# Realpolitik in the lab: Voting, heterogeneity, and group preferences for fair allocations in a threshold public goods game

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**Abstract**

By means of a laboratory experiment, this study investigates if groups consisting of two heterogeneous player types (with either different marginal contribution costs or different endowments) choose different efficient allocations under two separate decision rules: individual voluntary contributions in a repeated game or a binding unanimous vote on contribution vectors in a one-shot setting. While allocations do not vary significantly if contribution costs are heterogeneous (or in the homogeneous control treatments), heterogeneous endowments result in equal contributions in a voluntary repeated setting, but equal payoffs (and unequal contributions) in a unanimous vote. The subjects' behavior corresponds to what is called "realpolitik" in a political context, i.e., putting aside one's own ideologies in order to achieve what is feasible under the institutional constraints.

*Keywords:* threshold public good, distributive justice, experimental economics, unanimous voting, committee, heterogeneity

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## 1. Introduction

Merriam Webster's online dictionary defines "realpolitik" as "politics based on practical objectives rather than on ideals."[1] The entry also mentions a more Machiavellian connotation of the word: the idea that personal interests are valued higher than ethical norms. However, for the purposes of this study, realpolitik is to be understood in the former, morally neutral way. More precisely, it is the aim of this study to show that subjects in a laboratory experiment may be compelled to put aside their ideologies, their individual conception of what they personally deem fair and just in favor of a group notion of fairness that is strongly influenced by the process by which said group arrives at its collective decision.

As a more concrete example, imagine that community C wants to collect funding for a communal project which is expected to benefit all of its inhabitants. For this purpose, the community relies on voluntary donations with the effect that most of the inhabitants make a relatively small donation, some give nothing at all, and a small number of people (who are either very interested in this project or just want to appear generous) provide the major share of the funding. Now imagine that an otherwise identical community C' does not rely on voluntary donations, but invites all of its inhabitants to vote on a one-time mandatory tax payment to finance the project, with each inhabitant being allowed to propose how the burden of this tax is shared among the community members. Further assume[2] that these proposals can be arbitrarily discriminating, that is, can even assign each individual inhab-

[1] http://www.merriam-webster.com/dictionary/realpolitik

[2] In order to achieve comparability with the voluntary contributions in community C.

itant a different cost share. Will community C' then allocate the costs for this communal project in the same way as community C?

If the answer is no, this means that at least some of the inhabitants in either or even both communities will not contribute what they personally think is a fair share, if this opinion can be gleaned from them in a more abstract context, without mentioning donations or taxes. Moreover, this difference implies that some inhabitants would be better off living in C than in C', meaning that these individuals could, for example, try to sabotage the vote so that no agreement is reached and hope that voluntary donations are then used as a fall-back solution. A similar scenario currently exists for the negotiations to prevent global warming, where a failure to reach an internationally binding agreement would force individual countries to rely on voluntary efforts to reduce carbon emissions.

In order to create instances of realpolitik in a controlled environment like a laboratory experiment, it is necessary, on the one hand, to provide a scenario for a collective decision that allows for a variety of ideologies to co-exist and be demarcated from each other, while on the other hand using a neutral measure for these various ideologies that is independent from this decision-making process. In an attempt to conform to this ideal, the present study investigates contribution behavior to a threshold public goods game with heterogeneous players (which is basically the type of game played by community C in the above example), where heterogeneity may stem from differences in endowments or marginal costs of contribution, but not both at the same time. The contribution choice itself is either an individual decision, made by each player separately and voluntarily, or a collective decision, the result of a binding unanimous vote on group contributions. It will be argued that multiple distinct allocation choices can be motivated in the context of this game and that neither decision rule favors any of these allocations, at least according to standard game theory. As a second step, individual preferences for fair allocations are elicited in a questionnaire which the subjects are asked to fill in after the decision-making experiment is over.

While the ideologies measured in the questionnaire are very similar under all treatment variations, the contribution behavior is not. Voting groups in particular seem to be drawn to allocations that assign each player the same payoff, no matter what individual preferences are obtained in the subsequent questionnaire for the respective kind of heterogeneity. In what appears as a textbook example of realpolitik, not a single player is able to push through an individually preferred fairness norm against the group dynamics of unanimous decision-making. But even groups employing voluntary individual contributions show instances of realpolitik, although their allocations are more diverse. Groups with heterogeneous marginal costs are similarly focused on attaining equal payoffs, whereas heterogeneous endowments seem to favor an allocation with equal contributions (and unequal payoffs). As will be discussed in more detail below, this last result is especially interesting, because it most clearly shows that, under otherwise very similar circumstances, the decision rule can have a major impact on a collective decision.

The equal payoff outcome observed under the unanimous voting rule is also in stark contrast to what the previous literature on endowment heterogeneity in public goods games reports. van Dijk et al. (1999) explicitly look for predominant "coordination rules" and find a preference for contributions that are proportional to endowments, but do not involve equal payoffs. Rapoport and Suleiman (1993) only state that contributions in their threshold public good are proportional to endowments, but do not report any further details. In more recent experimental studies, Bernard et al. (2012) again report preferences for proportional contributions rather than equal contributions or payoffs, whereas Alberti and Cartwright (2011) predominantly observe outcomes with equal contributions. Other studies involving heterogeneous players in threshold public goods include Croson and Marks (1999, 2001), Marks and Croson (1999), Bagnoli and McKee (1991), and van Dijk and Grodzka (1992).

To the author's knowledge, Feige et al. (2014) and Ehrhart and Feige (2014) are so far the only studies that apply a binding vote to determine individual contributions in a threshold public goods game. However, Alberti and Cartwright (2011) come close to this design with their "full agreement" treatment, in which they also observe mostly equal contributions even though player endowments become more asymmetrical over time. Other studies involving voting on contributions in the context of a social dilemma are Walker et al. (2000) and Margreiter et al. (2005), who study a common-resource problem, and Kroll et al. (2007) who employ a binding majority vote in a linear public goods game. Moreover, Frohlich et al. (1987a,b) have their subjects vote unanimously to implement one of several distribution principles, finding a preference for maximizing average outcomes (with a constraint for the minimum outcome) over maximizing the minimum outcome, i.e. essentially a preference for utilitarianism over the maximin principle (Rawls, 1971).

The remainder of the paper is structured as follows. After briefly relating this work to experiments on committee voting in Section 2, the theoretical model and its solutions are described in Section 3, followed by the experimental design and procedure in Section 4. Section 5 presents the results of this experimental investigation, which are further discussed in Section 6. Section 7 concludes with suggestions for future research.

## 2. Realpolitik and committee voting experiments

To a reader familiar with the literature on committee voting experiments(e.g., Palfrey, 2006) it may be no surprise that groups required to come to a unanimous agreement will make some kind of compromise. It is unlikely that any single player will reach his "ideal point," but everybody is probably at least closer to this ideal than if no agreement is reached at all. More precisely, experiments like those by Eavey and Miller (1984) indicate that we can expect voting outcomes to reside in or near the core[3] associated with a particular voting rule.

Yet this also means that, if the sets of core allocations of two different decision rules do not coincide, as is the case, for example, for simple majority and unanimity in the divide-the-pie situation discussed here,[4], then the particular voting procedure will to a large extent determine the outcome. Going back to the above example, if only a simple majority of the inhabitants in community C' has to agree with a particular tax proposal, this majority may

[3] In a nutshell, the core set contains every allocation that maximizes group payoffs and is stable in the sense that no coalition that does not include every single player in the group has an incentive to deviate from this allocation. See also Moulin (1988), p. 87ff.

[4] Basically, unanimity results in a convex game where every allocation is in the core, whereas majority results in a game that is not convex and in fact has an empty core.

implement the tax to their advantage and make the other community members pay a larger share. However, other majorities are possible that could implement alternative allocations to their own advantage and even overturn a previous decision. In contrast, requiring a unanimous decision will, all things equal, result in a more balanced distribution of the burden, because even a single “No” is sufficient to block a given proposal. While unanimity might make agreement more difficult, such a decision will also be more stable than under a majority rule. An agreement requires more of a compromise, making a unanimous decision “fairer” in a certain sense. This conception of (collective) fairness is also called “universalism” (Weingast, 1979). Eavey and Miller (1984) test the predictions of universalism in a laboratory experiment involving majority voting, reporting that outcomes that are “fair” in this sense may be chosen, even if they do not belong to the set of core allocations.

The idea of universalism is also similar to what Walker et al. (2000) find in their experiment involving voting on individual actions in a common-pool resource game (that is, individual amounts withdrawn from a common pool of resources): When using a unanimous vote instead of majority, groups are less likely to reach agreement, but more likely to come to a symmetrical and efficient outcome if they do. Furthermore, with an additional baseline treatment using only individual withdrawals, Walker et al. (2000) point us towards a setting that allows for a comparison of these two different incarnations of voting community C’ with the voluntary donations employed by community C. Walker et al. (2000) find that, without the option of coordinating their actions by means of a vote, efficiency levels are significantly reduced.

Margreiter et al. (2005), who extend the study by Walker et al. (2000) to groups with heterogeneous players, confirm this reduction of efficiency levels.

Unfortunately, these results tell us only that individual voluntary donations are less likely to provide the funding for a project, to reach the threshold, but not how this difference will affect the allocation of cost shares if the funding is equally successful. However, following up on the idea that players are different in some sense and not identical, player heterogeneity seems to be an essential prerequisite to motivating differences in the cost allocation in the two communities C and C'. For, in this case, the different decision rules in both communities may result in different aggregations of individual preferences for "fair" allocations to a collective choice or, more precisely, to a social norm prescribing this choice.

The present study therefore investigates the effects of different decision rules – to wit, individual voluntary contributions and a unanimous vote on contribution vectors – on social norms in heterogeneous groups playing a threshold public goods game. In contrast with the common-pool resource game mentioned earlier, a threshold public goods game has the nice property of having a large number of efficient Nash equilibria which differ only in regard to the allocation of the threshold among the players. Furthermore, the voting rule does not remove any of these efficient equilibria, but only adds more inefficient ones. Finally, if an allocation is in the core of a treatment using the voting rule, then this allocation will also be in the core of the corresponding treatment using individual voluntary contributions. So standard game theory gives no reason why any of these allocation should be a more likely result for one decision rule, but not the other. Accordingly, if voluntary contributions result in a different allocation of the threshold than a unanimous vote, but there are no differences in individual fairness preferences, then some of the subjects must have compromised there ideologies in the sense of realpolitik.

## 3. Theoretical Model

### *3.1. Basic model*

The basic model of a threshold public goods game, in which the game is played once with voluntary individual contributions, contains both kinds of heterogeneity that are considered in the experiment, heterogeneous endowments and heterogeneous costs, although the subjects face at most one kind in each treatment.

A group of four players choose their contributions to a public goods game with a threshold $\bar{Q}$. Each player $i = 1, \ldots, 4$ starts with an endowment $e_i$ which can then be used to pay for his contribution $q_i \in [0, \bar{q}]$ to the public good. The marginal costs of contribution, meaning the conversion rate from endowment to contribution, is given by $c_i$.

The total contribution given by $Q = \sum_{i=1}^{4} q_i$ must reach the threshold $\bar{Q}$, i.e., $Q \geq \bar{Q}$. Otherwise each player suffers a penalty $x$ which is deducted from his remaining endowment. The contribution costs are refunded in this case. Let $\bar{q} < \bar{Q} \leq 2\bar{q}$, so that one player alone cannot reach the threshold, but two players can.

Furthermore, assume $4x > c_i\bar{Q}$ for all $i$, which ensures that reaching the threshold is not only feasible, but also collectively profitable for all possible allocations of $\bar{Q}$ among the players.

Player $i$'s payoff $\pi_i(q_i)$ is given by:

$$\pi_i(q_i) = \begin{cases} e_i - c_i q_i & if \quad Q \geq \bar{Q} \\ e_i - x & if \quad Q < \bar{Q} \end{cases} \tag{1}$$

Any vector of individual contributions that exactly reaches a total contribution of $Q = \bar{Q}$ is then obviously a Nash equilibrium. In addition to this large number of strict threshold equilibria, there are also many combinations of weakly best responses which result in a Pareto inferior total contribution of $Q < \bar{Q}$, also including a zero-contribution vector, which is called "Status Quo" in the following. These equilibria are the direct result of the refund rule in case the threshold is missed.

The fact that in this model players face a negative payment (or penalty) if they fail to reach the threshold (instead of a reward if they succeed) has the nice side-effect that the model's social optima do not depend on the size of this payment,[5] because this parameter is irrelevant if the threshold is reached. Although this is merely a re-framing of the standard public goods model, which offers a reward for reaching the threshold, we should expect – along the lines of prospect theory (Kahneman and Tversky, 1979) – a higher willingness to pay for avoiding a loss. In any case, any effect on total contributions should not matter too much for the purposes of this study, which is more concerned with the way in which a given total contribution is allocated among all players.

[5]Except in regard to boundary conditions.

*3.2. Equilibrium selection and fairness principles*

Considering that all of the threshold equilibria differ only in the way in which the contribution burden is distributed among the individual players, it appears likely that fairness concepts relating to distributive justice will largely determine the final outcome. Assuming that the players agree on any particular distribution norm, they will simply select the corresponding equilibrium. More importantly, at this point there is no reason to assume that differences in individually preferred distribution norms should not reflect in an equal variety of equilibrium outcomes.

Konow (2003) discusses several principles of distributive justice, only a few of which apply to the case at hand: Utilitarian welfare maximization (Bentham, 1789), Rawlsian maximin (Rawls, 1971), as well as notions of equity (Adams, 1965) and equality (Dworkin, 1981). Aside from these normatively motivated principles, Loewenstein et al. (1989) and Fehr and Schmidt (1999) additionally give a descriptive, empirical motivation for equitable payoffs.[6]

A Utilitarian like Bentham (1789) should be concerned only with total welfare levels, which are the same for all threshold equilibria, unless marginal costs are heterogeneous. In this case the two players with the lowest marginal costs should provide the threshold on their own in order to maximize welfare. Assuming that players of the same type make the same contribution, this reasoning can accordingly reduce the set of "fair" equilibria to a single outcome,

[6]Fehr and Schmidt (1999) (p. 819) even mention the possibility that the "economic environment" can affect equilibrium play, but are more concerned with out-of-equilibrium behavior (like positive contributions in linear public goods games) than the selection among several Nash equilibria.

which however involves very asymmetrical contributions and payoffs.

In contrast, the maximin criterion (Rawls, 1971) focuses on individual payoffs, picking the allocation in which the lowest payoff of any member of the group is maximized. It is easy to see that this is only possible if all group members receive equal payoffs. This in turn requires asymmetrical contributions, due to the player heterogeneity,[7] but not to such a strong degree as in the welfare-maximizing outcome.

The equity principle, according to which inputs and outputs must be balanced (Adams, 1965), leaves some room for interpretation, depending how "inputs" and "outputs" are defined in this context. If inputs are taken to mean "costs incurred through contribution", while outputs refer to "payoffs gained from reaching the threshold", then endowments are irrelevant to finding the "fair" allocation. All players should then incur the same contribution costs, i.e. $c_i q_i = c_j q_j$ for all $i, j$,[8] which reduces to the case of equal contributions if marginal costs are homogeneous. Heterogeneous endowments (with homogeneous costs) consequently should result in equal contributions, but unequal payoffs, because the payoff differences are not a direct result of the contribution decision. Other studies (notably Bernard et al., 2012) also argue that contributions proportional to the extent of heterogeneity (in their case either endowments or valuation) constitute an attractive focal point to

[7] To be true, as the model contains two kinds of heterogeneity, it is conceivably possible, but extremely unlikely, that the two differences cancel each other out, so that equal payoffs coincide with equal contributions. However, because both kinds do not occur at the same time in the experiment, this special case can be ruled out here.

[8] To see this, note that each player $i$ avoids the same penalty $x$ when reaching the threshold, but incurs differing costs of $c_i q_i$. This leads to a payoff improvement of $x - c_i q_i$ when reaching the threshold, which must be proportional to the invested costs $c_i q_i$ for all players.

resolve the coordination problem. For instance, Bernard et al. (2012) contrast "proportional sacrifice" with "proportional benefit" in this context, both of which principles can be derived from equity theory by redefining inputs or outputs.

Finally, equality (Dworkin, 1981), as probably the most basic notion of fairness, simply stipulates a symmetrical outcome of some kind, which in this context can mean either equal contributions or equal payoffs. Although equality's undiscriminating stance in the view of player heterogeneity makes it less appealing as a "fairness" principle, it is nevertheless a helpful rule-of-thumb for equilibrium selection, because symmetrical outcomes are certainly the most focal ones in the sense of Schelling (1980) or Sugden (1995).

In summary, equal contributions (EC) and equal payoffs (EP) appear to be the equilibria most likely selected when applying various fairness principles, although other allocations can certainly be similarly motivated under more specific circumstances. Furthermore, the contribution vectors $q^{EP}$ and $q^{EC}$ associated with these outcomes are both feasible and unique in all the heterogeneity treatments described below, thus motivating this methodological approach. Other outcomes, like welfare-maximizing allocations or those with contributions proportional to endowments, are unique only for respectively one kind of heterogeneity and are therefore only discussed tangentially in the following, in order to relate to other results from the literature. In order to observe instances of realpolitik, however, it is enough to show that, despite of a variety of individual fairness preferences, the investigated treatments differ in how close the collectively chosen allocations are to these two focal points.

### 3.3. *The Decision Rules*

The experiment consists of three treatments (one for each kind of heterogeneity) in which the basic game is simply played ten times in a row with the same group of players (partner setting). In each round the groups have to reach the same threshold. At the end of the experiment, each player receives the payoff for only a single randomly selected round. In these treatments, participants are given complete information on past decisions. All equilibria of the basic game can also be played as part of a subgame-perfect Nash equilibrium of the repeated game.

The three corresponding voting treatments each consist of up to ten voting rounds. This provides the subjects with the same number of interactions as in the repeated game. In every round, each player makes a proposal for a contribution vector $q$. Identical proposals are combined and their votes are added up. If all players agree unanimously on a single proposal, the associated contribution $q$ is implemented as the group's contribution choice and the game ends. If there is no agreement among the players, another voting round is started with new proposals and new votes. After ten voting rounds, if there is still no agreement, the zero-contribution vector $q^0 = (0, \ldots, 0)$ is used as the group's choice. This "Status Quo" outcome (SQ) is always added as an additional proposal.

The set of subgame-perfect Nash equilibria of this voting game is rather large, because every feasible outcome, in which each player gets an expected payoff higher than in the SQ, can be motivated as a mutual best response: If all other players propose and vote for a particular allocation that exceeds the threshold, the single remaining player can do no better than also vote

Table 1: Parameter combinations used in the experiment.

| | $\mathbf{e_H}$ | $\mathbf{e_L}$ | $\mathbf{c_H}$ | $\mathbf{c_L}$ |
|---|---|---|---|---|
| **Homogeneous** | 30 ExCU | 30 ExCU | 1.5 ExCU per CU | 1.5 ExCU per CU |
| **Heterogeneous marginal costs** | 30 ExCU | 30 ExCU | 3 ExCU per CU | 1 ExCU per CU |
| **Heterogeneous endowments** | 33 ExCU | 27 ExCU | 1.5 ExCU per CU | 1.5 ExCU per CU |

for this allocation, because his rejection would mean that the Pareto inferior SQ is implemented. However, only the allocations that match the threshold value exactly are Pareto efficient. This specifically includes all the previously motivated focal points, i.e., equal contributions, equal payoffs, welfare maximization, and proportional contributions. Furthermore, the set of core allocations for each kind of heterogeneity is identical for both decision rules. For homogeneous groups and those with heterogeneous endowments, all Pareto efficient Nash equilibria are also core allocations (and vice versa). In the case of heterogeneous costs, the core contains only a smaller set of welfare-maximizing allocations, all of which are also (Pareto efficient) Nash equilibria.

## 4. Experimental Design and Procedure

Based on the preceding theoretical sections, the following experimental design is used:

A group consists of four players, each endowed with an amount of "Experimental Currency Units" (ExCU). Every player can convert his endowment into up to $\bar{q} = 10$ "Contribution Units" (CU) at a particular rate of ExCU per CU. These Contribution Units are then collected in a public account (a common project).

Three parameter combinations are considered, each associated with a different kind of heterogeneity (see Table 1). If marginal contribution costs are heterogeneous, all four players will have the same endowment of 30 ExCU, but two players will have low costs of 1 ExCU per CU, whereas the other two players will have high costs of 3 ExCU per CU. If endowments are heterogeneous, all four players will have costs of 1.5 ExCU per CU, but two players will have a high endowment of 33 ExCU, whereas the other two players will have a low endowment of 27 ExCU. In the homogeneous treatments, all four players have the same endowment of 30 ExCU and the same marginal contribution costs of 1.5 ExCU per CU.

In total, this therefore results in six treatments which differ with respect to the decision rule (unanimous vote (V) vs. repeated game (R)) and with respect to the kind of heterogeneity (marginal costs of contribution (COST) vs. endowments (END) vs. none (HOM)), as displayed in Table 2.[9] Contributions can be made in steps of 0.01 CU, and costs are rounded to 0.01 ExCU. Unless the sum of contributions reaches a threshold value $\bar{Q} = 16$ CU, a penalty of $x = 25$ ExCU is deducted from each player's payoff instead of the contribution costs. This means that, for players with costs of 3 ExCU per CU, a contribution of at most $^{25}/_{3}$ CU $\approx 8.33$ CU is individually rational.

Proposals, votes, and individual contributions are all publicly displayed immediately after the choice has been made, together with the IDs of the associated players (e.g., "Player C"). Furthermore, after the first round the

[9] The names used for the individual treatments in the following are simply a combination of these acronyms, for example RHOM for "repeated game, homogeneous players". The two COST treatments are taken from Ehrhart and Feige (2014), where they appear as "VNT" and "RNT". The instructions to all treatments are included in the appendix.

Table 2: Investigated treatments and hypotheses for individual contributions $q, q_H, q_L$ in CU and expected total group payoffs $\Pi$ in ExCU by player type (H or L) and distribution norm (EC, EC).

| | | **HOM (V,R)** | **END (V,R)** | **COST (V,R)** |
|---|---|---|---|---|
| **EC** | $q_H$ | 4 CU | 4 CU | 4 CU |
| | $q_L$ | 4 CU | 4 CU | 4 CU |
| | $\pi_H$ | 24 ExCU | 27 ExCU | 18 ExCU |
| | $\pi_L$ | 24 ExCU | 21 ExCU | 26 ExCU |
| | $\Pi$ | 96 ExCU | 96 ExCU | 88 ExCU |
| **EP** | $q_H$ | 4 CU | 6 CU | 2 CU |
| | $q_L$ | 4 CU | 2 CU | 6 CU |
| | $\pi_H$ | 24 ExCU | 24 ExCU | 24 ExCU |
| | $\pi_L$ | 24 ExCU | 24 ExCU | 24 ExCU |
| | $\Pi$ | 96 ExCU | 96 ExCU | 96 ExCU |

subjects can call up the results from past rounds whenever they have to make a decision.

In line with the theory presented above, all treatments are expected to lead to the same optimal total contribution of $Q^{WM} = 16$ CU. Table 2 contains the numerical predictions for individual contributions by player type (high or low) for the two predominant distribution norms – equal payoffs (EP) and equal contributions (EC) – as well as the associated total group payoffs.[10]

During the experiment, the subjects were asked not to talk to each other and to turn off their cell phones. They were seated at computers, which were screened off from the other subjects by plastic dividers. The instructions to the experiment were handed out to the subjects in written form as well

[10]Technically, this is an expected value for the repeated game where only a single randomly chosen round is paid, although there is no theoretical reason to assume any variability among choices in different rounds.

as read aloud at the beginning of the experiment. Every subject had to complete a comprehension test consisting of 9 to 12 questions depending on the treatment. The experiment did not start until everybody had answered every question correctly.

Every treatment was followed by a questionnaire containing items on distributive justice (adapted from Konow, 1996, items 1I, 2B, and 5) and procedural justice (partially adapted from Folger and Konovsky, 1989, Table 1) for the purpose of eliciting the subjects' fairness preferences in a more neutral context. This serves as a control for the premise that the subjects do not have ideological differences that could possibly drive preferences for different allocations in different treatments. The questionnaire also included items related to general personal data (age, gender, experience with experiments).[11]

A total of 212 subjects (5 x 9 groups and 1 x 8 groups with four members each) were recruited via ORSEE (Greiner, 2004) from a student pool. The computerized experiment was conducted with z-Tree (Fischbacher, 2007). Including a show-up fee of €5 (€3 for the COST treatments), the subjects earned on average €15.53 (roughly US$21 at the time of the experiment) in all six treatments. Table 3 shows the average payoffs (excluding the show-up fee) by treatment in ExCU (with an exchange rate of 2 ExCU = €1). The subjects spent between one hour and one and a half hours in the laboratory.

[11]The complete questionnaire is found in the appendix. The items concerned with procedural justice and personal data showed no treatment differences and are therefore omitted from the analysis.

Table 3: Investigated treatments with average payoffs in ExCU (exchange rate: 2 ExCU = €1) and cluster-robust standard errors (in brackets) by player type.

| | **Player type** | **Vote (V)** | **Repeated (R) (only rounds paid)** | **All** |
|---|---|---|---|---|
| **HOM** | | 21.63 (2.2429) | 22.34 (0.9102) | 22.00 (1.1880) |
| **END** | both | 24.00 (0) | 23.20 (0.6283) | 23.60 (0.3347) |
| | $e_L = 27$ | 23.83 (0.1617) | 21.41 (0.3359) | 22.62 (0.3482) |
| | $e_H = 33$ | 24.17 (0.1617) | 24.99 (1.1423) | 24.58 (0.5854) |
| **COST** | both | 24.00 (0) | 19.20 (1.7162) | 21.60 (1.0509) |
| | $c_L = 1$ | 24.00 (0) | 19.32 (1.8184) | 21.66 (1.0713) |
| | $c_H = 3$ | 24.00 (0) | 19.06 (2.2560) | 21.53 (1.2770) |
| **All** | | 23.27 (0.7234) | 21.58 (0.7582) | 22.41 (0.5375) |

## 5. Results

The analysis of the experimental results proceeds as follows: First, it is shown that neither total contributions nor success rates, i.e., the frequency with which groups contribute enough to reach the threshold value, differ significantly among treatments, eliminating this dimension as a possible confound for allocation choices. As a next step, treatment differences with respect to this allocation choice are identified on the aggregate and the individual level. Finally, the questionnaire data are evaluated, indicating that there were no significant ideological differences between the subjects in the different treatments that could account for this treatment effect.

### *5.1. Total contributions, total payoffs, and success rates*

The comparison of total contributions is based on the agreed-upon total contribution in the voting treatments. For the groups in the repeated game, the results from the end of the experiment (Round 10) are the most interesting for the analysis, because at this point the groups have had the highest number of interactions, so that it is the most likely that they have selected a particular equilibrium. Accordingly, this round's results are used for the comparison with the voting treatments. Where applicable, data for Round 1 as well as averages over all ten rounds are provided as well.

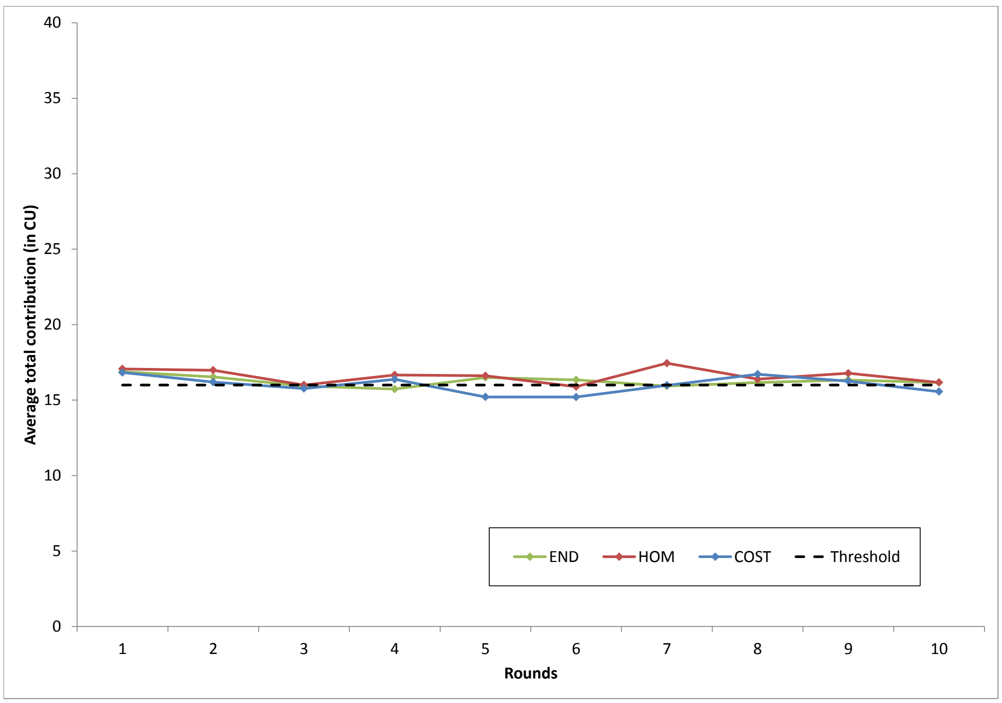


Figure 1: Average total contributions of groups in the repeated game treatments (R). The threshold value of 16 CU is included for reference.

Figure 1 shows the development of average total contributions in the repeated game treatments (R). Treatment averages are close to the threshold in all three cases, with no statistical difference between the treatments when tested with a Kruskal-Wallis equality-of-populations ranks test: Round 1 – chi-squared with ties = 0.196 (2 df), p = 0.9066; Round 10 – chi-squared

Table 4: Absolute frequency of equal contribution (EC) and equal payoff (EP) outcomes, as well as of success rates (last column, relative frequencies in brackets). These are final outcomes in voting treatments, as well as outcomes for Round 1 and Round 10 in the repeated game treatments.

| | | **EC** | **EP** | **EC and EP** | **Other** | **Unsuccessful** | **Success rates** |
|---|---|---|---|---|---|---|---|
| **VHOM** | | n.a. | n.a. | 6 | 1 | 1 | 7 of 8 (87.5%) |
| **VEND** | | 0 | 8 | n.a. | 1 | 0 | 9 of 9 (100%) |
| **VCOST** | | 0 | 9 | n.a. | 0 | 0 | 9 of 9 (100%) |
| **RHOM** | Rd 1 | n.a. | n.a. | 2 | 6 | 1 | 8 of 9 (88.9%) |
| | Rd 10 | n.a. | n.a. | 7 | 1 | 1 | 8 of 9 (88.9%) |
| **REND** | Rd 1 | 1 | 0 | n.a. | 6 | 2 | 7 of 9 (77.8%) |
| | Rd 10 | 5 | 1 | n.a. | 3 | 0 | 9 of 9 (100%) |
| **RCOST** | Rd 1 | 0 | 1 | n.a. | 6 | 2 | 7 of 9 (77.8%) |
| | Rd 10 | 0 | 3 | n.a. | 4 | 2 | 7 of 9 (77.8%) |

with ties = 0.287 (2 df), p = 0.8665; round avg – chi-squared with ties = 0.291 (2 df), p = 0.8646. When comparing the number of groups that exactly match the threshold value towards the end of the experiment, there appears a clear advantage for voting groups. All but one voting group (which did not come to an agreement) managed to reach the threshold value of 16 CU exactly. Nevertheless, an overall statistical comparison among all treatments (using Round 10 results for the repeated game treatments) finds no significant differences: chi-squared with ties = 3.392 (5 df), p = 0.6397.

When looking at final contribution outcomes (Round 10 contributions for the repeated game, final agreements for the unanimous vote) with respect to the distribution norms that groups employ, as shown in Table 4), we observe a strong difference due to the decision rule for both kinds of heterogeneity (Fisher's exact test: p = 0.002 (END), p = 0.009 (COST), but p = 1.000

(HOM)).[12] In the case of heterogeneous costs, this is obviously because of the higher variance of results in the repeated game, as the modal choice is equal payoffs both under a unanimous vote and in the repeated game and (as mentioned above) average total contributions are not significantly different. However, in the case of heterogeneous endowments, the groups actually apply different fairness principles, to wit, predominantly equal payoffs when voting and predominantly equal contributions in the repeated game. Furthermore, the latter are equally successful in reaching the threshold as the former at this point of the game (success rates are at 100% in both treatments, see also Table 4). This seems to indicate that the groups in the repeated game were indeed satisfied with this outcome and did not try to change it (which would involve coordination failures and thus lower success rates).

### *5.2. Individual contributions and distribution norms*

Although the aggregate data from Table 4 have already established an impact of the decision rule for the case of heterogeneous endowments, we can learn a bit more about what happened there by looking at the individual choices differentiated by player type. By referring to the benchmark values for individual contributions given in Table 2, I will first discuss the coordination process in the repeated game treatments, where all groups have played an identical number of rounds.

Figure 2 displays the development of average individual contributions over time in the repeated game treatments (R). Individual contributions are close together in the case of heterogeneous endowments (REND), with the

[12] The large number of ties in the data makes it necessary to use a categorical test for this comparison.

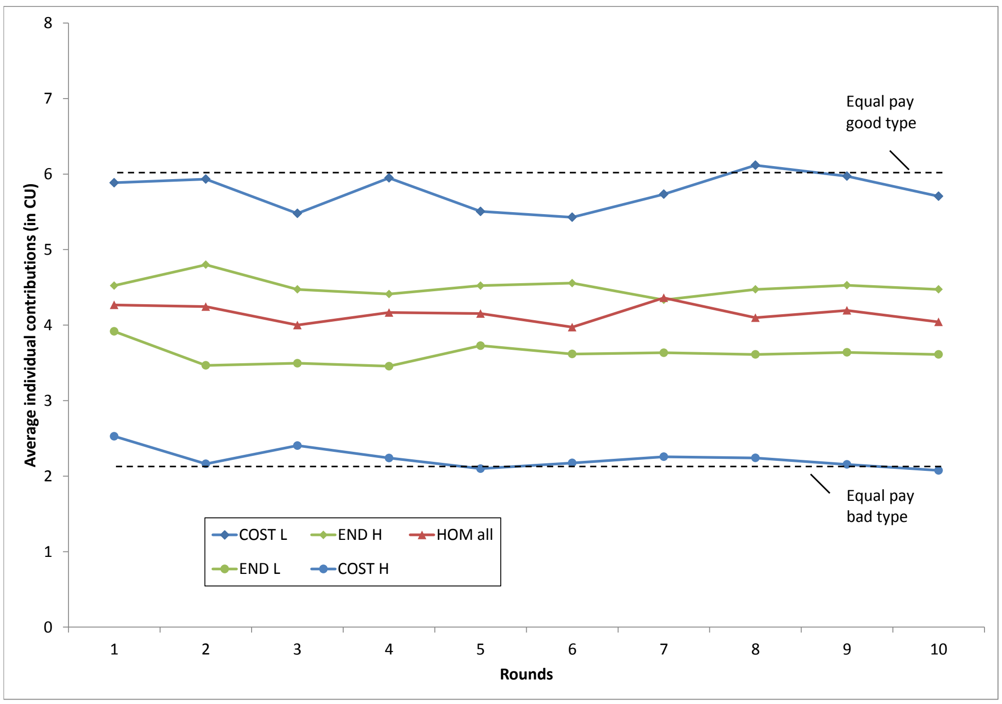


Figure 2: Average individual contributions over ten rounds for the repeated-game (RHOM, REND, and RCOST) treatments, differentiated by player type. For convenience, players with high endowments or low marginal costs are defined as belonging to the "good" type, whereas players with low endowments or high marginal costs belong to the "bad" type.

"good" type (high endowments) contributing slightly more on average over all ten rounds (4.51 CU (H) vs. 3.62 CU (L); two-tailed Wilcoxon signed-rank test based on group data: $W = 28, n_{s/r} = 8, p > 0.05$), but clearly different for heterogeneous marginal costs, where it is also the "good" type (low marginal costs) which contributes more (5.77 CU (L) vs. 2.23 CU (H); $W = 45, n_{s/r} = 9, p < 0.05$). The graph for the homogeneous treatment, which is right in the middle of the others, conveys the notion that these type-related differences are symmetrical around a strict application of the equal-contributions norm. Accordingly, the observed difference is caused simply by the way in which an otherwise efficient total contribution is allocated among the individual players. The differences in the statistical results are even more pronounced for Round 10, that is, the final round of the experiment:
REND: 4.47 CU (H) vs. 3.61 CU (L), $W = 8, n_{s/r} = 4, p > 0.05$
RCOST: 5.71 CU (L) vs. 2.08 CU (H), $W = 45, n_{s/r} = 9, p < 0.05$.

In comparing average individual payoffs using only rounds in which a group successfully reaches the threshold,[13] we can establish a similar statistical type-related difference, now for high and low endowments (round average: 26.10 ExCU (H) vs. 21.48 ExCU (L); $W = 45, n_{s/r} = 9, p < 0.05$). Groups with heterogeneous marginal costs, in contrast, appear to divide payoffs almost equally between player types, at least towards the end of the experiment (Round 10: 24.14 ExCU (L) vs. 23.51 ExCU (H) $W = 10, n_{s/r} = 4, p > 0.05$).

[13] Remember that groups that do not reach the threshold in a given round receive a predetermined payoff for this round which therefore does not reflect fairness preferences. However, individual contributions are determined before the group's success or failure is known and are therefore equally meaningful in either case. This is why unsuccessful rounds are excluded from an analysis related to payoffs, but not to contributions.

Table 5: Absolute frequency of own individual contribution choices (actual for repeated game or as part of proposal for unanimous vote) in Round 1 by associated distribution norm – equal contribution (EC) and equal payoff (EP) – and player type (H or L).

| | | **EC** | **EP** | **EC and EP** | **Other** |
|---|---|---|---|---|---|
| **VHOM** | all | n.a. | n.a. | 26 | 6 |
| **VEND** | H | 4 | 5 | n.a. | 9 |
| | L | 0 | 5 | n.a. | 13 |
| | all | 4 | 10 | n.a. | 22 |
| **VCOST** | H | 2 | 12 | n.a. | 4 |
| | L | 2 | 7 | n.a. | 9 |
| | all | 4 | 19 | n.a. | 13 |
| **RHOM** | all | n.a. | n.a. | 26 | 10 |
| **REND** | H | 8 | 5 | n.a. | 5 |
| | L | 12 | 3 | n.a. | 3 |
| | all | 20 | 8 | n.a. | 8 |
| **RCOST** | H | 2 | 7 | n.a. | 9 |
| | L | 0 | 8 | n.a. | 10 |
| | all | 2 | 15 | n.a. | 19 |

Although this analysis is insufficient to conclude that players with heterogeneous endowments indeed preferred equal contributions or that players with heterogeneous costs preferred equal payoffs, we can at least rule out that the respectively other most focal allocation principle played a significant role in the contribution choice. Ehrhart and Feige (2014) further report that the RCOST groups did not coordinate on welfare-maximizing outcomes.

Finally, by examining individual contribution behavior in the first round of the experiment (Table 5), we can see that the focal points which prevail in the end are already present before the players start their interactions. Specifically, the difference due to the decision rule for heterogeneous endowments can be traced back to an initial focus of low-endowment players on equal contributions, which is chosen by 12 of 18 or 66% of these players in the repeated game, but not a single low-endowment player in voting groups.[14] In contrast, players with high endowments are only slightly more likely to choose equal contributions in the first round of the repeated game compared to under a unanimous vote (8 of 18 or 44% vs. 4 of 18 or 22%, Fisher's exact: $p = 0.321$). The initial choices for players with heterogeneous costs are not significantly different between the decision rules regardless of type (Fisher's exact: $p = 0.379$ for both types combined).

A series of OLS regressions of final individual contributions (voting outcome or contribution in Round 10) with standard errors clustered at the group level (see Tables A.9, A.10 and A.11 in the appendix) confirms that it is the decision rule, not the initial contribution, that drives the results in the heterogeneous treatments. While the first model for END treatments shows that good types (i.e., high endowment) contributed significantly more in general, introducing an interaction term in a second model makes it clear that this difference only reflects the equal-payoff outcomes in the voting treatment. The fact that the player type does not significantly affect contributions by itself is once again compatible with the idea that voluntary contributions in the repeated game predominantly led to equal-contribution outcomes.

It appears from these observations that the difference in the decision rule in the case of heterogeneous endowments does not originate from a learning process that induces two otherwise similar populations of players to adapt their behavior to what the respective decision rule requires of them. To the contrary, this difference is already present when the subjects begin the

[14]This difference is also statistically highly significant ($p < 0.001$), measured once again by using Fisher's exact test.

experiment. There are three possible explanations for this:

1. The players reacted to procedural differences between the decision rules and therefore chose different contribution strategies right from the start.
2. The players reacted to contextual differences between the decision rules, which triggered different social norms and thus differences in individual preferences for “fair” allocations.
3. The populations of test subjects were not similar, that is, they differed with respect to individual fairness preferences, which in aggregation resulted in different group preferences or allocations.

Both of the first two explanations are compatible with the notion of realpolitik influencing the allocation choice, because either the procedure or the context of the decision could conceivably be the vessel of this influence.

An explanation based on procedural differences requires some elaboration as to how these strategic differences come to be and why fully rational players should not act on them. Basically, voting players can send a multi-dimensional signal, indicating preferences for total contribution and individual contribution at the same time via different components of their proposals. In contrast, players in the repeated game only have a one-dimensional signal to convey both preference layers. If they contribute too little, but according to their individually preferred distribution norm, they risk that the total contribution falls short of the threshold. On the other hand, if they decide to contribute enough to reach the threshold, this may come at the cost of compromising their own understanding of a “fair” allocation.

Fully rational players should not make use of such costly signals under either decision rule. They may instead apply principles of equilibrium selection, but should then be consistent and use the same principle for both decision rules, that is contribute the same in both cases. If one assumes boundedly rational players instead, then the increased complexity of the voting rule can conceivably facilitate coordination on similarly more complex distribution norms, whereas the restricted action set in the repeated game forces the subjects to stick to more easily implemented norms.

Strikingly, though, players with heterogeneous costs do not appear to have this problem and predominantly prefer the same distribution norm under both decision rules. It is therefore unlikely that the varying degrees of complexity can explain the outcomes in groups with heterogeneous endowments, at least they cannot do so entirely. After all, if groups with heterogeneous costs manage to coordinate on a (2,2,6,6) allocation in the repeated game in order to achieve equal payoffs, groups with heterogeneous endowments should be able to do the same thing if they wanted to.

### *5.3. Self-reported fairness preferences*

Since the decision rule apparently affects a group's collective preference for a "fair" allocation of contributions, one might wonder what these players' individual fairness preferences are in similar situations. In order to find this out, the subjects were presented with a number of questionnaire items after the experiment, which were previously used by Konow (1996) to measure just this type of preference.

**Question 1 (Konow, 1996, item 1I)**

*Bob and John are identical in terms of physical and mental abilities. They* *become shipwrecked on an uninhabited island where the only food is bananas. 10 bananas per day fall to their feet on land while others fall into the ocean. They can collect as many bananas as they want by climbing up a tree, picking them before they fall into the ocean and throwing them into a pile. In this way Bob picks 7 bananas per day and John picks 3 per day. Thus, there are a total of 20 bananas per day on the island. If you could decide the distribution of bananas and wanted to be fair, which of the following would you choose?*

*A. Bob gets 10 bananas, the 7 that he picked plus 3 which fell, and John gets 10, the 3 which he picked plus 7 which fell.*

*B. Bob gets 12 bananas, the 7 that he picked plus 5 which fell, and John gets 8, the 3 which he picked plus 5 which fell.*

*C. Bob gets 14 bananas, the 7 that he picked plus 7 which fell, and John gets 6, the 3 which he picked plus 3 which fell.*

The first of these items (shown above) (Konow, 1996, item 1I) entails a direct comparison between different allocations of an output variable (bananas received) among two parties that differ in their input variable (bananas picked). Accordingly, this item can distinguish between different instances of the equity principle. Option A refers to equality of overall payoffs, as both parties receive the same total sum of bananas. Option B indicates a different kind of payoff equality, namely one in which only the "free" earnings (bananas which fell) are shared equally. Option C represents proportionality of inputs and outputs, because the share of bananas that fell on the ground is equal to the proportion of previously picked bananas.

Table 6 shows how the subjects answered this question in the six treatments, contrasted with the observed frequencies reported by Konow (1996).

Table 6: Answers to Question 1 by treatment.

| | | **A (equal sum)** | **B (equal share)** | **C (proportional share)** | **# observations** |
|---|---|---|---|---|---|
| **Repeated game** | HOM | 9 (25%) | 27 (75%) | 0 (0%) | 36 |
| | END | 12 (33%) | 23 (64%) | 1 (3%) | 36 |
| | COST | 12 (33%) | 23 (64%) | 1 (3%) | 36 |
| **Unanimous vote** | HOM | 9 (28%) | 23 (72%) | 0 (0%) | 32 |
| | END | 16 (44%) | 20 (56%) | 0 (0%) | 36 |
| | COST | 15 (42%) | 18 (50%) | 3 (8%) | 36 |
| **Total** | | 73 (34%) | 134 (63%) | 5 (3%) | 212 |
| **Konow (1996)** | | 68 (33%) | 125 (61%) | 12 (6%) | 205 |

Strikingly, we do not only not see any statistically significant treatment differences (overall Fisher's exact: $p = 0.278$), but also no difference to the original Konow (1996) survey. Only the voting treatments show a slight tendency towards Option A, probably as a result of the abundance of equal payoff outcomes in these treatments.

**Question 2 (Konow, 1996, item 2B)**

*Smith and Jones work in identical office jobs at a large company and have the same experience, seniority and past performance records. Smith chooses to work 40 hours per week and gets paid $800 while Jones chooses to work 20 hours per week and gets paid $400.*

1. *Very fair*
2. *Fair*
3. *Unfair*
4. *Very unfair*

**Question 3 (Konow, 1996, item 5)**

*Bill and Sam manage a small grocery store at different times and on different*

Table 7: Answers to Question 2 by treatment.

| | | Very fair | Fair | Unfair | Very unfair | # observations |
|---|---|---|---|---|---|---|
| **Repeated game** | HOM | 18 (50%) | 14 (39%) | 3 (8%) | 1 (3%) | 36 |
| | END | 15 (42%) | 13 (36%) | 6 (17%) | 2 (6%) | 36 |
| | COST | 15 (42%) | 19 (53%) | 2 (6%) | 0 (0%) | 36 |
| **Unanimous vote** | HOM | 16 (50%) | 14 (44%) | 1 (3%) | 1 (3%) | 32 |
| | END | 21 (58%) | 14 (39%) | 1 (3%) | 0 (0%) | 36 |
| | COST | 19 (53%) | 11 (31%) | 4 (11%) | 2 (6%) | 36 |
| **Total** | | 104 (49%) | 85 (40%) | 17 (8%) | 6 (3%) | 212 |
| **Konow (1996)** | | 90 (74%) | | 31 (26%) | | 121 |

Table 8: Answers to Question 3 by treatment.

| | | A (600,600) | B (700,500) | C (800,400) | # observations |
|---|---|---|---|---|---|
| **Repeated game** | HOM | 1 (3%) | 4 (11%) | 31 (86%) | 36 |
| | END | 1 (3%) | 6 (17%) | 29 (81%) | 36 |
| | COST | 1 (3%) | 3 (8%) | 32 (89%) | 36 |
| **Unanimous vote** | HOM | 0 (0%) | 4 (13%) | 28 (88%) | 32 |
| | END | 0 (0%) | 4 (11%) | 32 (89%) | 36 |
| | COST | 1 (3%) | 0 (0%) | 35 (97%) | 36 |
| **Total** | | 4 (2%) | 21 (10%) | 187 (88%) | 212 |
| **Konow (1996)** | | 6 (2%) | 38 (13%) | 281 (85%) | 295 |

*days. The manager's duties are always the same and the days and times which each work vary pretty much randomly, but Bill works 40 hours per week while Sam works 20 hours per week. Suppose the manager's salary for a 60 hour week is $1200. Which of the following is the most fair division of this salary?*

*A. Bill gets $600 and Sam gets $600.*

*B. Bill gets $700 and Sam gets $500.*

*C. Bill gets $800 and Sam gets $400.*

The second and third item are framed in the context of a work environment, where the input-output comparison from equity theory may be even more influential. Not surprisingly, proportional outcomes are perceived as the most fair in this context, meaning that most players choose "Very Fair" or "Fair" for Question 2 and Option C for Question 3. Again there is no difference among treatments (Fisher's exact: $p = 0.533$ (Question 2), $p = 0.320$ (Question 3)), nor are the results for Item 3 (Table 8) significantly different from the original survey (Fisher's exact: p $>$ 0.1 (Item3, treatments vs. Konow (1996))). The responses to Question 2 (Table 7) tend more towards "Fair" judgments than in Konow (1996) (Fisher's exact: p = 0.0006), but this could be explained with the lower differentiation between answers in the latter case, where subjects could only choose between "Fair" and "Unfair". Overall, we can conclude that the subjects had more or less similar self-reported preferences in all treatments, which in turn more or less corresponded to what was observed by Konow (1996) in telephone interviews.

It seems that there is no correlation between the choices in the experiment and the fairness preferences stated in the subsequent questionnaire. At least, the regression tables A.9, A.10 and A.11 in the appendix further indicate that Question 1, which is the closest to exhibiting a treatment effect, does not correlate with the contribution behavior in the experiment. Yet by contrasting Question 1 with Questions 2 and 3, we can see that the subjects reacted to contextual differences. The social norm for the "work" context apparently does not set as much store in sharing "random earnings" equally as does the one for the "shipwrecked" context.

There certainly is a contextual difference between a unanimous vote and a series of individual choices. Speaking of "proposals, votes, and unanimous agreement" may evoke a more cooperative and egalitarian mind-setting than speaking simply of "individual contributions". Thus, a framing effect may result, explaining the observed treatment differences for heterogeneous endowments. However, once again, groups with heterogeneous costs are exposed to the same framing and should therefore be liable to the same effect, all the more so since voting groups seem to prefer equal payoffs no matter the type of heterogeneity. In the end, it turns out that neither fairness preferences nor contextual differences are sufficient to explain the findings.

## 6. Discussion

Did the experiments show behavior consistent with the notion of realpolitik?

For the unanimous voting treatments, this is certainly the case, if simply because the subjects almost always agreed on a compromise that did not favor individual players or even their varying fairness preferences. With only a few exceptions, the voting players seem to be unerringly drawn towards equal payoff shares. As mentioned above, this outcome is in accordance with the maximin principle (Rawls, 1971), meaning also that these results run contrary to what Frohlich et al. (1987a,b) found in their experiments, where subjects chose utilitarian allocations. On the other hand, the voting treatments do in a way corroborate the findings of Eavey and Miller (1984), because the equal payoff allocation is "fair", but does not belong to the core set if costs are heterogeneous (as the outcome is not welfare-maximizing in this case).

Yet also in the repeated game with individual voluntary contributions, the subjects were apparently forced to comprise their ideas of fairness. Here the reason may have been less the equal bargaining power and more the difficulty to coordinate, but still only a few allocations result the most frequently and rarely those consistent with the individual fairness preferences stated by the subjects afterwards. Previous studies involving heterogeneous endowments in games with voluntary contributions (van Dijk et al., 1999; Rapoport and Suleiman, 1993; Bernard et al., 2012) support this focus on only a small number of salient points, although they almost exclusively report that the better endowed players contribute more, usually in proportion to their endowment share. This study does not seem to corroborate these findings, since most groups end up with equal contributions similar to Alberti and Cartwright (2011). However, in the present study, proportional contributions may have simply been dismissed by the subjects as a focal outcome, because this allocation involved non-integer contributions. In fact, equal contributions ($q = 4$ CU) are still very close to a proportional allocation of the threshold ($q_H = 3.6$ CU, $q_L = 4.4$ CU).

Given that the two decision rules do not result in strategically equivalent games, an alternative explanation for the observed differences could be therefore very well be found when conducting a more thorough analysis involving concepts of cooperative game theory (e.g., Moulin, 1988), i.e., addressing the problem from a cooperative perspective. For example, it appears that the characteristic functions for the two decision rules, specifying the total payoffs that various coalitions of players can attain under their own power (that is, if the remaining players do everything in their power to hamper this coalitions actions), differ in all values except those for the grand coalition (all players) and the singleton coalitions (single players). This is because a unanimous vote requires all players to cooperate (the grand coalition) in order to implement any outcome other than the Status Quo, whereas a coalition of any two players suffices to reach the threshold (and thereby increase total payoffs significantly) if individual contributions are voluntary.

Assuming non-transferable utilities, which makes sense if there are no side-payments among the players, it is then easy to see that all focal points in both decision rules are consistent with the NTU core (e.g., Moulin, 1988, p. 102), basically because they are all Pareto efficient. Although the NTU core is also unable to directly explain the treatment differences, because it is too imprecise, it likely that other concepts for NTU cooperative games will be more successful.

The questionnaire results, finally, are in accordance with Gaertner and Schokkaert who state that questionnaire studies (as part of empirical social choice) "derive information about norms" (Gaertner and Schokkaert, 2012, ch. 2.2.1, p. 21). In other words, self-reported preferences measure what the subjects think *should be* chosen, i.e., what is socially acceptable, whereas experiments measure what *is* chosen by the subjects, i.e., what maximizes their individual utility. So, if we find that the subjects report a preference for similar norms in all treatments, then this does not mean that they are also able to (or even want to) conform to these norms with their actual behavior in the experiment. Strategic considerations may lead them to ignore what should be done and pragmatically stick to what can be done. Still, establishing that there are no treatment differences with respect to what the subjects think is socially acceptable in a similar context is essential for claiming that the observed treatment differences in actual behavior are indeed caused by the different decision rules.

In summary, it appears that there are several possible theoretical explanations of parts of the results reported in this study, but (as yet) no all-encompassing theory that can explain all of these results in a single model.

## 7. Conclusion

This study finds that a unanimous binding vote on contributions to a threshold public good results in equal-payoff allocations under several kinds of heterogeneity. In contrast, individual voluntary contributions in a similar scenario result in equal contributions (and unequal payoffs) for players with heterogeneous endowments. Although each result by itself is not very controversial, the combination warrants further investigation of the consistency (or lack thereof) of collective allocation choices under various decision rules.

The experiments presented here indicate that the decision rule employed to bring about a collective choice has an influence on the outcome of this choice. Accordingly, the two communities C and C' mentioned in the introductory example can indeed be expected to allocate the costs for providing their communal project differently under different decision rules. More strikingly, strategic considerations can apparently overrule individual preferences for fair cost allocations. Like politicians in real life, the subjects' choices are governed by what is feasible, they employ realpolitik to reach their goals.

Furthermore, in contrast with the example, communities in real life will usually have a choice in whether to finance a particular project publicly (by a vote on taxes) or to leave the funding to the private sector (i.e., voluntary contributions). In the light of the findings of this study, this choice becomes even more difficult, because communal involvement may not simply affect the chances of project being successful, but may also result in a different allocation of the cost burden.

Future research should attempt to reproduce the results reported here in other settings, e.g., in other variants of divide-the-pie games. Some kind of player heterogeneity seems to be required, though, in order to separate the various fairness concepts from each other. Apart from the comparison of cooperative and non-cooperative decision rules, it might also be interesting to compare various voting rules with respect to the fairness concept that they relate to. Majority voting will likely lead to more unequal allocations, but not necessarily so if no player type is in a minority position.

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## Appendix A. OLS regressions

Table A.9: OLS regression for final contributions in HOM treatments, cluster-robust standard errors (17 groups)

| Variable | Coefficient (Std. Err.) |
|---|---|
| OwnContribution_rd1 | 0.439** |
| | (0.123) |
| dummy_vote | -0.283 |
| | (0.372) |
| konow1 | 0.567 |
| | (0.402) |
| Intercept | 1.175 |
| | (1.031) |
| N | 68 |
| $R^2$ | 0.243 |
| $F_{(3,16)}$ | 5.08 |

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table A.10: OLS regression for final contributions in END treatments, interaction, cluster-robust standard errors (18 groups)

| Variable | Coefficient (Std. Err.) | Coefficient (Std. Err.) |
|---|---|---|
| OwnContribution_rd1 | 0.205$^{\dagger}$ | 0.069 |
| | (0.107) | (0.072) |
| dummy_vote | -0.041 | -1.461$^{**}$ |
| | (0.055) | (0.272) |
| dummy_good | 2.042$^{**}$ | 0.783 |
| | (0.492) | (0.501) |
| dummy_good x dummy_vote | | 2.900$^{**}$ |
| | | (0.497) |
| konow1 | -0.259 | 0.133 |
| | (0.262) | (0.155) |
| Intercept | 2.595$^{**}$ | 3.135$^{**}$ |
| | (0.634) | (0.531) |
| N | 72 | 72 |
| $R^2$ | 0.611 | 0.801 |
| $F_{(5,17)}$ | 17.07 | 109.19 |

Significance levels : $\dagger$ : 10% $*$ : 5% $**$ : 1%

Table A.11: OLS regression for final contributions in COST treatments, interaction, cluster-robust standard errors (18 groups)

| Variable | Coefficient (Std. Err.) | Coefficient (Std. Err.) |
|---|---|---|
| OwnContribution_rd1 | $0.436^{\dagger}$ | $0.446^{\dagger}$ |
| | (0.220) | (0.221) |
| dummy_vote | $0.279^{*}$ | 0.017 |
| | (0.114) | (0.162) |
| dummy_good | $2.448^{**}$ | $2.152^{*}$ |
| | (0.787) | (0.879) |
| dummy_good x dummy_vote | | 0.531 |
| | | (0.312) |
| konow1 | -0.118 | -0.123 |
| | (0.226) | (0.145) |
| Intercept | $1.030^{*}$ | $1.146^{*}$ |
| | (0.473) | (0.457) |
| N | 72 | 72 |
| $R^2$ | 0.839 | 0.843 |
| $F_{(5,17)}$ | 351.53 | 306.42 |

Significance levels : $\dagger$ : 10% $*$ : 5% $**$ : 1%

## Appendix B. Questionnaire

*The questionnaire used for the most part items from English-language sources which were translated into German as literally as possible. Here, however, we reprint the original English version of these items. Since several of the items on procedural justice had to be slightly changed to fit the context of our experiment, we provide both the original item and our changed version (translated from German) in these cases.*

Please answer the following questions completely. As this is about personal attitudes, there are neither "right" nor "wrong" answers.

**Question 1 (Konow, 1996, item 1I)**
Bob and John are identical in terms of physical and mental abilities. They become shipwrecked on an uninhabited island where the only food is bananas. 10 bananas per day fall to their feet on land while others fall into the ocean. They can collect as many bananas as they want by climbing up a tree, picking them before they fall into the ocean and throwing them into a pile. In this way Bob picks 7 bananas per day and John picks 3 per day. Thus, there are a total of 20 bananas per day on the island. If you could decide the distribution of bananas and wanted to be fair, which of the following would you choose?

A. Bob gets 10 bananas, the 7 that he picked plus 3 which fell, and John gets 10, the 3 which he picked plus 7 which fell.
B. Bob gets 12 bananas, the 7 that he picked plus 5 which fell, and John gets 8, the 3 which he picked plus 5 which fell.
C. Bob gets 14 bananas, the 7 that he picked plus 7 which fell, and John gets 6, the 3 which he picked plus 3 which fell.

**Question 2 (Konow, 1996, item 2B)**
Smith and Jones work in identical office jobs at a large company and have the same experience, seniority and past performance records. Smith chooses to work 40 hours per week and gets paid $800 while Jones chooses to work 20 hours per week and gets paid $400.

1. Very fair
2. Fair

3. Unfair
4. Very unfair

**Question 3 (Konow, 1996, item 5)**
Bill and Sam manage a small grocery store at different times and on different days. The manager's duties are always the same and the days and times which each work vary pretty much randomly, but Bill works 40 hours per week while Sam works 20 hours per week. Suppose the manager's salary for a 60 hour week is $1200. Which of the following is the most fair division of this salary?

A. Bill gets $600 and Sam gets $600.
B. Bill gets $700 and Sam gets $500.
C. Bill gets $800 and Sam gets $400.

**Question 4**
Please rate the decision mechanism used in this experiment on the provided scale (strongly agree, agree, disagree, strongly disagree). The mechanism ...

1. ... gave you an opportunity to express your side. (Folger and Konovsky, 1989, Table 1, item 2)
2. ... used consistent standards in evaluating your behavior. [originally: ... to evaluate your performance.] (Folger and Konovsky, 1989, Table 1, item 3)
3. ... gave you feedback that led you to reevaluate you decisions. [originally: ... gave you feedback that helped you learn how you were doing.] (Folger and Konovsky, 1989, Table 1, item 5)
4. ... was honest and ethical in dealing with you. (Folger and Konovsky, 1989, Table 1, item 1)
5. ... was designed to achieve a fair result. [originally: ... showed a real interest in trying to be fair.] (Folger and Konovsky, 1989, Table 1, item 7)
6. ... led to a result with which you were not satisfied. (own item)
7. ... allowed personal motives to influence the result. [originally: ... allowed personal motives or biases to influence recommendation.] (Folger and Konovsky, 1989, Table 1, item 25)
8. ... gave you the opportunity to significantly influence the other players' payoff. (own item)

**Socio-demographic questions:**

- Age:
- Gender (female, male):
- How often did you participate in an economic experiment? (never, once, two to five times, more than five times)

## Appendix – Participant Instructions

*The following experimental instructions were translated from German. Please note that the instructions are only translations for information; they are not intended to be used in the lab. The instructions in the original language were carefully polished in grammar, style, comprehensibility, and avoidance of strategic guidance. Treatment differences referring to transfer payments are put in italics and are indicated by the respective treatment abbreviations in square brackets (e.g., [REND:…] for the wording in the repeated-game treatment with heterogeneous endowments).*

[All treatments]

**Welcome to the experiment!**

You are now participating in a scientific experiment. Please read the following instructions carefully. Here you will be told everything that you know for the participation in the experiment. Please also note the following:

From now on as well as during the entire experiment **no communication** is permitted. Please turn off your cell phones. If you have any questions, please raise your hand. All **decisions are made anonymously**, meaning that none of the other participants learns the identity of those who made a particular decision.

**For showing up on time you receive an amount of €5 [RCOST, VCOST: €3]**. Over the course of the experiment you can earn an additional amount of up to €15 [REND, VEND: €16.50]. The precise amount is influenced by the decisions of the other participants. The total amount will be paid to you **in cash** at the end of the experiment. The **payment occurs anonymously, too**, meaning that no participant will know another participant's payoff. This experiment uses the currency "Experimental Currency Units" (ExCU).

**Two Experimental Currency Units are equal to one euro.**

[Voting treatments (VHOM, VEND, VCOST)]

**Experimental Procedure**

In the experiment you form **a group with three other players**. The composition of this group is determined randomly at the beginning of the experiment and will not change throughout the entire experiment.

**THE PROJECT**

Your task in this experiment is to choose your and your fellow players' contributions to a project. Your decision consists in a **vote on the individual contributions of all players in a group**. The contributions of all players in a group are added up to a **total contribution**. **For the project to be successful, your group's total contribution must reach a minimum contribution.** If the project is **not successful**, the contributions of all players are refunded just as if nobody had made any contribution. Instead of the contributions, the players than must make a **fixed payment**.

**PROCEDURE OF THE DECISION**

In the experiment, you and your fellow players vote on the **individual contributions of all group players to a project**. This happens in **up to ten voting rounds** and proceeds as follows:

(1) Proposals for contributions to the project
(2) Unanimous vote on the proposals
(3) Result: Project successful?

If there is **no unanimous agreement**, Steps (1) and (2) are repeated, i.e., **new proposals** are made and **new votes** are cast. After the tenth unsuccessful voting round, the **Status Quo** is implemented, which means that nobody contributes anything.

**DETAILS OF THE PROCEDURE**

(1) Proposals for contributions to the project and for transfer payments between the players

At the beginning of the experiment, each player has an **endowment which is measured in Experimental Currency Units (ExCU).**

**[VCOST: …**has an **endowment of 30 Experimental Currency Units (ExCU).]**

**[VEND: The exact amount of this endowments differs among the players:**

**Players A and B** Endowment of **27 ExCU**

**Players C and D** Endowment of **33 ExCU]**

**[VHOM: The exact amount of this endowment is the same for all players:**

**Players A, B, C, D** Endowment of **30 GE]**

**[VEND, VHOM:** At the beginning of the experiment you will be told which player you are (A, B, C, D). This is determined randomly.]

**Each player's contribution is measured in Contribution Units (CU).** Each player can provide **up to 10 Contribution Units** by investing Experimental Currency Units from his endowment. The group's total contribution can therefore amount up to 40 Contribution Units.

**[VHOM, VEND: The costs per provided contribution unit are the same for all players:**

**Players A, B, C, D** 1 Contribution Unit costs 1.5 Experimental Currency Unit **(1 CU = 1.5 ExCU)]**

**[VCOST: The costs per provided contribution unit differ among the players:**

| | |
|---|---|
| **Players A and B** | 1 Contribution Unit costs 1 Experimental Currency Unit **(1 CU = 1 ExCU)** |
| **Players C and D** | 1 Contribution Unit costs 3 Experimental Currency Units **(1 CU = 3 ExCU)** |

At the beginning of the experiment you will be told which player you are (A, B, C, D). This is determined randomly.]

**Each player makes a proposal for the contribution of every single player. All players make their proposals individually and at the same time.** In order to do this, each player chooses an amount between 0 and 10 Contribution Units (in steps of 0.01 CU). **The individual contributions from each proposal are automatically summed up to a total contribution.**

By clicking on "**Calculate values**" you can make the program display the total contribution, as well as each player's contribution costs and earnings in Experimental Currency Units.

The proposals (that is, contribution, contribution costs, total contribution, and resulting earnings) are shown to all players in a list (see Figure A.1). Among these is also a proposal called "**Status Quo**". This proposal means that each player makes a contribution of 0 Contribution Units (total contribution 0 CU). Next to each proposal there is a list of the player(s) who made this proposal. Identical proposals are displayed only once, together with all players who made this proposal. Including the Status Quo, there can accordingly be up to five different distribution proposals.

(2) Unanimous vote on the proposals

**At the same time as all of the other players in his group, each player casts a vote for exactly one of these proposals.** In order to vote for a proposal please click on "Accept" in the column directly to the right of the proposal. Each player then learns the result of the vote, i.e., the number of votes for each proposal as well as which player has voted for which alternative.

a) **Unanimous decision** (all four players vote for the same proposal):
The experiment ends with the calculation of earnings and payoffs.

b) **No unanimous decision**:
**Rounds 1 to 9**: New proposals are made (see above (1)), on which new votes are then cast.
**Round 10**: The **Status Quo** (each player makes a contribution of 0 Contribution Units, total contribution of 0 contribution units, individual earnings of 5 [VEND: 2 or 8]] Experimental Currency Units) is used for the calculation of payoffs.

(3) Result: Project successful?

In the experiment the provided contributions must reach a **minimum contribution of 16 Contribution Units**. If the minimum contribution is not reached, each player must make a **payment in Experimental Currency Units**, which is deducted from his endowment. The provided contributions are **refunded** in this case, so that except for the payment no additional costs are incurred.

**The payment if the minimum contribution is not reached is the same for all players:**

**Players A, B, C, D** Payment of **25 ExCU**

a) Total contribution **greater than or equal to** 16 CU

Every player pays his contribution costs.

**Earnings = your endowment (in ExCU) – your contribution costs (in ExCU)**

b) Total contribution **less than** 16 CU

Every player pays 25 ExCU.

**Earnings = Your endowment (in ExCU) – 25 ExCU**

**YOUR PAYOFF**

In order to calculate the total payoff at the end of the experiment, the obtained earnings are converted into euros **(2 ExCU = €1)** and added to your show-up fee (€5) [VCOST: (€3)].

**Example for the procedure of a voting round:**

A total of five proposals for the group players' individual contributions:

[VHOM:

| **Proposal** | | **Player A** | **Player B** | **Player C** | **Player D** | **Total Contribution (CU)** |
|---|---|---|---|---|---|---|
| | Endowment (ExCU) | **30 ExCU** | **30 ExCU** | **30 ExCU** | **30 ExCU** | |
| **Player A** | Contribution (CU) | 1 | 3 | 4 | 2 | 10 |
| **Player C** | Payment (ExCU) | -25 | -25 | -25 | -25 | |
| | Earnings (ExCU) | 5 | 5 | 5 | 5 | |
| **Player B** | Contribution (CU) | 8 | 3 | 4 | 2 | 17 |
| | Contribution Costs (ExCU) | -12 | -4.5 | -6 | -3 | |
| | *Earnings (ExCU)* | 18 | 25.5 | 24 | 27 | |
| **Player D** | Contribution (CU) | 9 | 5 | 6 | 3 | 23 |
| | Contribution Costs (ExCU) | -13.5 | -7.5 | -9 | -4.5 | |
| | *Earnings (ExCU)* | *16.5* | *22.5* | *21* | *25.5* | |
| **Status Quo** | Contribution (CU) | 0 | 0 | 0 | 0 | 0 |
| | Payment (ExCU) | -25 | -25 | -25 | -25 | |
| | Earnings (ExCU) | 5 | 5 | 5 | 5 | |

]

[VEND:

| Proposal | Endowment (ExCU) | Player A 27 ExCU | Player B 27 ExCU | Player C 33 ExCU | Player D 33 ExCU | Total Contribution (CU) |
|---|---|---|---|---|---|---|
| **Player A** | Contribution (CU) | 1 | 3 | 4 | 2 | 10 |
| **Player C** | Payment (ExCU) | -25 | -25 | -25 | -25 | |
| | Earnings (ExCU) | 2 | 2 | 8 | 8 | |
| **Player B** | Contribution (CU) | 8 | 3 | 4 | 2 | 17 |
| | Contribution Costs (ExCU) | -12 | -4.5 | -6 | -3 | |
| | *Earnings (ExCU)* | 15 | 22.5 | 27 | 30 | |
| **Player D** | Contribution (CU) | 9 | 5 | 6 | 3 | 23 |
| | Contribution Costs (ExCU) | -13.5 | -7.5 | -9 | -4.5 | |
| | *Earnings (ExCU)* | *13.5* | *19.5* | *24* | *28.5* | |
| **Status Quo** | Contribution (CU) | 0 | 0 | 0 | 0 | 0 |
| | Payment (ExCU) | -25 | -25 | -25 | -25 | |
| | Earnings (ExCU) | 2 | 2 | 8 | 8 | |

]

[VCOST:

| Proposal | Endowment (ExCU) | Player A 30 ExCU | Player B 30 ExCU | Player C 30 ExCU | Player D 30 ExCU | Total Contribution (CU) |
|---|---|---|---|---|---|---|
| **Player A** | Contribution (CU) | 1.60 | 2.20 | 4.40 | 3.60 | 11.80 |
| **Player C** | Payment (ExCU) | -25.00 | -25.00 | -25.00 | -25.00 | |
| | Earnings (ExCU) | 5.00 | 5.00 | 5.00 | 5.00 | |
| **Player B** | Contribution (CU) | 5.80 | 3.50 | 4.60 | 2.40 | 16.30 |
| | Contribution Costs (ExCU) | -5.80 | -3.50 | -13.80 | -7.20 | |
| | *Earnings (ExCU)* | 24.20 | 26.50 | 16.20 | 22.80 | |
| **Player D** | Contribution (CU) | 9.00 | 3.80 | 5.40 | 4.90 | 23.10 |
| | Contribution Costs (ExCU) | -9.00 | -3.80 | -16.20 | -14.70 | |
| | *Earnings (ExCU)* | *21.00* | *26.20* | *13.80* | *15.30* | |
| **Status Quo** | Contribution (CU) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Payment (ExCU) | -25.00 | -25.00 | -25.00 | -25.00 | |
| | Earnings (ExCU) | 5.00 | 5.00 | 5.00 | 5.00 | |

]

The proposal “1 CU, 3 CU, 4 CU, 2 CU” with a total contribution of 10 CU [VCOST: “1.60 CU, 2.20 CU, 4.40 CU, 3.60 CU” with a total contribution of 11.80 CU] has been made twice, but only counts as a single alternative.

All four players vote for “B”. The other three different proposals (“Status Quo”, “A, C”, “D”) do not receive any votes this time.

The voting procedure ends in this example with the selection of proposal “B” and a total contribution of 17 CU.

**Abstimmungsrunde 2 von maximal 10**
Sie sind Spieler B
Bitte entscheiden Sie sich für einen der folgenden Vorschläge!
Ist der Gesamtbetrag kleiner als 16.00 BE, muss jeder Spieler **anstatt** der eingesetzten Beiträge eine Zahlung von 25 GE leisten.

Ergebnis Runde 1 | Zurück zur Entscheidung

| Vorschlag | Anfangsausstattung (GE) | Spieler A 27.00 | Spieler B 27.00 | Spieler C 33.00 | Spieler D 33.00 | Gesamtbeitrag (BE) | |
|---|---|---|---|---|---|---|---|
| Spieler A | *Beitrag (BE)* | *1.00* | ***3.00*** | *4.00* | *2.00* | *10.00* | Akzeptieren |
| Spieler C | Zu leistende Zahlung (GE) | -25.00 | **-25.00** | -25.00 | -25.00 | | |
| | Ertrag (GE) | 2.00 | **2.00** | 8.00 | 8.00 | | |
| Spieler B (Ihr Vorschlag) | *Beitrag (BE)* | *8.00* | ***3.00*** | *4.00* | *2.00* | *17.00* | Akzeptieren |
| | Beitragskosten (GE) | -12.00 | **-4.50** | -6.00 | -3.00 | | |
| | Ertrag (GE) | 15.00 | **22.50** | 27.00 | 30.00 | | |
| Spieler D | *Beitrag (BE)* | *9.00* | ***5.00*** | *6.00* | *3.00* | *23.00* | Akzeptieren |
| | Beitragskosten (GE) | -13.50 | **-7.50** | -9.00 | -4.50 | | |
| | Ertrag (GE) | 13.50 | **19.50** | 24.00 | 28.50 | | |
| Status Quo | *Beitrag (BE)* | *0.00* | ***0.00*** | *0.00* | *0.00* | *0.00* | Akzeptieren |
| | Zu leistende Zahlung (GE) | -25.00 | **-25.00** | -25.00 | -25.00 | | |
| | Ertrag (GE) | 2.00 | **2.00** | 8.00 | 8.00 | | |

*Figure A.1 – Voting decision in treatment VEND*

**Examples for the calculation of earnings:**

*Example 1:*

[VHOM, END: The players in a group provide the following individual contributions which add up to a **total contribution of 10 CU**:

- Player A: 1 CU with costs of 1.5 ExCU
- Player B: 3 CU with costs of 4.5 ExCU
- Player C: 4 CU with costs of 6 ExCU
- Player D: 2 CU with costs of 3 ExCU

The minimum contribution of 16 CU is **missed** in this case. Each player is refunded the contributions he provided. Instead each player is deducted a payment of 25 ExCU, because the minimum contribution has not been reached. [VHOM: Accordingly, each player receives earnings of 5 ExCU.] [VEND: Accordingly, Players A and B (endowment 27 ExCU) receive earnings of 2 ExCU, whereas Players C and D (endowment of 33 ExCU) receive earnings of 8 ExCU.]

[VCOST: The players in a group provide the following individual contributions which add up to a **total contribution of 11.4 CU**:

- Player A: 1.2 CU (1.2*1 ExCU = 1.2 ExCU)
- Player B: 3.4 CU (3.4*1 ExCU = 3.4 ExCU)
- Player C: 4.5 CU (4.5*3 ExCU = 13.5 ExCU)
- Player D: 2.3 CU (2.3*3 ExCU = 6.9 ExCU)

The minimum contribution of 16 CU is **missed** in this case. Each player is refunded the contributions he provided. Instead each player is deducted a payment of 25 ExCU, because the minimum contribution has not been reached. Accordingly, each player receives earnings of 5 ExCU.]

*Example 2:*

[VHOM, END: The players in a group provide the following individual contributions which add up to a **total contribution of 17 CU**:

- Player A: 8 CU with costs of 12 ExCU
- Player B: 3 CU with costs of 4.5 ExCU
- Player C: 4 CU with costs of 6 ExCU
- Player D: 2 CU with costs of 3 ExCU

The minimum contribution of 16 CU is **reached** in this case. [VHOM: Accordingly, Player A for example receives earnings of 30 ExCU – 12 ExCU = 18 ExCU. In contrast, Player C receives earnings of 30 ExCU – 6 ExCU = 24 ExCU.] [VEND: Accordingly, Player A (endowment 27 ExCU) for example receives earnings of 27 ExCU – 12 ExCU = 15 ExCU. In contrast, Player C (endowment 33 ExCU) receives earnings of 33 ExCU – 6 ExCU = 27 ExCU.] A payment of 25 ExCU is not incurred in this case, because the minimum contribution has been reached.]

[VCOST: The players in a group provide the following individual contributions which add up to a **total contribution of 16.3 CU**:

- Player A: 5.8 CU (5.8*1 ExCU = 5.8 ExCU)
- Player B: 3.5 CU (3.5*1 ExCU = 3.5 ExCU)
- Player C: 4.6 CU (4.6*3 ExCU = 13.8 ExCU)
- Player D: 2.4 CU (2.4*3 ExCU = 7.2 ExCU)

The minimum contribution of 16 CU is **reached** in this case. Player A (contribution cost of 1 ExCU per invested CU) therefore receives earnings of 30 ExCU – 5.8 ExCU = 24.2 ExCU. A payment of 25 ExCU is not incurred in this case, because the minimum contribution has been reached.]

Please note that, with the beginning of the second voting round, you may recall the **results from preceding rounds** during each decision by clicking on the button “Result Round X” for the respective Round X. By clicking on the button “Back to Decision” you can return to the current voting round.

**Experimental Procedure**

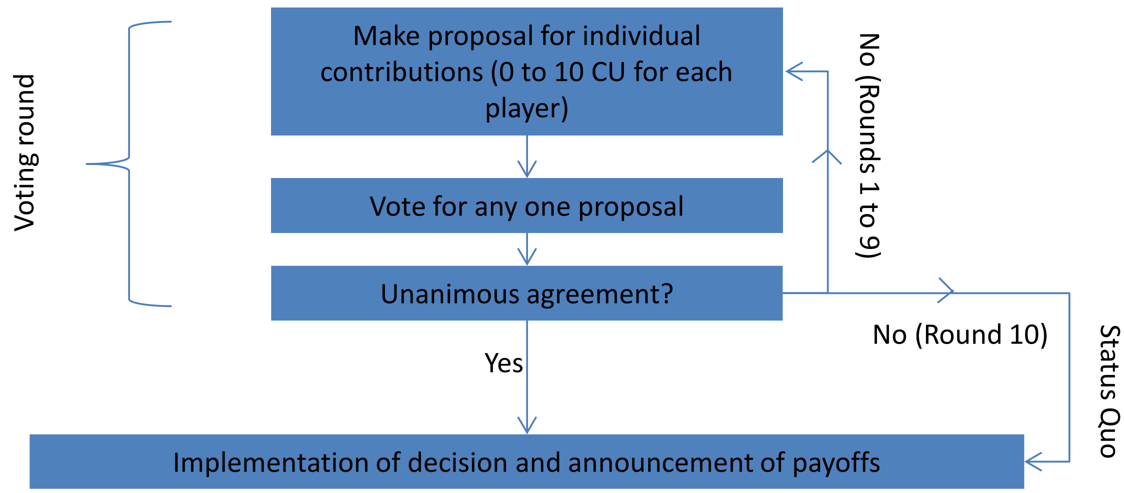


*Figure A.2 – Experimental procedure of voting treatments*

**THE MOST IMPORTANT INFORMATION AT A GLANCE**

| | | |
|---|---|---|
| Players in each group: | | 4 |
| Required votes to accept proposal: | | 4 |
| Maximum number of voting rounds: | | 10 |
| Endowment: | [VHOM, VCOST: | 30 ExCU] |
| | [VEND: Players A and B: | 27 ExCU |
| | Players C and D: | 33 ExCU] |
| Minimum contribution: | | 16 CU |
| Cost per contribution unit: | [VHOM, VEND: | 1 CU = 1.5 ExCU] |
| | [VCOST: Players A and B: | 1 CU = 1 ExCU |
| | Players C and D: | 1 CU = 3 ExCU] |
| Payment, if total contribution < 16 CU | | 25 ExCU |
| Earnings: | | |
| Total contribution < 16 CU: | Earnings = endowment minus payment | |
| Total contribution ≥ 16 CU: | Earnings = endowment minus contribution costs | |
| Status Quo | Total contribution 0 CU | |
| Exchange rate for payoff | | 2 ExCU = €1 |

[Repeated-game treatments (RHOM, REND, RCOST)]

| **Experimental Procedure** |
|---|

In the experiment you form **a group with three other players**. The composition of this group is determined randomly at the beginning of the experiment and will not change throughout the entire experiment, that is, in all **ten rounds**.

**THE PROJECT**

Your task in each of the ten rounds is to choose your contribution to a project. At the same time, all other players in your group also choose their own contributions to this project. The contributions of all players in a group are added up to a **total contribution**. **For the project to be successful, your group's total contribution must reach a minimum contribution.** If the project is **not successful**, the contributions of all players are refunded just as if nobody had made any contribution. Instead of the contributions, the players than must make a **fixed payment**.

**PROCEDURE OF THE DECISION**

In the experiment, you and your fellow players each choose **your own contribution to a project**. This occurs repeatedly in a total of **ten decision rounds**, which all proceed as follows:

(1) Choice of contributions to the project
(2) Result: Project successful?

The Experiment consists of a **total of ten such independent decisions** in a total of ten rounds. **Only one of these rounds is relevant for your payoff, however.** Which of these rounds is paid will be randomly determined at the end of the experiment, individually for each player. In doing so, each of the ten rounds has the same probability of being chosen.

**DETAILS OF THE PROCEDURE**

(1) <u>Choice of contributions to the project</u>

At the beginning of each round, each player has an **endowment which is measured in Experimental Currency Units (ExCU).**

**[RCOST: …**has an **endowment of 30 Experimental Currency Units (ExCU).]**

**[REND: The exact amount of this endowments differs among the players:**

| | |
|---|---|
| **Players A and B** | Endowment of **27 ExCU** |
| **Players C and D** | Endowment of **33 ExCU]** |

**[RHOM: The exact amount of this endowment is the same for all players:**

| | |
|---|---|
| **Players A, B, C, D** | Endowment of **30 GE]** |

**[REND, RHOM:** At the beginning of the experiment you will be told which player you are (A, B, C, D). This is determined randomly.]

**Each player's contribution is measured in Contribution Units (CU).** In every single round, each player can provide **up to 10 Contribution Units** by investing Experimental Currency Units from his endowment. The group's total contribution in each round can therefore amount up to 40 Contribution Units.

**[RHOM, REND: The costs per provided contribution unit are the same for all players:**

| | |
|---|---|
| **Players A, B, C, D** | 1 Contribution Unit costs 1.5 Experimental Currency Unit **(1 CU = 1.5 ExCU)]** |

**[RCOST: The costs per provided contribution unit differ among the players:**

**Players A and B** 1 Contribution Unit costs 1 Experimental Currency Unit **(1 CU = 1 ExCU)**

**Players C and D** 1 Contribution Unit costs 3 Experimental Currency Units **(1 CU = 3 ExCU)**

At the beginning of the experiment you will be told which player you are (A, B, C, D). This is determined randomly.]

**At the same time as all of the other players in his group, each player chooses his own contribution to the project.** In order to do so, he chooses an amount between 0 and 10 Contribution Units (in steps of 0.01 CU). By clicking on "**Calculate values**" you can make the program display the corresponding amount in Experimental Currency Units, as well. **The individual contributions of all players are automatically summed up to a total contribution.**

(2) Results: Project successful?

In each round the provided contributions must reach a **minimum contribution of 16 Contribution Units**. If the minimum contribution is not reached in a particular round, each player must make a **payment in Experimental Currency Units**, which is deducted from his earnings in the respective round. The provided contributions are **refunded** in this case, so that except for the payment no additional costs are incurred.

**The payment if the minimum contribution is not reached is the same for all players:**

**Players A, B, C, D** Payment of **25 ExCU**

a) Total contribution **greater than or equal to** 16 CU

Every player pays his **individual contribution costs**.
**Earnings = your endowment (in ExCU) – your contribution costs (in ExCU)**

b) Total contribution **less than** 16 CU

Every player pays **25 ExCU**.
**Earnings = your endowment (in ExCU) – 25 ExCU**

After all players in your group have made their contribution choice, all players are shown the total contribution of their group as well as the resulting earnings of all players. The contributions and contribution costs of the other players in the group are displayed, too.

**YOUR PAYOFF**

In order to calculate the total payoff at the end of the experiment, one of the ten rounds is selected at random. All rounds have the same probability of being selected. **This means that you receive only the final earnings of a single round.** The results of the remaining rounds are no longer relevant for your payoff, no matter whether or not the minimum contribution was reached in these rounds. The earnings obtained in the randomly selected round are converted into euros **(2 ExCU = €1)** and added to your show-up fee (€5) [RCOST: (€3)].

**Examples for the procedure of a round:**

*Example 1:*

[RHOM, REND: The players in a group provide the following individual contributions which add up to a **total contribution of 10 CU**:

- Player A: 1 CU with costs of 1.5 ExCU
- Player B: 3 CU with costs of 4.5 ExCU
- Player C: 4 CU with costs of 6 ExCU
- Player D: 2 CU with costs of 3 ExCU

The minimum contribution of 16 CU is **missed** in this case. Each player is refunded the contributions he provided. Instead each player is deducted a payment of 25 ExCU, because the minimum contribution has not been reached. [RHOM: Accordingly, each player receives earnings of 5 ExCU.] [REND: Accordingly, Players A and B (endowment 27 ExCU) receive earnings of 2 ExCU, whereas Players C and D (endowment of 33 ExCU) receive earnings of 8 ExCU.]

[RCOST: The players in a group provide the following individual contributions which add up to a **total contribution of 11.4 CU**:

- Player A: 1.2 CU (1.2*1 ExCU = 1.2 ExCU)
- Player B: 3.4 CU (3.4*1 ExCU = 3.4 ExCU)
- Player C: 4.5 CU (4.5*3 ExCU = 13.5 ExCU)
- Player D: 2.3 CU (2.3*3 ExCU = 6.9 ExCU)

The minimum contribution of 16 CU is **missed** in this case. Each player is refunded the contributions he provided. Instead each player is deducted a payment of 25 ExCU, because the minimum contribution has not been reached. Accordingly, each player receives earnings of 5 ExCU.]

*Example 2:*

[RHOM, REND: The players in a group provide the following individual contributions which add up to a **total contribution of 17 CU**:

- Player A: 8 CU with costs of 12 ExCU
- Player B: 3 CU with costs of 4.5 ExCU
- Player C: 4 CU with costs of 6 ExCU
- Player D: 2 CU with costs of 3 ExCU

The minimum contribution of 16 CU is **reached** in this case. [RHOM: Accordingly, Player A for example receives earnings of 30 ExCU – 12 ExCU = 18 ExCU. In contrast, Player C receives earnings of 30 ExCU – 6 ExCU = 24 ExCU.] [REND: Accordingly, Player A (endowment 27 ExCU) for example receives earnings of 27 ExCU – 12 ExCU = 15 ExCU. In contrast, Player C (endowment 33 ExCU) receives earnings of 33 ExCU – 6 ExCU = 27 ExCU.] A payment of 25 ExCU is not incurred in this case, because the minimum contribution has been reached.]

[RCOST: The players in a group provide the following individual contributions which add up to a **total contribution of 16.3 CU**:

- Player A: 5.8 CU (5.8*1 ExCU = 5.8 ExCU)
- Player B: 3.5 CU (3.5*1 ExCU = 3.5 ExCU)
- Player C: 4.6 CU (4.6*3 ExCU = 13.8 ExCU)
- Player D: 2.4 CU (2.4*3 ExCU = 7.2 ExCU)

The minimum contribution of 16 CU is **reached** in this case. Player A (contribution cost of 1 ExCU per invested CU) therefore receives earnings of 30 ExCU – 5.8 ExCU = 24.2 ExCU. A payment of 25 ExCU is not incurred in this case, because the minimum contribution has been reached.]

Please note that, with the beginning of the second voting round, you may recall the **results from preceding rounds** during each decision by clicking on the button "Result Round X" for the respective Round X. By clicking on the button "Back to Decision" you can return to the current voting round. After choosing your contribution (Button "Confirm Choice") you have one additional opportunity to correct this choice if necessary. As soon as you click the button "Confirm Choice and Continue", your choice is final.

**Experimental Procedure**

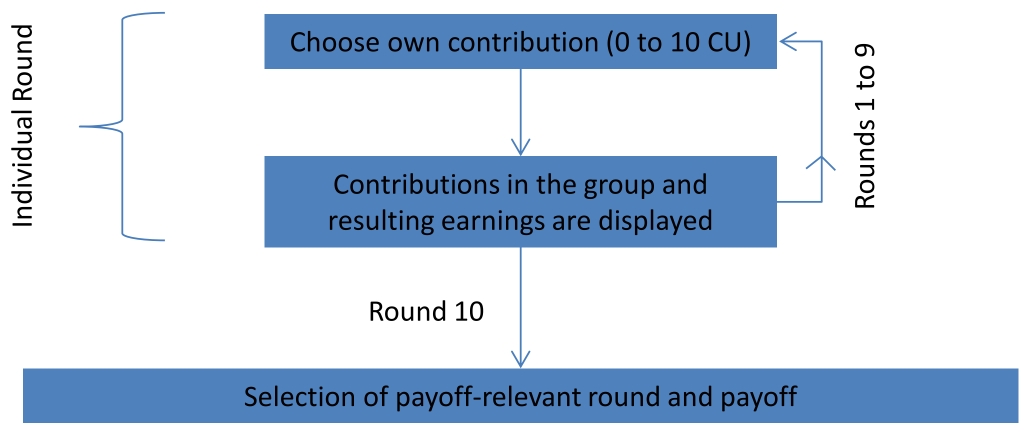


*Figure A.3 – Experimental procedure of repeated game treatments*

| THE MOST IMPORTANT INFORMATION AT A GLANCE | | |
|---|---|---|
| Number of rounds | | 10 |
| Players in each group: | | 4 |
| Endowment each round: | [RHOM, RCOST: | 30 ExCU] |
| | [REND: Players A and B: | 27 ExCU |
| | Players C and D: | 33 ExCU] |
| Minimum contribution: | | 16 CU |
| Cost per contribution unit: | [RHOM, REND: | 1 CU = 1.5 ExCU] |
| | [RCOST: Players A and B: | 1 CU = 1 ExCU |
| | Players C and D: | 1 CU = 3 ExCU] |
| Payment, if total contribution < 16 CU | | 25 ExCU |
| Earnings: | | |
| Total contribution < 16 CU: | Earnings = endowment minus payment | |
| Total contribution ≥ 16 CU: | Earnings = endowment minus contribution costs | |
| Exchange rate for payoff | | 2 ExCU = €1 |

[All treatments]

**ADDITIONAL REMARKS**

Please think carefully about all of your decisions, because they determine your payoff at the end of the experiment. Before the actual experiment can begin, you must answer a few questions which ensure that you have understood the procedure of the experiment and your task. You find the questions on the left side of the screen, and you can enter your answers on the right side. Please enter decimal numbers with a point instead of a comma (that is, e.g., 12.34 instead of 12,34).

If you have any questions of your own during the experiment, please remain seated quietly and raise your hand. Please wait until the experimenter has come to your seat and then ask your question as quietly as possible. In any event, you should only ask questions about the instructions and not about strategies!

Furthermore, please note that the game only continues after all players have made their decisions.

Feel free to use the last sheet of these instructions for your own notes.

**END OF THE EXPERIMENT**

After the experiment, we will ask you to fill in a questionnaire. Please remain seated after completing the questionnaire until we call up your place number. Take your instructions with you to the front desk. Only then will you be able to receive your payoff.

**Thank you very much for your participation and good luck!**