* and *propcont*) have a significantly positive impact on participants' profits compared to the *VCM*. Finally, we find that also the exogenously given schemes prevent contributions from declining (see Table 12).

Next, we turn our analysis towards the comparison of profits in endogenously chosen contribution schemes (*Multi-Phase Game*) and their exogenously implemented counterparts (*Single-Phase Game*).

Observation 9: Payoffs in Endogenously and Exogenously Implemented Contribution Schemes

c) *Considering the eqpay scheme, payoffs are higher if this scheme is implemented by voting compared to if it is implemented exogenously.*

d) *Considering the VCM, payoffs are lower if participants did not manage to agree upon a common rule-based contribution scheme and, hence, chose to play the VCM compared to if the VCM is implemented exogenously.*

We find that the opportunity to choose a rule-based contribution scheme has an effect on participants' payoffs. If participants manage to agree upon the *eqpay* scheme, profits are significantly higher compared to the exogenously implemented *eqpay* scheme ($p<0.10$, U-test, Table 11). In contrast, we find that profits are significantly lower if participants did not manage to agree upon a common rule-based contribution scheme and had to participate in the *VCM* compared to the situation in which the *VCM* is implemented exogenously ($p<0.05$, U-test, Table 11). These results are confirmed by our regression results (see Table 15, column 3-6). Here we consider observations from the same contribution scheme (*VCM*, *eqcont*, *eqpay* and *propcont*) exogenously or endogenously implemented. We find that profits are significantly lower in the endogenously compared to the endogenously implemented *VCM*. In contrast, profits in the endogenously implemented *eqpay* scheme are higher than in the exogenously implemented *eqpay* scheme. Averaged over all periods and agents, profits in the exogenously implemented *eqpay* scheme are 47.2 tokens, if, however the *eqpay* scheme is implemented endogenously payoffs are 51.2 tokens. In contrast, in the exogenously implemented VCM profits are 44 tokens and if participants fail to agree upon a common rule-based contribution scheme in the voting stage of the *Multi-Phase Game* and therefore chose the VCM profits are 37 tokens (see Table 7).

4.2.3 Minimum Group Contribution Level

As derived in Section 3 and illustrated in Figure 1, in the *eqpay* and *propcont* schemes we expect the binding group minimum contribution level to be higher than in *eqcont*. Table 16 reports the average binding group minimum contribution levels. Our findings are illustrated in Figure 9. At first, we investigate groups' average binding minimum contribution levels in the contribution phase of the *Multi-Phase Game*.

Figure 9: Average Binding Group Minimum Contribution Level in the Endogenously and Exogenously Implemented Contribution Schemes

Including all periods, the average binding minimum group contribution levels under the *eqpay* scheme are on average 76.6 tokens and therefore higher than in the *propcont* (66.7 tokens) and *eqcont* (60.7 tokens) scheme. According to a U-test only the difference between the *eqpay* and the *eqcont* scheme is statistically significant at a conventional level ($p<0.05$, U-test, Table 17).

Next, we investigate the binding group minimum contribution levels in the exogenously implemented rule-based contribution schemes: the single-phase game. Here we find that the average binding group contributions under the *propcont* scheme are on average 69.5 tokens and therefore higher than under the *eqpay* (61.4 tokens) and *eqcont* (61.1 tokens) scheme ($p<0.10$, U-test, Table 17).

Observation 10: Average Binding Minimum Proposals in Exogenously and Endogenously Implemented Rule-Based Contribution Schemes

Considering the eqpay scheme, the binding group minimum contribution levels are higher if participants chose the scheme themselves compared to the exogenously implemented scheme.

Finally, we find in the *eqpay* scheme the average binding minimum group contribution levels are higher if participants chose the contribution scheme for themselves (76.6 tokens) than under the exogenously implemented eqpay scheme (61.4 tokens) ($p<0.01$, U-test, Table 17). In contrast, in the *eqcont* and *propcont* schemes there is no significant difference between the exogenously and endogenously implementation.

5. Summary and Concluding Remarks

In this experiment we investigate if groups of heterogeneous agents agree by voting upon a common rule-based contribution scheme for providing a public good and to which extent the endogenous choice of a contribution scheme affects their contribution behavior. International climate policy might serve as a possible application for this framework. In climate negotiations delegates try to agree upon an overall greenhouse gas reduction target in combination with a pre-determined rule for the distribution of the overall reduction target among the participating countries. A variety of such rules is conceivable and it is the negotiators' first challenge to agree upon a common rule how to distribute the overall burden among the participating countries.

Our major finding is that the endogenous choice of a contribution scheme does affect the level of contributions to the public good. In case of the *eqpay* scheme, subjects contribute more to the public good if they have selected the scheme themselves instead of a situation where the scheme is implemented exogenously by the experimenter. This effect is even stronger if groups agree by unanimity compared to majority rule on the *eqpay* scheme. While we observe this positive effect of endogenous institutional choice on contributions to the public good there is also a negative effect. If group members fail to agree upon a rule-based contribution scheme in the collective-choice phase of the *Multi-Phase Game* they have to play the *VCM*. In this endogenous case, contributions are lower than in the exogenous case were the *VCM* is implemented exogenously by the experimenter. Therefore, we have to reject our initial research hypothesis H3 stating that there is no difference in contributions to the public good between endogenously and exogenously implemented contribution schemes. The positive effect of the choice of institutions is, nevertheless, in line with the existing literature, postulating (weak) evidence for enhancing cooperation through voting.

With respect to the remaining hypotheses derived from standard preferences subjects votes in the collective-choice phase of the *Multi-Phase Game* are largely predictable by self-interest and, therefore, we cannot reject hypothesis H2. Low- and middle-endowed players vote more frequently for the *eqpay* and *propcont* than for the *eqcont* scheme. On the other hand, subjects with high initial endowment vote more frequently for the *eqcont* scheme. Furthermore, we find groups in most cases to use the opportunity to agree upon a common rule-based contribution scheme in the collective-choice phase of the *Multi-Phase Game*. Regarding the average contribution levels, we cannot reject hypothesis H1, all endogenously and exogenously implemented rule-based contribution schemes (*eqcont*, *eqpay* and *propcont*) are effective in increasing the level of contributions to the public good. Remarkably, all rule-based contribution schemes counteract the characteristic downward trend in contributions to the public good observed in the *VCM* – exogenously or endogenously implemented.

What remains unanswered is that contributions in case the *eqpay* scheme is chosen by unanimity are higher compared to a situation in which the scheme is chosen by majority and that contributions are lower in case the *VCM* is implemented endogenously compared to an exogenously implemented *VCM*. On possible explanation could be that subjects do not want to be overruled in the collective-choice phase of the *Multi-Phase Game* and behave accordingly uncooperative in case they are. This is in line with our finding in the endogenously implemented *eqpay* scheme. Here overruled *type40* players contribute less than *type40* players who could implement the *eqpay* scheme as their favored rule-based contribution scheme. We conclude, that in the by majority implemented *eqpay* scheme overruled *type40* players decrease the average contributions to the public good. In the endogenously implemented *VCM*, one could argue that all group members are overruled. No one could implement his favored rule-based contribution scheme and behave accordingly uncooperative. Nevertheless, the significant low level of contributions to the public good in the endogenously implemented *VCM* could be driven by a sample selection effect induced by the collective-choice phase of the *Multi-Phase Game*. In our experimental design we cannot not exclude that the endogenously implemented *VCM* acts as the collection point for uncooperative participants who could not manage to agree upon a common rule-based contribution scheme.

More generally, our results show that it may be important how a policy or an institutional mechanism is implemented, i.e., whether it is implemented endogenously or exogenously. We find that the choice of an institution itself has an effect on cooperation: A positive effect in case agents are able to agree in an election upon a common mechanism and a negative effect in case a sufficient majority is failed and agents have to accept a mechanism they have not voted for. Of course, this implication has to be treated with caution, because our experimental design does not allow us to control for individual selection into a specific mechanism. It would be interesting to control for possible selection effects in future work by, for example, extending our experimental setting according to the design suggest by Dal Bó et al. (2013). Furthermore, one potentially fruitful extension would be to relax the assumption that all agents are fully informed about the cost and benefits from investing into the public good, i.e., the voting procedure could takes place behind a “veil of ignorance” (Rawls 1971).

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Appendix

Table 1: Experimental Design

	Treatment	Phases	No. of Subjects (Ind. Obs.)
Single-Phase Game	*VCM*	contribution	45 (15)
	eqpay	contribution	45 (15)
	eqcont	contribution	48 (46)
	propcont	contribution	48 (12)
Multi-Phase Game	*majority*	collective-choice and contribution	87 (29)
	unanimity	collective-choice and contribution	93 (31)

Notes: Players participate in groups of 3 in a repeated public good game with overall 10 periods (excluding trial periods) and a marginal per capita return from investing into the public good of 0.6. Each group consists of one player with an initial endowment of 20, 30, and 40 LD. In the collective-choice phase, subjects vote on the proposed rule-based contribution schemes (*eqcont*, *eqpay* and *propcont*). To be adopted, a rule-based contribution scheme must receive 2 out of 3 votes (majority rule) and 3 out of 3 votes (unanimity rule). If a rule-based contribution scheme is adopted it is implemented in the contribution phase. If no rule-based contribution scheme is adopted a *VCM* is implemented in the contribution phase.

Table 2: Theoretical Predictions according to Standard Preferences

	Q^{min}	q_{type20}	q_{type30}	q_{type40}	π_{type20}	π_{type30}	π_{type40}	Π
VCM	0	0	0	0	20	30	40	90
eqcont	78	20	29	29	46.8	47.8	57.8	152.4
eqpay	90	20	30	40	54	54	54	162
propcont	90	20	30	40	54	54	54	162

Notes: Q^{min} = binding minimum group contribution level; q_i = individual contribution of player i to the public good; π_i = individual payoff of player i; Π = group payoff.

Table 3: Test Between Types (Binomial Test): Individually Chosen Rule-Bases Contribution Schemes

	eqcont		***eqpay***		***propcont***	
	type20	*type30*	*type20*	*type30*	*type20*	*type30*
type30	>		<***		>***	
type40	>***	>***	<***	<***	>	<**

Notes: Votes in all three voting rounds for a rule-based contribution scheme serve as one observation. We compare rows with columns, *p<0.1, **p<0.05 and ***p<0.01. Example: *type40* players vote less frequently for the *eqpay* scheme compared to *type20* players, this difference is significant at the 1%-level.

Table 4: Implemented Contribution Schemes in the *Multi-Phase Game*

	Majority rule voting	Unanimity rule voting	Total
VCM	1	13	14
	(3.45)	(41.94)	(23.33)
eqcont	3	2	5
	(10.34)	(6.45)	(8.33)
eqpay	18	10	28
	(62.07)	(32.26)	(46.67)
propcont	7	6	13
	(24.14)	(19.35)	(21.67)
Total	29	31	60
	(100)	(100)	(100)

Notes: Contribution schemes chosen by a group serves as one observation. Percentage in parentheses.

Table 5: Implemented Contribution Schemes in the *Multi-Phase Game* (Binomial Test)

	VCM	*eqpay*	*eqcont*
eqpay	>***		
eqcont	<***	<***	
propcont	>	<***	>***

Notes: Contribution schemes chosen by a group serves as one observation. We compare rows with columns, *p<0.1, **p<0.05 and ***p<0.01. Example: *eqpay* is more frequently implemented compared to *eqcont*, this difference is significant at the 1%-level.

Table 6: Test Between Rounds (Binomial Test): Chosen Rule-Based Contribution Schemes

		Round 1			*Round 3*		
		eqcont	*eqpay*	*Propcont*	*eqcont*	*eqpay*	*propcont*
Round 2	*eqcont*	<			>		
	eqpay		<			>***	
	propcont			>**			<***
Round 3	*eqcont*	<					
	eqpay		<***				
	propcont			>***			

Notes: Votes in each of the three voting rounds for a rule-based contribution scheme serve as one observation. We compare rows with columns, *p<0.1, **p<0.05 and ***p<0.01. Example: participants vote less frequently for the *eqpay* scheme in the third voting round compared to the first voting round, this difference is significant at the 5%-level.

Table 7: Summary Statistic of all Contribution Schemes: Average Contributions and Payoffs per Group in Endogenously and Exogenously Implemented Contribution Schemes

	ex-VCM	*end-VCM*	*ex-eqcont*	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*	*end-propcont*
All Periods								
q_{all}	17.45	8.14	21.20	20.33	21.45	26.32	24.29	22.48
q_{type20}	13.13	6.74	16.73	15.74	13.6	17.07	16.58	15.27
q_{type30}	17.75	10.20	21.91	21.35	21.31	26.04	24.21	22.49
q_{type40}	21.46	7.49	24.96	23.89	29.45	35.84	32.09	29.68
π_{all}	43.96	36.51	46.96	46.26	47.16	51.05	49.43	47.99
π_{type20}	32.27	27.91	41.44	40.85	45.02	50.30	47.15	45.19
π_{type30}	43.65	34.46	46.25	45.24	47.30	51.33	49.52	47.97
π_{type40}	49.95	47.17	53.20	52.70	49.17	51.53	51.63	50.79
Last Five Periods								
q_{all}	15.58	6.63	22.14	20.91	21.61	27.27	24.43	23.70
q_{type20}	11.64	5.75	17.30	15.83	14.16	17.70	16.74	15.82
q_{type30}	16.06	8.37	23.33	22.18	21.32	26.93	24.38	23.74
q_{type40}	19.04	5.77	25.81	24.72	29.36	37.18	32.19	31.54
π_{all}	42.47	35.30	47.72	46.73	47.29	51.82	49.55	48.96
π_{type20}	36.40	26.19	42.56	41.81	44.74	51.39	47.24	46.84
π_{type30}	41.99	33.57	46.53	45.46	47.58	52.16	49.60	48.92
π_{type40}	49.00	46.16	54.05	52.92	49.54	51.90	51.79	51.12
Last Period								
q_{all}	8.91	2.98	23.29	21.60	21.00	27.64	24.38	26.27
q_{type20}	7.67	2.21	18.33	16.00	14.67	18.32	17.45	17.54
q_{type30}	10.73	6.00	24.47	23.40	20.33	26.79	23.81	26.31
q_{type40}	8.33	0.71	27.07	25.40	28.00	37.82	31.86	34.98
π_{all}	37.13	32.38	48.63	47.28	46.80	52.11	49.50	51.02
π_{type20}	28.37	23.14	43.59	42.88	43.13	51.44	46.42	49.76
π_{type30}	35.31	29.36	47.45	45.48	47.47	52.97	50.06	50.98
π_{type40}	47.71	44.64	54.85	53.48	49.80	51.94	52.02	52.32

Notes: q_{all} = average contributions per group over all 10 periods (excluding trial periods), the last five periods and in the last period; q_i = individual contribution of player i; π = average profits per group over all 10 periods (excluding trial periods), the last five periods and in the last period; π_i = individual payoff of player i. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*).

Table 8: Tests Between Treatments (U-Test): Average Contributions per Group in Endogenously and Exogenously Implemented Contribution Schemes

Treatment	*ex-VCM*	*end-VCM*	*ex-eqcont*	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*
All Periods							
end-VCM	<**						
ex-eqcont	>						
end-eqcont		>*	<				
ex-eqpay	>		>				
end-eqpay		>***		>	>**		
ex-propcont	>**		>**		>		
end-propcont		>***		>		<	<
Last Five Periods							
end-VCM	<**						
ex-eqcont	>						
end-eqcont		>**	<				
ex-eqpay	>**		<				
end-eqpay		>***		>*	>*		
ex-propcont	>***		>**		>		
end-propcont		>***		>		<	<
Last Period							
end-VCM	<**						
ex-eqcont	>***						
end-eqcont		>**	<				
ex-eqpay	>***		<				
end-eqpay		>***		>**	>*		
ex-propcont	>***		>*		>		
end-propcont		>**		>		<	>

Notes: Average contributions per group serve as one observation. We compare rows with columns, e.g. over all 10 periods (excluding trial periods), the last five periods and in the last period; *p<0.1, **p<0.05 and ***p<0.01. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*). Example: averaged over all periods contributions in *ex-propcont* are higher than in *ex-VCM*, this difference is significant at the 5%-level.

Table 9: Time Trends in all Contribution Schemes: Average Contributions per Group in Endogenously and Exogenously Implemented Contribution Schemes

Treatment	*ex-VCM*	*end-VCM*	*ex-eqcont*	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*	*end-propcont*
All players	▼***	▼***	▲*			▲***		

Note: Average contributions per group in each period (excluding the trial periods) of the game serves as one observation. Statistical results for time trends are based on a nonparametric Wilcoxon-type test for trends developed by Cuzick (1985) (Cuzick's test). ▼:= decreasing contributions over periods, ▲:= increasing contributions over periods;* p<0.1, ** p<0.05, *** p<0.01. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*).

Table 10: Summary Statistic of endogenously *eqpay* Scheme: Average Contributions per Group in the by Unanimity and Majority Implemented *eqpay* Scheme

		end-eqpay	
	all	*unanimity*	*majority*
q_{all}	26.32	28.84	24.43
q_{type20}	17.07	18.87	15.73
q_{type30}	26.04	28.85	23.93
q_{type40}	35.84	38.79	33.62

Notes: $q =$ average contributions per group over all 10 periods (excluding trial periods).

Table 11: Tests Between Treatments (U-Test): Average Payoffs per Group in Endogenously and Exogenously Implemented Contribution Schemes

	ex-VCM	*end-VCM*	*ex-eqcont*	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*
All Periods							
end-VCM	<**						
ex-eqcont	>						
end-eqcont		>*	<				
ex-eqpay	>		>				
end-eqpay		>***		>	>**		
ex-propcont	>**		>**		>		
end-propcont		>***		>		<	<
Last Five Periods							
end-VCM	<**						
ex-eqcont	>						
end-eqcont		>**	<				
ex-eqpay	>**		<				
end-eqpay		>***		>*	>*		
ex-propcont	>***		>**		>		
end-propcont		>***		>		<	<
Last Period							
end-VCM	<**						
ex-eqcont	>***						
end-eqcont		>**	<				
ex-eqpay	>***		<				
end-eqpay		>***		>**	>*		
ex-propcont	>***		>*		>		
end-propcont		>***		>		<	>

Notes: Average payoffs per group serve as one observation. We compare rows with columns, e.g. over all 10 periods (excluding trial periods), the last five periods and in the last period; *p<0.1, **p<0.05 and ***p<0.01. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*). Example: averaged over all periods profits in *ex-eqpay* are higher than in *ex-VCM*, this difference is not significant at a conventional level.

Table 12: Time Trends in all Contribution Schemes: Average Payoffs per Group in Endogenously and Exogenously Implemented Contribution Schemes

Treatment	*ex-VCM*	*end-VCM*	*ex-eqcont*	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*	*end-propcont*
All players	▼***	▼***	▲*			▲***		

Note: Average contributions in each period (excluding the trial periods) of the game serves as one observation. Statistical results for time trends are based on a nonparametric Wilcoxon-type test for trends developed by Cuzick (1985) (Cuzik's test). ▼:= decreasing contributions over periods, ▲:= increasing contributions over periods;* p<0.1, ** p<0.05, *** p<0.01. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*).

Table 13: Definition of Variables

Variable	Description
q_i	Individual contribution of subject i to the public good
π_i	Subject i's profit
eqcont	= 1 if subject i played *eqcont*, 0 else
eqpay	= 1 if subject i played *eqpay*, 0 else
propcont	= 1 if subject i played *propcont*, 0 else
voting	= 1 if subject i played the *Multi-Phase Game*, 0 else
male	= 1 if subject i is male, 0 if female
exp	Number of experiments subject i has taken part in MaXLab

Table 14: FGLS Random-Effects Regression of Contributions per Subject in Endogenously and Exogenously Implemented Contribution Schemes

	1	2	3	4	5	6
	q_i	q_i	q_i	q_i	q_i	q_i
Contribution Scheme	all	all	*VCM*	*eqcont*	*eqpay*	*propcont*
Implementation	endogenously	exogenously	endogenously and exogenously	endogenously and exogenously	endogenously and exogenously	endogenously and exogenously
Independent Variables↓						
eqpay	17.92*** (1.66)	4.29* (2.38)				
eqcont	11.79*** (3.17)	4.05* (2.12)				
propcont	14.23*** (2.15)	6.92*** (2.31)				
voting			-9.38*** (2.14)	-1.19 (2.88)	4.63** (1.98)	-1.85 (2.30)
male	1.44 (1.54)	2.42 (1.52)	1.16 (2.20)	4.82** (2.15)	0.12 (1.89)	3.63 (2.32)
exp	-0.02 (0.10)	0.12 (0.10)	0.12 (0.12)	-0.28** (0.13)	0.08 (0.13)	0.14 (0.18)
Constant	7.67*** (1.64)	14.94*** (2.28)	15.58*** (2.56)	21.51*** (1.93)	20.72*** (2.13)	21.02*** (2.18)
Observations	1.800	1.830	870	600	1.290	870
Number of Groups	180	183	87	60	129	87

Notes: q_i = Individual contribution of subject i to the public good in each period (excluding the trial periods). Standard errors in parentheses, *p<0.1, **p<0.05 and ***p<0.01. Model 1 considers observations from all endogenously implemented contribution schemes (*end-VCM*, *end-eqcont*, *end-eqpay*, and *end-propcont*). Model 2 considers all observations from exogenously implemented contribution schemes (*ex-VCM*, *ex-eqcont*, *ex-eqpay*, and *ex-propcont*). Model 3 considers observations from the endogenously and exogenously implemented *VCM* (*end-VCM* and *ex-VCM*). Model 4 considers observations from the endogenously and exogenously implemented *eqcont* (*end-eqcont* and *ex-eqcont*). Model 5 considers observations from the endogenously and exogenously implemented *eqpay* (*end-eqpay* and *ex-eqpay*). Model 6 considers observations from the endogenously and exogenously implemented *propcont* (*end-propcont* and *ex-propcont*).

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Table 15: FGLS Random-Effects Regression of Payoffs per Subject in Endogenously and Exogenously Implemented Contribution Schemes

	1	2	3	4	5	6
	π_i	π_i	π_i	π_i	π_i	π_i
Contribution Scheme	all	all	*VCM*	*eqcont*	*eqpay*	*propcont*
Implementation	endogenously	exogenously	endogenously and exogenously	endogenously and exogenously	endogenously and exogenously	endogenously and exogenously
Independent Variables↓						
eqpay	14.11***	3.51*				
	(1.72)	(1.90)				
eqcont	9.16***	3.28*				
	(3.03)	(1.93)				
propcont	11.27***	5.53***				
	(2.07)	(1.88)				
voting			-7.33***	-1.71	3.44***	-1.48
			(2.27)	(2.76)	(1.17)	(1.63)
male	2.24*	1.91	0.39	3.99*	1.66	2.74
	(1.28)	(1.21)	(2.30)	(2.22)	(1.08)	(1.67)
exp	-0.04	0.13*	-0.06	-0.01	0.11*	0.10
	(0.09)	(0.07)	(0.13)	(0.12)	(0.07)	(0.13)
Constant	36.02***	41.64***	44.38***	45.12***	45.38***	47.04***
	(1.85)	(1.88)	(2.35)	(2.02)	(1.44)	(1.81)
Observations	1.800	1.830	870	600	1290	870
Number of Groups	180	183	87	60	129	87

Notes: $q_i =$ Individual profit of subject i in each period (excluding the trial periods). Standard errors in parentheses, *p<0.1, **p<0.05 and ***p<0.01. Model 1 considers observations from all endogenously implemented contribution schemes (*end-VCM*, *end-eqcont*, *end-eqpay*, and *end-propcont*). Model 2 considers all observations from exogenously implemented contribution schemes (*ex-VCM*, *ex-eqcont*, *ex-eqpay*, and *ex-propcont*). Model 3 considers observations from the endogenously and exogenously implemented *VCM* (*end-VCM* and *ex-VCM*). Model 4 considers observations from the endogenously and exogenously implemented *eqcont* (*end-eqcont* and *ex-eqcont*). Model 5 considers observations from the endogenously and exogenously implemented *eqpay* (*end-eqpay* and *ex-eqpay*). Model 6 considers observations from the endogenously and exogenously implemented *propcont* (*end-propcont* and *ex-propcont*).

Table 16: Summary Statistic of all Contribution Schemes: Average Binding Group Minimum Contribution Level in Endogenously and Exogenously Implemented Rule-Bases Contribution Schemes

	ex-eqcont	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*	*end-propcont*
All Periods						
Q^{min}	61.14	60.66	61.44	76.55	69.51	66.67
q^{min}_{type20}	16.57	15.46	12.03	16.04	15.45	14.82
q^{min}_{type30}	21.25	21.31	20.31	25.39	23.17	22.22
q^{min}_{type40}	23.32	23.89	29.10	35.12	30.89	29.63
Last Five Periods						
Q^{min}	64.5	62.20	63.30	79.98	70.50	70.85
q^{min}_{type20}	17.24	15.37	13.12	17.06	15.67	15.74
q^{min}_{type30}	22.57	22.12	20.89	26.55	23.50	23.62
q^{min}_{type40}	24.68	24.71	29.29	36.38	31.33	33.49
Last Period						
Q^{min}	68.80	64.80	61.20	80.57	69.94	78.69
q^{min}_{type20}	18.33	16.00	13.00	17.43	15.54	17.48
q^{min}_{type30}	24.47	23.40	20.33	26.75	23.31	26.23
q^{min}_{type40}	26.00	25.40	27.87	36.39	31.08	34.98

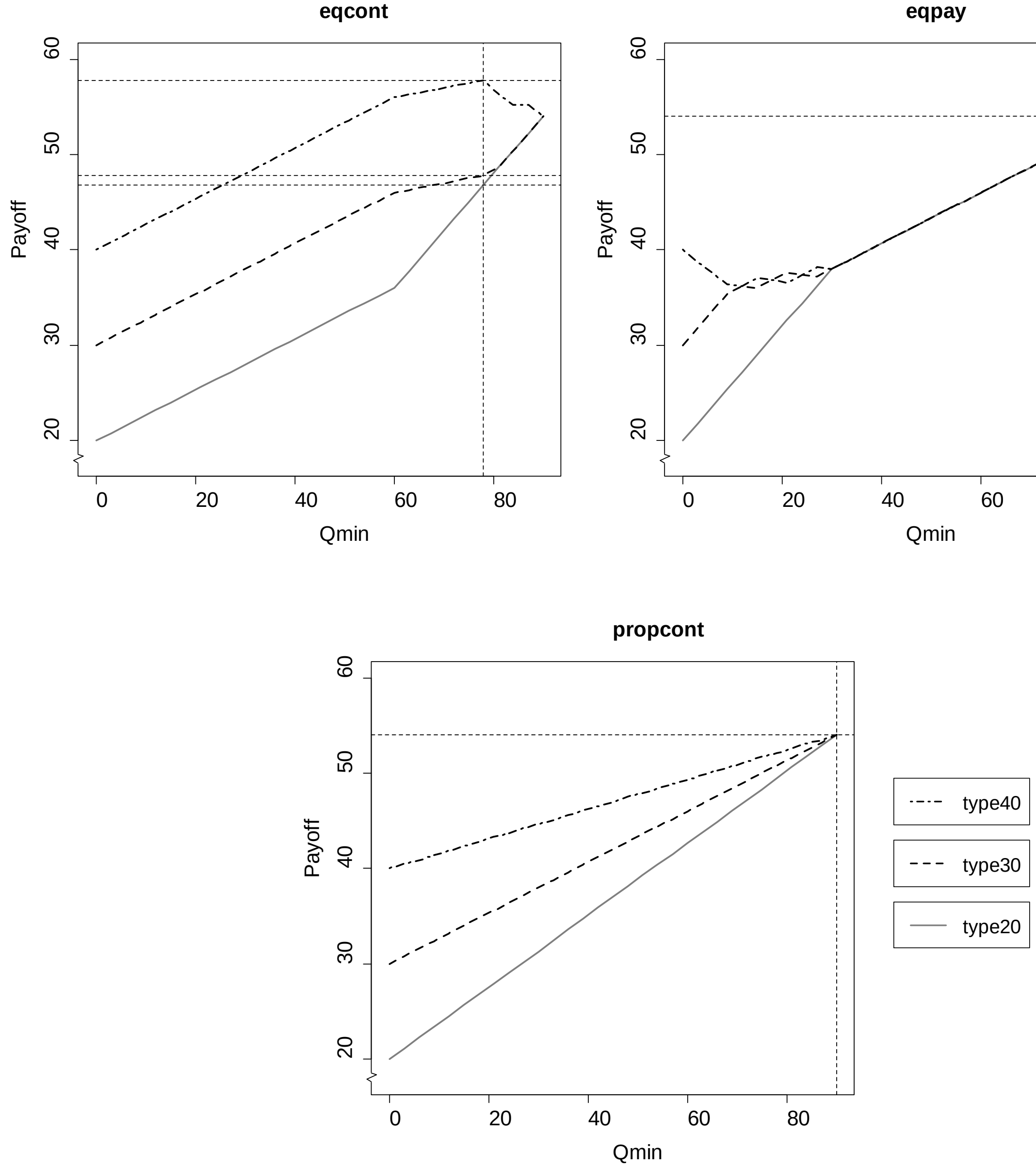
Notes: Q^{min} = binding minimum group contribution level. q_i^{min}= binding individual contribution level. In all 10 periods (excluding trial periods), the last five periods and in the last period. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*).

Table 17: Tests Between Treatments (U-Test): Average Minimum Group Contribution Levels

	ex-eqcont	*end-eqcont*	*ex-eqpay*	*end-eqpay*	*ex-propcont*
All Periods					
end-eqcont	<				
ex-eqpay	>				
end-eqpay		>**	>***		
ex-propcont	>***		>*		
end-propcont		>		<	<
Last Five Periods					
end-eqcont	<				
ex-eqpay	<				
end-eqpay		>*	>		
ex-propcont	>*		>		
end-propcont		>		<	>
Last Period					
end-eqcont	<				
ex-eqpay	<				
end-eqpay		>**	>		
ex-propcont	>		>		
end-propcont		>		<	>

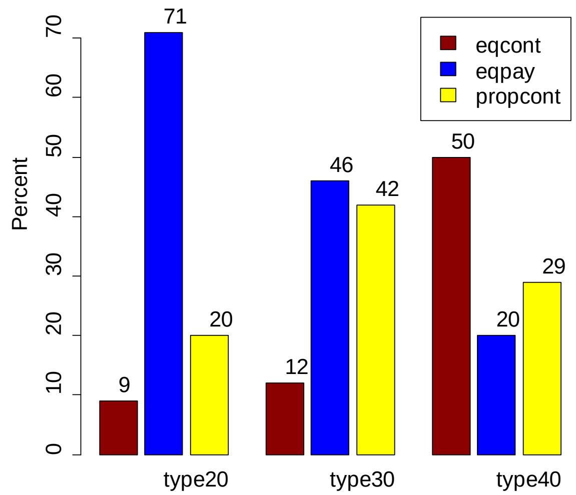
Notes: Average binding minimum group contributions serve as one observation. We compare rows with columns, e.g. over all 10 periods (excluding trial periods), the last five periods and in the last period; *p<0.1, **p<0.05 and ***p<0.01. Exogenously implemented contribution schemes get the prefix *ex-* (i.e. *ex-VCM*, *ex-eqcont*, *ex-eqpay* and *ex-propcont*), endogenously implemented contribution schemes get the prefix *end-* (i.e. *end-VCM*, *end-eqcont*, *end-eqpay* and *end-propcont*). Example: averaged over all periods binding minimum group contributions in *ex-propcont* are higher than in *ex-eqpay*, this difference is significant at the 10%-level.

Figure 1: Theoretical Predictions according to Standard Preferences



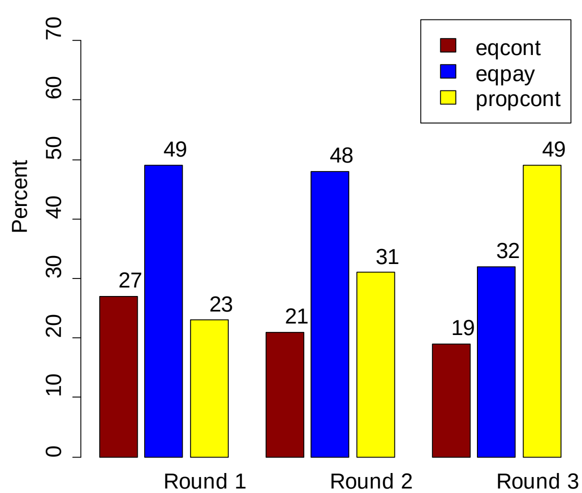
Notes: Binding minimum group contribution levels on the x-axis and corresponding payoffs for each player per group on the y-axis. Dotted lines indicate type-specific equilibrium quantities and corresponding payoffs.

Figure 2: Individually Chosen Rule-Based Contribution Scheme by Types



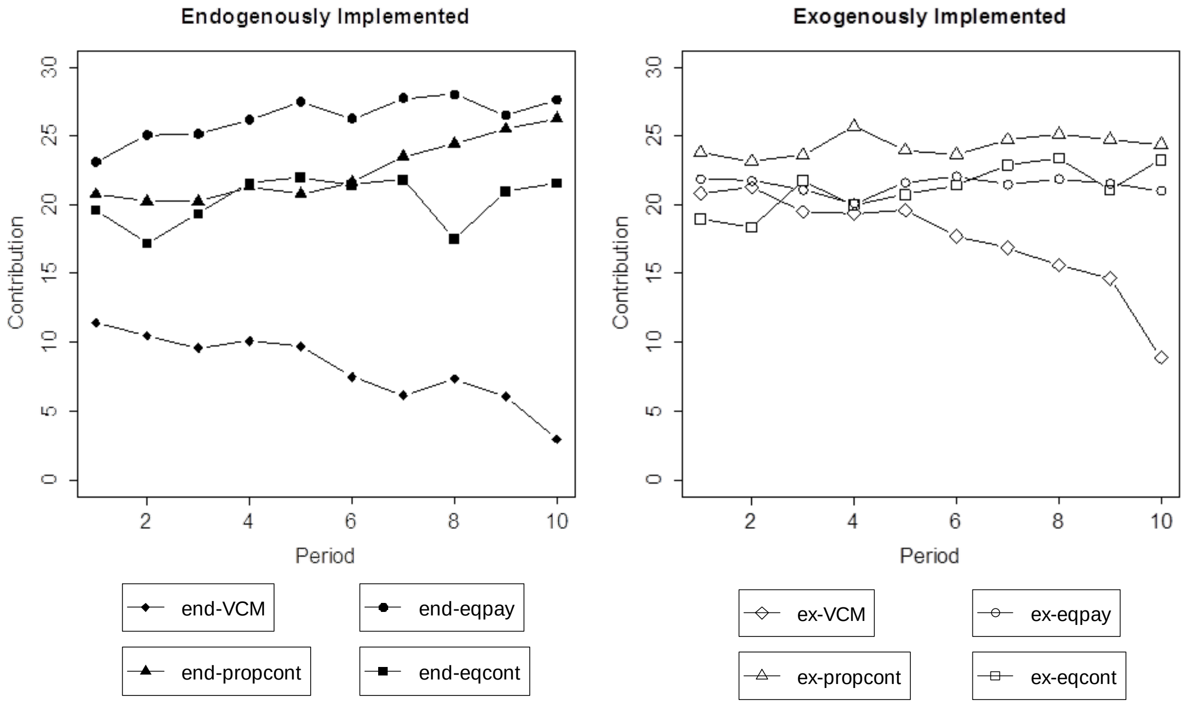
Notes: Individually chosen rule-based contribution scheme in all three rounds of the collective-choice phase of the *Multi-Phase Game* by players.

Figure 3: Chosen Rule-Based Contribution Scheme by Rounds



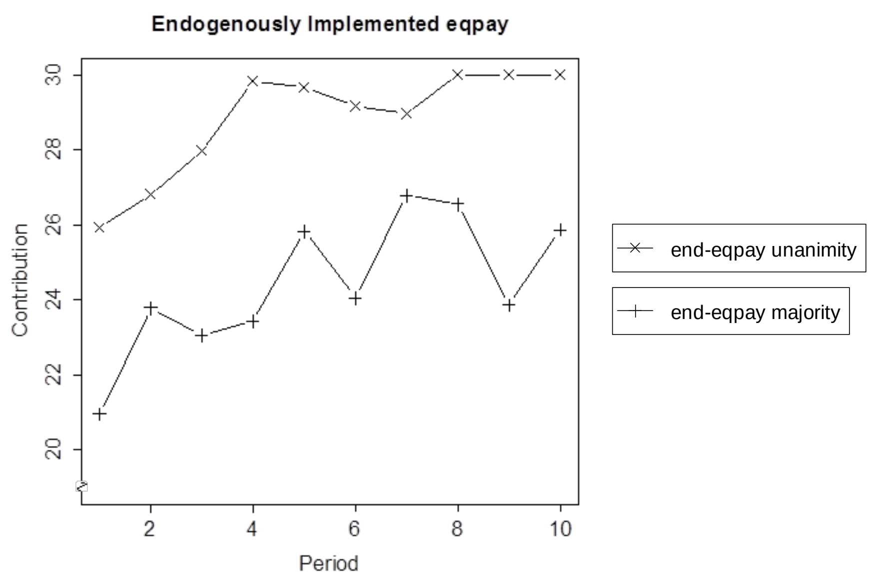
Notes: Chosen rule-based contribution scheme of all players in the collective-choice phase of *Multi-Phase Game* by rounds.

Figure 4: Average Contributions per Group in Endogenously and Exogenously Implemented Contribution Schemes



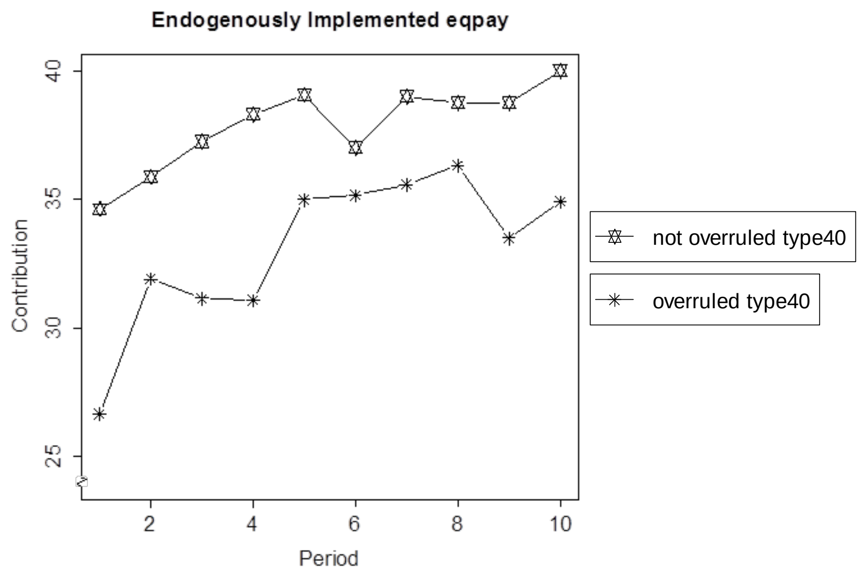
Notes: Average group contributions to the public good in each period (excluding the trial periods) of the game serves as one observation. On the left (right): contributions in the endogenously (exogenously) implemented contribution schemes.

Figure 5: Average Contributions per Group in by Unanimity and Majority Implemented *eqpay* Scheme



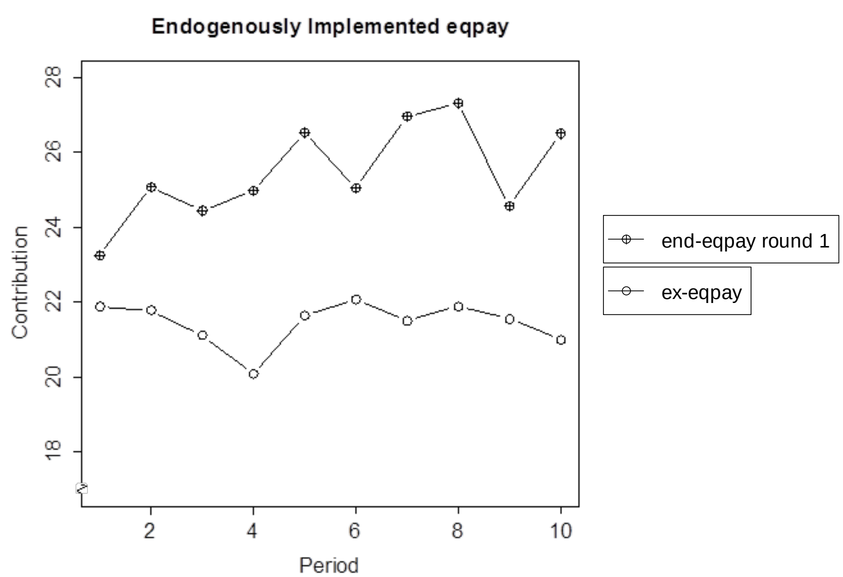
Notes: Average group contributions in each period (excluding the trial periods) of the endogenously *eqpay* scheme serves as one observation.

Figure 6: Average Contributions per Player in by Majority Implemented *eqpay* Scheme from Overruled and Not Overruled *type40* Players



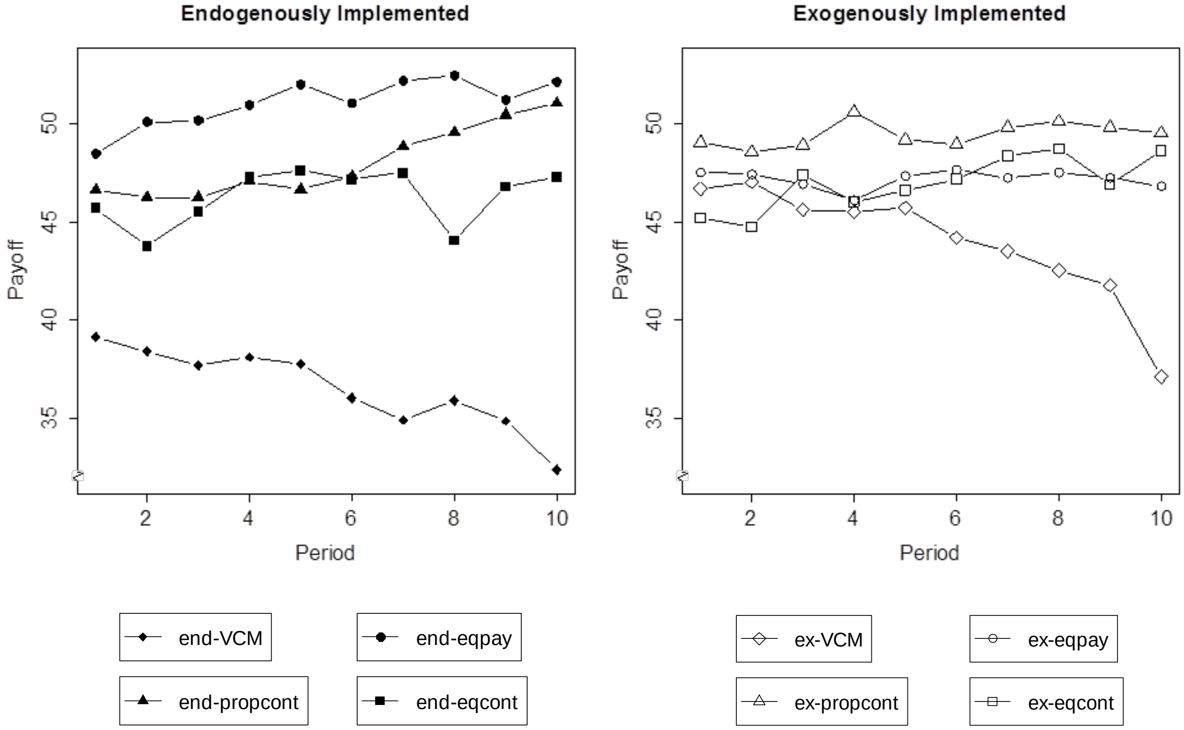
Notes: Average contributions in each period (excluding the trial periods) of the by majority implemented *eqpay* scheme serves as one observation.

Figure 7: Average Contributions per Group in the *eqpay* Scheme implemented by Voting in the First Round or Exogenously



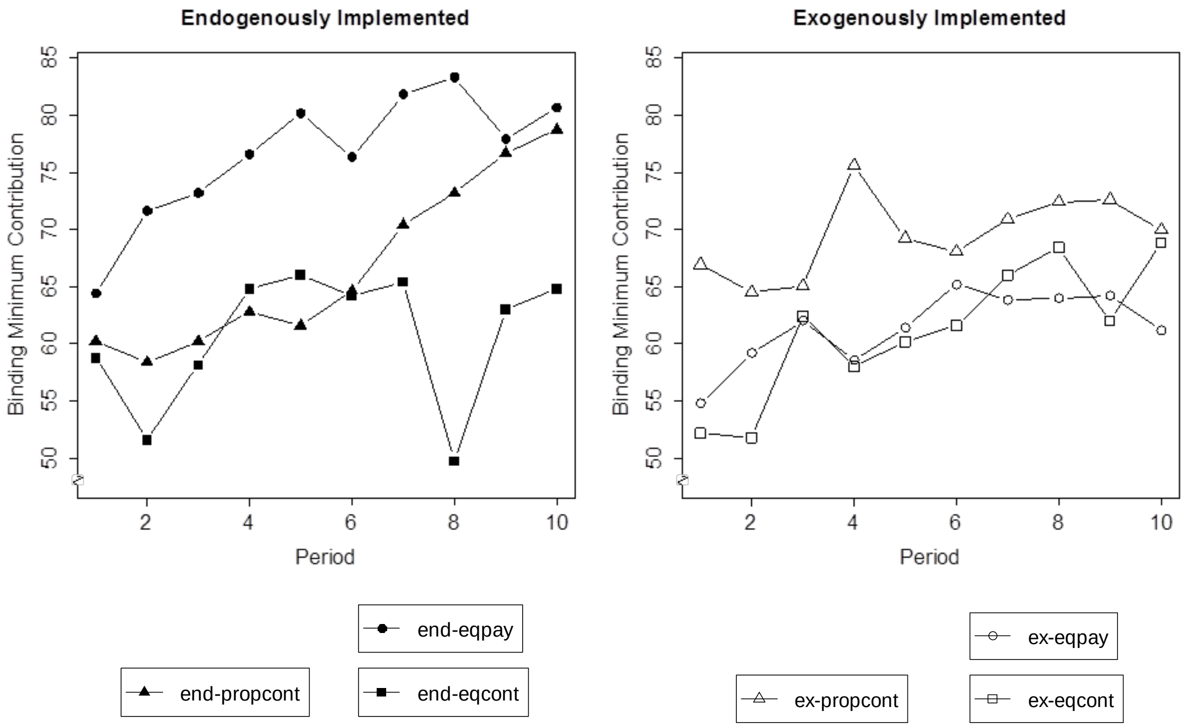
Notes: Average group contributions in each period (excluding the trial periods) of the *eqpay* scheme serves as one observation.

Figure 8: Average Payoffs per Group in Endogenously and Exogenously Implemented Contribution Schemes



Notes: Average group payoffs in each period (excluding the trial periods) of the game serves as one observation. On the left (right): payoffs in the endogenously (exogenously) implemented contribution schemes.

Figure 9: Average Binding Group Minimum Contribution Levels in Endogenously and Exogenously Implemented Contribution Schemes



Note: Average binding group minimum contribution level in each period (excluding the trial periods) of the game serves as one observation. On the left (right): average binding group minimum contribution level in the endogenously (exogenously) implemented contribution schemes.

Theoretical Predictions: Analytical Solution according to Standard Preferences

Equal-Contribution Scheme (eqcont)

In the *eqcont* scheme a subgame perfect equilibrium in weakly dominant strategies is characterized by $Q^{min} = 78$, $q^{min}_{type20} = e_{type20}$ and $q^{min}_{type30} = q^{min}_{type40} = \frac{1}{n-1}\left(78 - e_{type20}\right)$.

type20 and *type30* players have a weakly dominant strategy to propose $Q^{min} = E$ because their marginal payoff from increasing the groups' binding minimum contribution level is positive for all $Q^{min} \in [0, E]$. In case their proposal is binding, increasing the minimum contribution until $Q^{min} = E$ would increase their payoff. In case their proposal is not binding, proposing $Q^{min} = E$ would not hurt them. Following this logic *type40* players have a weakly dominant strategy to propose $Q^{min} = 78$, because their payoff is maximized for $Q^{min} = 78$. Since the smallest proposal is binding the subgame perfect equilibrium in weakly dominant strategies given by $Q^{min} = 78$.

Since it is obligatory that Q^{min} is provided and $q_i \in [0, e_i]$ payoff functions are discontinuous and separated in three parts:

Part 1: If $Q^{min} \in [0,60]$, players' minimum individual contribution levels are given by $q_i^{min} = \frac{1}{n}Q^{min}$ and individual payoff is given by

$$\pi_i = e_i - c * \frac{1}{n}Q^{min} + bQ^{min}.$$

Therefore, players' marginal payoff form increasing the groups' binding minimum contribution level is given by $\frac{\partial \pi_i}{\partial Q^{min}} = -c * \frac{1}{n} + b = -\frac{1}{3} + \frac{3}{5} = \frac{4}{15} > 0$ and the marginal benefits exceeding its costs.

Part 2: If $Q^{min} \in]60,80]$, $q^{min}_{type20} = e_{type20}$ and $q^{min}_{type30} = q^{min}_{type40} = \frac{1}{n-1}\left(Q^{min} - e_{type20}\right)$. Therefore, *type20* players' marginal payoff is given by $\frac{\partial \pi_{type20}}{\partial Q^{min}} = b = \frac{3}{5} > 0$ and for *type30* as well as *type40* given by $\frac{\partial \pi_{type30}}{\partial Q^{min}} = \frac{\partial \pi_{type40}}{\partial Q^{min}} = -c * \frac{1}{n-1} + b = -\frac{1}{2} + \frac{3}{5} = \frac{1}{10} > 0$.

Part 3: If $Q^{min} \in]80,90]$, $q^{min}_{type20} = e_{type20}$, $q^{min}_{type30} = e_{type30}$ and $q^{min}_{type40} = \frac{1}{n-2}\left(Q^{min} - e_{type20} - e_{type30}\right)$. Therefore *type20* and *type30* players' marginal payoff is given by $\frac{\partial \pi_{type20}}{\partial Q^{min}} =$

$\frac{\partial \pi_{\ type30}}{\partial Q^{min}} = b = \frac{3}{5} > 0$ and for *type40* players' given by $\frac{\partial \pi_{\ type40}}{\partial Q^{min}} = -c * \frac{1}{n-2} + b = -1 + \frac{6}{10} = -\frac{2}{5} < 0$.

Equal-Payoff Scheme (eqpay)

In the *eqpay* scheme there are two subgame perfect equilibriums in weakly dominant strategies. One by $Q^{min} = E$, and $q^{min}_{type20} = e_{type20}, q^{min}_{type30} = e_{type30}$ and $q^{min}_{type40} = e_{type40}$ and one by $Q^{min} = 0$, and $q^{min}_{type20} = q^{min}_{type30} = q^{min}_{type40} = 0$.

type20 and *type40* players have a weakly dominant strategy to propose $Q^{min} = E$ and also *type40* players payoff is maximized at $Q^{min} = E$. Therefore we expect the groups' binding minimum contribution level to be $Q^{min} = E$, which implies $q^{min}_{type20} = e_{type20}, q^{min}_{type30} = e_{type30}$ and $q^{min}_{type40} = e_{type40}$.

Since we do not allow for direct redistribution of initial endowment and $q_i \in [0, e_i]$ payoff functions are discontinuous and separated in three parts.

Part 1: If $Q^{min} \in [30{,}90]$ individual minimum contributions are given by $q_i^{min} = e_i - \frac{1}{n}\left(E - Q^{min}\right)$ and individual payoffs are

$$\pi_i = e_i - c * (e_i + \frac{1}{n}\left(E - Q^{min}\right)) + bQ^{min}.$$

Therefore, the marginal benefits form increasing the groups' minimum contribution level exceeds its costs for all players and the marginal payoff is given by $\frac{\partial \pi_{\ i}}{\partial Q^{min}} = -c * \frac{1}{n} + b = -\frac{1}{3} + \frac{3}{5} = \frac{4}{15} > 0$.

Part 2: If $Q^{min} \in]9{,}30[$ individual minimum contributions are $q^{min}_{type20} = 0$, $q^{min}_{type30} = q^{min}_{type40} = \frac{1}{n-1}\left(e_{type40} + e_{type30} - Q^{min}\right)$. Therefore, the marginal payoff for *type20* players is given by $\frac{\partial \pi_{\ type20}}{\partial Q^{min}} = b = \frac{6}{10} > 0$, and for *type30* as well *type40* it is given by $\frac{\partial \pi_{\ type30}}{\partial Q^{min}} = \frac{\partial \pi_{\ type40}}{\partial Q^{min}} = -c * \frac{1}{n-1} + b = -\frac{1}{2} + \frac{3}{5} = \frac{1}{10} > 0$.

Part 3: If $Q^{min} \in [0,9]$ individual minimum contributions are $q_{type20}^{min} = q_{type30}^{min} = 0$ and $q_{type40}^{min} = Q^{min}$. Therefore, marginal payoffs for *type20* and *type30* players are given by $\frac{\partial \pi_{\ type20}}{\partial Q^{min}} = \frac{\partial \pi_{\ type30}}{\partial Q^{min}} = b = \frac{3}{5} > 0$ an $\frac{\partial \pi_{\ type40}}{\partial Q^{min}} = -c + b = -1 + \frac{3}{5} = -\frac{2}{5} < 0$ for type40 players.

Proportional-Contribution Scheme (propcont)

In the *propcont* scheme a subgame perfect equilibrium in weakly dominant strategies is characterized by $Q^{min} = E = 90$, and $q_{type20}^{min} = e_{type20}, q_{type30}^{min} = e_{type30}$ and $q_{type40}^{min} = e_{type40}$.

For all players, the benefits from increasing the binding group minimum contribution level exceeds its costs for all $Q^{min} \in [0, E]$ and it is the weakly dominant strategy for all players to propose $Q^{min} = E$.

For all $Q^{min} \in [0, E]$ the binding individual contribution level is given by $q_i^{min} = \frac{e_i}{E} Q^{min}$ and individual payoffs are given by

$$\pi_i = e_i - c * \frac{e_i}{E} Q^{min} + bQ^{min}.$$

Therefore for all players the marginal benefits from increasing the groups' binding minimum contribution level exceeds its costs and the marginal payoffs are given by $\frac{\partial \pi_{\ i}}{\partial Q^{min}} = -c * \frac{e_i}{E} + b = -\frac{2}{9} + \frac{3}{5} = \frac{17}{45} > 0$ for *type20* players, $-\frac{1}{3} + \frac{3}{5} = \frac{4}{15} > 0$ for *type30* players and $-\frac{4}{9} + \frac{3}{5} = \frac{7}{45} > 0$ for *type40* players.

Instructions: Majority Treatment

Please read the instructions carefully and contact us by opening the door or giving a hand signal if you have any questions. Please do not talk to each other and do not use any electronic devices such as mobile phones, smart phones, or the like throughout the whole experiment. In the experiment you are now taking part in, you can earn money depending on your decisions and those of your teammates. Your payoff from the experiment is calculated in LaborDollars (LD) and the exchange rate between € and LD is 1:3, i.e., 3 LD equals 1 €.

During the experiment, you make your decisions **anonymously**. Only the experimenter will know your identity and your data will be treated confidentially. This experiment consists of **two parts** that will be carried out consecutively: **(1) voting** and **(2) game**. Please read the rules of the **game** in the following. After that, you will get details about the voting procedure.

Rules of the Game

Three players will take part in the game, i.e., apart from you, there are two other players. All in all, your group of three players has an initial endowment of 90 LD. One of the players is provided with an initial endowment of 20 LD ("type20" in the following). Another player ("type30") is provided with an initial endowment of 30 LD and another one is provided with an initial endowment of 40 LD ("type40"). Whether you are type20, type30, or type40 will be **drawn by lot** and announced before the voting.

Your task in the game (which is the same for your teammates in your group) is to decide what amount of LD you are willing to contribute to a **joint project.** Your **contribution, q, to the project** can range between 0 and 20 LD if you are type20. Your contribution can range between 0 and 30 LD if you are type30 and between 0 and 40 LD if you are type40.

The individual payoff (in LD) for each one of the three players is derived as follows:

Payoff = (initial endowment of player – contribution of player) + 0.6·(total sum of contributions by **all** players)

Assume you are **type20**, then your payoff (in LD) is:

Payoff = (**20** – your contribution) + 0.6·(total sum of contributions by **all** players)

That means, if, for example, the other two players contribute a total of 70 LD and you contribute 10 LD to the project, then your payoff is

Payoff = (20 – 10) + 0,6·(70 + 10) = 58

Whereas, if the other two players contribute a total of 70 LD and you contribute nothing, your payoff is

Payoff = (20 – 0) + 0,6·(70 + 0) = 62

If you are **type30**, your payoff is (in LD):

Payoff = (**30** – your contribution) + 0.6·(total sum of contributions by **all** players)

If you are **type40**, your payoff is (in LD):

Payoff = (**40** – your contribution) + 0.6·(total sum of contributions by **all** players)

The **game** has **two stages**. In **stage 1**, you decide which minimum contribution, Q_{min}, the group shall make. The other players in your group state as well which minimum contribution, Q_{min}, they would like to have for the group.

The minimum of the suggestions, **min(Q_{min}),** is set as the **minimum contribution of the group**. Then in **stage 2**, you decide about your contribution, q, to the project, whereby for every player a lower limit, q_{min}, for the individual contribution is calculated from min(Q_{min}) according to a specific **rule**.

There are **three rules** to vote from:

Rule 1 "Equal Contribution": q_{min} is determined from min(Q_{min}) so that the **minimum contributions**, q_{min}, of all players are as equal as possible* so that every player contributes at least one third of the group's minimum contribution, min(Q_{min}), i.e., $q_{min} = (1/3) \cdot \min(Q_{min})$.

Rule 2 "Equal Payoff": q_{min} is determined from min(Q_{min}) so that the **payoffs** off all players are **equal** or at least adjusted as far as possible*.

Rule 3 "Proportional Contribution": q_{min} is determined from min(Q_{min}) so that the **minimum contributions**, q_{min}, of all players are proportional to their initial endowment. I.e., the higher the initial endowment the higher is the minimum contribution, q_{min}, to the joint project by the player.

* Please note that the adjustment is subject to the condition that the minimum contribution of the group to the joint project is reached.

Examples for the rules 1-3 with a minimum contribution of the group $\min(Q_{min}) = 45^{*}$.

	Rule 1 "Equal Contribution"		**Rule 2 "Equal Payoff"**		**Rule 3 "Proportional Contribution"**	
	Lower limit of contribution	Payoff	Lower limit of contribution	Payoff	Lower limit of contribution	Payoff
Type20	15	32	5	42	10	37
Type30	15	42	15	42	15	42
Type40	15	52	25	42	20	47

* Assumption: Each player chooses their lower limit as the contribution, i.e. $q = q_{min}$.

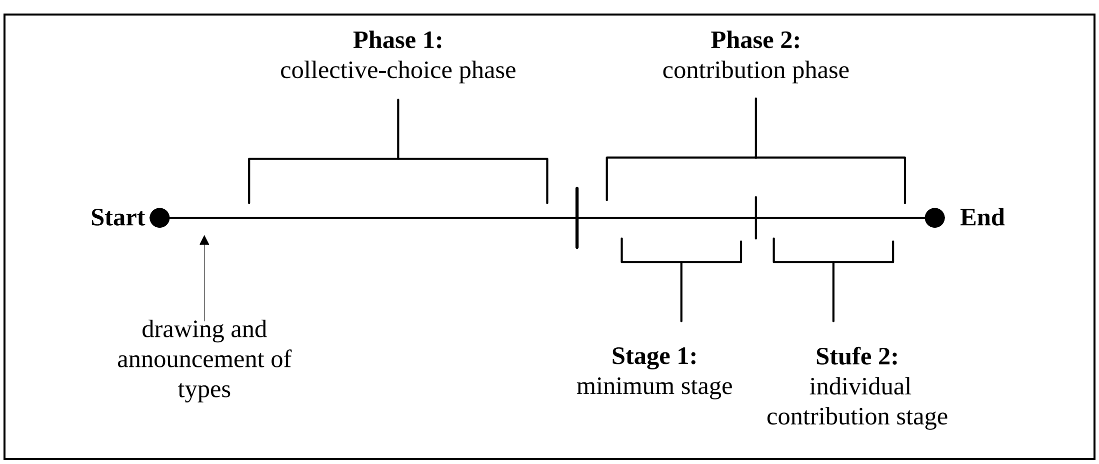
Please use the **simulator** to understand the examples. On your screen you will find an Excel file named "**simulator**". You can enter your desired **minimum contribution of the group**, $\min(Q_{min})$, in the simulator. For each rule (rule 1 "Equal Contribution", rule 2 "Equal Payoff", rule 3 "Proportional Contribution") the individual minimum contributions, q_{min}, and the corresponding **payoffs** to each player as well as the payoff to the group are calculated. Please note that only the corresponding minimum contributions are calculated, i.e. the minimum contribution of the group, $\min(Q_{min})$, is distributed to the players according to the different rules. Of course, you can also contribute **more** than the calculated minimum contribution, but only as long as your contribution does not exceed your initial endowment.

The game consists of **ten separate rounds**, in which you always play the same game, you remain the same type and you interact with the same two participants. In each round, you will be informed about the proposals of the minimum contribution (Q_{min1} to Q_{min3}), the contributions (q_1 to q_3) and the payoffs ($payoff_1$ to $payoff_3$) of all players in your group as well as the average values (D).
At the end of the experiment you will receive the **payoff of one of the ten rounds** in € (3 LD = 1 €). The round that will be disbursed is chosen **randomly**. Therefore, in **each** round, you should act as if it was relevant to disbursement. In the beginning, there will be **two trial rounds** which are **not relevant to disbursement**.

Voting
The members of a group decide for themselves which rule will be applied for the distribution of the group's minimum contribution, $\min(Q_{min})$. The voting is a **majority vote** (between rule 1 "Equal Contribution", rule 2 "Equal Payoff" and rule 3 "Proportional Contribution"), i.e. if at least two of the three group members vote for the same rule, it will be applied. There is a maximum of three votings.
If there is no rule that has received at least two of the three votes after the **third** voting, the game will be played **without stage 1,** i.e. no minimum contribution is determined and each player just states their contribution to the project and the payoffs will be determined as mentioned above.

Illustration 1 shows the course of the experiment in a nutshell.

Illustration 1



Control Questions (please answer, use the simulator if necessary)

1. Assume, the three players have stated 10, 20 and 30 respectively as the proposal for the minimum contribution.
   What is the group's minimum contribution $\min(Q_{min})$?
   The group's minimum contribution, $\min(Q_{min})$, is: _______

2. Assume, the group's minimum contribution, $\min(Q_{min})$, to the project is 30. What is your minimum contribution and payoff if you have agreed on the following rules, if all the players contribute their minimum contribution and you are **type20**? (Tip: Use the simulator)

Agreed rule →	Rule 1 "Equal Contribution"	Rule 2 "Equal Payoff"	Rule 3 "Proportional Contribution"
My minimum contribution q_{min}			
My payoff			

3. Assume, you could not agree on a rule in your group. Afterwards you make as a **type3**0 a contribution of 20 LD. The other two players contribute 0 LD and 10 LD. What is your payoff?
   My payoff is: ________

4. We have the same situation as in 3.) and the other players in your group have contributed their whole initial endowment to the project. Which of the following contributions gives **you** the highest payoff as a **type40?** (please tick)
   O 0 LD O 10 LD O 20 LD O 40 LD

5. We have the same situation as in 3.) and the other players in your group have contributed their whole initial endowment to the project. Which of the following contributions gives **the group** the highest payoff if you are a **type40**? (please tick)
   O 0 LD O 10 LD O 20 LD O 40 LD

If you have answered all the questions, please give us a sign. We will then check your answers. The **game** will start (with explanations on the screen) when all participants have answered the control questions correctly.

Good luck!
The MaXLab-Team

Figure 10: Screenshot of the Collective-Choice Phase of the *Multi-Phase-Game* (majority voting)

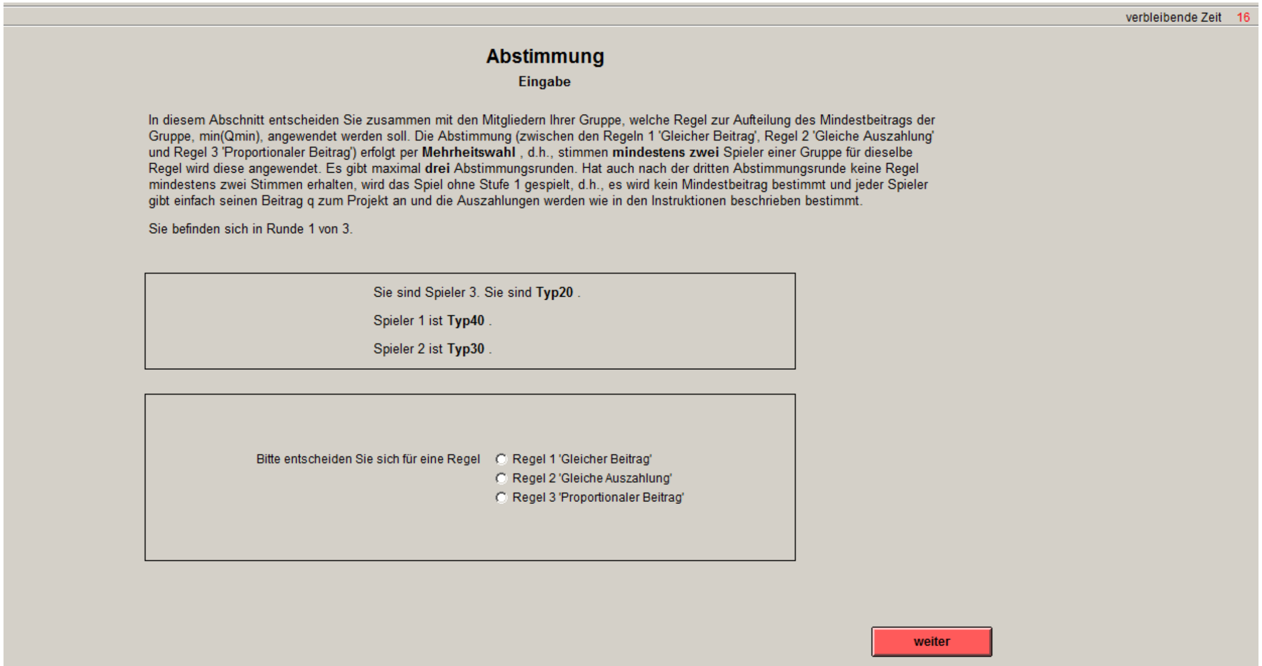


Figure 11: Screenshot of the Contribution Phase of the *Multi-Phase-Game* (*eqcont*)

Figure 12: Screenshot of the Simulator (for $Q_{min} = 45$, above: majority voting, below: *propcont*)

Simulator

Bitte nehmen Sie nur Änderungen in den GELB markierten Feldern vor

Gewünschter **Mindestbeitrag der Gruppe**, min(Q_{min}), bitte hier eintragen: 45 Beitrag zwischen 0 und 90 (durch 3 teilbar)

Regel 1 "Gleicher Beitrag"	Mindestbeitrag, q_{min}	Auszahlung in LD
Typ20	15.0	32.0
Typ30	15.0	42.0
Typ40	15.0	52.0
Auszahlung an die gesamte Gruppe:		126.0

Regel 2 "Gleiche Auszahlung"	Mindestbeitrag, q_{min}	Auszahlung in LD
Typ20	5.0	42.0
Typ30	15.0	42.0
Typ40	25.0	42.0
Auszahlung an die gesamte Gruppe:		126.0

Regel 3 "Proportionaler Beitrag"	Mindestbeitrag, q_{min}	Auszahlung in LD
Typ20	10.0	37.0
Typ30	15.0	42.0
Typ40	20.0	47.0
Auszahlung an die gesamte Gruppe:		126.0

Ohne Stufe 1	Beitrag, q	Auszahlung in LD
Typ20	0	20.0
Typ30	0	30.0
Typ40	0	40.0
Auszahlung an die gesamte Gruppe:		90.0

Die hier berechneten Beiträge sind lediglich die **Mindestbeiträge**. Ihr tatsächlicher Beitrag zum gemeinsamen Projekt kann höher sein, solange Ihr Beitrag nicht Ihre Anfangsausstattung übersteigt.

Simulator

Bitte nehmen Sie nur Änderungen im GELB markierten Feld vor

Gewünschter **Mindestbeitrag der Gruppe**, min(Q_{min}), bitte hier eintragen: 45 Beitrag zwischen 0 und 90 (durch 3 teilbar)

Regel "Gleicher Beitrag"	Mindestbeitrag, q_{min}	Auszahlung in LD
Typ20	15.0	32.0
Typ30	15.0	42.0
Typ40	15.0	52.0
Auszahlung an die gesamte Gruppe:		126.0

Die hier berechneten Beiträge sind lediglich die **Mindestbeiträge**. Ihr tatsächlicher Beitrag zum gemeinsamen Projekt kann höher sein, solange Ihr Beitrag nicht Ihre Anfangsausstattung übersteigt.