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**THE EFFECT OF VOTING ON CONTRIBUTIONS
IN A PUBLIC GOODS GAME**

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The Effect of Voting on Contributions in a Public Goods Game

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Abstract

This paper reports the results of a public good experiment with voting. The standard game in which subjects decide simultaneously on their contributions to a public good is extended by a second stage. In this stage, subjects can express agreement or disagreement with the contributions of their group members and the resulting payoff by voting yes or no. The treatment variable is the voting threshold, which specifies how many votes are at least needed to implement the outcome. We find that average contributions are higher with a voting system, but only if the required number of votes is sufficiently high. The higher average contribution level is mainly realized because subjects manage to avoid the typical pattern of declining contributions across periods. We argue that the higher and rather stable contributions observed under high threshold levels may be related to the fact that voting is seen as a legitimate instrument. Support for this claim is provided by results from a post-experimental questionnaire.

Keywords: public goods, laboratory experiment, voting

JEL- classification: C92, H41, D72, D02

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1 Introduction

Since the early experiments on the provision of public goods or, more generally social dilemmas (e.g. Bohm, 1972, Dawes et al., 1977, Marwell and Ames, 1979, 1980, 1981), numerous public goods experiments have been conducted.³ Standard public game use a basic voluntary contribution mechanism, which can be described as follows. Subjects are assigned to groups. In each period, subjects receive a token endowment, which may be allocated either to a group project or to a private account. Tokens invested (or rather kept) in the private account only yield payoffs to the subject whereas tokens contributed to the group project yield a lower return to the individual, but yield returns to all group members too. Parameters are chosen such that a public-good problem arises: it is individually optimal to contribute everything to the private account, but the socially optimal outcome (maximizing total payoffs) is obtained when all group members contribute their full endowment to the group project. The dominant strategy in a one-shot game is therefore to contribute nothing to the public good (i.e. complete free-riding). Also when the game is repeated this is the only Nash equilibrium due to a standard backward induction argument.

If players play this game repeatedly over multiple periods the typical findings are (i) group members contribute between 40% and 60% of the social optimum in the first period and (ii) contributions decline across periods. Numerous studies have looked at instruments that may enhance cooperation in this game and/or or reduce the decay across periods, for example communication (Isaac and Walker, 1988), group size (Marwell and Ames, 1979), provision points (Marwell and Ames, 1980), sanctions and rewards (Fehr and Gächter, 2000, Sefton et al. 2007), and leadership (Güth et al., 2007).

Relatively few papers in the economics literature have looked at the instrument we examine here, voting (e.g., Walker et al., 2000, Kroll et al. 2007, Messer et al., 2007, 2013, Güth et al., 2007, Levati et al., 2007). For example, Walker et al. (2000) analyse voting in a two-stage common-pool resource game. In the first stage, individuals first submit a proposal over how much everybody should contribute to the common good, and then they vote on the set of proposed allocation rules. If a rule is accepted (they implement both majority and unanimity voting), the proposed allocation is implemented. They find that both types of voting rules substantially increase efficiency relative to a baseline without the voting stage. Kroll et al. (2007) use a similar set-up to examine the effect of voting in a linear public good experiment. In addition to a binding-voting condition a la Walker et al. (2000) they introduce a nonbinding-vote condition and a nonbinding-vote-with-punishment condition. They only consider a majority voting rule. Their binding-vote results are consistent with those in Walker et al. (2000). In the treatments with nonbinding votes, however, voting by itself does not increase contributions, but when voting is combined with the opportunity to punish voters who ignore the majority voting outcome, contributions increase significantly. Finally, Messer et al. (2007) and Messer et al. (2013) examine voting in a positively framed and in a negatively framed social dilemma experiment, respectively. In their voting treatment, participants can vote on whether or not to

³ See Davis and Holt (1993) and Ledyard (1995) for summaries of the earlier experiments. Chaudhuri (2011) provides a more recent overview.

participate in the social dilemma game (or to opt out and participate in a private lottery). Both studies find only a very small effect of voting on contributions. Note that the voting mechanisms in all these papers are different from what we have in mind and implement in this paper.⁴

In our experiment the standard design is extended by a second stage, in which subject can vote. Stage one is the standard decision-making phase in which subjects simultaneously choose their contributions to the public good, in groups of three. Then, in stage two, subjects can indicate their agreement or disagreement with the contributions of their group members by means of a vote. If the group outcome of the voting is yes, contributions as made in stage one are implemented and the corresponding payoffs are paid. If the group outcome of the voting is no, all contributions to the private account are worthless and only contributions to the public good are translated into payoffs. We have conducted three experimental treatments, which only differ in the number of votes required for a yes outcome (i.e. agreement). This so-called threshold level of votes is 1, 2, or 3. The control treatment is a standard public good game without the voting stage. Subjects participate in only one condition, so we use a between-subject design.

Consistent with findings in standard public good experiments, in all treatments subjects contribute about 60% of the endowment in the very first period. In the treatments without voting and with a low threshold a clear decay of contributions over periods can be observed, in line with typical behaviour in these games. The decline in the two treatments with a high voting threshold is much less pronounced, and even almost absent in the treatment that requires unanimity voting (three agreement votes). As a result, average contributions over all periods are 40%-50% higher in the treatments which require two or three yes votes. We argue that these higher contributions may have to do with the fact that the voting system is seen as a legitimate instrument and a good or fair way to express one's opinion. Support for this claim comes from results of a post-experimental, which indicate a clear difference between how behaviour and outcomes are judged in the separate treatments. Subjects in the treatments with a high threshold are much more satisfied about their own absolute and relative payoffs and about the cooperation of both themselves and their group members than subjects in the other two treatments. The conclusion is that voting is likely to have a positive influence, but only when the required threshold is sufficiently high to let the voting system serve as a credible threat, are contributions significantly higher and can the usual decline in contributions over time be avoided.

2 The experiment

2.1 Experimental design and procedure

The computerized experiment was programmed in Z-tree (Fischbacher, 2007) and conducted in the CentERlab of Tilburg University in November/December 2014. CentERlab has 24 computers, which was the maximum number of players we could accommodate in each session. In total 81 subjects participated in the experimental

⁴ In general, it seems that the voting stage mostly is implemented as the first stage in a game, whereas in the present paper it is the second stage.

sessions, 27 groups of three. The participants were students from Tilburg University, coming from various disciplines like business, economics, and law, who were recruited from a large subject pool of people interested to participate in economic experiments. Four sessions, consisting of three treatments and one control treatment, were conducted in a between-subject design, see Table 1. At the beginning of each session, subjects were randomly assigned to computers and also randomly and anonymously assigned to groups of three. Groups stayed the same for all periods of the experiment (partner matching) and subjects could participate only once.

Table 1: Treatments, participants and groups.

Treatment	Abbreviation	Threshold	# Groups	# Participants
Control	T0	No	6	18
Treatment 1	T1	1	8	24
Treatment 2	T2	2	7	21
Treatment 3	T3	3	6	18

Each treatment consisted of ten repetitions of a public game, i.e. ten periods, and this was known to all players. At the beginning of each period, every group member started with a token endowment of 20 ECU's (Experimental Currency Unit, 1 ECU was worth €0.04). Players could decide to keep their endowment for themselves, in which case 1 ECU would yield 1 ECU only for themselves, or to contribute it to a project (the public good). Every ECU contributed to the project was multiplied by a factor 1.5, and thereafter divided equally amongst the group members. Hence the return from the project was the same for all group members, and independent of the contributions made by of each group member.

In all treatments, stage one was a standard phase in which subjects could decide, independently and simultaneously, on their contributions to the public good. At the end of stage one, subjects were informed about the contributions and pay-offs of their group members (including their own). In the control treatment (which is labelled T0), this was the end of the period and a new period started after the information feedback. In the other three treatments stage one was followed by a second stage where subjects could indicate their agreement or disagreement with the outcome in stage one, by voting yes or no, respectively.⁵ The three experimental treatments differ in the number of yes votes required to let the voting pass; so the treatment variable is the threshold level of votes needed. In treatments T1, T2, T3, in total at least one, two, or three votes had to be casted in favour to meet the threshold and to let the voting pass. If the threshold was reached the outcome of stage one was implemented as the final outcome for that period. If the threshold was not reached, i.e. the voting resulted in disagreement, the outcome of stage one was not realized. If voting failed, only ECU's contributed to the project were paid, while ECU's kept for oneself were not

⁵ Instructions of the control and treatments can be found in Appendix A.

paid (and thus basically wasted).⁶ Note that in treatment T3 the ECU's one kept for oneself only yielded (individual) payoff if all three group members agreed (voted yes). Hence in this treatment, the instrument of voting is powerful in the sense that already one subject can block the stage one outcome. In treatment T1, on the other hand, only one yes vote is needed, such that in fact every individual group member can approve a certain outcome. Consequently, the voting mechanism is much weaker in this treatment. The situation in treatment T2 is in between. Finally, at the end of stage two of all treatments, subjects received feedback about the number of votes in favour, the group voting outcome, and they were informed about the final payoffs for that period.

In all treatments, total earnings in the experiment were the sum of the individual's final pay-offs from all 10 periods (so payoffs at the end of stage two). After filling in a brief questionnaire subjects were privately paid their earnings in cash and left. Sessions lasted about one hour and individuals earned on average €10.

2.2 Hypotheses

Before formulating the hypotheses, it may be useful to indicate the similarities and differences between the treatments in somewhat more detail. First of all, it should be noted that T1 requires only one vote to let the voting of a group pass, which implies that every single group member can make sure that the outcome after stage one will be the final outcome. Therefore, from a theoretical point of view the decisions of the other group members do not matter in this respect, and hence the prediction for this treatment would be the same as for the control treatment T0 and any standard public good game: zero contributions to the project. However, as indicated above, typically subjects contribute positive amounts, usually between 40-60% of the endowment, in the first period, and then gradually reduce their contributions over time. In spite of that robust finding, contributions in the two treatments T0 and T1 are predicted to be the same, as are the payoffs. Basically, this also applies to treatment T2, where agreement requires two yes votes. Here the final outcome depends on the votes of the group members, but each individual has not enough power to block the outcome. As a result, it is still a dominant strategy to free-ride and contribute zero (and vote yes), and thus the theoretical prediction for this treatment is again the same as for T0 (and T1).

The situation is slightly different in T3. As in this treatment all group members have to vote yes to make the voting pass, every group member has the ability to veto an outcome. For example, if one subject contributes the full endowment and the other two group members are free riders, the cooperative subject can express his disagreement by casting a no vote, which makes all tokens kept privately by the two free riders completely worthless. Voting no instead of yes does not affect the full contributor's payoff but it reduces the payoffs of the free-riders. Assuming rational, selfish, money-maximizing individuals this should not matter and people should be indifferent between voting yes and no in this situation. However, it is very conceivable that a (cooperative) group member votes no in this case, for instance due to inequity aversion (Fehr and Schmidt, 1999). Nevertheless, free-riding incentives are still

⁶ Note that this implicitly assumes the existence of an authority with the power to implement the outcome. While this may seem a strong assumption, it is very standard in experiments on voting or punishment (e.g. Walker et al., 2000, Fehr and Gächter, 2000).

present, and contributing zero is still an equilibrium. On the other hand, contributing the full endowment also generates a unique situation. If the voting does not pass, the only tokens that yield returns are those contributed to the public good, and hence the vote is irrelevant for the payoff of the full contributor. The vote is important, however, for the payoffs of the group members, since subjects' payoffs are reduced by a no vote unless they also contributed their full endowment. Therefore, in treatment T3 the case in which all group members contribute the maximum to the project seems an alternative, natural outcome.

We will now summarize this discussion and formulate the testable hypotheses more formally. First of all, standard economic theory, assuming subjects are selfish, rational and money-maximizing, suggests that contribution will be 0 in every treatment. So our first null hypothesis (H1) reads:

H1: Contributions are equal to 0 in every treatment.

Results from economic experiments and behavioural economics suggest that subjects do not behave in line with this Nash prediction, but make positive contributions. So our first alternative hypothesis is that contributions are positive.

Based on the existing literature, one can safely expect H1 to be rejected. If that is the case, and contributions are found to be larger than zero, the question remains whether they differ across treatments. As indicated above, the standard theoretical prediction is that contributions are equal in all treatments, and thus are independent of the threshold. This is formulated as the second null hypothesis (H2). Alternatively, one could speculate that the voting system may somehow make positive contributions (and in particular full contributions) less risky, such that one may anticipate higher contributions in treatments with a higher threshold level. On the other hand, there may be reasons why contributions could be lower with higher threshold (for example if one wants to punish a group member). Therefore the second alternative hypothesis is two-sided and states that contributions are not the same in all treatments (i.e. they depend on the threshold).

H2: Contributions are equal in all treatments (i.e. they do not depend on the threshold)

The last hypothesis is related to the second one, but it is about payoffs. Because voting no may be costly, standard theory would predict no no-votes. Consequently, if hypothesis H2 holds, payoffs are expected to be the same in all treatments too. This is formulated as the third null hypothesis (H3). But if subjects have other-regarding preferences, they may vote no. If the voting does not pass (which is more likely the higher the threshold), some tokens are essentially lost and therefore payoffs may be reduced. Alternatively, H2 may be rejected, and higher thresholds may induce higher contributions, and as a result higher payoffs. As the net effect of these potential forces is unclear, the alternative hypothesis is that payoffs are not equal in all treatments.

H3: Payoffs are equal in all treatments.

3 Results

In this section we compare and test the results from the different treatments. The main findings are discussed in the main text, whereas some more basic results per treatment, per group, and per individual can be found in Appendices B and C.

3.1 Contributions and payoffs

For each treatment separately, the average contributions of all groups for each period are shown in Table 2 and Figure 1. Some first observations can be drawn. First of all, consistent with results from other experiments, the data show that contributions in the very first period are about 60% of the endowment. Secondly, and more importantly, it is clear that at the aggregate level a clear distinction is visible between the treatments with no or low threshold (T0 and T1) and a high threshold (T2 and T3), whereas within the two groups of treatments (T0-T1 or T2-T3) contributions are very similar. Finally, while contributions in treatments T0 and T1 follow the standard decaying pattern, the decline is slower and less pronounced in the other two treatments. In particular in treatment T3 contributions remain remarkably stable and even in the very last period – being the ‘ultimate free-rider period’ – there is no sharp decrease.

Table 2: Average contribution per period

Period	T0	T1	T2	T3
1	12.6	11.9	13.1	13.2
2	12.6	12.0	15.0	14.8
3	11.1	10.8	15.6	14.5
4	11.6	10.3	13.9	14.7
5	9.9	9.0	13.9	13.8
6	9.2	8.5	13.7	12.8
7	6.7	6.6	11.1	13.7
8	6.3	6.3	12.8	13.2
9	6.8	6.2	11.5	13.8
10	5.0	2.2	7.1	11.9
Average	9.2	8.4	12.8	13.6

The data in Table 2 and Figure 1 clearly show that for all treatments we can reject the first null hypothesis (contributions are 0) in favour of the alternative hypothesis that contributions are positive.

To test the second null hypothesis (contributions are the same in all treatments) we have performed several non-parametric tests. The result of a Jonckheere-Terpstra test on contributions averaged over all ten periods indicate that we can reject this null hypothesis in favour of the alternative hypothesis that average contributions are not equal in all treatments ($p=0.046$, $N=27$).⁷

⁷ All tests use group levels data as independent observations.

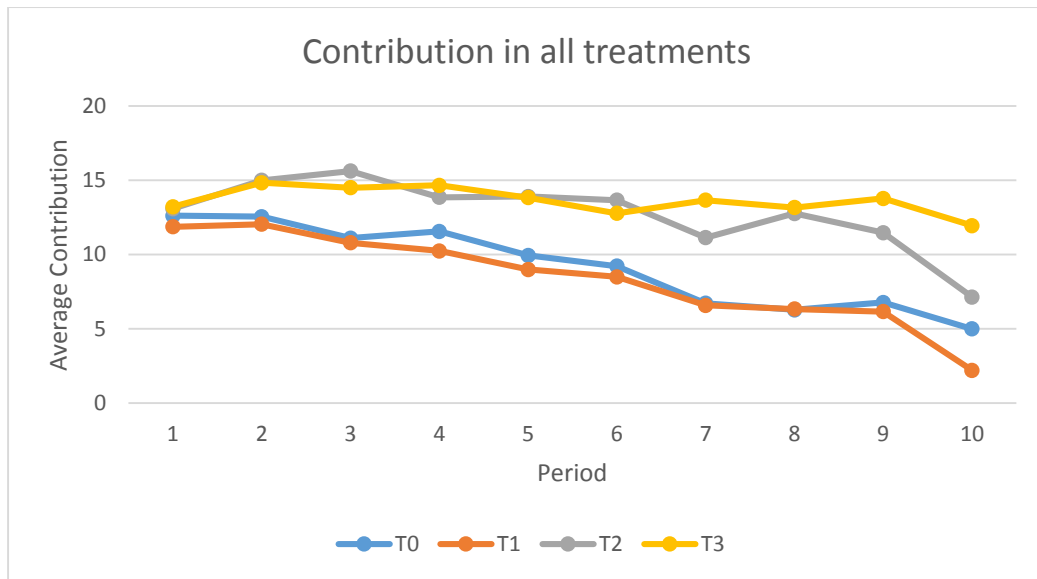


Figure 1: Average contribution per period

Next we compare treatments pairwise by running Mann-Whitney U tests. If we consider data from all ten periods, test results show that average contributions in T2 and T3 are significantly higher than in T1 ($p=0.08$ and $p=0.07$, respectively), whereas all other contribution averages do not differ significantly between the treatments. Test on separate periods, or on a number of periods, confirm the pattern visible from Figure 1. On the whole, contributions in T2 and T3 are never significantly different, and the same holds for treatments T0 and T1. Contributions in T0 or T1 on the one hand and T2 and T3 on the other hand are found to differ substantially, and the differences are sometimes significant, depending on the period considered. For example, for period 10 we can reject the hypothesis that contributions in T3 are the same as in T0 or T1 ($p=0.07$ and $p=0.01$, respectively). All in all, the evidence regarding the second hypothesis is a bit mixed. We find support for the alternative hypothesis that contributions do depend on the threshold level. However, not all (pairwise) treatment comparisons yield significant differences. Still we can conclude that there is a clear distinction between contributions levels in the treatments with no threshold or a low one, and the two treatments with a high threshold. Contributions start off at a similar level, but then develop in different ways, depending on the treatment.

The last result and the last hypothesis are about the payoffs. If the voting results in a disagreement outcome, subjects may lose all or a part of their endowment, depending on how much they kept in their private account. Hence another way of judging whether a voting system is successful or not is to look at the final payoffs. To that end, Table 3 and Figure 2 display for each treatment the average payoffs per period. Note that every period every subject starts with an endowment of 20 ECU, which is the resulting payoff if no contributions are made (and voting passes). The maximum payoff – when all group members contribute their full endowment and voting passes – is 30.

Table 3: Average contribution per period

Period	T0	T1	T2	T3
1	26.3	25.9	26.5	23.6
2	26.3	26.0	27.5	26.9
3	25.6	25.4	27.5	26.5
4	25.8	25.1	26.3	27.1
5	25.0	24.5	26.5	26.6
6	24.6	24.3	26.6	25.2
7	23.4	23.3	25.6	24.4
8	23.1	23.2	26.4	26.3
9	23.4	23.1	25.7	24.9
10	22.5	21.1	20.7	24.0
Average	24.6	24.2	25.9	25.6

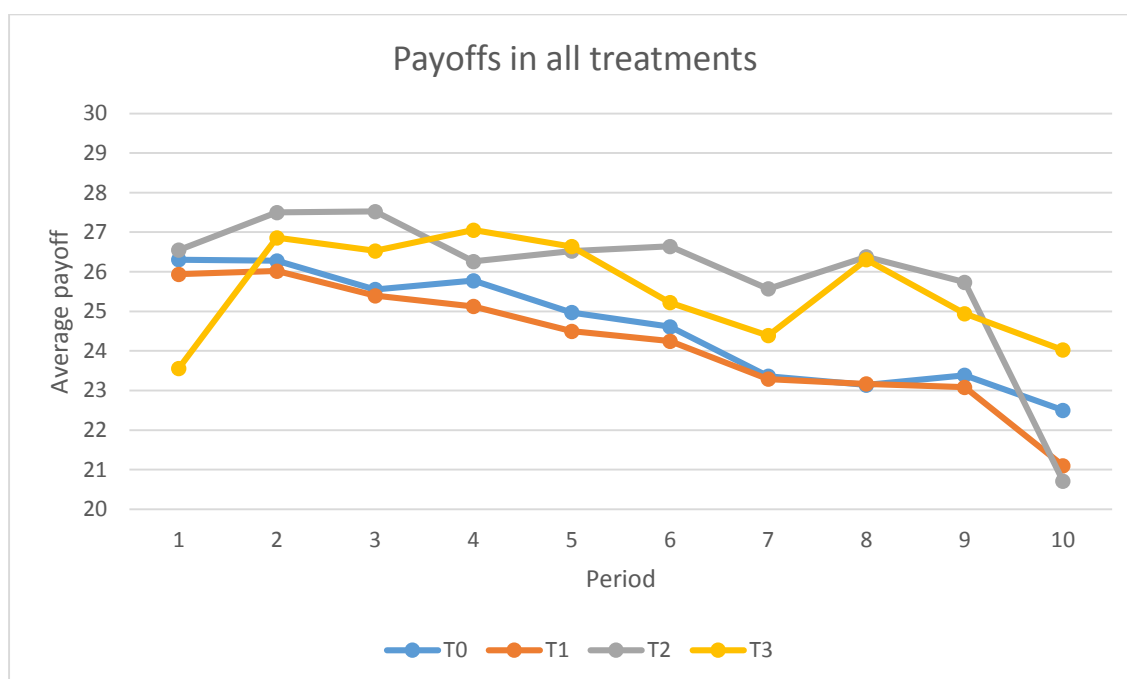


Figure 2: Average payoff per period

Inspection of Table 3 and Figure 2 reveals that the payoff differences between the treatments are considerably smaller than differences in contributions. While average payoffs in treatments T2 and T3 are still higher compared to those in treatments T0 and T1, the values are much closer. In addition, and in contrast to the contributions, not in all periods payoffs are higher in the treatments with higher thresholds.⁸ Yet, apart from the first and last periods, payoffs are relatively stable in treatments T2 and

⁸ For example, the average payoff in period 10 of T2 is the lowest payoff of all treatments. However, it should be noted that this is due to an extreme outlier as a result of the voting in the last period, since averaged over all ten periods T2 actually has the highest payoff of all treatments.

T3 whereas in T0 and T1 payoffs are clearly decreasing over time. A Jonckheere-Terpstra test indicates, however, that we cannot reject the third null hypothesis (stating no payoff differences between the treatments) in favour of the alternative hypothesis.⁹

3.2 Voting

In this section we examine voting behaviour in more detail and look at its impact. There are two, related, ways in which the voting system can have an effect on the behaviour and decisions of individuals. First, the mere threat of a negative outcome may affect the decisions of the subjects (directly) as they know that in case of disagreement only contributions to the public good will yield returns. Secondly, if subjects experience a negative outcome, and thus a lower payoff - unless they contributed their entire endowment - they could decide to contribute more in the upcoming periods to prevent another loss of ECU's if the votes fail again.

Table 4 shows the total number of votes over all treatments, the number and proportion of yes votes (at the individual level), and the number of instances with disagreement (group voting outcome no). More detailed results at the group and individual level can be found in Appendix C. Recall that in treatments T1, T2, and T3, at least 1, 2, and 3, subjects have to vote yes in order to implement the outcome. This explains why T3 (which has the highest threshold) has the highest share of individual agreement votes, but at the same time is the treatment where most group disagreed.

Table 4: Individual votes per treatment including average

Treatment	# participants	# votes	# yes votes	share	# disagreement
T1	24	240	207	0.86	0
T2	21	210	180	0.86	5
T3	18	180	159	0.88	16

As can be seen from Table 4, in treatment T1 no group outcome was ever blocked, even though some individual no votes can be observed. This makes sense as in this treatment even a free-rider can make the vote pass by voting yes. Subjects may still vote no for example to express their negative opinion about the contributions of their group members. In treatment T2 there were five cases where the voting threshold was not met. In one group this happened three times in a row, but it did not result in higher contributions. In one group it happened once, after which the contributions increased to the maximum (and stayed there) and in one other group it happened in the very last period.¹⁰ Treatment T3 clearly has most instances where the voting

⁹ Pairwise comparisons by Mann-Whitney U tests yield only a significant difference between T1 and T2 ($p=0.08$).

¹⁰ This is the outlier mentioned in the previous section. In this period none of the subjects made any contribution to the public good. Had the voting passed, each of them would have earned their 20 (free-riding) ECU's, but for some reason, two of the group members voted no to the outcome of the first stage. As a result, the payoff for all subjects in this group was 0 in this very last period.

threshold was not met. In most of these cases the negative outcome resulted in an increasing and/or unchanged total contributions in the next period. This suggests that although the contributions did not always increase to full endowment, the credible threat of a no vote made contributions fairly stable in this treatment. For example, one group had total contributions below 60 in the first eight periods, and experienced a disagreement in all these periods. In the final two periods all group members contributed the full amount to the public good.

3.3 Questionnaire

At the end of each session, every player was asked to fill in a brief questionnaire (see Appendix A3), consisting of some socio-demographic questions and four questions about the experiment. In particular they were asked to indicate, on a scale from 1 to 7, how cooperative they consider their group members and themselves, as well as to specify how satisfied they were with their payoffs (absolute payoffs) and with their payoffs compared to their group members (relative payoffs). Results are presented in Table 5.

Table 5: Questionnaire results per treatment

Question	T0	T1	T2	T3
Group cooperation	3.1	3.4	4.1	4.9
Own cooperation	4.0	4.4	5.2	5.6
Absolute payoffs	3.7	4.0	4.9	4.8
Relative payoffs	3.7	3.9	4.9	4.9

Note: answers on a 1-7 scale, 1 not at all happy/satisfied, 7 extremely happy/satisfied

Again, there is a clear difference between treatments T0 and T1 on the one hand and treatments T2 and T3 on the other hand. Subjects in the latter treatments are not only much more satisfied about the cooperation of both themselves and their group members (in particular in T3¹¹) but also about the payoffs in absolute and relative terms. This is somewhat surprising given the fact that payoffs are not significantly different between the treatments. One can only speculate why this is the case, but it suggests that the voting system per se is perceived as a good thing.¹²

¹¹ Mann-Whitney U tests show that the differences between treatments T3 and T0 are all significant at the 10% level.

¹² That this does not apply to treatment T1 is not unexpected given the fact that in this treatment the instrument of voting stimulates a cooperative attitude less than in T2 and T3 (as free-riders can still make their decisions pass).

4 Conclusion

The main aim of this paper was to study what happens to contributions to a public good when a voting system is introduced. To examine this, we have extended the standard public good experiment by adding a second stage. In this stage, subjects could, after all contributions to the public good had been made and observed, vote for or against the tentative outcome. Depending on the treatment, the outcome passed if 1, 2, or all 3 group members agreed (or, alternatively, the outcome was blocked if all, 2, or 1 group member voted no). If the required threshold level of yes votes was not reached, only contributions to the public good yielded returns whereas contributions kept for oneself were lost. As a control we have run a baseline treatment without voting.

In line with previous experimental results we find that in all treatments contributions started out at an initial level of about 60% of the endowment. In the treatments without voting and with the lowest possible threshold of 1, a clear decay of contributions over rounds can be observed, in line with typical behaviour in these games, whereas contributions are relatively stable in the treatments with a high threshold. In particular in the treatment that requires unanimity voting (three yes votes), contributions remain remarkably stable, and even in the very last period there is no sharp decrease (still almost 60% of the endowment contributed to the public good). As a result, average contributions over all periods are about 40%-50% higher in the two treatments with the high threshold compared to the other two treatments. We can therefore reject the hypothesis that contributions are equal in all treatments, in favour of the hypothesis that the voting system affects contributions. Payoff differences between treatments are much smaller than differences in contributions levels.¹³ This is partly due to the fact that if the voting outcome is no, players lose part of their contributions (unless they contributed everything to the public good).

We therefore conclude that a voting system is a promising instrument to enhance cooperation, and it is likely to have a positive influence on contributions. However, the efficiency of the mechanism seems rather sensitive to the very details of the system. Our findings imply that only if the required threshold is sufficiently high, contributions are raised and the usual decline in contributions over time can largely be prevented. In addition, the results suggest that such a voting system is even more successful when the future consists of more rounds.

One reason why a voting system could enhance cooperation is that it may be perceived to be a fair or legitimate instrument. People may like the option that they can express their opinion by voting for or against a certain outcome, for example in case of a free-rider group members. With a low threshold of 1, the free-rider can still make the vote pass, such that an individual vote of a cooperative person is in a way less powerful (and indeed no disagreement outcomes are observed in this treatment). If two or three yes-votes are needed, the share of negative voting outcomes at the group level is still rather low (7% (26%) for threshold 2(3)), but the required threshold seems sufficiently high to let the voting system serve as a credible threat and hence to realise higher levels of contributions. The idea that the success of the voting system

¹³ This finding is very common, also in standard public good experiments, as even large differences in contributions often translate into rather small earning differences due to the specific payoff scheme.

is related to its legitimacy – at least partly – is supported by evidence from a post-experimental questionnaire. The answers imply that the outcomes and behaviour are judged differently, depending on whether treatments have no or a low threshold or a threshold level above 1. Subjects in the latter treatments appear to be much more satisfied about the cooperation of both themselves and their group members and about their own absolute and relative payoffs. The latter is remarkable, given the fact that payoffs are very similar in all treatments. At the same time, this suggests that subjects appreciate the option to express their (dis)agreement with a situation, and having this option may result in higher and more sustainable levels more cooperation, in particular in the longer run.

Although the experimental environment is rather stylized, the design may capture some situations in real life. For example, one could think of situations in which groups of individuals or countries try to cooperate and contribute to team production, or climate agreements/emission reductions. The findings in this paper suggest that having a voting system may help to increase contributions to the joint project. However, the scale of the current experiment is rather small, and more experiments are needed before one can draw clear conclusions. Interesting topics to study in future research include other voting systems, the effect of voting in other social dilemma games like common pool resource dilemmas or public bad games, different move structures, etcetera.

References

- Bohm, P. (1972). Estimating demand for Public Goods: An Experiment. *European Economic Review*, 2, 111-130.
- Chaudhuri A. (2011). Sustaining Cooperation in Laboratory Public Goods Experiments: A Selective Survey of the Literature. *Experimental Economics*, 14(1), 47-83.
- Cinyabuguma, M., Page, T. & Putterman, L. (2005). Cooperation under the Threat of Expulsion in a Public Goods Experiment. *Journal of Public Economics*, 89(8), August 2005, 1421–1435.
- Davis, D.D. & Holt, C.A. (1993). *Experimental Economics*. Princeton University Press, Princeton, New Jersey, US.
- Dawes, R. M., McTavish, J., & Shaklee, H. (1977). Behavior, Communication, and Assumptions about Other Peoples' Behavior in a Commons Dilemma Situation. *Journal of Personality and Social Psychology*, 35(1), 1-11.
- Fehr, E. & Gächter, S. (2000). Cooperation and Punishment in Public Goods Experiments. *American Economic Review*, 90 (4), 980-994.
- Fehr, E., & Schmidt. K. (1999). A Theory of Fairness, Competition, and Cooperation. *Quarterly Journal of Economics*, 114, 817–868.
- Fischbacher, U. (2007). Z-tree: Zurich Toolbox for Ready-Made Economic Experiments. *Experimental Economics*, 10, 171-178.
- Güth, W., Levati, M.V., Sutter, M., & van der Heijden, E. (2007). Leading by Example With and Without Exclusion Power in Voluntary Contribution Experiments. *Journal of Public Economics*, 91 (5-6), 1023-1042.
- Isaac M. & Walker, J. (1988a). Group Size Effects in Public Goods Provision: The Voluntary Contribution Mechanism. *Quarterly Journal of Economics*, 103, 179-200.
- Isaac M. & Walker, J. (1988b). Communication and Free-Riding Behavior: The Voluntary Contribution Mechanism. *Economic Inquiry*, 26(4), 585-608.
- Kroll S., Cherry T.L., & Shogren J.F. (2007). Voting, Punishment, and Public Goods. *Economic Inquiry*, 45, 557–570.
- Ledyard J.O. (1995). Public Goods: A Survey of Experimental Research, in J.H. Kagel and A.E. Roth (eds) *The Handbook of Experimental Economics*. Princeton University Press, Princeton, New Jersey, US, 111-194.
- Levati, M.V., Sutter, M. & van der Heijden, E. (2007). Leading by Example in a Public Goods Experiment with Heterogeneity and Incomplete Information. *Journal of Conflict Resolution*, 51(5), 793-818.
- Marwell G. & Ames R.E. (1979). Experiments on the Provision of Public Goods I: Resources, Interest, Group Size, and the Free-Rider Problem. *American Journal of Sociology*, 84(6), 1335-1360.
- Marwell G. & Ames R.E. (1980). Experiments on the Provision of Public Goods II: Provision Points, Stakes, Experience, and the Free-Rider Problem. *American Journal of Sociology*, 85(4), 926-937.
- Marwell G. & Ames R.E. (1981). Economists Free Ride, does Anyone Else: Experiments on the Provision of Public Goods IV. *Journal of Public Economics*, 15, 295-310.
- Messer, K.D., Suter, J., & Yan J. (2013). Context Effects in a Negatively Framed Social Dilemma Experiment. *Environmental & Resource Economics*, 55(3), 397-405.

- Messer, K.D., Zarghamee, H., Kaiser, H.M., & Schulze, W.D. (2007). New Hope for the Voluntary Contribution Mechanism: The Effects of Context. *Journal of Public Economics*, 91(9), 1783-1799.
- Sefton, M., Shupp, R., Walker, J.M. (2007). The Effect of Rewards and Sanctions in Provision of Public Goods. *Economic Inquiry*, 45(4), 671-690.
- Walker, J. M., Gardner, R., Herr A., & Ostrom, E. (2000). Collective Choice in the Commons: Experimental Results on Proposed Allocation Rules and Votes. *Economic Journal*, 110, 212–34.

Appendices

Appendix A: Instructions and questionnaire

Appendix A1: Instructions T0

Instructions

Welcome in CentERlab and thanks for participating in our experiment. Read these instructions carefully so you know how this experiment works, because your decisions will affect your earnings. During this experiment, amounts will be denoted in ECU's (Experimental Currency Unit). 1 ECU is worth €0.04 and your ECU's will be paid out in Euro's at the end of the experiment.

It is strictly forbidden to communicate with the other participants during the experiment. If you have a question or a concern, please raise your hand. It is very important that you follow the rules and instructions provided on this paper as well as by the instructors. If you do not follow them, you will be excluded from the experiment and from the payments.

Information about the experiment

The experiment consists of 10 periods, in which you will interact with two other participants (groups of 3). The groups will stay the same during the entire experiment. Groups are assigned randomly. You will not know with whom you interact, neither will your group members know your identity. Within your group you will only be identified by a number between 1 and 3.

DECISION

At the beginning of each period, each participant is given 20 ECU's. Each participant will have the opportunity to contribute to a project. The contribution can be as small as 0 ECU's and as large as 20 ECU's. You are free to keep or contribute any number of ECU's you want. The number of ECU's you keep and the number of ECU's you contribute will always add up to 20 ECU's. Any ECU that is contributed to the project will be multiplied by factor 1.5. (Hence, 10 ECU's contributed to the project will become 15 ECU's). The sum of ECU's contributed to the project by all the group members will be equally divided amongst all group members after it is multiplied by 1.5. This means, for every ECU that you or your group members contribute, everyone in the group will earn 0.5 ECU. The ECU's that you keep for yourself will not be multiplied or divided amongst your group members. Hence each ECU that you keep for yourself will yield 1 ECU for yourself only.

Example:

Suppose all group members contribute 10 ECU's to the project and keep 10 ECU's for themselves. 30 ECU's contributed to the project will be multiplied by 1.5 (=45) and divided amongst all group members (=15 each). In addition, everyone kept 10 ECU's for themselves which means the pay-off for everyone is 15+10=25 ECU's.

From this the following pay-off equation can be derived for each participant at the end of each period:

$$\text{Pay-off} = \frac{1 \cdot K + (1.5 \cdot P)}{3}$$

Where K stands for how much ECU's you decide to keep for yourself and P stands for the sum of ECU's contributed to the project by all the group members.

Note: The total contribution to the project will always be divided by 3, regardless of the number of ECU's you and your group members have contributed to it.

Information at the end of each period

At the end of each period all the group members will be provided with the same information. The information shows the contribution to the project by each group member as well as the pay-off of each group member for this particular period.

Total final earnings

Your total final earnings in the experiment will simply be determined by the sum of your final pay-offs from all 10 periods.

Remember! During the experiment you are not allowed to communicate with any participant.

Appendix A2: Instructions T1-T3

(Instructions of treatment T1; the instructions of T2 and T3 differ only in the threshold)

Instructions

Welcome in CentERlab and thanks for participating in our experiment. Read these instructions carefully so you know how this experiment works, because your decisions will affect your earnings. During this experiment, amounts will be denoted in ECU's (Experimental Currency Unit). 1 ECU is worth €0.04 and your ECU's will be paid out in Euro's at the end of the experiment.

It is strictly forbidden to communicate with the other participants during the experiment. If you have a question or a concern, please raise your hand. It is very important that you follow the rules and instructions provided on this paper as well as by the instructors. If you do not follow them, you will be excluded from the experiment and from the payments.

Information about the experiment

The experiment consists of 10 periods, in which you will interact with two other participants (groups of 3). The groups will stay the same during the entire experiment. Groups are assigned randomly. You will not know with whom you interact, neither will your group members know your identity. Within your group you will only be identified by a number between 1 and 3.

Each period consists of two stages.

DECISION IN STAGE 1

At the beginning of each period, each participant is given 20 ECU's. Each participant will have the opportunity to contribute to a project. The contribution can be as small as 0 ECU's and as large as 20 ECU's. You are free to keep or contribute any number of ECU's you want. The number of ECU's you keep and the number of ECU's you contribute will always add up to 20 ECU's. Any ECU that is contributed to the project will be multiplied by factor 1.5. (Hence, 10 ECU's contributed to the project will become 15 ECU's). The sum of ECU's contributed to the project by all the group members will be equally divided amongst all group members after it is multiplied by 1.5. This means, for every ECU that you or your group members contribute, everyone in the group will earn 0.5 ECU. The ECU's that you keep for yourself will not be multiplied or divided amongst your group members. Hence each ECU that you keep for yourself will yield 1 ECU for yourself only.

Example:

Suppose all group members contribute 10 ECU's to the project and keep 10 ECU's for themselves. 30 ECU's contributed to the project will be multiplied by 1.5 (=45) and

divided amongst all group members (=15 each). In addition, everyone kept 10 ECU's for themselves which means the pay-off for everyone is $15+10=25$ ECU's.

From this the following pay-off equation can be derived for each participant at the end of each period:

$$\text{Pay-off} = 1 \cdot K + (1.5 \cdot P) / 3$$

Where K stands for how much ECU's you decide to keep for yourself and P stands for the sum of ECU's contributed to the project by all the group members.

Note: The total contribution to the project will always be divided by 3, regardless of the number of ECU's you and your group members have contributed to it.

Information at the end of STAGE 1 of each period

At the end of stage 1 of each period all the group members will be provided with the same information. The information consists of the contribution to the project by each group member as well as the pay-off of each group member for that particular period.

DECISION IN STAGE 2

Now you are aware of the contributions to the project and the pay-offs for each of your group members, you will have a chance to cast your vote on this outcome. You can indicate your agreement by voting 'yes' and you can indicate your disagreement by voting 'no'.

In this experiment, at least 1 group members has to agree with the outcome of Stage 1 to let the voting pass. If the voting passes, the pay-off as obtained in Stage 1 will be finalized for *all group members* as the pay-off for this particular period. If the voting fails, *all group members* will earn an amount X. The amount X is the income from the project. (I.e. the sum of the contributions to the project multiplied by 1.5 and divided by 3). This means that in case the voting fails, all ECU's that you kept for yourself will become completely worthless.

Example:

Suppose you contribute 10 ECU's to the project (and thus keep 10 ECU's for yourself). Suppose total contribution to the project by all group members is 30 ECU's.

If voting passes your final pay-off for the period is: $\text{Pay-off} = 10 \cdot 1 + (30 \cdot 1.5) / 3 = 25$ ECU's.

If voting fails your final pay-off for the period is: $\text{Pay-off} = 10 \cdot 0 + (30 \cdot 1.5) / 3 = 15$ ECU's.

Information at the end of STAGE 2 of each period

At the end of stage 2 of each period all the group members will be provided with the same information. The information shows how many group members voted yes for the outcome as well as the final pay-off for each group member for this particular period as a result of the voting.

Total final earnings

Your total final earnings in the experiment will simply be determined by the sum of your final pay-offs from all 10 periods.

Remember! During the experiment you are not allowed to communicate with any participant.

Appendix A3: Questionnaire

1. What is your age?
2. What is your gender? (Male/Female)
3. What is your nationality?
4. At what faculty are you studying?
5. What type of student are you? (Bachelor/Master/Pre-Master/Other)
6. On a scale from 1 to 7, how cooperative do you consider your group members in this experiment? (1 = not cooperative at all, 7 = extremely cooperative)
7. On a scale from 1 to 7, how cooperative do you consider yourself in this experiment? (1 = not cooperative at all, 7 = extremely cooperative)
8. On a scale from 1 to 7, how satisfied are you with your final pay-offs for this experiment? (1 = not happy at all, 7 = extremely happy)
9. On a scale from 1 to 7, how satisfied are you with your final pay-offs compared to the final pay-offs of your group members? (1 = not happy at all, 7 = extremely happy)
10. Is the setting of this experiment familiar to you? (Yes, and I have participated in a similar experiment before; Yes, but I have not participated in a similar experiment before; No, the setting was completely new to me.)

Appendix B: Additional figures

Contributions per group

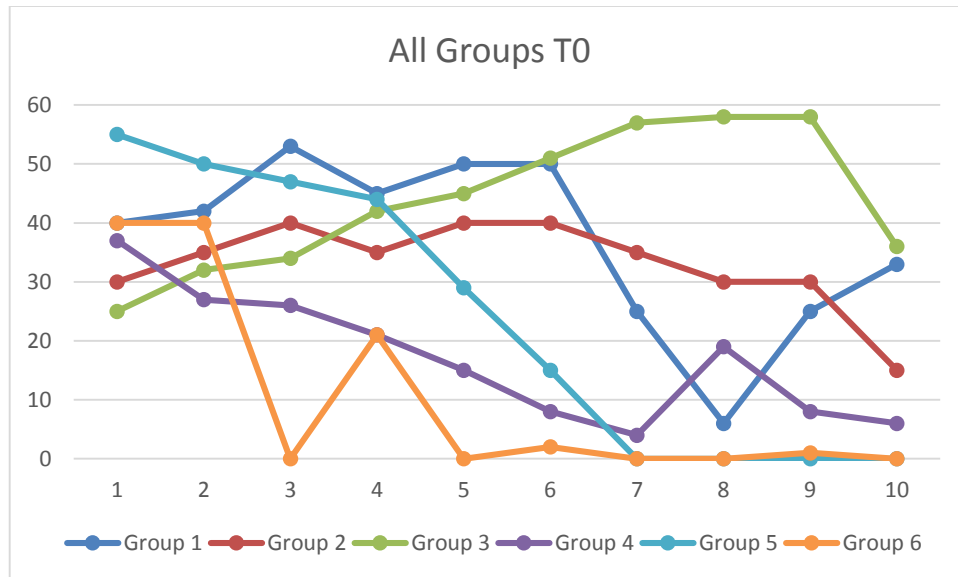


Figure B1: Contributions per group in T0

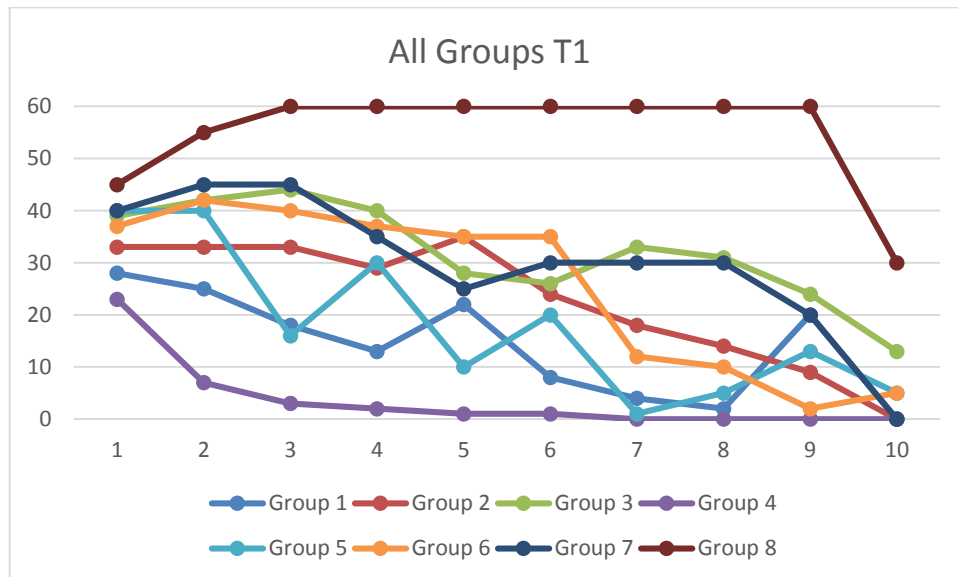


Figure B2: Contributions per group in T1

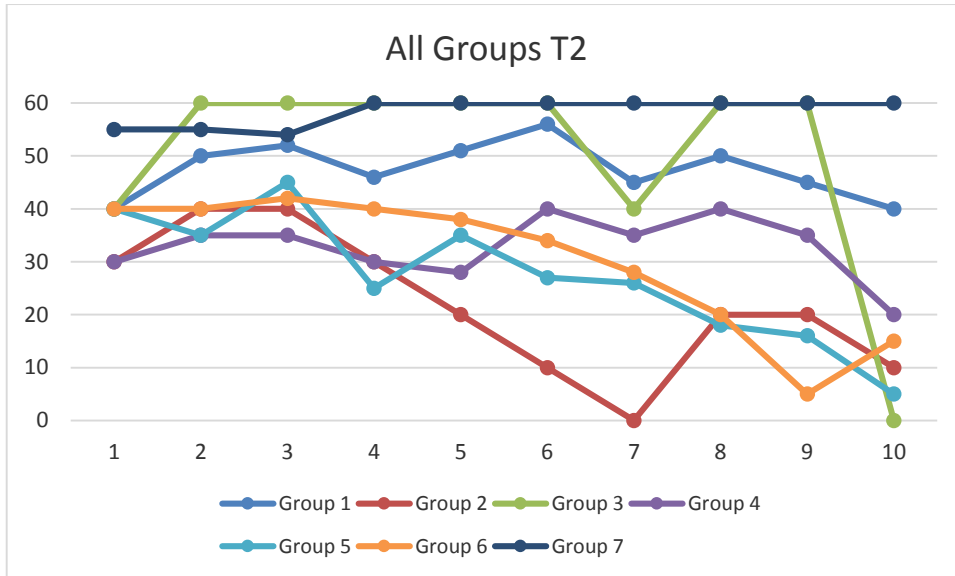


Figure B3: Contributions per group in T2

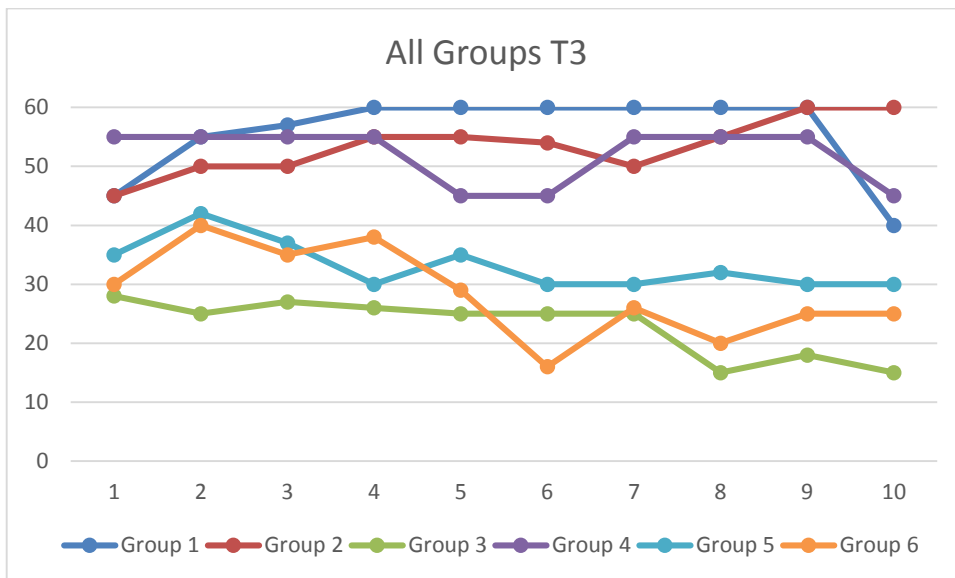


Figure B4: Contributions per group in T3

Appendix C: Additional tables

Appendix C1: Total contributions and voting per group

*Table C1: Total group contributions per period and group voting outcome in T2**

* Outcomes in bold indicate period in which the voting outcome was no

Group	1	2	3	4	5	6	7	8	9	10
1	40	50	52	46	51	56	45	50	45	40
2	30	40	40	30	20	10	0	20	20	10
3	40	60	60	60	60	60	40	60	60	0
4	30	35	35	30	28	40	35	40	35	20
5	40	35	45	25	35	27	26	18	16	5
6	40	40	42	40	38	34	28	20	5	15
7	55	55	54	60	60	60	60	60	60	60

*Table C2: Total group contributions per period and group voting outcome in T3**

Group	1	2	3	4	5	6	7	8	9	10
1	45	55	57	60	60	60	60	60	60	40
2	45	50	50	55	55	54	50	55	60	60
3	28	25	27	26	25	25	25	15	18	15
4	55	55	55	55	45	45	55	55	55	45
5	35	42	37	30	35	30	30	32	30	30
6	30	40	35	38	29	16	26	20	25	25

* Outcomes in bold indicate period in which the voting outcome was no

Appendix C2: Individual contributions and votes

Tables below represent the contributions per individual per period and their vote in the second stage of that period. (1 = yes, 0 = no), for treatments T1-T3.

Table C3: Individual contributions and votes in T1

Group	Period 1		Period 2		Period 3		Period 4		Period 5	
	1	1v	2	2v	3	3v	4	4v	5	5v
1	10	1	9	1	4	1	5	1	3	1
	10	1	6	1	8	1	5	1	5	1
2	8	1	10	0	6	1	3	1	14	0
	15	0	15	0	13	1	13	1	13	1
3	3	1	13	1	13	1	15	0	15	1
	15	1	5	1	7	1	1	1	7	1
4	20	0	20	0	15	1	17	0	10	1
	10	1	10	1	12	1	16	1	14	1
5	9	1	12	1	17	1	7	1	4	1
	1	1	2	1	1	1	0	1	1	1
6	8	1	5	1	1	1	2	1	0	1
	14	1	0	1	1	0	0	1	0	1
7	20	0	20	0	10	1	15	0	20	0
	10	1	10	1	15	1	20	0	10	1
8	20	0	20	1	20	1	0	1	10	1
	10	1	15	1	10	1	15	0	5	1
9	15	1	20	1	20	1	20	1	20	1
	20	0	15	1	20	1	20	1	20	1
10	10	1	20	1	20	1	20	1	20	1

	6	6v	7	7v	8	8v	9	9v	10	10v
	4	1	0	1	2	1	0	1	0	1
	4	1	0	1	0	1	0	1	0	1
	0	1	4	1	0	1	20	0	0	1
	0	1	13	0	0	1	9	0	0	1
	14	0	5	1	12	0	0	1	0	1
	10	1	0	1	2	1	0	1	0	1
	4	1	10	1	12	1	7	1	0	1
	8	1	10	1	12	1	8	1	10	1
	14	1	13	1	7	1	9	1	3	1
	0	1	0	1	0	1	0	1	0	1
	1	1	0	1	0	1	0	1	0	1
	0	1	0	1	0	1	0	1	0	1
	0	1	0	1	0	1	5	1	0	1
	5	1	0	1	5	1	0	1	5	1
	15	1	1	1	0	1	8	1	0	1
	10	0	2	1	5	1	0	1	5	0
	5	1	10	0	5	1	2	1	0	1
	20	0	0	1	0	1	0	1	0	1
	10	1	10	1	10	1	10	1	0	0
	10	1	10	1	10	1	0	1	0	1
	10	1	10	1	10	1	10	1	0	0
	20	1	20	1	20	1	20	1	20	0
	20	1	20	1	20	1	20	1	0	1
	20	1	20	1	20	1	20	1	10	1

Table C4: Individual contributions and votes in T2*

Group	Period 1		1v		2		2v		3		3v		4		4v		5		5v	
	1	5	1	1	10	1	1	15	1	1	12	1	11	1	11	1	20	0	20	0
	15	1	1	1	20	1	17	1	14	0	20	0	20	0	20	0	20	0	20	0
	20	0	0	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0
	10	1	1	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1	10	0
	0	1	1	1	20	1	10	1	0	1	0	1	0	1	0	1	0	1	0	1
	20	0	0	0	10	1	20	1	20	1	20	1	20	0	20	1	10	1	10	1
	10	1	1	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
	10	1	1	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
	15	1	1	1	15	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1
	10	1	1	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1
	5	1	1	1	10	1	5	1	10	1	10	1	5	1	10	1	5	1	10	1
	10	1	1	1	15	1	20	0	5	1	5	1	10	1	10	1	10	1	10	1
	20	1	1	1	10	1	15	1	10	1	10	1	15	1	15	1	15	1	15	1
	10	1	1	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1	10	1
	5	1	1	1	15	1	17	1	10	1	10	1	10	1	10	1	10	1	10	1
	15	1	1	1	15	1	15	1	15	1	15	1	13	1	13	1	13	1	13	1
	20	0	0	0	10	1	10	1	15	1	15	1	15	1	15	1	15	1	15	1
	20	0	0	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0	20	0
	20	1	1	1	20	1	20	0	20	1	20	0	20	1	20	1	20	1	20	1
	15	1	1	1	15	1	14	1	20	1	20	1	20	1	20	1	20	1	20	1

	6	6v	7	7v	8	8v	9	9v	10	10v
	16	1	20	1	20	1	20	1	20	0
	20	0	5	1	20	1	15	1	10	1
	20	0	20	0	10	1	10	1	10	1
	10	0	0	1	0	1	10	1	0	1
	0	1	0	0	10	0	10	0	10	0
	0	1	0	1	10	1	0	1	0	1
	20	1	20	1	20	1	20	1	0	0
	20	1	0	1	20	1	20	1	0	0
	20	1	20	1	20	1	20	1	0	1
	15	1	15	1	20	0	5	1	10	1
	10	1	10	1	15	1	10	1	10	1
	15	1	10	1	5	1	20	1	0	1
	7	1	13	0	3	1	1	1	0	1
	10	1	5	1	7	1	10	1	0	1
	10	1	8	1	8	1	5	1	5	1
	10	1	8	1	7	1	0	1	0	1
	14	1	10	1	13	1	0	1	15	1
	10	1	10	1	0	1	5	0	0	1
	20	1	20	1	20	1	20	1	20	1
	20	1	20	1	20	1	20	1	20	1
	20	1	20	1	20	1	20	1	20	1

* Entries in red indicate a negative voting outcome (at the group level)

Table C5: Individual contributions and votes in T3*

Group	Period 1		1v	2		2v	3		3v	4		4v	5		5v
	1	10		15	20		20	17		20	20		8	15	
	10	1	1	15	1	1	20	0	20	1	20	1	20	1	
	15	1	1	20	1	1	17	1	20	1	20	1	20	1	
	20	0	0	20	1	0	20	0	20	0	20	1	20	1	
	10	1	1	15	1	1	15	1	20	0	20	0	20	0	
	20	1	1	15	1	1	15	1	15	1	15	1	15	1	
	15	0	0	17	1	1	12	1	10	1	10	1	15	1	
	10	1	1	15	1	1	10	1	10	1	10	1	10	1	
	10	1	1	15	1	1	10	1	15	1	15	1	12	1	
	10	1	1	15	1	1	15	1	8	1	8	1	10	1	
	10	1	1	10	1	1	10	1	15	1	15	1	7	1	
	10	1	1	10	1	1	10	1	8	1	8	1	8	1	
	10	1	1	10	1	1	10	1	10	1	10	1	10	1	
	20	1	1	15	1	1	15	1	15	1	15	1	10	1	
	15	1	1	20	1	1	20	1	20	1	20	1	15	1	
	20	1	1	20	1	1	20	1	20	1	20	1	20	1	
	10	1	1	10	1	1	15	1	10	1	10	1	10	1	
	15	1	1	10	1	1	15	1	10	1	10	1	10	1	
	10	1	1	10	1	1	10	1	10	1	10	1	10	1	
	10	1	1	15	1	1	15	1	8	1	8	1	10	1	
	10	1	1	10	1	1	10	1	15	1	15	1	7	1	

	6	6v	7	7v	8	8v	9	9v	10	10v
	20	1	20	1	20	1	20	1	0	1
	20	1	20	1	20	1	20	1	20	1
	20	1	20	1	20	1	20	1	20	0
	20	0	20	0	15	1	20	1	20	1
	14	1	10	1	20	0	20	1	20	1
	20	0	20	0	20	0	20	1	20	1
	7	1	8	1	7	1	5	1	5	1
	8	1	7	1	8	1	8	1	5	1
	10	1	10	1	0	1	5	1	5	1
	10	1	15	1	15	1	15	1	10	1
	15	1	20	1	20	1	20	1	15	1
	20	0	20	1	20	1	20	1	20	0
	10	1	10	1	10	1	10	1	10	1
	10	1	10	1	12	1	10	1	10	1
	10	1	10	1	10	1	10	1	10	1
	5	1	8	1	10	1	15	0	5	1
	5	1	15	0	5	1	5	1	10	1
	6	1	3	1	5	1	5	1	10	1

* Entries in red indicate a negative voting outcome (at the group level)