Discussion Papers
Department of Economics
University of Copenhagen

No. 12-04

Competition, cooperation, and collective choice

Thomas Markussen, Ernesto Reuben and Jean-Robert Tyran

Øster Farimagsgade 5, Building 26, DK-1353 Copenhagen K., Denmark
Tel.: +45 35 32 30 01 – Fax: +45 35 32 30 00
http://www.econ.ku.dk

ISSN: 1601-2461 (E)

Competition, cooperation, and collective choice

Thomas Markussen

University of Copenhagen, e-mail: Thomas.Markussen@econ.ku.dk

Ernesto Reuben

Columbia University and IZA, e-mail: ereuben@columbia.edu

Jean-Robert Tyran

University of Vienna, University of Copenhagen, and CEPR, e-mail: jean-robert.tyran@univie.ac.at

This version: May 2012

ABSTRACT

The ability of groups to implement efficiency-enhancing institutions is emerging as a central theme of research in economics. This paper explores voting on a scheme of intergroup competition which facilitates cooperation in a social dilemma situation. Experimental results show that the competitive scheme fosters cooperation. Competition is popular but the electoral outcome depends strongly on specific voting rules of institutional choice. If the majority decides, competition is almost always adopted. If likely losers from competition have veto power, it is often not, and substantial gains in efficiency are foregone.

JEL Codes: D72, J33, H41

Keywords: public goods; competition; tournament; cooperation; voting

1. Introduction

Cooperation is precious but frail. Cooperation in teams is efficient since it boosts team performance but incentives tend to be stacked against cooperation. Individual team members may have incentives to free ride as they benefit from overall team performance even when they do not contribute to it. A vast literature in economics and the social sciences has therefore investigated institutions that foster cooperation.[1]

Competition between teams provides incentives to cooperate within a team by rewarding relative group performance. Intergroup competition is therefore an institution that has the potential to increase efficiency in organisations consisting of several "teams", like member states in a federation, divisions in a firm, departments in a University, or teams in a sports league. Such intergroup competition has received comparatively little attention in the academic literature, perhaps because competition and cooperation are often thought to be antagonistic modes of interaction, or perhaps because the institution is not trivial to analyse in theory and practice.[2] Previous studies emphasize that the effectiveness of intergroup competition depends on institutional details (e.g. the grading of prizes among top-performers or how ties are broken when there are several winners), but by and large, the research finds

[1] The problem of insufficient cooperation has been investigated under various labels like teamwork, the under-provision of public goods or as social dilemmas. Examples of experimental research testing the effectiveness of such institutions include communication (e.g., Isaac and Walker, 1988), advice (Chaudhuri et al. 2006), peer sanctions (e.g., Fehr and Gächter, 2000), formal sanctions meted out by an authority (e.g. Tyran and Feld, 2006), redistribution (Sausgruber and Tyran, 2007), tax and subsidy mechanisms (Falkinger et al., 2000), selection of group members (Gunnthorsdottir et al., 2010), ostracism (Maier-Rigaud et al., 2010), among others.

[2] We refer to intergroup competition in cases where group membership is fixed. There is an important literature based on the seminal work of Tiebout (1956) and Buchanan (1965) that explores the conditions under which intergroup competition for members leads to the efficient provision of public goods.

that intergroup competition is rather effective in fostering cooperation within teams, thus promoting the overall efficiency of the organisation (for a survey see Bornstein, 2003).[3]

This paper presents an experimental study of endogenous choice of intergroup competition as an institution to foster cooperation within teams, and it is, to the best of our knowledge, the first to do so. Do people opt for exposing their group to competition with others when they have a choice? Are they willing to vote for an institution that rewards top-performing groups while punishing low-performing ones? How does the voting rule affect whether competition is implemented?

We design an experiment in which rational and self-interested voters unanimously support competition. The intuition behind this prediction is that free riding is prevalent in the absence of competition and that intergroup competition has direct and indirect effects. The direct effect of competition is to create winners and losers: a fixed amount of money is transferred from the worst-performing team to the best performing team. However, the indirect effect of competition creates winners only, and it is predicted to dominate the direct effect. The indirect effect arises because intergroup competition creates incentives for individuals to cooperate and hence reduces free-riding. Because we study a setting in which teams compete on a level playing field, all teams ought to perform equally well such that no team is a consistent winner or loser in equilibrium (which is in mixed strategies). In other words, the institution we study is Pareto-efficient (all team members in all teams earn more because the overall level of cooperation is higher), it is revenue neutral (the bonus for the winning team is financed by a fine on the losing team), and it does not increase inequality in expectation (while some lose and some win, no team is predicted to systematically win or lose). Given these desirable properties, economic theory predicts that competition is endorsed by all and this holds independent of the specific voting rule applied in making the collective choice.

---

[3] For examples of experimental studies on intergroup competition see, e.g., Rapoport and Bornstein (1987, 1989), Bornstein et al. (1990; 2002), Bornstein (1992), Bornstein and Erev (1994), Nalbantian and Schotter (1997), van Dijk et al. (2001), Großer and Sausgruber (2005), Tan and Bolle (2007), and Reuben and Tyran (2010).

A number of plausible reasons suggest that intergroup competition may not be as popular as predicted by standard economic theory. A key candidate is heterogeneity of social preferences. It is well-established that some people display a preference for cooperation while others' behaviour is more in line with strict self-interest (e.g. Thöni et al. 2012), which explains why teams tend to cooperate to some extent even when material incentives to cooperate are absent. In the presence of intergroup competition, intrinsically cooperative individuals might provide a competitive advantage to their teams over teams without any such members.[4] Thus, if teams with more intrinsically cooperative members are more likely to win, rational and self-interested individuals have an incentive to vote against competition if they think that other teams have more intrinsically cooperative members, and vice versa. On the other hand, the introduction of extrinsic incentives has been shown to crowd out the intrinsic motivation of individuals (e.g. Gneezy et al., 2011), and therefore the impact of intergroup competition on cooperation might not be as large as predicted. In this case, voting would be affected by beliefs over the distribution of types across teams and the reaction of types to competition.

Another candidate explanation for why voters oppose competition is bounded rationality in the guise of salience effects. For example, inexperienced voters may underestimate the indirect effect of intergroup competition because it is less salient than the direct effect. The direct effect of the institution is built-in and highly salient (the winning team obtains what is taken from the losing team), but the indirect effect is more difficult to anticipate (the equilibrium is in mixed strategies and is non-trivial to deduce). In short, social preferences and bounded rationality may cause biased expectations of the effects of competition. However, the biases may cut either way. For example, pessimistic individuals may fear to be consistent losers or might think that competition will not produce a net increase in cooperation, while optimistic or overconfident individuals may think they will win

[4] This issue has been much discussed in the literature on evolutionary biology to explain why cooperative traits provide an evolutionary advantage, see e.g. Gintis (2000) and Nowak (2006).

the competition regularly. Such beliefs are likely to be shaped by experience, and therefore, we measure expectations in an experimental setting with repeated interaction and voting.

Yet another reason why competition might be unpopular is the potentially important role played by preferences against risk and/or losses and by aversion against the act of competing *per se*. The literature documenting that individuals exhibit small-stakes risk aversion and are particularly averse to losses is considerable (Kahneman et al., 1991). Such preferences can make competition much less palatable than one would expect under traditional assumptions. In addition, there is a growing literature that argues that some individuals, in particular women, avoid competing with others even when they hold a high expected probability of winning (see Niederle and Vesterlund, 2010). Some individuals will therefore vote against implementing competition even if they correctly foresee its effectiveness. The extent to which competition works and whether it is popular are thus inherently empirical questions.

Given that deviations from rationality and self-interest are plausible, electoral support for competition most likely depends on how collective choice is organized. To test this conjecture, we study two voting rules. In majority voting, a simple majority of all voters suffices to implement competition. In the group veto rule, a majority of voters in each group is required for approval while a majority of voters in a single group suffices to veto the adoption of competition. This type of voting rule is commonly used to protect particular (often minority) groups.[5]

[5] Examples of voting rules with the characteristics of the group veto rule abound. For example, free trade agreements under the World Trade Organisation must be unanimously agreed upon by all member states. In the European Union, ratification of new treaties, admission of new member states, and other important decisions can only be implemented with the support of all countries. In so-called "consociational" democracies, each of the main ethnic or religious groups has a veto against major reforms (Lijphart, 1977). More broadly speaking, minority protection is a prevalent feature of many democratic systems. In the U.S. Senate, for example, a coalition of senators representing far less than half the population is sufficient to block new legislation.

Our main results are as follows. Intergroup competition fosters cooperation and efficiency. We find that the effect of competition on cooperation is strong, robust, and immediate. While competition is quite popular among voters, electoral support for competition is far from unanimous. As a consequence, the voting rule used is crucial for collective choice. With majority voting, competition is adopted in almost all cases (96 per cent). However, it is adopted in less than half of the cases when individual groups have veto power (48 per cent). We show that expectations are a key driver of these differences. We observe two countervailing forces: voters tend to underestimate the absolute increase in performance (i.e. they underestimate indirect effect of competition by about 50 per cent), but they tend to be overconfident about their relative performance and their likelihood of winning (i.e. they overestimate the direct effect of competition). For example, about twice as many voters expect to win as to lose the competition. While intergroup competition significantly improves cooperation, it is not Pareto efficient. Around one out of five groups consistently underperform other groups when they compete, which makes them worse off with competition than without. Experience shapes expectations: individuals in losing groups are more likely to expect losing in the future and therefore oppose competition (and vice versa for winners). Such individuals are successful in blocking the adoption of competition under the group veto rule but have essentially no impact with the majority rule. We also find some opposition to competition that is unrelated to the expected benefits of competing. In particular, women are more likely to vote against competition irrespective of their beliefs.

Our paper adds to the literature on several accounts. First, it contributes to the growing literature on the effectiveness of exogenously imposed intergroup competition to improve cooperation (see footnote 3 for references). Second, it complements a rather thin literature studying institutional choice. Only few experimental studies have investigated whether institutions that improve cooperation also enjoy popular support (for a review of this literature pertaining to cooperation problems see Markussen et al., 2011). This is a crucial question to ask. After all, an institution that works well in principle but is rejected by potential beneficiaries is unlikely to be implemented in a democratic society. Third, our paper illustrates the importance of adopting a behavioural perspective in assessing the effects of

institutions to promote cooperation. People make mistakes and may hold biased beliefs. If so, requiring a supermajority is socially costly as misguided voters may prevent the adoption of an institution benefitting all. But behavioural heterogeneity may also create persistent losers and their justified opposition may have no bite when using a simple majority rule.

2. Experimental design

2.1. The public good game with competition

In essence, we study competition between K groups, each of which produces a local public good. Groups are ranked according to their performance, i.e. by how successful they are in producing the local public good. High-performing groups get a bonus while low-performing groups a malus. The competitive scheme is revenue neutral as the bonuses for the high performers are funded by transfers from the low performing groups.

More specifically, we build on the linear public good game where $i = 1, \dots, N$ players, each with an endowment of e points, decide how many points $c_i \in [0, e]$ to contribute to a public good with a constant marginal per capita return of $\alpha < 1$. To this basic structure we add intergroup competition between K groups, each with its own (local) public good. Each group $k = 1, \dots, K$ competes with $K - 1$ other groups (we refer to the set of K competing groups as an organisation). Groups are ranked according to the sum contributions to their public good $C_k = \sum_{i \in k} c_i$. The group with the highest sum of contributions is assigned rank $R = 1$, the group with the second-highest sum of contributions rank $R = 2$, and so on down to the group with the lowest sum of contributions, which receives a rank $R = K$. Ties are randomly broken such that there is always a strict ranking of groups. A group's ranking determines whether its members gain or lose points. Groups with rankings above the median are transferred points from groups with rankings below the median. Specifically, the earnings of player i in group k in an organisation are given by

$$\pi_{ik} = e - c_{ik} + \alpha C_k + \frac{\gamma}{K-1}(K + 1 - 2R_k)$$

where c_{ik} is player i's contribution to the public good, good, C_k is the sum of contributions in group k, R_k is group k's ranking within the organisation, and γ is a parameter determines the amount of points that are transferred from low ranking groups to high ranking groups.

This type of competition scheme has the following important characteristics. First, it is revenue neutral by construction as groups with low ranks gain points at the expense of groups with high ranks. Specifically, each group with rank $\underline{R}_k < \frac{1}{2}(K+1)$ receives a transfer from the group ranked $\overline{R}_k = K + 1 - \underline{R}_k$ (if K is odd and a group's rank equals $R_k = \frac{1}{2}(K+1)$ then its members neither gain nor lose). Second, the gain from competition strictly increases as a group's rank improves, where γ equals the maximum gain by the group ranked first. The converse holds for losses from competition, and in this case γ equals the maximum loss by the group ranked last. Third, there are no direct spillovers between groups from individual contributions but such spillovers are entirely mediated through the bonus/malus scheme. There are also no spillovers between organisations.

In our experiment we used parameters $N = 3$ players, and $K = 3$ groups, $e = 30$ points, and $\alpha = \frac{1}{2}$ so that player i's earnings simplify to

$$\pi_{ik} = 30 - c_{ik} + \frac{1}{2}C_k + \gamma(2 - R_k),$$

and the competition scheme is simply a transfer of γ points from the group ranked last to the group ranked first.

2.2. Institutional choice

We investigate two institutions: *Competition*, where $\gamma = \gamma^C = 10$, and *No competition*, where $\gamma = \gamma^N = 0$, and two rules for institutional choice within the organisation.

Players vote on whether their organisation implements competition or not (voting is compulsory and is not costly). With the *Majority* rule, competition is implemented if a majority of players in the organisation (i.e. more than $NK/2$ players irrespective of their group) vote in favour of it. In contrast, with the *Group Veto* rule, competition is implemented if a majority of players *in each group* (i.e. more than $N/2$ players in each of the K groups) votes in favour of it. Thus, the electoral bar is set higher for competition to be accepted with the group veto than with the majority rule. For example, in the experiment, two voters in one

group suffice to block the implementation of competition with the group veto rule even with unanimous support for competition in the other two groups. We compare the effects of these voting rules against a baseline condition called *No Voting* where players do not get to choose which institution is implemented, and instead, organisations are exogenously assigned to either competition or to no competition.

2.3. Experimental procedures

The experiment is divided into three phases of 8 periods each. Before each phase (i.e. before playing periods 1, 9 and 17) subjects use one of the rules described above to select an institution for their organisation for the next 8 periods. In each period, subjects play the public good game described above. Subjects are always matched with the same participants within their group and compete with the same groups within an organisation. At the end of each period, participants are informed about the individual contributions of all members of their own group, the average contribution of other groups in their organisation, the rank of their group within the organisation, and their own earnings.

Table 1 shows the sequences in which organisations went through the various conditions along with the number of subjects, organisations, and the rule used. The first two sequences allow us to observe the rate with which competition is chosen and how endogenously chosen competition affects contribution behaviour under the majority and group veto rules, respectively. The last two sequences serve as controls that allow us to determine the impact of competition on contributions without any selection effects because (no) competition is imposed in these cases. Appropriate comparison of the outcomes across sequences also allow us to evaluate whether imposed vs. chosen competition has the same impact on cooperation. In phase 3 of sequences 3 and 4, participants choose by majority vote whether to implement competition. Comparison with sequence 1 allows us to see how controlling for experience (in sequences 3 and 4) affects the popularity of the competition scheme.

Table 1 – Experimental treatments and number of observations

Sequence	*Number of subjects/organisations*	*Rule used in*		
		Phase 1	*Phase 2*	*Phase 3*
1	54/6	Majority	Majority	Majority
2	63/7	Group veto	Group veto	Group veto
3	27/3	No voting (competition)	No voting (no competition)	Majority
4	27/3	No voting (no competition)	No voting (competition)	Majority

Before the institutional choice was made, we elicited the subjects' expected contributions by others for the next phase. These expectations were elicited for other players in their own group and for players in other groups conditional on the implemented institution. Specifically, we asked them to indicate the average contribution of: (i) other subjects in their group given that they play with competition, (ii) other subjects in their group given that they play without competition, (iii) subjects in other groups given that they play with competition, and (iv) subjects in other groups given that they play without competition. In addition, we asked subjects to indicate their expected average transfer (gain or loss) due to their group's ranking over the next 8 periods given that they play with competition. To avoid complicating the incentives to contribute, the elicitation of expectations of the subjects' own group was not incentivized. However, we did elicit expectations concerning other groups in an incentive-compatible way.[6]

Competition increases the variance of payoffs *ceteris paribus* and may therefore be unpopular with subjects who dislike risk. To obtain a measure of preference for risk, we ask subjects at the end of the experiment to choose between the following two options: a lottery that yields 30, 40, or 50 points each with equal probability or receiving 36 points with certainty. The specific parameters of the lottery where chosen to mimic a choice between the low certain payoff of no competition and the higher but more risky payoff of competing (the

[6] We paid subjects an amount that decreased with the square of the difference between their expectation and the realized contributions (see the online appendix for details).

lottery is calibrated to the case where competition increases everyone's contribution by 8 points). The interpretation of rejecting lotteries such as this one, which would imply absurd levels of risk aversion (see Rabin, 2000), is a matter of considerable debate. For convenience, we follow Köszegi and Rabin (2006) and refer to subjects who choose the certain option as loss averse.

The experiment was conducted in the Laboratory for Experimental Economics at the University of Copenhagen. Participants were all first-year students in economics. We used standard experimental procedures, including neutrally worded instructions that explained the game and all the experimental procedures. At the end of the experiment points earned during the experiment were converted into money using an exchange rate of 12 points per 1 DKK (participants earned around 100 DKK ≈ 17 USD on average). The detailed experimental procedures, including the instructions, are available in the online appendix.

3. Predictions

We now briefly discuss the theoretical predictions of the game. We start with the contribution decision in the one-shot version of the game under the assumption that all players are risk neutral and own-earnings maximizers. If groups play without competition, the game is reduced to a standard linear public good game where the unique Nash equilibrium is for all subjects to keep their entire endowment.

The introduction of intergroup competition increases contributions as full defection is no longer an equilibrium. In fact, for our experimental parameters, with intergroup competition there are no equilibria in pure strategies. To see this, consider the following cases. First, suppose that groups are *strictly ranked* in terms of their total contributions to the public good. In this case, players who are making a positive contribution to the public good can make a profitable deviation by reducing their contribution by any amount which is small enough to preserve the initial ranking. Hence, there are no pure-strategy equilibria where groups are strictly ranked. Second, suppose that at least two groups have tied ranks and are contributing less than their full endowment. In this case, a player for whom $c_i < e$ in any of the tied groups can make a profitable deviation by contributing a bit more and improving his

group's rank by at least one (if two groups are tied) and up to $K-1$ ranks (if all groups are tied), which increases his own earnings by at least $2\gamma/(K-1)$ and up to γ points (in the experiment this corresponds to at least 5 and up to 10 points). Hence, there are also no pure-strategy equilibria where groups are tied, which implies that full defection is indeed no longer an equilibrium. The only pure strategy profile not covered by these arguments is that of full contributions to the public good, where upward deviations are ruled out. If all players contribute their full endowment to the public good, each group's expected rank is $\frac{1}{2}(K+1)$ and the expected transfer is zero. From this point, any downward deviation costs individuals γ points as their group would be ranked last. Therefore, if $\gamma \geq (1-\alpha)e$ such deviations are not profitable and full contributions to the public good is an equilibrium, which is the case investigated in the earlier studies on intergroup competition (e.g., see Nalbantian and Schotter, 1997). We deliberately chose a lower value of $0 < \gamma < (1-\alpha)e$ to contribute to the literature by studying a case where full contribution by all is not an equilibrium because endowments are large relative to the intergroup transfer that can be applied. This is arguably a very common situation, e.g., in many occupations relative performance pay is only a small part of total compensation.

Since downward deviations are profitable, we can conclude that under these assumptions there are no pure-strategy equilibria in our experiment and all Nash equilibria are in mixed strategies. Calculating the precise probability distributions with which players mix strategies in the full set of resulting equilibria is conceptually straightforward but is tedious and computationally intensive.[7] Hence, we refrain from doing so here. However, there is one equilibrium that stands out because it has various properties that make it highly desirable and therefore make it plausible candidate. In the following, we refer to the symmetric equilibrium where all players mix by making independent draws from the same

[7] Although more complex, our game has a similar structure to the participation games studied in the costly voting literature (e.g., Schram and Sonnemans 1996; Levine and Palfrey, 2007). As is our case, these games do not have pure strategy equilibria and their mixed equilibria are hard to compute. See Palfrey and Rosenthal (1985) for proof of existence of equilibria in quasi-symmetric mixed strategies.

probability distribution. First, this equilibrium does not require that individuals within a group coordinate their contributions, something that would be hard in the experiment since subjects could not communicate. Second, the equilibrium is symmetric which makes it focal as players are also symmetric in the game and therefore can also help coordination. Third, the equilibrium is procedurally fair as all groups have the same probability of wining. Fourth, this equilibrium delivers the highest feasible mean contribution. The intuition for this observation is that high contributions are sustained by the threat of foregoing a positive transfer and having to fund the transfer for a winning group. The threat results from one's group dropping in the expected ranking as an individual player reduces his or her contribution. The symmetric equilibrium maximizes this threat for the largest number of groups.[8] Finally, in this equilibrium all players in all groups are (*ex ante*) better off compared to the equilibrium without competition (i.e. full free riding). Thus, playing this equilibrium with competition constitutes a Pareto-improvement compared to the equilibrium without competition. We summarize these arguments as:

Prediction 1 (Effect of competition): *If players are rational, risk neutral, and maximize own earnings, competition is an efficiency-enhancing institution. In addition, if players play a symmetric equilibrium, competition is Pareto-improving.*

Now we turn to the predictions for voting. Since universal defection is not an equilibrium of the game with competition, it is clear that mean expected earnings are higher with competition than without. Moreover, if subjects anticipate playing the highly salient symmetric equilibrium then competition is in fact Pareto-improving. Therefore, all voters have a weakly dominant strategy to support competition. Given that there are no incentives to vote against one's preference and voting is both compulsory and costless, it is reasonable to

[8] For example, it is easy to see that there are no equilibria where the mean contribution of a player i in group k exceeds $\bar{c}_{ik} > 2\gamma\left(R_k^0 - R_k^e\right)/(1-\alpha)(K-1)$ points where R_k^e is k's expected rank if i plays according to the equilibrium strategy and R_k^0 is k's expected rank if i deviates to $c_{ik} = 0$ because otherwise i is willing to deviate downwards even if it implies losing points with certainty. In a symmetric equilibrium the loss in ranking equals $R_k^0 - R_k^e = K - 1$, which makes the above condition equal to $\bar{c}_{ik} > \gamma/(1-\alpha)$ for all groups in the organisation.

assume that all players vote sincerely, which then predicts that competition is implemented irrespective of whether the organisation is using the majority of group veto rule.

Prediction 2 (Voting for competition): *If players are rational, risk neutral, maximize own earnings, and play a symmetric equilibrium, all players vote in favour of implementing competition irrespective of the voting rule used.*

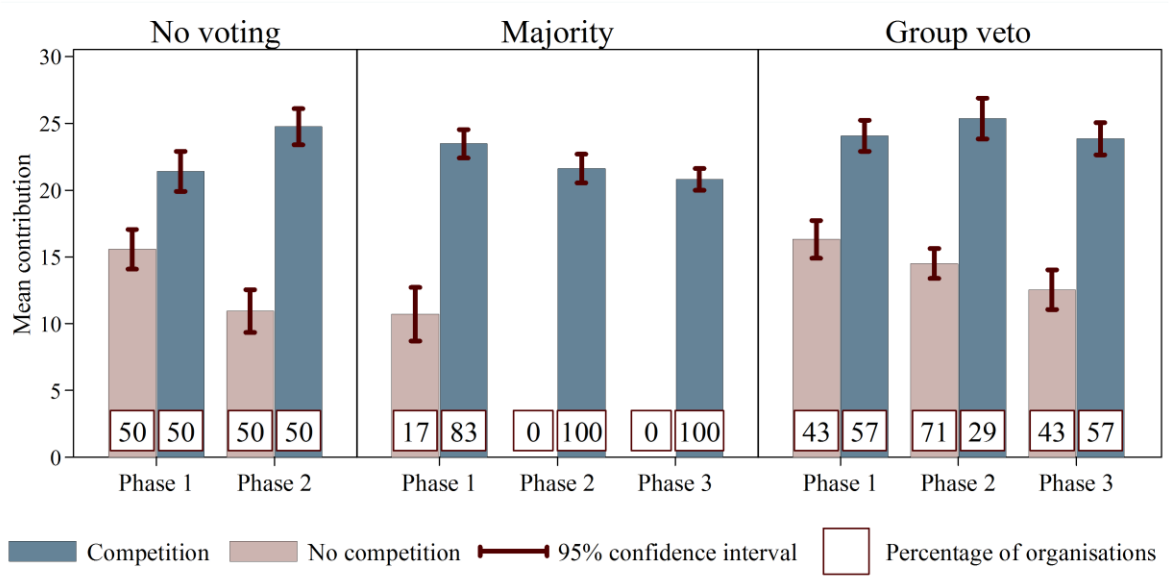
There are plausible reasons to think that predictions 1 and 2 will not always hold. In the introduction, we discussed potential effects of heterogeneity of social preferences, bounded rationality, salience effects, aversion to risk and/or losses and a dislike of competing *per se*. We refrain from formally modelling these deviations from standard assumptions as precise predictions are hard to derive, are highly dependent on the specific model used, and it is unclear *a priori* which of these deviations from the standard model may be relevant in our context. Instead, we find it more fruitful to not make specific assumptions but to let the experimental data speak for itself.

4. Results

Figure 1 provides descriptive statistics of cooperation and the prevalence of competition. Specifically, it displays the mean contribution to the public good with and without competition, and the fraction of organisations that compete. The same information is presented in Table A1 in the online appendix.

Figure 1 shows that competition has a strong and immediate positive effect on cooperation. This holds irrespective of the voting rule being used. Overall, competition increases contributions to the public good by around 10 points (about 80 per cent) compared to no competition. Specifically, mean contributions increase from 13.3 points to 23.1 points when the institution is imposed exogenously, from 10.7 points to 21.6 points when it is implemented with the majority rule, and from 14.5 points to 24.5 points with the group veto rule. The positive impact of competition is remarkably robust. *All* the 13 organisations that experienced both no competition and competition (6 of these organisations are from the no voting rule) had higher mean contributions under competition than under no competition.

Figure 1 – Contributions with and without competition by voting rule



Note: In phase 3, the 6 organisations that played with the no voting rule switched to the majority rule.

The effect of competition on cooperation is not only strong and robust, it is also immediate. The cooperation-increasing effect does not seem to be contingent on having experienced the institution. In fact, contributions are higher with competition already in the first period.[9]

Table 2 shows that the effects of competition are strong, immediate, and independent of the voting rule by means of regression analysis.[10] The table shows regressions of individual contributions and includes dummy variables for the voting rule interacted with a dummy

[9] Recall that, irrespective of the institution, we inform subjects of their group's relative standing. Hence, the observed effect of competition is due to the monetary incentive only. Tan and Bolle (2007) show that providing information on rankings without providing monetary incentives can already improve cooperation.

[10] Throughout the paper, we use regression analysis to test the statistical significance of our findings. In all regressions we use robust standard errors, and if the dependent variable is at the subject level then we cluster standard errors on organisations and, unless it is otherwise noted, we include subject random effects. In addition, we conducted the basic treatment comparisons with non-parametric tests using organisation averages as units. The results of these tests are qualitatively and quantitatively similar and are available in the online appendix.

Table 2 – Effect of competition on contributions

	All periods		All periods		Period 1	
Independent variables	coef.	std. err.	coef.	std. err.	coef.	std. err.
Competition × No voting	9.8**	(1.9)	9.8**	(1.9)	6.1**	(2.1)
Competition × Majority	7.4**	(0.2)	9.2**	(1.3)	8.2**	(1.0)
Competition × Group veto	8.7**	(0.9)	8.6**	(1.0)	8.2**	(1.7)
Majority	1.5	(2.2)			–0.4	(1.5)
Group veto	2.2	(2.3)			–1.4	(2.2)
Constant	12.8**	(2.0)	14.7**	(1.4)	17.4**	(1.5)
Period × rule fixed effects	No		Yes		No	
Subject fixed effects	No		Yes		No	
R^2	0.122		0.175		0.334	
# of obs./subj./org.	4104/171/19		4104/171/19		171/171/19	

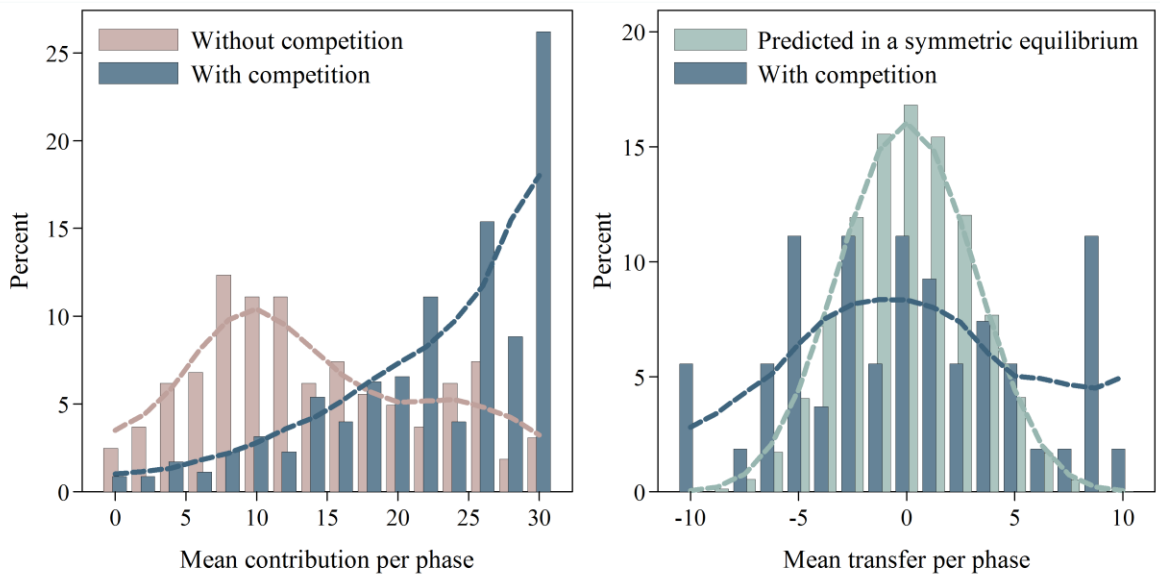
Note: GLS regressions with the amount contributed as the dependent variable. Clustered standard errors are calculated allowing for intra-organisation correlation. Asterisks indicate significance at the 1 per cent (**) and 5 per cent (*) level.

variable indicating whether competition is implemented.[11] The first column in Table 2 presents results of a standard GLS regression. The second regression includes subject fixed effects as well as period and rule fixed effects. This regression controls for rule-specific time trends and individual levels of cooperativeness. The third column shows again a GLS regression but restricts the sample to the first period.

The coefficients in the first three lines show that competition significantly increases contributions in all three rules ($p < 0.001$), and it does so from the first period (see last column). These results are in line with Erev, Galili and Bornstein (1993), Nalbantian and Schotter (1997), Tan and Bolle (2007) and Reuben and Tyran (2010), who also find positive effects of intergroup competition on cooperation in social dilemma experiments.

[11] We do not find that contribution or voting behaviour differs between the 6 organisations that were assigned to the majority rule from the beginning of the game and the 6 organisations that were assigned to the majority rule after having played two phases with the no voting rule. Therefore, we pool these observations throughout the paper. Our results do not differ if we exclude these observations.

Figure 2 – Distribution of the subjects' mean contribution and mean transfer



Note: Bars show the actual distributions and the dotted lines the distributions using lowess smoothing.

If we use the regressions in Table 2 to test whether the effect of competition differs depending on the rule used to implement it, we find that it does not (Wald tests, $p > 0.154$). Therefore, unlike other institutions studied in the experimental literature on institutional choice (e.g. Walker et. al., 2000; Tyran and Feld, 2006; Dal Bó et al., 2010; and Sutter et al., 2010), we do not find that the effect of competition depends on whether it was adopted through a vote or exogenously imposed on the subjects. We discuss why this might be the case in the conclusions. We summarize these findings as our first result.

Result 1 (Effect of competition): *Competition is an efficiency-enhancing institution as it significantly increases contributions to the public good. The effect of competition is immediate and its strength is independent of whether competition is imposed exogenously or implemented endogenously through voting.*

Figure 2 illustrates the direct and indirect effects of competition. The left panel presents the distribution of each subjects' mean contribution when competing vs. when not competing. The right panel shows the distribution of the groups' mean transfer per phase, and for comparison, we also show the predicted distribution of mean transfers in a symmetric equilibrium, i.e., when all groups have the same probability of winning.

The left panel shows that competition clearly shifts the distribution of contributions to the right. The mode of the distribution shifts from values around 8 points without competition to a value of 30 points, i.e. full contribution, with competition (the median shifts from 12 points to 26 points). However, the figure also shows considerable variation in the subject's mean contribution.[12] Clearly, even when they are competing, some subjects are more cooperative than others. Similarly, the distribution of mean transfers in the right panel also displays more variation than in the theoretical benchmark. For example, if all groups have the same probability of winning, the predicted distribution of transfers has a standard deviation of 2.9 points while the distribution of actual transfers has one of 5.3 points. This observation is consistent with the existence of systematic winners and losers, i.e. groups that persistently win or lose when competing with others. Since such groups could have a very different stance towards competition, we explore next the persistence of winning and losing in more detail.

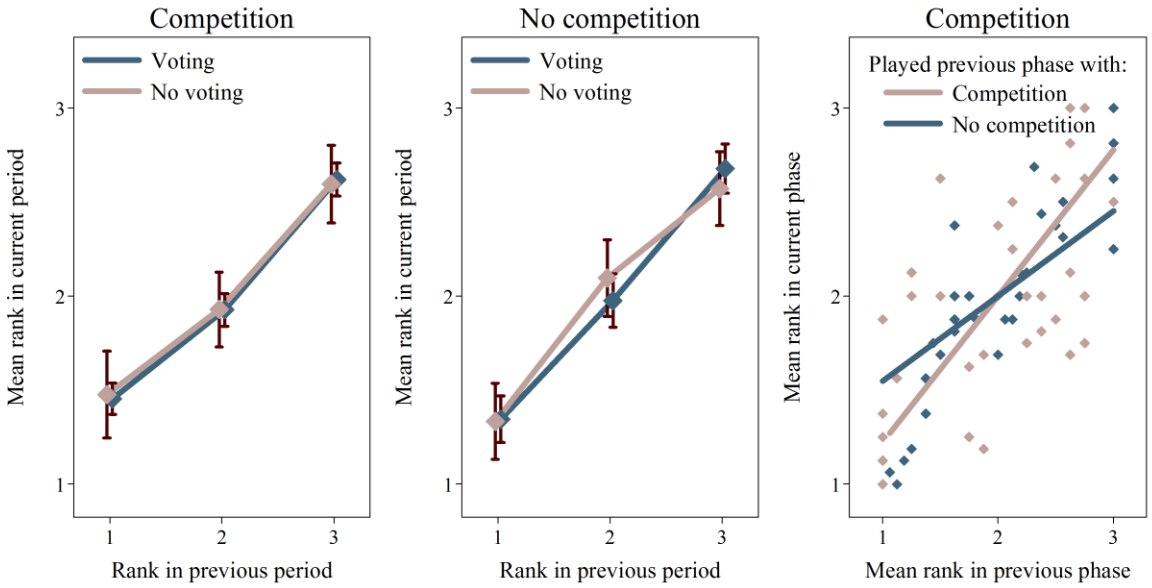
Figure 3 examines the persistence of winning and losing across periods within a phase and across phases. More precisely, the left and middle panels display the mean rank obtained in period t of phase r as a function of its rank in the period $t - 1$. We display this relation for groups that are competing (left panel) as well as for groups that are not competing (middle panel), and we also separate groups depending on whether intergroup competition is imposed exogenously (light red) or implemented with the majority or group rule (dark blue). The right panel shows the persistence for groups that played with competition in a phase r. It shows a scatter plot (and corresponding best linear fit) of each group's mean rank in phase r as a function of its mean rank when it competed in the preceding phase (light red) and when it did not (dark blue).[13]

---

[12] Note that the units used to construct the distribution are the subject's mean contribution over 8 periods. Therefore, even though one should expect some variation in contributions due to subjects playing a mixed strategy, the observed distribution of mean contributions exhibits much more variation than the distribution one would obtain if subjects mix independently using the same probability distribution.

[13] Since there are few sequences where a phase with competition was preceded by a phase without competition, we pool the data from the no voting, majority, and group veto rules for this analysis.

Figure 3 – Persistence of group rank across periods within phases and across phases



Note: Error bars in the left and middle panels show 95 per cent confidence intervals.

If groups play a symmetric equilibrium of the stage game, the fact that a group wins or loses in a particular period does not predict whether that group will win or lose in the next period. Similarly, a group's mean rank in a given phase does not predict that group's mean rank in the subsequent phase. Thus, the lines should be flat in all panels of Figure 3 according to the equilibrium prediction. However, we find that lines have positive slope, meaning that a group's rank is an excellent predictor of its rank in subsequent periods and phases.[14]

We can also see that the persistence of ranks across periods is very similar within phases where competition is imposed exogenously and phases where it is implemented

[14] We formally test the relation between a group's rank in periods $t - 1$ and t with four ordered probit regressions, one for each of the four relations seen in Figure 3 (left and middle panels). We test the relation between a group's mean rank in phases $r - 1$ and r with two GLS regressions, one for organisations playing with competition and the other for organisations playing without competition (this latter case is not included in Figure 3). We use an interaction variable to test the effect of the institution implemented in phase $r - 1$. The estimated coefficients are available in the online appendix. In all cases, a group's previous (mean) rank significantly predicts its current rank ($p < 0.022$). Moreover, coefficients do not significantly differ between ordered probit regressions ($p > 0.315$) or between GLS regressions ($p > 0.207$), and the interaction term was never statistically significant ($p > 0.070$).

endogenously, which indicates that rank persistence is not due to a selection effect. Similarly, we do not see that rank persistence across periods or phases depends on the implemented institution. In fact, a group's performance under intergroup competition is predicted equally well by its previous rank irrespective of whether it was competing or not in the previous phase (graphs in the right panel have a similar slope). Hence, it appears that there are some groups that are simply more or less cooperative than others and their relative standing is unaffected by intergroup competition. Such differences in cooperativeness imply that less cooperative groups tend to consistently lose out if competition is implemented. For example, we find that a fifth of the groups are net losers from (forced) competition: 4 of the 18 groups (22.2 per cent) that played under the no voting rule have lower earnings with than without competition, which leaves 14 of them (79.8 per cent) as net winners from competition. These findings are summarized in:

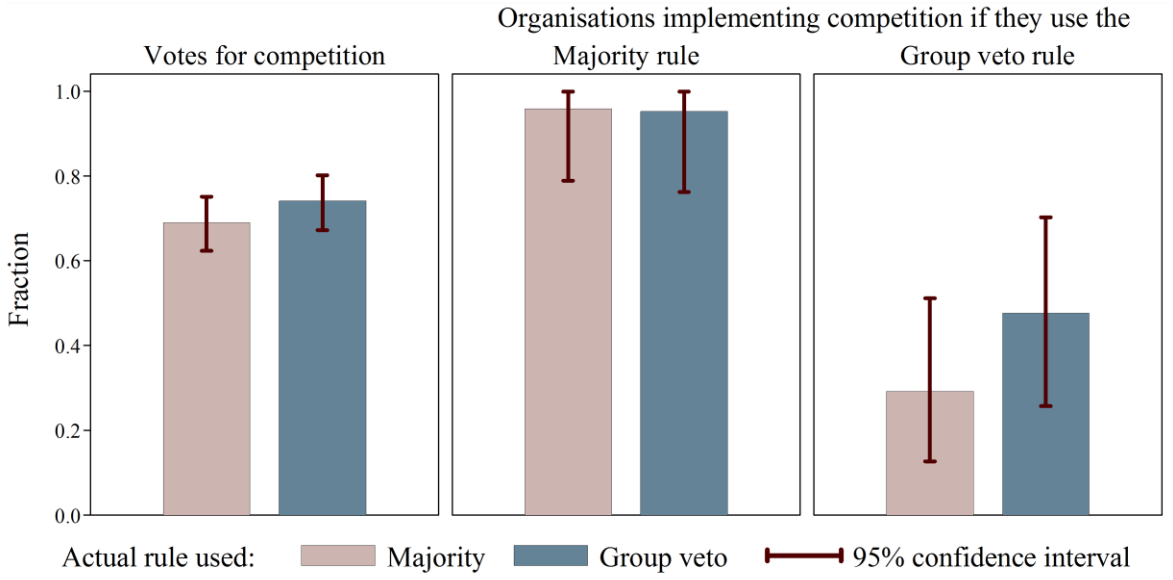
Result 2 (Winners and losers from competition): *A majority (about 80 per cent) of groups are net winners and a minority (about 20 per cent) of groups are net losers from competition. The reason is that some groups consistently cooperate more and some groups consistently contribute less than others irrespective of whether they play with or without competition.*

Next we take a closer look at the implementation of competition and the subjects' voting behaviour. Recall from Figure 1 that whether competition is implemented strongly depends on the voting rule used. Organisations using the majority rule almost always implement competition (in 95.8 per cent of all elections) but those using the group veto rule only do so in half of the cases (47.7 per cent of all elections).[15].

Detailed analysis shows that competition is embraced much more often with the majority rule than with the group veto rule because these rules mechanically aggregate individual votes differently, not because voters behaved differently under the respective rules.

[15] A probit regression of implementing competition (in an organisation in a given phase) on a dummy variable indicating the voting rule used (either majority or the group veto rule) shows that competition is implemented significantly more often with the majority rule ($p < 0.001$). The online appendix provides additional non-parametric tests.

Figure 4 – Votes in favour of competition and fraction of organisations that would implement competition depending on the voting rule



The left panel of Figure 4 shows that most subjects vote in favour of competition irrespective of the voting rule used (69.0 and 74.1 per cent respectively with the majority and group veto rules). Individual voting behaviour is not significantly different according to a probit regression of voting in favour competition on a dummy variable indicating the voting rule used ($p = 0.501$).

Figure 4 also shows the results of a simulation exercise to further explore the behavioural vs. mechanical effects of the voting rules. The panel on the left shows the share of individual votes cast in support of competition in the two voting rules. As noted before, these shares are very similar and are not significantly different. The middle panel shows the share of organisations that indeed accepted competition using the majority rule (light red bar). The dark blue bar shows the counterfactual share of organisations that would have implemented competition had they used the majority voting rule but cast their votes (as they did) in the group veto rule. Since the blue bar in the middle panel is almost identical to the light red one (95.2 vs. 95.8 per cent), we conclude that the difference in implementation is not due to behavioural but to the different way the voting rules aggregate votes. A similar conclusion emerges if we do the reverse exercise, i.e. to calculate the counterfactual acceptance rate applying the group veto rule to the individual votes effectively cast under majority rule (see

right panel). While the acceptance rate is lower in the counterfactual case than in the observed case (29.2 vs. 47.6 per cent), the difference is not significant.[16] We summarize our findings in:

Result 3 (Implementing competition): *Competition is almost always implemented by organisations that use the majority rule but it is implemented less than half the time by organisations that use the group veto rule. The difference in implementation rates is explained by "mechanical" differences in how individual votes are aggregated into collective choices and not by behavioural differences in voting. Roughly 30 per cent of subjects vote against competition under either voting rule.*

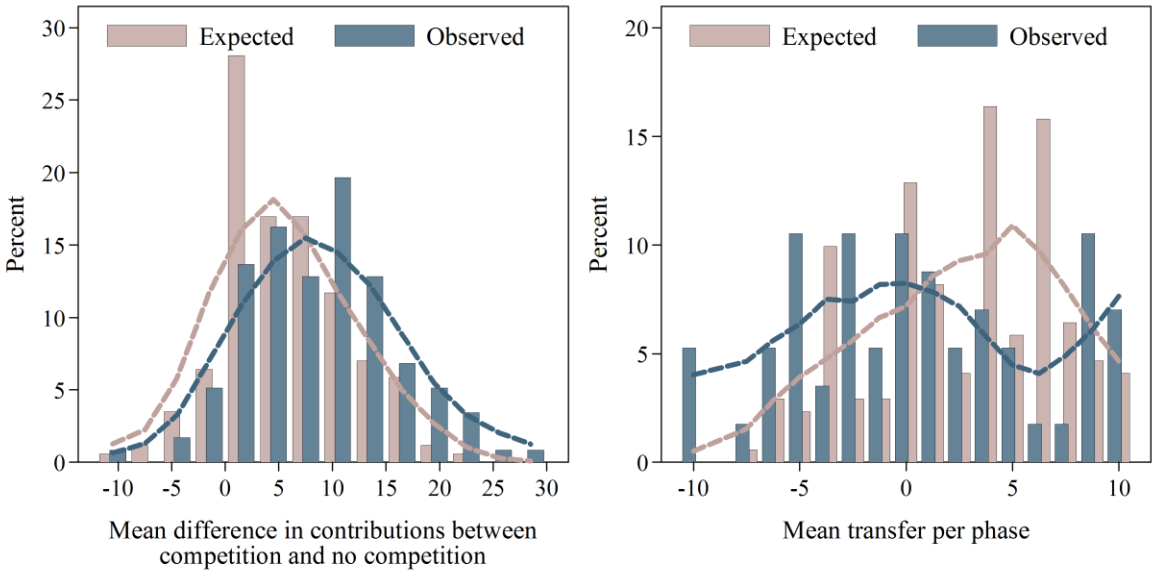
The next logical step is to analyse why some subjects vote against competition. Whether voters support or oppose competition is quite plausibly driven by their expectations on whether doing so is profitable. Specifically, opposition to competition can occur because voters anticipate their group will lose to other groups and/or because they believe competition will generally not motivate individuals to contribute more. Alternatively, it can also be the result of particular preferences such as an aversion to competing *per se* or loss aversion. We find that, by and large, voters have qualitatively correct expectations in that they expect competition to increase cooperation. However, expectations are not entirely rational. Most voters underestimate the overall (indirect) effect of competition and overestimate how well their group will perform relative to others. We also find that *ceteris paribus* women are more likely to vote against competition.

Figure 5 shows the accuracy of voters' expectations on the benefits of competition through its (indirect) effect on contributions and its (direct) effect of redistributing money from the worst to the best performing group.[17]

---

[16] We run two probit regressions with the assigned rule as the independent variable. In the first regression, the dependent variable indicates whether competition would be implemented with the majority rule, and in the second regression, it indicates whether competition would be implemented with the group veto rule. We do not find significant differences (p = 0.921 if organisations would have used the majority rule and p = 0.190 if organisations would have used the group veto rule).

Figure 5 – Distributions of the actual and expected impact of competition on contributions and transfers



Note: Bars show actual distributions and dotted lines show the distributions using lowess smoothing.

The left panel of the figure shows that, by and large, subjects expect competition to have a positive impact on cooperation,[18] but it also shows that they underestimate its effect. Most subjects expect competition will increase the contributions of others in their group and those in other groups (on average by 5.4 points and 5.7 points respectively), but by a smaller amount the actual increase in contributions, which was around 10 points on average.[19]

---

[17] Since we do not find significant differences in the subjects' expectations across the three rules, this analysis is done pooling the expectations data (these tests and the descriptive statistics of the subjects' expectations are available in the online appendix). However, the results are robust to controlling for the rule being used.

[18] Subjects anticipate the fact that competition increases cooperation as the difference in their expectations is already present before they play the game (i.e., in phase 1).

[19] We test whether the expected increase in contributions due to competition is significantly different from zero by running two GLS regressions (one for expectations regarding their own group and one for other groups) with phase fixed effects as the independent variables. We find that subjects expect significantly higher contributions with competition in all three phases ($p < 0.001$). To test whether subjects underestimate the effect of competition, we calculate the difference between each subject's expected contributions and the realized contributions and then use GLS regressions to evaluate whether this difference is significantly different from zero in each phase. We find that subjects significantly underestimate the effect of competition in all phases ($p < 0.027$). However, the amount

The right panel of Figure 5 shows the distribution of expected transfers, i.e., the amount a subject expects to win or lose per period during the next phase due to competition with other groups (light red) and the observed distribution of transfers for subjects who played under competition. Since by construction the mean transfer is zero points, it is evident that on average subjects tend to be overly optimistic as they expect a positive transfer from competing with other groups (on average they expect to get 2.6 points). Regression analysis shows that their overestimation is statistically significant.[20] This observation is consistent with the growing literature on individuals being overconfident of their own performance relative to that of others (see e.g., Camerer and Lovallo, 1999; Malmendier and Tate, 2005; 2008). Interestingly, we find that the expected direct and indirect effects of competition are unrelated. That is, the correlation between a subject's expected transfer and expected impact of competition on contributions is not significant (Spearman's $\rho = 0.042$, $p = 0.582$).

Table 3 shows how these (biased) expectations drive voting for competition, and how they interact with subject characteristics. Model I regresses voting for competition at the beginning of each phase on two variables that capture the subjects' expected benefits of competition. Specifically, we use the expected transfer and their expected increase in the contributions of others in their group due to competition.[21] Model II adds dummy variables indicating whether a subject is female (31.9 per cent of all subjects are female) and whether the subject is loss averse according to our measure at the end of the experiment (see

---

by which they underestimate is significantly smaller in phase 3 compared to phases 1 and 2 ($p < 0.005$), which suggests some learning occurs over time.

[20] We run two GLS regressions: the first uses the expected transfer as the dependent variable, the second uses the difference between the expected transfer and the transfer actually received. In both cases we use phase fixed effects as the independent variables. We find that in all phases subjects expect a transfer that is significantly higher than zero and that subjects who compete significantly overestimate the transfer they receive ($p < 0.030$). We find some evidence of learning as the amount by which they overestimate the transfer is significantly smaller in phases 2 and 3 compared to phase 1 ($p < 0.001$).

[21] Results are almost identical if we instead use the expected increase in the contributions of other groups due to competition.

Table 3 – Voting in favour of competition

	Model I		Model II	
Independent variables	coef.	std. err.	coef.	std. err.
Expected transfer	2.5**	(0.3)	2.5**	(0.3)
Expected increase in contributions	1.1**	(0.4)	1.3**	(0.4)
Loss averse			–18.7	(9.8)
Female			–16.1*	(6.4)
Prediction at mean values	81.0		81.1	
Phase × rule fixed effects	Yes		Yes	
# of obs./subj./org.	405/135/19		405/135/19	

Note: Probit regressions with a binary variable indicating voting in favour of competition as the dependent variable. Table shows marginal effects in per cent. Clustered standard errors are calculated allowing for intra-organisation correlation. Asterisks indicate significance at the 1 per cent (**) and 5 per cent (*) level.

experimental procedures, only 9.4 per cent are classified as loss averse). Both models include a dummy variable indicating whether subjects use majority voting or the group veto rule, which we interact with phase fixed effects to control for rule-specific time trends.

Both models indicate that expected benefits from competition are a key determinant of voting in favour of it. That is, the coefficients for the expected transfer and the expected increase in contributions due to competition are both significantly positive ($p < 0.001$). The fact that the first coefficient is around twice as large as the second one suggests that subjects are simply evaluating the effect of competition on their earnings irrespective of its source.[22]

Model II reveals that *ceteris paribus* female participants have a 16.1 per cent lower probability of voting in favour of competition. Note that, since we are controlling for expectations, this aversion to competition is unlikely to be due to women holding different expectations concerning the benefits of competition or (anticipating) contributing less than

[22] A subject receives one point for every two-point increase in the contribution of others in the group. We cannot reject the hypothesis that the coefficient for expected transfers is twice as large as that of the expected increase in contributions in any of the regressions ($p > 0.799$).

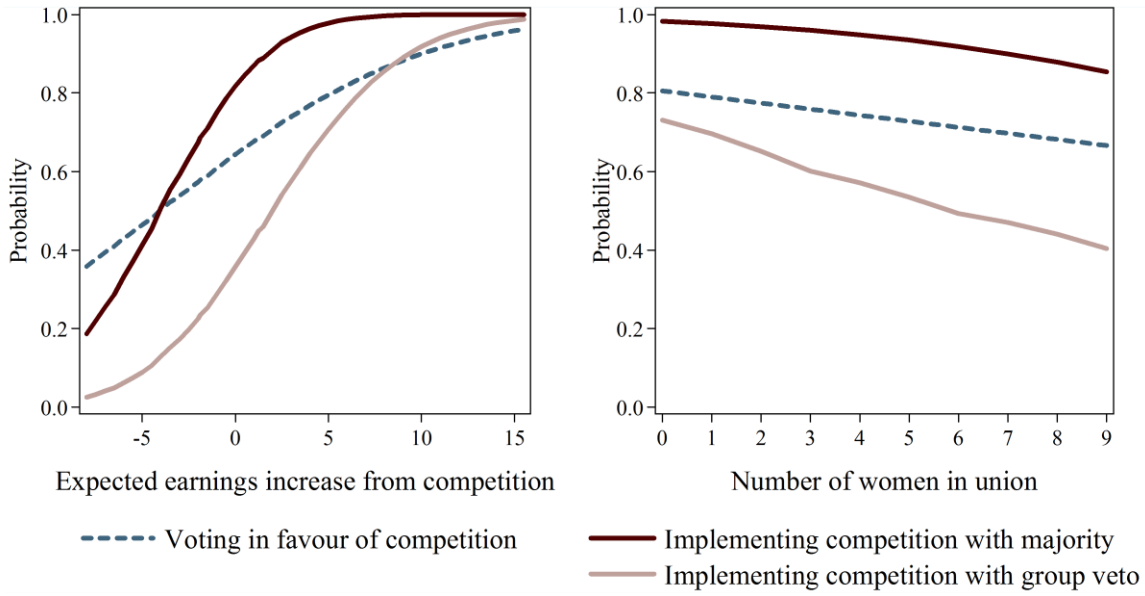
men in competitive environments (as in Gneezy et al., 2003; Gneezy and Rustichini, 2004).[23] This finding is consistent with Healy and Pate (2011) who report that when competing in teams women do not perform worse than men. Hence, the gender effect we find is more in line with the literature that argues that women avoid tournaments even after controlling for their expected performance (see Niederle and Vesterlund, 2007; Niederle et al., 2009; Balafoutas and Sutter, 2012). Model II also shows that loss aversion has a negative effect on the probability of voting for competition, but unlike gender, it is not statistically significant.

Figure 6 illustrates that both expectations and gender have a considerable impact on the probability of voting in favour of competition. The dotted lines show the predicted probability of voting in favour of competition. The solid lines show the effect this probability has on the probability that competition is implemented with either voting rule, which we calculated with a Monte Carlo simulation. The left panel shows that a 7.5 point decrease in the expected benefit of competition (one standard deviation) decreases the probability of voting for competition by 18.5 percentage points. Such a decrease by all individuals in an organisation can have a considerable impact on the probability of implementing competition. For example, a one standard deviation decrease in the expected benefit (evaluated at the mean) causes a decrease of 29.7 percentage points with the majority rule and a decrease of 50.2 percentage points with the group veto rule.

The right panel illustrates the estimated effect (from Model II above) of the share of women in an organisation on the probability of voting in favour and implement competition. For example, if the mean number of women in an organisation increases by two (about one standard deviation), the probability to implement competition falls by 2.5 percentage points with the majority rule by 6.6 percentage points with the group veto rule.

[23] We tested the effect of gender on contributions by adding gender (interacted with competition and each of the voting rules) to the regressions reported in Table 2. The contributions of women do not differ significantly from those of men when competing irrespective of whether competition is imposed or endogenously chosen ($p > 0.301$).

Figure 6 – Estimated probability of voting for and of implementing competition depending on the expected increase in earnings from the competition and on the number of women in the organisation



Note: The estimated probabilities for voting are calculated with Model II in Table 3, setting all other variables to their mean value. The probability of implementing competition is calculated by making 1,000,000 random draws with the probability if voting in favour of competition.

Result 4 (Voting in favour of competition): *Subjects are more likely to vote in favour of competition the more they expect competition to increase their earnings. They tend to underestimate competition's indirect effect of increasing the contributions of others, but to overestimate its direct effect, i.e., their group's ability to win. Ceteris paribus, women are considerably less likely to vote in favour of competition.*

As we have seen, there is lots of heterogeneity in the subjects' actual and expected contributions as well as in their actual and expected transfers. Hence, it is interesting to take a look at how subjects update their expectations and test whether groups that consistently win (lose) do in fact expect higher (lower) benefits from competition and, as established in Result 4, vote in favour (against) implementing it.

To investigate how subjects update their beliefs, we run four GLS regressions with the subjects' expectation at the beginning of phase *r* as the dependent variable. In all cases, we use subject fixed effects as well as phase and rule fixed effects. Moreover, the first independent variable is always a dummy variable indicating whether a subject played with or without

competition in phase $r - 1$. The dependent variables for each of the first three models are: (i) the subjects' expected mean contribution of others in their group conditional on playing phase r *without* competition, (ii) the subjects' expected mean contribution of others in their group conditional on playing phase r *with* competition, and (iii) the subjects' expected effect of competition on the contributions of others in their group, i.e., the difference between (ii) and (i). As the second and third independent variables we use the difference between the mean contribution of other group members in phase $r - 1$ and the subjects' expected mean contribution conditional on competition being implemented in phase $r - 1$, which we interact with the dummy variable indicating whether competition was indeed implemented. The fourth and fifth independent variables are similar to the second and third, the only difference being that we use the subjects' expected mean contribution conditional on competition not being implemented in phase $r - 1$. The dependent variable for the fourth model is the subjects' expected mean transfer if they compete in phase r. We use similarly constructed independent variables. Namely, we calculate the difference between the mean transfer and the subjects' expected mean transfer in phase $r - 1$, which we interact with the variable indicating whether competition was implemented. If competition was not implemented, we use the group's rank to calculate the hypothetical transfer the subject would have received given the observed contributions. For interpretation purposes, we normalize the independent variables to have a mean of zero and a standard deviation of one. The estimated coefficients are presented in Table 4.

Models I and II show that subjects update their beliefs in the right direction, but only within a given competition regime. For example, subjects who previously played without competition and were surprised to see high contributions (i.e. contributions exceed their expectations), expect higher contributions when the following phase is also played without competition, and vice versa (see coefficient with value 6.1). The updating is similar in the analogous case with competition (coefficient with value 4.5 in Model II).

Table 4 – Updating expectations

	Expected contributions with no competition		Expected contributions with competition		Expected effect of competition		Expected transfer	
	Model I		Model II		Model III		Model IV	
Independent variables	coef.	std. err.	coef.	std. err.	coef.	std. err.	coef.	std. err.
Experienced competition	–0.9	(1.3)	–1.0	(0.5)	–0.1	(1.2)	0.5	(0.3)
Observed contributions minus expected contributions *with* competition								
× experienced competition	1.1	(0.8)	4.5**	(0.6)	3.4**	(1.0)		
× experienced no competition	–2.0*	(0.7)	–0.9	(0.7)	1.1	(1.0)		
Observed contributions minus expected contributions *without* competition								
× experienced competition	0.0	(0.9)	–0.8	(0.5)	0.8	(0.9)		
× experienced no competition	6.1**	(1.3)	1.3**	(0.5)	–4.7**	(1.3)		
Observed transfers minus expected transfers								
× experienced competition							2.3**	(0.4)
× experienced no competition							1.1	(0.7)
Constant	21.2**	(0.4)	18.0**	(1.1)	3.3**	(1.0)	1.6**	(0.2)
Phase × rule fixed effects	Yes		Yes		Yes		Yes	
Subject fixed effects	Yes		Yes		Yes		Yes	
R^2	0.128		0.065		0.035		0.078	
# of obs./subj./org.	342/171/19		342/171/19		342/171/19		342/171/19	

Note: GLS regressions with the subject's expectations in phase *r* as the dependent variable. All independent variables correspond to phase *r* – 1. Clustered standard errors are calculated allowing for intra-organisation correlation. Asterisks indicate significance at the 1 per cent (**) and 5 per cent (*) level.

However, updating is asymmetric: subjects do not seem to update their expectations regarding contributions in one competition regime when their experience comes from the other regime. That is, by and large, subjects do not use counterfactual information to update their expectations.[24] Model III shows that this asymmetry in updating causes biased expectations concerning the impact of competition on contributions, with the direction of the

[24] There are only two exceptions: the coefficients with value 1.3 and–2.0. Note that since the first coefficient is smaller than 6.1 and the second is negative, subjects who played without competition and observe surprisingly high contributions update their net expected impact of competition down, and vice versa for surprisingly low contributions.

bias depending on which regime subjects happened to have experienced. The reason a bias occurs is that groups that perform well under no competition also perform well under competition (see Result 2). Experiencing surprisingly high contributions by others should therefore lead to the expectation that contributions will generally (in both competition regimes) be higher, not just in the one regime they happened to experience. The coefficient with value 3.4 shows that voters expect competition to have particularly beneficial effects when contributions were surprisingly high with competition. The coefficient with value -4.7 shows the reverse case: voters expect competition to have detrimental effects when contributions were surprisingly high without competition.

Model IV shows that matters are similar with respect to expected transfers. Subjects who experienced a surprisingly high transfer when competing significantly increase their expected transfer for the following phase (coefficient with value 2.3). However, subjects who experienced a high relative performance when not competing do not significantly update their expectation (coefficient with value 1.1). Our last result summarizes these findings.

Result 5 (Updating expectations regarding competition): *Subjects use information concerning contributions to update their expectations concerning future contributions but only for the institution they happen to experience. Consequently, subjects who observed higher than expected contributions when they compete expect higher benefits from competition in the future, and vice versa when observing unexpectedly low contributions. However, subjects who observe higher than expected contributions when they do not compete take this information as being relevant only when not competing and hence expect lower benefits from competition, and vice versa when observing unexpectedly low contributions.*

Combining Results 4 and 5 explains why it is hard to overcome a consistent opposition to competition, which makes it is hard to implement with the group veto rule. In organisations where competition was implemented, individuals from groups that consistently lose update down their expected (indirect) effect on contributions and their expected (direct) effect on transfers. In organisations where competition was not implemented, individuals from groups that do well think their performance applies only to the no competition regime, and therefore,

they update down their expected indirect effect and leave unchanged their expected direct. In both cases, their updated expectations make them more likely to vote against competition.

5. Concluding remarks

Do people vote for introducing competition between their group and other groups when the alternative is not to compete? If the terms of competition are properly chosen, they should. The reason is that competition provides individuals with incentives to cooperate, i.e. to contribute to the performance of one's own group, because intergroup competition rewards high performing groups and sanctions low performing ones. Thus, in theory, the incentive to outperform other groups mitigates the free rider problem within one's own group. And each individual benefits if other members of one's own group cooperate at higher levels. As a result, the competitive scheme studied here makes everyone better off, i.e. is a Pareto-improvement compared to groups not competing.

But does intergroup competition work with real people? And do these people in fact collectively agree to subject themselves to competition? Our experimental results show that the answer to the first a question is a resounding yes, the answer to the second question is "it depends" (on the voting rule). We find that competition fosters cooperation. The effect is strong, robust and immediate. For example, cooperation levels are about 80 per cent higher with competition than without, all organisations cooperate more with than without competition, and the improvement is significant even if groups had not experienced competition beforehand. A majority of voters anticipate the beneficial effects of competition and vote in favour of it. Consequently, competition is implemented by collective choice in almost all cases (96 per cent) with majority voting. These findings are very much in line with theory. However, contrary to predictions, competition is not Pareto-improving. Some groups are systematically left behind (about 20 per cent of groups earn less with competition than without). Moreover, a substantial share of voters (about 30 per cent) oppose intergroup competition. These votes tend not to be pivotal under majority voting, but they make a difference when the electoral bar is set higher, i.e. when a majority in all groups is need to approve. As a result, competition is rejected, and the efficiency gains from competition are

forgone, much more often than predicted (in about 50 per cent of the cases) under a group veto rule.

Opposition to intergroup competition comes from three sources. As one would expect, individuals from persistently underperforming groups (correctly) believe that competition reduces their earnings and therefore vote against it. However, we also find that individuals tend to underestimate the effect of competition on cooperation, particularly if they have not experienced it before. Therefore, some individuals oppose competition even though they would benefit from it. Lastly, we find that women are more likely to vote against competition, possibly due to aversion to the act of competing as such.

These results are informative for principals who have an interest in the overall performance of their organisation (e.g., the owner of a firm who benefits from the overall performance of its various work teams, or a minister of education who has an interest in the overall performance of the system of higher education). Should the principal introduce intergroup competition? In theory, the answer is a resounding yes as the competition scheme studied here has many attractive theoretical properties. In practice, although the competition scheme does increase overall performance, not all groups react favourably, which suggests that some caution might be in order. In particular if group membership is not fixed and individuals can move between organisations with different incentive schemes (see Kosfeld and von Siemens, 2011; Bandiera et al., in press).

Suppose the principal has the power to simply impose the scheme, would she not be well-advised to nevertheless ask her constituency to collectively approve? Might the competitive scheme not work better if it is legitimized by majoritarian approval? Perhaps surprisingly, our results suggest that the answer is no. We find that the beneficial effects of competition are just as strong, robust, and immediate whether competition is imposed or accepted in a vote. This finding contrast with a literature showing that democracy can affect outcomes, not just by determining which rules are adopted, but also by affecting how a particular rule shapes behaviour. For example, Tyran and Feld (2006) show that non-deterrent sanctions for free riding improve cooperation more markedly when such sanctions were accepted in a vote rather than simply imposed. The reason for this dividend of

democracy seems to be that voters can signal their intentions to cooperate by approving (theoretically ineffective) sanctions (for similar results see Dal Bó et al., 2010; Kamei, 2012). It seems that such signalling of intentions through voting is ineffective in the present experiment. Perhaps this is so because unanimous approval of competition is optimal both for a self-interested player and for a player with a concern for the earnings of the organisation. Observing that others vote for competition is therefore not informative about cooperativeness. Finally, suppose the principal needs the agents' approval to introduce competition but she has control over the electoral rule. In this case, such a principal is well-advised not to set the electoral bar too high. Our results suggest that the competition scheme is attractive enough to gather sufficient support in a majority vote but not if individual groups are given a veto.

We close with some caveats and point out interesting avenues for further research. First, the positive effect, and hence the support for, intergroup competition in our design may importantly depend on the symmetry of groups. In our experiment, competition takes place in a "level playing ground" in the sense that all groups are (ex ante) objectively the same and therefore competition is intense and all groups had the same chance of winning the competition. It is easy to think of settings where this is not the case. For example, a University in a country may be privileged (perhaps because of its location or status) or otherwise dominant (perhaps because of its size). If nation-wide competition between Universities is introduced in such situations, smaller Universities may well be discouraged to compete and the natural high-performer may slack for lack of challenge (see e.g. Müller and Schotter, 2010 for tournaments between individuals). Differences in technology or endowments across competing groups reduce the intensity of competition and tend to create systematic winners and losers. Electoral support for the scheme will thus be weakened. Those who expect to lose are likely to oppose the introduction of competition, and the gains from increased cooperation, if any, need to be partly redistributed to those who expect to lose if their support is required.

Second, the popularity of intergroup competition may well depend on the characteristics of competitors and voters. The sample in our subjects is clearly not

representative of the population at large. About two thirds of our participants are male and all are undergraduate students of economics. Voters drawn from the general population tend to hold systematically different views from those advanced by trained economists (e.g. Caplan 2002), and such voters are likely to have more reservations against competition.

Third, the popularity of intergroup competition observed in our experiment may have been high because the alternative was simply no competition. It would be interesting to investigate whether intergroup competition is equally popular if pitted against an alternative institution that is known to promote cooperation, such as communication or sanctions for free riders. While the result of an institutional choice among a set of alternatives most likely depends on what is on the menu (see introduction for a list of examples of alternative institutions), we speculate that institutions with informal sanctions might often be more popular than competition (see Markussen et al. 2012 on the popularity of informal sanctions).

The effects of introducing competition between groups on cooperation have not been studied much in the literature. This paper has not only shown that such competition foster cooperation, it has also shown that voters seem to be able to anticipate its beneficial effects. Intergroup competition, if properly designed, is therefore not only a promising institution to improve cooperation, it is also a feasible institution when subject to democratic choice.

References

Balafoutas, L. and M. Sutter (2012). Affirmative action policies promote women and do not harm efficiency in the laboratory. *Science* 335: 579-582.

Bandiera, O., I. Barankay and I. Rasul (in press). Team incentives. Evidence from a firm-level experiment. *Journal of the European Economic Association*.

Bornstein, G. (1992). The free rider problem in intergroup conflicts over step-level and continuous public goods. *Journal of Personality and Social Psychology* 62: 597-606.

Bornstein, G. (2003). Intergroup conflict: individual, group, and collective interests. *Personality and Social Psychology Review* 7: 129-145.

Bornstein, G. and I. Erev, (1994). The enhancing effect of intergroup competition on group performance. *International Journal of Conflict Management* 5: 271-281.

Bornstein, G., I. Erev and O. Rosen (1990). Intergroup competition as a structural solution to social dilemmas. *Social Behaviour* 5: 247-260.

Bornstein, G., U. Gneezy and R. Nagel (2002). The effect of intergroup competition on group coordination. *Games and Economic Behavior* 41: 1-25.

Buchanan, J.M. (1965). An economic theory of clubs. *Economica* 32: 1-14.

Camerer, C. and D. Lovallo (1999). Overconfidence and excess entry: An experimental approach. *American Economic Review* 89: 306-318.

Caplan, B. (2002). Systematically biased beliefs about economics: Robust evidence of judgmental anomalies from the survey of Americans and economists on the economy. *The Economic Journal* 112: 433-458.

Chaudhuri, A., S. Graziano and P. Maitra (2006). Social learning and norms in a public goods experiment with inter-generational advice. *Review of Economic Studies* 73: 357-380.

Dal Bó, P., A. Foster and L. Putterman (2010). Institutions and behavior: Experimental evidence on the effects of democracy. *American Economic Review* 100: 2205-2229.

Falkinger, J., E. Fehr, S. Gächter and R. Winter-Ebmer (2000). A simple mechanism for the efficient provision of public goods: Experimental evidence. *American Economic Review* 90: 247-264.

Fehr, E. and S. Gächter (2000). Cooperation and punishment in public goods experiments. *American Economic Review* 90: 980-994.

Gintis, H. (2000). Strong reciprocity and human sociality. *Journal of Theoretical Biology* 206: 169-179.

Gneezy, U. and A. Rustichini (2004). Gender and competition at a young age. *American Economic Review Papers and Proceedings* 94: 377-381.

Gneezy, U., M. Niederle and A. Rustichini (2003). Performance in competitive environments: Gender differences. *Quarterly Journal of Economics* 118: 1049-1074.

Gneezy, U., S. Meier and P. Rey-Biel (2011). When and why incentives (don't) work to modify behavior. *Journal of Economic Perspectives* 25: 191-209.

Großer, J. and R. Sausgruber (2005). Effort externalities and social norms in the workplace. Mimeo.

Gunnthorsdottir, A., R. Vragov, S. Seifert and K. McCabe (2010). Near-efficient equilibria in contribution-based competitive grouping. *Journal of Public Economics* 94: 987-994.

Healy, A. and J. Pate (2011). Can teams help to close the gender competition gap? *The Economic Journal* 121: 1192–1204.

Isaac, R.M. and J.M. Walker (1988). Communication and free-riding behavior: The voluntary contribution mechanism. *Economic Inquiry* 26: 585-608.

Kahneman, D., J.L. Knetsch and R.H. Thaler (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives* 5: 193-206.

Kamei, K. (2012). Democracy and resilient pro-social behavioral change: An experimental study. Working paper Brown University.

Kosfeld M. and F.A. von Siemens (2011). Competition, cooperation, and corporate culture. *RAND Journal of Economics* 42: 23-43.

Köszegi, B. and M. Rabin (2006). A model of reference-dependent preferences. *Quarterly Journal of Economics* 121: 1133-1165.

Levine, D. and T. Palfrey (2007). The paradox of voter participation: A laboratory study. *American Political Science Review* 101: 143-158.

Lijphart, A. (1977). *Politics in plural societies: A comparative exploration*. New Haven: Yale University Press.

Maier-Rigaud, F.P., P. Martinsson and G. Staffiero (2010). Ostracism and the provision of a public good: experimental evidence. *Journal of Public Economics* 73: 387-395.

Malmendier, U. and G. Tate (2008). Who makes acquisitions? CEO overconfidence and the market's reaction. *Journal of Financial Economics* 89: 20-43.

Malmendier, U. and G. Tate (2005). CEO Overconfidence and Corporate Investment. *Journal of Finance* 60: 2661-2700.

Müller, W. and A. Schotter (2010). Workaholics and dropouts in organizations. *Journal of the European Economic Association* 8: 717-743.

Nalbantian, H.R. and A. Schotter. (1997). Productivity under group incentives: An experimental study. *American Economic Review* 87: 314-341.

Niederle, M. and L. Vesterlund (2010). Explaining the gender gap in math test scores: The role of competition. *Journal of Economic Perspectives* 24: 129-144.

Niederle, M. and L. Vesterlund (2007). Do women shy away from competition? Do men compete too much? *Quarterly Journal of Economics* 122: 1067-1101.

Niederle, M., C. Segal and L. Vesterlund (2009). How costly is diversity? Affirmative action in light of gender differences in competitiveness. Working paper.

Markussen, T., L. Putterman and J.-R. Tyran (2011). Self-organization for collective action. An experimental study of voting on sanction regimes. Working paper.

Nowak, M.A. (2006). Five rules for the evolution of cooperation. *Science* 314: 1560-1563.

Rabin, M. (2000). Risk-aversion and the expected utility theorem: A calibration theorem. *Econometrica* 68: 1281-1292.

Rapoport, A. and G. Bornstein (1987). Intergroup competition for the provision of binary public goods. *Psychological Review* 94: 291-299.

Rapoport, A. and G. Bornstein (1989). Solving public goods problems in competition between equal and unequal size groups. *Journal of Conflict Resolution* 33: 460-479.

Reuben, E. and J.-R. Tyran (2010). Everyone is a winner: Promoting cooperation through all-can-win intergroup competition. *European Journal of Political Economy* 26: 25-35.

Sausgruber, R. and J.-R. Tyran (2007). Pure redistribution and the provision of public goods. *Economics Letters* 95: 334-338.

Schram, A.J.H.C. and J. Sonnemans (1996). Voter turnout and the role of groups: participation game experiments. *International Journal of Game Theory* 25: 385-406.

Sutter, M., S. Haigner and M. Kocher (2010). Choosing the carrot or the stick? Endogenous institutional choice in social dilemma situations. *Review of Economic Studies* 77: 1540-1566.

Tan, J.H.W. and F. Bolle (2007). Team competition and the public goods game. *Economics Letters* 96: 133-139.

Tiebout, C. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy* 64: 416-424.

Tyran, J.-R. and L.P. Feld (2006). Achieving compliance when legal sanctions are non-deterrent. *Scandinavian Journal of Economics* 108: 1-22.

van Dijk, F., J. Sonnemans and F. van Winden (2001). Incentive systems in a real effort experiment. *European Economic Review* 45: 187-214.

Walker, J.M., R. Gardner, A. Herr, E. Ostrom (2000). Collective choice in the commons: Experimental results on proposed allocation rules and votes. *The Economic Journal* 110: 212-234.

Appendix A – Additional statistical analysis

A.1. Descriptive statistics

For each rule and phase, Table A1 contains summary statistics of the subject's contribution and voting behaviour. Specifically, it displays the mean overall contribution to the public good, the mean contribution if there is no competition, the mean contribution if there is competition, the fraction of organisations that implement competition, and the fraction of subjects the vote in favour of competition.

Table A1 – Descriptive statistics by institution and rule

Phase	*Rule*	*Overall contributions*	*Contributions without competition*	*Contributions with competition*	*Percentage of organisations with competition*	*Percentage of votes for competition*
1	No voting	18.5 (11.6)	15.6 (11.1)	21.4 (11.3)	50.0%	–
	Majority	21.3 (11.0)	10.7 (8.5)	23.5 (10.2)	83.3%	70.4%
	Group veto	20.8 (10.9)	16.3 (10.5)	24.1 (10.0)	57.1%	71.4%
2	No voting	17.8 (13.0)	10.9 (12.0)	24.8 (10.1)	50.0%	–
	Majority	21.6 (11.4)	–	21.6 (11.4)	100.0%	63.0%
	Group veto	17.6 (11.4)	14.5 (10.8)	25.4 (9.2)	28.6%	73.0%
3	Majority	20.8 (12.1)	–	20.8 (12.1)	100.0%	71.3%
	Group veto	19.0 (12.1)	12.6 (11.1)	23.9 (10.4)	57.1%	77.8%
All	No voting	18.2 (12.3)	13.3 (11.8)	23.1 (10.8)	50.0%	–
	Majority	21.1 (11.7)	10.7 (8.5)	21.6 (11.6)	95.8%	69.0%
	Group veto	19.1 (11.6)	14.5 (10.9)	24.2 (10.0)	47.6%	74.1%

Note: The table presents means and standard deviations in parenthesis. In phase 3, the 6 organisations that played with the no voting rule switched to the majority rule.

Table A2 complements Table A1 and presents the same statistics for phase 3 for organisations that used the majority rule, but it separates them depending on the type of rule they used in pervious phases. That is, it displays the 6 organisations that previously played under the no voting rule from the 6 organisations that played with the majority rule throughout the experiment.

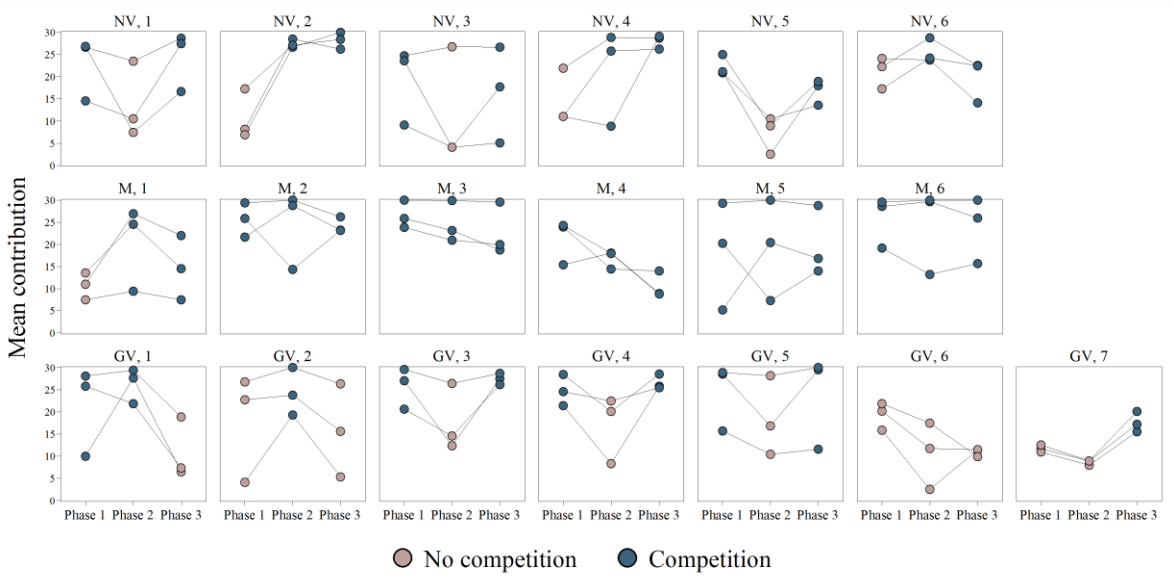
Table A2 – Descriptive statistics for organisations using the majority rule in phase 3 by previous rule

Phase	*Previous rule*	*Overall contributions*	*Contributions without competition*	*Contributions with competition*	*Percentage of organisations with competition*	*Percentage of votes for competition*
3	No voting	22.3 (11.9)	–	22.3 (11.9)	100.0%	77.8%
	Majority	19.3 (12.1)	–	19.3 (12.1)	100.0%	64.8%

Note: The table presents means and standard deviations in parenthesis.

Figure A1 displays the mean contributions to the public good of each group in each organisation. Each group corresponds to three connected circles, i.e., the groups mean contribution in each phase. The figure also displays the institution that was implemented in each organisation. Dark blue circles correspond to contributions when competition was implemented and light red circles correspond to contributions when competition was not implemented. We can see that with very few exceptions, the introduction of competition increases group contributions.

Figure A1 – Mean group contributions per phase and organisation



Note: NV corresponds to "No voting", M to "Majority", and GV to "Group Veto". Each circle indicates the mean contribution of each group in each phase. Each plot is a different organisation. The implemented institution in each phase is indicated by the circle's colour. Organisations that played with the no voting rule in phases 1 and 2 subsequently played phase 3 using the majority rule.

For each rule and phase, Table A3 contains summary statistics of the subject's expectations regarding the contribution behaviour of others. Specifically, it displays the subjects' mean expected contribution of others in their own group when competition is not implemented and when it is, the subjects' mean expected contribution of others in other groups when competition is not implemented and when it is, and the mean transfer they expect to receive from other groups if competition is indeed implemented. Tests evaluating treatment differences in expectations are reported in subsection A.2.

Table A3 – Expectations by institution and voting rule

Phase	*Voting rule*	*Contributions without competition*		*Contributions with competition*		*Contributions without competition*		*Contributions with competition*		*Expected transfer*	
1	No voting	18.6	(7.8)	19.8	(7.3)	17.3	(7.6)	19.5	(7.5)	3.9	(5.1)
	Majority	17.4	(6.7)	23.6	(5.7)	15.9	(6.1)	22.4	(4.7)	4.5	(3.2)
	Group veto	18.6	(7.0)	23.3	(6.3)	18.1	(6.6)	22.8	(5.3)	3.9	(4.4)
2	No voting	16.8	(6.9)	20.7	(6.7)	17.1	(7.0)	21.2	(5.5)	1.5	(6.6)
	Majority	14.7	(8.4)	20.3	(9.1)	15.1	(6.5)	21.3	(6.6)	0.9	(7.2)
	Group veto	17.8	(7.9)	22.4	(6.5)	17.6	(6.5)	23.3	(5.2)	2.1	(6.1)
3	Majority	14.7	(8.6)	21.4	(8.5)	14.4	(7.0)	21.0	(6.6)	2.2	(6.5)
	Group veto	15.1	(8.4)	24.0	(5.7)	15.5	(7.2)	23.7	(4.6)	1.9	(5.9)
All	No voting	17.7	(7.4)	20.3	(7.0)	17.2	(7.3)	20.3	(6.6)	2.7	(6.0)
	Majority	15.4	(8.2)	21.7	(8.1)	15.0	(6.7)	21.4	(6.2)	2.5	(6.1)
	Group veto	17.1	(7.9)	23.2	(6.2)	17.1	(6.9)	23.3	(5.0)	2.7	(5.6)

Note: The table presents means and standard deviations in parenthesis. In phase 3, the 6 organisations that played with the no voting rule switched to the majority rule.

A.2. Non-parametric tests

In this subsection we compare the subject's contributions, voting behaviour, and expectations across the different conditions with non-parametric tests.

We start with their contribution behaviour (descriptive statistics of contributions are reported in Table A1). Given the structure of our data, we perform both between-subjects (which assumes that observations across phases are independent) and within-subjects tests. For the former we use Mann-Whitney U tests and for the later we use Wilcoxon signed ranked

tests. In all cases we use organisation averages as the unit of observation. Since there was only one organisation in the majority treatment that implemented competition in a phase, we pool the data from both voting rules. In Table A4 we present the exact *p* values of tests evaluating the difference in contributions between competition and no competition depending on whether players could vote or not (top half) and the difference in contributions between imposed and chosen competition/no competition (bottom half). For simplicity, we do not use the observations from the sequences that played with no voting in phases 1 and 2 (results are unchanged if we include them) in any of the test but one: the within-subjects test evaluating whether contributions vary between imposed and chosen competition.

Table A4 – Non-parametric tests for differences in contributions

	All phases				*First period*	
Comparison	*Between-subjects*	*Obs.*	*Within-subjects*	*Obs.*	*Between-subjects*	*Obs.*
Competition vs. no competition						
No voting	0.009	12	0.050	6	0.100	6
Voting	0.001	20	0.025	7	0.003	13
Voting vs. no voting						
Competition	0.892	18	0.844	6	0.727	7
No competition	0.755	14	–	–	0.629	12

As reported in the main body of the paper, competition has a significant and immediate effect on contributions irrespective of whether it is imposed or is chosen with a vote. Moreover, contributions do not significantly differ depending on whether an institution (competition or no competition) is imposed or not.

Now we turn to the differences in voting behaviour and election outcomes between the majority and group veto rules that are reported in the main body of the paper. Since these are all between-subject comparisons, we calculate the mean rate at which competition is implemented/voted for in each organisation and then test whether the observed means are drawn from the same distribution using Mann-Whitney U tests. In all tests we have 19 independent observations (12 for the majority rule and 7 for the group veto rule). We perform four tests. First, we test whether the mean voting rates in favour of competition differ

between the two voting rules. We do not find a significant difference (p = 0.650). Second, we test whether the mean implementation rates of competition significantly differ between the two voting rules. We find that they do (p < 0.001). Third, we test whether the mean implementation rates of competition would differ between organizations assigned to the majority and group veto rule *if all organizations used the majority rule*. We do not find a significant difference (p = 0.837). Finally, we test whether the mean implementation rates of competition would differ between organizations assigned to the majority and group veto rule *if all organizations used the group veto rule*. Once again, we do not find a significant difference (p = 0.482).

Lastly, we look at differences in subjects' expectations (descriptive statistics for these variables are reported in Table A3). In particular, we show that there are no significant differences in expectations between the majority and group veto rules, which is why we pooled these data when performing the regressions reported in Tables 3 and 4 in the main body of the paper. We calculate the mean expectation in each organisation and then test whether the observed means are drawn from the same distribution using Mann-Whitney U tests. In all tests we have 19 independent observations (12 from the majority rule and 7 from the group veto rule). We do not find a significant difference between voting rules in any of the measured expectations: p = 0.384 for the expected contributions of others in their own group under competition, p = 0.299 for the expected contributions of others in their own group under no competition, p = 0.227 for the expected contributions of other groups under competition, p = 0.056 for the expected contributions of other groups under no competition, and p = 0.384 for the expected contributions of others in their own group under competition.

A.3. Persistence of ranks across periods and phases

We test the extent to which a group's rank in a period (phase) is predicted by its rank in the previous period (phase) by running six regressions. The first four regressions estimate the persistence of a group's rank across periods within a phase. The first two regressions are based on organisations that played with the no voting rule whereas the second two regressions are based on organisations that played with the majority or group veto rules (in

each case, one regression is for organisations playing with competition and the other for organisations playing without competition). They are all ordered probit models where the dependent variable is a group's rank in period *t* within phase *r* and the independent variable is the group's rank in period *t* – 1. The last two regressions estimate the persistence of a group's rank across phases. Again, one regression is for organisations playing with competition and the other for organisations playing without competition.[25] These are GLS models where the dependent variable is a group's mean rank in phase *r*. As independent variables we use the group's mean rank in phase *r* – 1 and an interaction variable to capture whether the persistence of ranks depends on the institution implemented in phase *r* – 1. The estimated coefficients are available in Table A4.

Table A4 – Persistence of ranks

Persistence across:	Periods				Phases	
	No voting		Voting		All rules	
Independent variables	coef.	std. err.	coef.	std. err.	coef.	std. err.
With competition						
Rank in previous period/phase	0.9*	(0.4)	1.0**	(0.2)	0.5**	(0.1)
Rank in previous phase × competition					0.0	(0.2)
# of obs./groups/org.	126/18/6		693/54/18		81/54/18	
Without competition						
Rank in previous period/phase	1.0**	(0.3)	1.2**	(0.3)	0.5**	(0.1)
Rank in previous phase × competition					0.3	(0.2)
# of obs./groups/org.	126/18/6		252/42/8		33/30/10	

Note: First two regressions are ordered probit regressions with a group's rank in a period as the dependent variable. The third regression is an GLS regression with a group's mean rank in a phase as the dependent variable. Clustered standard errors are calculated allowing for intra-organisation correlation. Asterisks indicate significance at the 1 per cent (**) and 5 per cent (*) level.

[25] Since there are only three organisations per sequence under the no voting rule, there are too few observations to run separate GLS regressions for organisations where competition is imposed exogenously.

Appendix B – Experimental Instructions

Here we provide the detailed experimental procedures (including the wording used to elicit expectations and risk preferences) and the instructions for the majority vote treatments (instructions for other treatments are available on request).

B.1. Experimental procedures

The computerized experiment was conducted in the fall of 2006 in the LEE laboratory at the University of Copenhagen. Subjects were recruited subjects with an online recruitment website, which is run with ORSEE (Greiner, 2004) and the experiment was programmed with z-Tree (Fischbacher, 2007). The experiment lasted around one hour. In total, 171 subjects participated in the experiment. Subjects were all first year students of economics but the experiment was conducted in the first month after their arrival, therefore, they had not yet completed any economics course. The number of subjects in each treatment and sequence of play is summarized in Table 1 in the main body of the paper. Subjects played repeatedly for 24 periods, which were divided into 3 phases of 8 periods each.

After their arrival subjects drew a card to be randomly assigned to a seat in the laboratory. Once everyone was seated, subjects were given the instructions for the experiment (see below). After they read the instructions, subjects had to answer a few exercises in order to check their understanding of the game. Next, they played the 24 periods of the game via the computer. After finishing the second part, subjects answered a debriefing questionnaire after which they were paid in private and dismissed.

Eliciting expectations

During the game subjects were asked to provide their expectations of the contributions other players and the transfer their group would receive if competition is implemented. The precise wording for the elicitation is provided below.

Before you start the next 8 periods, we ask you think carefully and predict what will happen during these 8 periods depending on the payment rule. In all three questions we are asking for the *average per person and per period*.

- Question 1: First, we ask you to predict what will be the average number of points allocated to the group account by participants in *all groups except yours* (a number between 0 and 30). You should give an answer for groups that will use payment rule A and another answer for groups that will use payment rule B.
- Question 2: Second, we ask you to predict what will be the average number of points allocated to the group account in *your group* (a number between 0 and 30). You should give an answer in case your group uses payment rule A and another answer in case it uses payment rule B.
- Question 3: Third, we ask you to predict what will be the average number of points that participants in your group will win or lose due to its ranking if it turns out that your group uses payment rule A (a number between –10 and 10).

Note: You can earn additional points depending on the accuracy of your answer to *Question 1*. If your answer matches the actual average you earn 16 additional points. If it doesn't but it is at most 4 points away then you earn: 16 – (real average – your prediction)^2 points. If it is more than 4 points away you earn 0 points. The important thing to note is that the more accurate your answer is the more points you can earn.

Eliciting risk preferences

We used the choice and wording below to measure the subjects' risk preferences.

- Final Choice: To finish, you will be given the option to accept or reject a lottery. If you *accept* the lottery then you have a probability of 1/3 of getting *30 additional points*, a probability of 1/3 of getting *40 additional points*, and a probability of 1/3 of getting *50 additional points*. If you *reject* the lottery then you get *36 additional points*.

B.2. Instructions

You are now taking part in an economic experiment. Depending on your decisions and the decisions of other participants you can earn money. How you can earn money is described in these instructions. Please read them carefully.

During the experiment you are not allowed to communicate with other participants. If you have a question, raise your hand. One of us will come to answer your question. During the

experiment your earnings will be calculated in points. At the end of the experiment points will be converted to Danish kroner (DKK) at the following rate:

12 points = 1 DKK

In the experiment, all participants are randomly divided into *groups of 3*. This means that you are in a group with two other participants. *You will be part of the same group throughout the entire experiment*. Nobody knows which other participants are in their group, and nobody will be informed who was in which group after the experiment.

The experiment is divided into *24 periods*. In each period, everyone will be given an *endowment of 30 points*. In every period you will have to make one decision.

Your decision

You and the other two group members simultaneously decide how to use the endowment. There are two possibilities:

1. You can allocate points to a group account.

2. You can allocate points to a private account.

You will be asked to indicate the number of points you want to put in the group account. The remaining points will be automatically allocated to the private account. Your earnings depend on the total number of points in the group account, and the number of points in your private account.

How to calculate your earnings

Your earnings from your private account are equal to the number of points you allocated to the private account. *For each point you allocate to the private account you get 1 point as earnings*. The earnings of other group members are not affected by the points you allocate to your private account. For example, your earnings from the private account equal 3 points if you allocate 3 points to it.

Your earnings from the group account equal the *sum* of points allocated to the group account by all 3 group members multiplied by 0.5. *For each point you put into the group account you and all other group members get 0.5 points as earnings*. For example, if the sum of

points in the group account is 24, then your earnings from the group account and the earnings of each other group member from the group account equal 12.

Your earnings can be calculated with the following formula:

30 – (points you allocated to the group account) + 0.5 * (sum of points allocated by all group members to the group account)

Note that, you get 1 point as earnings for each point you allocate to your private account. If you instead allocate 1 extra point to the group account, your earnings from the group account increase by 1 * 0.5 = 0.5 points and your earnings from your private account decrease by 1 point. However, by doing this the earnings of other group members also increase by 0.5 points. Therefore, the total group earnings increase by 3 * 0.5 = 1.5 points. Note that you also obtain income from points allocated to the group account by other members. You obtain 1 * 0.5 = 0.5 points for each point allocated to the group account by another group member.

Example

Suppose you allocate 20 points to the group account, the second member of your group allocates 30 points and the third group member allocates 0 points. In this case, the sum of points in the group account is 50 points. All group members get an income of 50 * 0.5 = 25 points from the group account.

Your earnings are: 30 – 20 + 25 = 35 points.

The second group member's earnings are: 30 – 30 + 25 = 25 points.

The third group member's earnings are: 30 – 0 + 25 = 55 points.

In addition to your earnings from the private account and the earnings in the public account, your final earnings depend on the type of *payment rule*.

Payment rules

There two different types of payment rules: *rule A* and *rule B*.

Payment Rule A

Under payment rule A, your earnings are influenced by *your group's rank*. To calculate your group's ranking, the sum of points in the group account of your group is compared to the sum of points in the group account of *two* other groups. Note that your group will be compared to the *same two other groups* every time payment rule A is used in the experiment.

The group with the highest number of points in the group account is ranked 1st. The group with the second highest number of points in the group account is ranked 2nd, and the group with the lowest number of points in the group account is ranked 3rd.

Ties are resolved in the following way:

a. If two groups have the highest number of points then a random lottery will determine which of the two groups is ranked 1st and which is ranked 2nd. Both groups have the same probability of being ranked 1st or 2nd.
b. If two groups have the lowest number of points then a random lottery will determine which of the two groups is ranked 2nd and which is ranked 3rd. Both groups have the same probability of being ranked 2nd or 3rd.
c. If all three groups are tied then a random lottery will determine which of the three groups is ranked 1st, which is ranked 2nd, and which is ranked 3rd. All groups have the same probability of being ranked 1st, 2nd, or 3rd.

Everyone in the group that is ranked 1st *wins 10 points* as additional earnings. Everyone in the group that is ranked 3rd *loses 10 points* of their earnings. Participants in the group that is ranked 2nd *do not win or lose points*.

Payment Rule B

Under payment rule B, your earnings are *not* influenced by the actions of other groups. In other words, your earnings are simply your earnings from the private account plus your earnings from the group account.

Examples

To follow up on the previous example, suppose that you allocated 20 points to the group account and that your other group members allocated in total 30 points. The sum of points in the group account of your group is 50 points. Your earnings so far equal 35 points.

Suppose that the two other groups that your group is compared with allocated 53 points and 56 points to their group account.

Example 1

If payment rule B applies: your earnings remain unchanged and thus your final earnings in this period equal: 30 – 20 + 25 = 35 points.
If payment rule A applies: your group is ranked 3rd and you as well as the other two members in your group lose 10 points. In this case, your final earnings in this period equal: 30 – 20 + 25 – *10* = 25 points.

Example 2

Suppose that instead of allocating 20 you allocate 30 points to the group account. In this case the sum of points in the group account of your group equals 60 points.
If payment rule B applies: your final earnings now equal: 30 – 30 + 30 = 30 points.
If payment rule A applies: your group is ranked 1st and thus you win 10 points. Your final earnings equal: 30 – 30 + 30 *+ 10* = 40 points.
Next we explain which payment rule is applied.

Which payment rule is used?

Before you start making your decisions, a *vote* will be used to determine which rule is to be applied. The rule that is selected will be used for *8 consecutive periods*. After this, a second vote will determine the rule for the second 8 periods. Finally, a third vote will determine the rule used in the last 8 periods.

Everyone in your group plus everyone in the two groups with whom your group is compared gets one vote. Thus in total there are 9 votes. If a *majority* (5 or more) votes for

payment rule A then payment rule A is used for all three groups. If a majority votes for payment rule B then payment rule B is used for all three groups.

Appendix references

Fischbacher, U. (2007). Z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics* 10: 171-78.

Greiner, B. (2004). An Online Recruitment System for Economic Experiments. In K. Kremer and V. Macho (Eds.) *Forschung und wissenschaftliches Rechnen 2003*. Göttingen: Ges. für Wiss. Datenverarbeitung.