Competition, cooperation, and collective choice

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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.

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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. It is therefore unsurprising that many companies actively foment intergroup competition by reassigning their internal resources based on relative team performance. A good example is that of large retailers where various selling teams constantly compete over limited floor space that is regularly reassigned from the worst to the best performers, which seriously impacts the teams' revenues and even their survival (Peters and Waterman, 1982).[2]

In spite of its popularity, fomenting cooperation with 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

[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; Reuben and Riedl, 2013), 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), group member selection (Gunnthorsdottir et al., 2010), ostracism (Maier-Rigaud et al., 2010), among others.

[2] Similarly impactful forms of intergroup competition have been documented in companies as diverse as Procter & Gamble, IBM, Johnson & Johnson, GM, Hewlett-Packard, DuPont, Fidelity, Fuji, Xerox, Ericsson, Lucent, and Motorola (see Marino and Zábojník, 2004).

institution is not trivial to analyse in theory and practice.[3] Previous studies emphasize that the effectiveness of intergroup competition depends on institutional details,[4] but by and large, the research finds that intergroup competition effectively fosters cooperation within teams, thus promoting the overall efficiency of the organisation. For example, Bornstein and Ben-Yossef (1994) found in a laboratory experiment that intergroup competition doubled the amount of cooperation in a prisoners' dilemma game. Erev et al. (1993) showed in a field experiment that intergroup competition reduced free riding by 30 per cent in an orange picking task where rewards were based on team performance (for a survey of this literature see Bornstein, 2003).[5]

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?

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[3] 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.

[4] Institutional details studied in the literature include the availability and type of pre-play communication (Bornstein, 1992), the relative sizes of groups (Rapoport and Bornstein, 1989), the size of the prize and how it is distributed among the top-performers (Bornstein, 2003; Reuben and Tyran, 2010).

[5] Other examples of experimental studies on intergroup competition include Bornstein et al. (1990; 2002), Bornstein and Erev (1994), Nalbantian and Schotter (1997), Tan and Bolle (2007), and Kugler et al. (2010). For a non-experimental study on the effects of intergroup competition see Lavy (2002), who investigates a teacher incentive scheme where teachers are rewarded based of the relative performance of their school. Recently, a few field experiments have been run to evaluate the effectiveness of team tournaments in increasing the productivity of students (Blimpo, 2010), fruit pickers (Bandiera et al., 2013), and retailers (Casas-Arce and Martinez-Jerez, 2009; Delfgaauw et al. 2011, 2013). Early theoretical frameworks for the study of intergroup competition are provided by Palfrey and Rosenthal (1985) and Rapoport and Bornstein (1987).

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.[6] 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.[7] 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. 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

[6] Having the prize for the winners sponsored by the losers sets the study apart from most studies on intergroup competition, which consider the case where groups compete for an externally funded prize (e.g., Bornstein et al., 1990; Erev et al., 1993; an exception being Nalbantian and Schotter, 1997). This design feature is attractive because we focus on the endogenous choice between competition and no competition. If prizes in the competition regime are externally funded, the increase in the total amount of resources provides an independent incentive to favour competition, even if individuals do not expect that competition will increase cooperation. Our revenue-neutral intergroup competition regime is a simplified version of the common practice of fomenting competition between teams by reassigning resources within companies. More broadly, it captures instances where competition enhances cooperation but results in large losses for losers as well as gains for winners. An interesting example where losses and gains are carried out by a market mechanism instead of a central authority is provided by Rogerson (1989), who estimates that winning/losing a defence contract has a large effect on the stock market valuation of aerospace firms and that the loss of the loser approximately equals the gain of the winner.

[7] The increased willingness to cooperate can be driven by the individuals' reaction to the new extrinsic incentive structure (i.e., the prize), but also by their intrinsic reaction to the more competitive framing of the game. In this paper, we do not distinguish between these two motivations and instead focus on their combined effect. See Bornstein et al. (2002) and Tan and Bolle (2007) for studies that identify the distinct effect of each motivation.

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.[8]

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., Reuben and Suetens, 2012; 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.[9] 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 about 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

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[8] The fact that groups compete for fixed prizes that are awarded on the basis of rank implies that the experiment implements a *tournament* between groups (Lazear and Rosen, 1981). Early experimental studies on tournaments between individuals, rather than groups, include Bull et al. (1987) and Schotter and Weigelt (1992). There is also a literature on the rent-seeking model of Tullock (1980), where groups compete for a fixed price but where effort destroys instead of creates resources (for a review see Dechenaux et al., 2012).

[9] There is also evidence of individuals with antisocial preferences who undermine cooperation (e.g., see Herrmann et al., 2008). Such individuals would be disadvantageous to their teams prompting others to vote against competition. Moreover, they might dislike and therefore vote against any institution that encourages cooperation.

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 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, 2007). 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.[10]

[10] Examples of voting rules with the characteristics of the group veto rule abound. For example, free trade agreements in the WTO must be approved by all member states. In the European Union, ratification of new treaties

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 the 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 footnotes 4 and 5 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

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and other important decisions require 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, minority protection is a prevalent feature of 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.

literature see Markussen et al., in press). 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 and 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 of 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, 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 third 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

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

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.

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. Subjects were monetarily rewarded for correct expectations regarding the contributions of other groups.[11] However, to avoid complicating the incentives to contribute, the elicitation of expectations of the subjects' own group was not incentivized. Note that by eliciting the expected contributions for each rule, we might be forcing subjects to think more carefully about the effects of competition than they

[11] We paid subjects an amount that decreased with the square of the difference between their expected and the realized contributions (see the online appendix for details). In theory, this payment scheme introduces an incentive for risk-averse subjects to hedge against the possibility of losing the competition. In practice, this type of hedging has been shown not to occur when then incentives to hedge are small (Blanco et al., 2010), as is the case in our experiment.

otherwise would have. We see this as a benefit because we wanted to ensure that the voting choice is an informed decision.

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 were chosen to mimic a choice between the low certain payoff of no competition and the higher but more risky payoff of competing (the lottery is calibrated to the case where competition increases everyone's contribution by 8 points).[12] Although it is debatable whether behaviour in lotteries like this one is driven by aversion to risks or losses (see Rabin, 2000; Palacios-Huerta and Serrano, 2006), for convenience, we refer to subjects who choose the certain option as being risk averse.

The experiment was conducted in the Laboratory for Experimental Economics at the University of Copenhagen. Participants were all students in economics, albeit all were less than two months into the economics program. 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). 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

[12] As in any empirical study with sequential measurements, there is the possibility that earlier measures affect the latter ones. However, if we look at how mean contributions, mean earnings, and lottery choices correlate between subjects within the same group, we find that contributions ($r = 0.881$, $p < 0.001$) and earnings ($r = 0.823$, $p < 0.001$) are highly correlated within groups but lottery choices are not ($r = 0.091$, $p = 0.237$). This suggests that the lottery choice was not unduly affected by the events in the game.

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 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.[13] 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 a plausible candidate. In the following, we refer to the symmetric equilibrium where all players mix by making independent draws from the same 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 winning. 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.[14] Finally, in this equilibrium all players in all groups are (*ex ante*) better off compared to the equilibrium without competition (i.e. full

[13] 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.

[14] 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.

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.*

Although there is plenty of evidence that risk neutrality and own-earnings maximization do not necessarily hold, note that prediction 1 will generally hold if we allow individuals to be risk averse or possess social preferences. In fact, these types of preferences tend to increase the efficiency-enhancing effect of competition because they make losing relatively more painful than winning (due to the concavity of the utility function in case of risk preferences or due to disliking disadvantageous inequality more than advantageous inequality in the case of models of social preferences such as Fehr and Schmidt, 1999).

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 assume that all players vote sincerely, which then predicts that competition is implemented irrespective of whether the organisation is using the majority or 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 prediction 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*. Generally speaking, opposition to intergroup competition can be conceptualized as coming from three different sources.

First, heterogeneity in individual preferences can lead to persistent differences in the ability of groups to cooperate. In this case, even if competition increases overall efficiency, members of underperforming groups can nevertheless end up worse off than without competition and therefore vote against it. In particular, as mentioned above, social- and risk preferences can lead to differences in the willingness of individuals to cooperate under competition. Hence, if a group happens to have a low fraction of individuals who are risk averse (or inequity averse) it may be outperformed by other groups.[15]

Second, although competition might be beneficial, cognitive limitations might lead individuals to underestimate its efficiency-enhancing effect. Particularly, individuals might focus on the highly salient prize of winning, which in itself does not increase efficiency, and ignore the indirect benefits of intergroup competition, the anticipation of which requires more complex reasoning. In this sense, the strategic depth of people's thinking is very important. For instance, models of limited strategic thinking such as the K-level model of Stahl and Wilson (1995) predict that individuals with low levels of strategic thinking tend to underestimate the reaction of others to intergroup competition (i.e., underestimate its indirect effect) and therefore end up overestimating their chance of winning (i.e., its direct effect).

Third, even if individuals expect competition to increase their mean income, they may nonetheless have preferences that make them strongly dislike the act of competing or the variation in income that competition entails. Examples of such preferences include risk aversion and a dislike of competing *per se*, as proposed by Niederle and Vesterlund (2007).

[15] Note that, even though individuals who are risk neutral and maximize their own earnings can react to the increased cooperativeness of others by increasing their own contributions, there is a limit to the contribution they can credibly commit themselves. For example, as illustrated in footnote 14, in a symmetric equilibrium a risk-neutral earnings maximizer is better off not contributing if others are contributing $\bar{c}_j > \gamma/(1-\alpha)$.

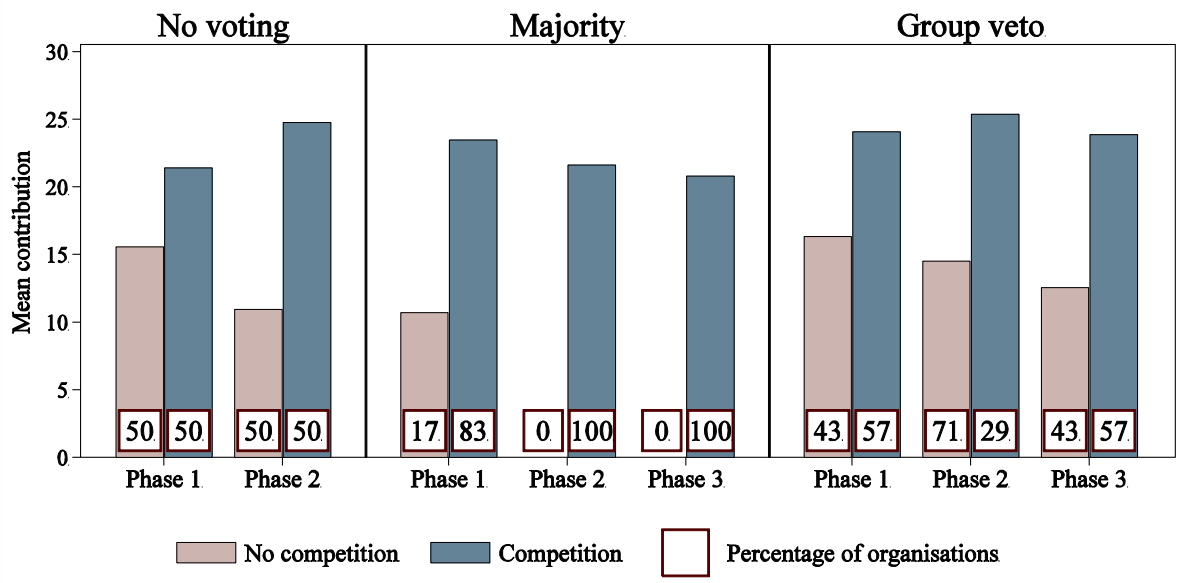
We refrain from formally modelling these deviations from standard assumptions as precise predictions are hard to derive, are highly dependent on the specific model used, and it is unclear *a priori* which of these deviations from the standard model may be relevant in our context.[16]

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 (this information is also available in Table A1 in the online appendix). The figure shows that, irrespective of the voting rule, competition has a strong and immediate positive effect on cooperation. 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. 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.

[16] As an illustration, take the potential effect of risk aversion. Risk aversion promotes cooperation in the competitive environment by making people want to avoid losses, which enhances the indirect effect of competition and makes it more desirable. At the same time, the unavoidable variation in earnings that comes from competition diminishes its attractiveness. Lastly, heterogeneity in risk preferences introduces the added complication of differences in the ability of groups cooperate, making competition more attractive to some but less attractive to others. Ultimately, the effect that dominates will depend on the specific form and distribution of risk aversion that is assumed.

Figure 1 – Contributions with and without competition by voting rule



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

Table 2 shows that the effects of competition are strong, immediate, and independent of the voting rule by means of regression analysis.[17] The table shows regressions of individual contributions and includes dummy variables for the voting rule interacted with a dummy variable indicating whether competition is implemented.[18] The first regression is a random-effects GLS regression. The second regression uses 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 regression is an OLS regression run with data from the first period.

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[17] 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.

[18] 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.

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		0.191	
# of obs./subj./org.	4104/171/19		4104/171/19		171/171/19	

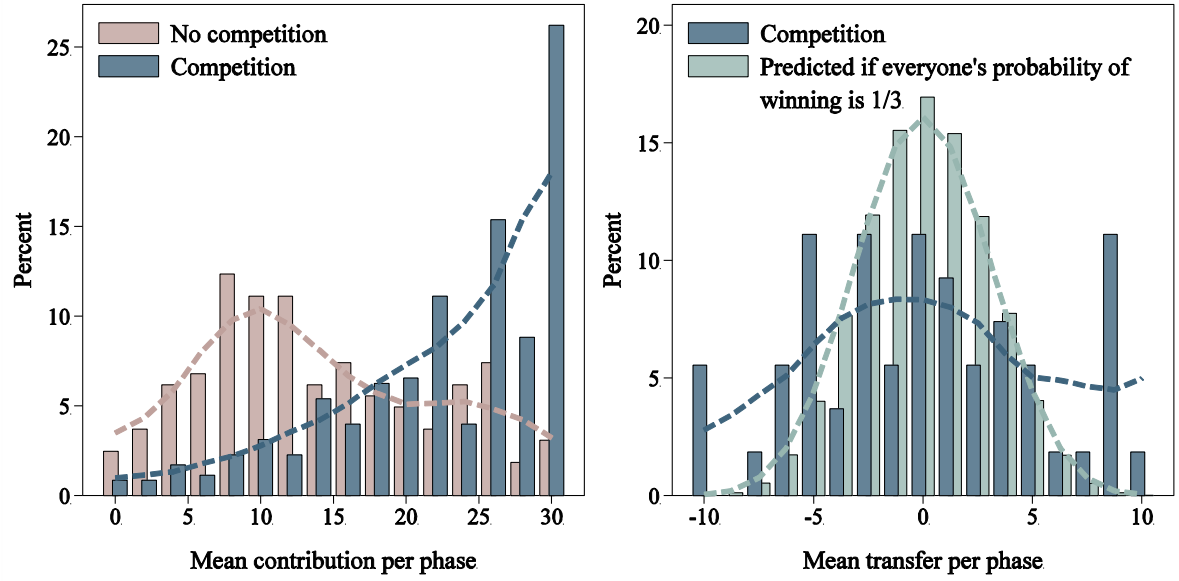
Note: GLS regressions with the amount contributed as the dependent variable. Clustered standard errors allowing for intra-organisation correlation. Asterisks indicate significance at 1 (**) and 5 (*) per cent.

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 et al. (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.

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.[19] We discuss why this might be the case in the conclusions. We summarize these findings as our first result.

[19] We also run the regressions in Table 2 including a variable indicating whether a subject voted in favour of competition (interacted with whether competition is implemented and the voting rule). We find that the effect of

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.

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, it also shows the predicted distribution of mean transfers if all groups in an organization have the same probability of winning, as is the case in any symmetric equilibrium.

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

competition when it is exogenously imposed is not different from its effect when it is adopted through a vote, irrespective of whether the subject voted in favour of it ($p > 0.138$) or against it ($p > 0.136$).

contribution. Clearly, even when they are competing, some subjects are more cooperative than others.[20] 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. The left and middle panels display the mean rank obtained in period t of phase r as a function of the rank in period $t - 1$. We display this relation for groups that are competing (left panel) as well as those that are not (middle panel), and we also divide groups depending on whether intergroup competition is imposed exogenously (light red) or is chosen with one of the voting rules (dark blue). The right panel shows persistence across phases for groups that played with competition in phase r. It shows a scatter plot (and resulting best linear fit) of each group's mean rank in phase r as a function of its mean rank in phase $r - 1$, dividing groups by whether they competed in phase $r - 1$ (light red) or not (dark blue).[21]

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

[20] Even though one should expect some variation in contributions due to subjects playing a mixed strategy, if subjects mix using the same probability distribution, then their mean contributions over 8 periods would vary less than the observed mean contributions depicted in Figure 2.

[21] 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.

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.[22]

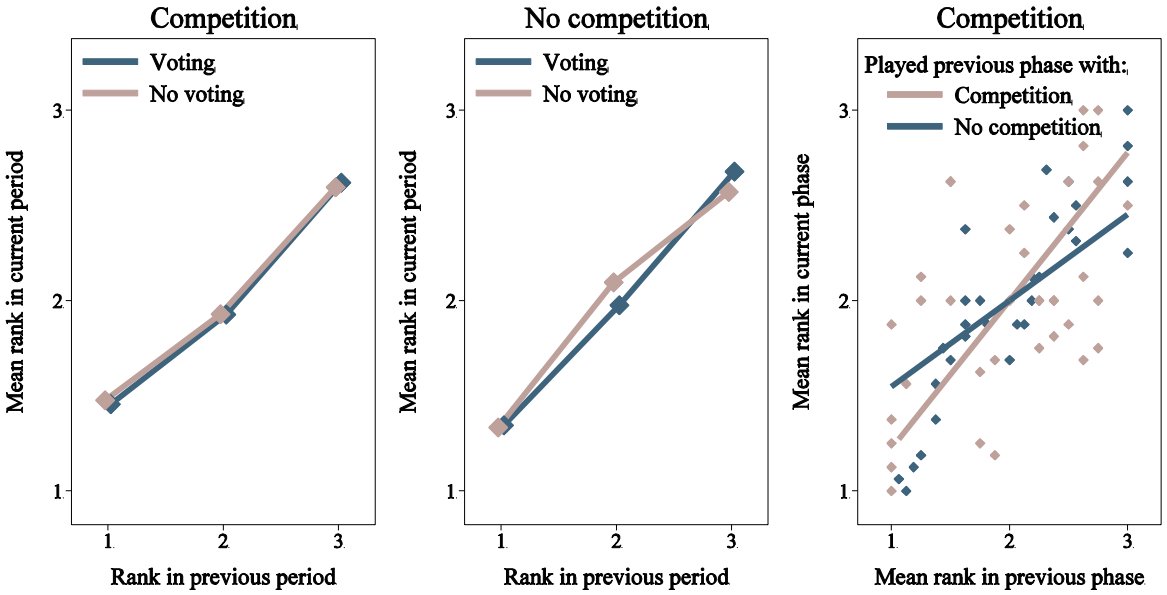
We can also see that the persistence of ranks across periods is very similar within phases where competition is imposed exogenously and phases where it is implemented endogenously, which indicates that rank persistence is not due to a selection effect. Similarly, we do not see that rank persistence across 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 some groups 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, 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 (77.8 per cent) as net winners from competition. This persistence in the groups' rank highlights the importance of carefully considering the role of heterogeneous (other-regarding) preferences when thinking about the impact of intergroup competition (see the discussion in the predictions section). In summary:

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.*

---

[22] We test the relation between a group's rank in periods $t - 1$ and t with 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 GLS regressions, one for groups that competed in phase r and one for groups that did not compete (the latter case is not part of Figure 3). We use an interaction term to test the effect of the institution of phase $r - 1$. The online appendix contains the estimated coefficients. In all cases, a group's previous rank predicts well its current rank ($p < 0.022$). Also, coefficients do not differ significantly between ordered probit regressions ($p > 0.315$) or between GLS regressions ($p > 0.207$), and there are no significant interaction terms ($p > 0.070$).

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

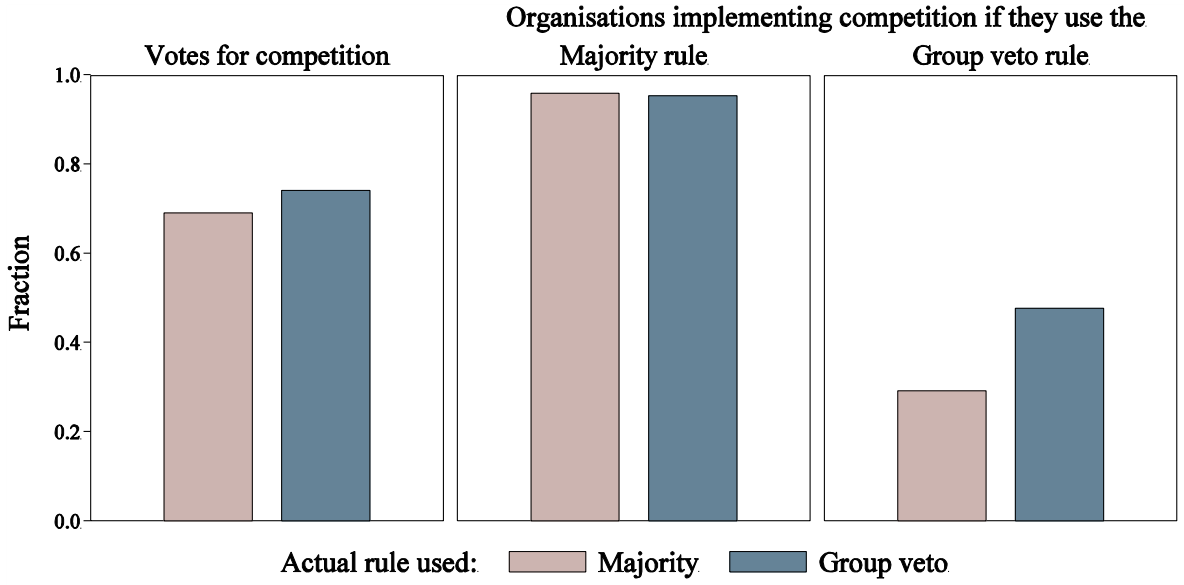


Next we take a closer look at the implementation of competition and the subjects' voting behaviour. Recall from Figure 1 that whether competition is implemented strongly depends on the voting rule used. Organisations using the majority rule almost always implement competition (in 95.8 per cent of all elections). This result mirrors the findings of Putterman et al. (2011) and Kamei et al. (2011) who show that efficiency-improving institutions are not unanimously accepted but are generally implemented with the majority rule. By contrast, groups using the group veto rule implement competition only in half of the cases (47.7 per cent of all elections).[23]

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. The left panel of Figure 4 shows that most subjects vote in favour of competition irrespective of the voting rule used: 69.0 per cent with the majority rule and 74.1 per cent with the group veto rule ($p = 0.501$

[23] 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 group veto) 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



with a probit regression of voting in favour of competition on a dummy variable indicating the voting rule used).[24]

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 under 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

[24] The level of support for competition might be affected by the fact that our subjects are economics students. It would be interesting for a future study to investigate whether competition receives high levels of support with subjects from other disciplines. The fact that our students had less than two months of exposure to economic classes suggests that any differences would be due to selection effects.

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.[25] In summary:

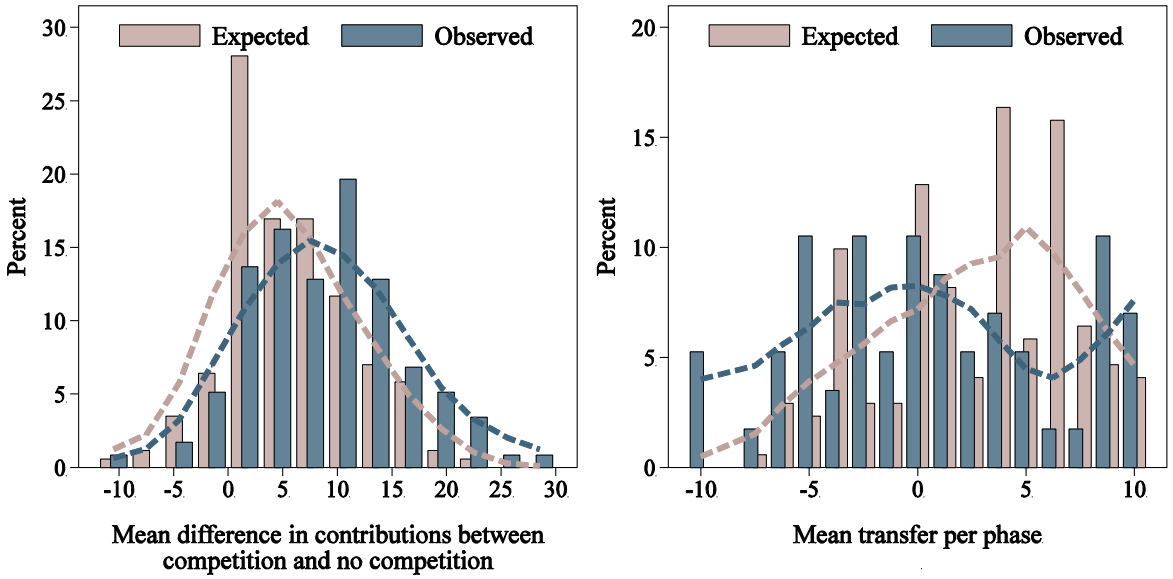
Result 3 (Implementing competition): *Competition is almost always implemented by organisations that use the majority rule but it is implemented less than half the time by organisations that use the group veto rule. The difference in implementation rates is explained by "mechanical" differences in how 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 risk aversion.

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

[25] 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). The lack of significant differences in the propensity to vote for and implement competition supports the assumption that subjects vote sincerely. Albeit, the fact that votes supporting competition are a bit more common with the group veto rule and that the difference in implementation rates would be the largest with that same voting rule suggests that some subjects might be voting strategically.

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.

worst to the best performing group.[26] The left panel shows that, by and large, subjects expect competition will increase the contributions of others (on average by 5.4 points) but by a smaller amount than the actual increase in contributions (around 10 points on average).[27]

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

[26] 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.

[27] 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 ($p < 0.027$). We test these hypotheses non-parametrically in the online appendix.

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 ($p < 0.030$).[28] 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; Reuben et al., 2012). Interestingly, we find that the expected direct and indirect effects of competition are unrelated. That is, the correlation between the subjects' expected transfer and their expected impact of competition on contributions is small and is not statically 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 the expected increase in the contributions of others in their group due to competition.[29] 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 risk averse according to our measure at the end of the experiment (see experimental procedures, only 9.4 per cent are classified as risk averse). Both models include subject random effects and a dummy variable indicating the voting rule being used, 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

[28] 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 test these hypotheses non-parametrically in the online appendix.

[29] Results are almost identical if we use the expected impact of competition on the contributions of other groups.

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)	1.2**	(0.4)
Risk averse			–18.9	(10.6)
Female			–17.6*	(7.7)
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. The table shows marginal effects in per cent. Subject random effects and clustered standard errors allowing for intra-organisation correlation. Asterisks indicate significance at 1 (**) and 5 (*) per cent.

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.[30]

Model II reveals that, *ceteris paribus*, the probability of voting in favour of competition is 17.6 percentage points lower for female participants. 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 men in competitive environments (as in Gneezy et al., 2003; Gneezy and Rustichini, 2004).[31] 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

[30] 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 ($p > 0.799$).

[31] 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. When competing, the contributions of women do not differ significantly from those of men, irrespective of whether competition is exogenously imposed or is endogenously chosen ($p > 0.301$).

the literature that argues that men and women have different preferences for performing in a competitive environment, even after controlling for their expected relative performance (see Niederle and Vesterlund, 2007; Balafoutas and Sutter, 2012; Niederle et al., 2013).[32] Model II also shows that risk aversion has a negative effect on the probability of voting for competition, but unlike gender, it is not statistically significant at the five per cent level (its *p*-value equals $p = 0.075$). However, the effect is moderately large (the probability of voting in favour of competition is 18.9 percentage points lower for risk-averse subjects) and the lack of statistical significance may be ascribed to the small number of subjects classified as risk averse.

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 and by 6.6 percentage points with the group veto rule.

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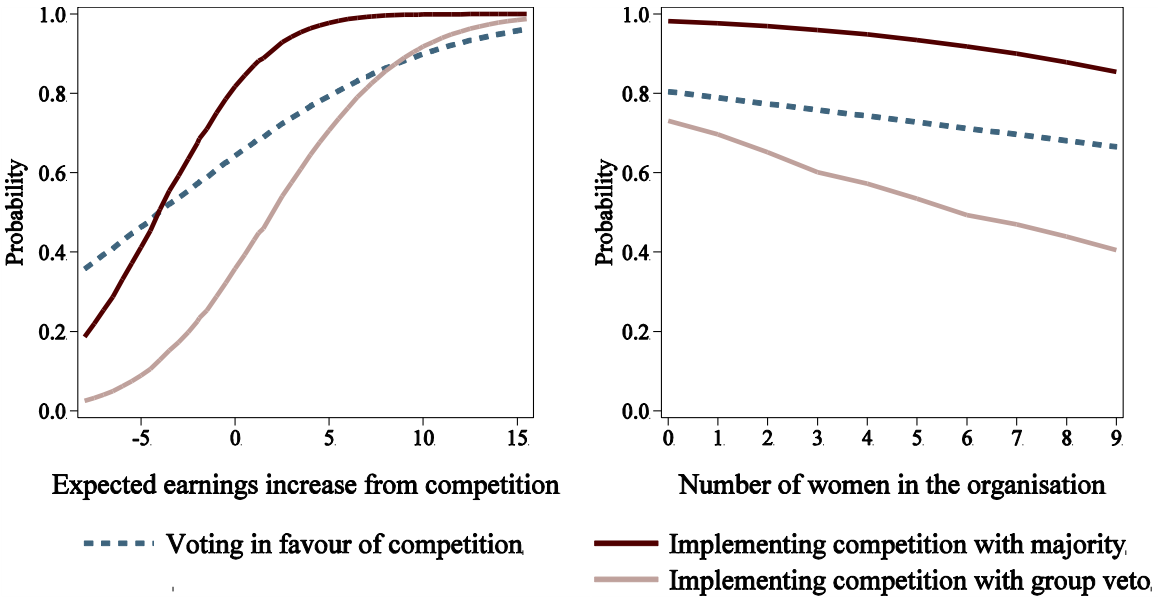
[32] If we add interaction terms between gender and the other independent variables to Model II, we find that none of the interaction terms are statistically significant ($p > 0.708$). In other words, the effect of expectations on voting is indistinguishable between men and women, which reinforces the interpretation of the female coefficient as an aversion to competition *per se*.

Figure 6 – Estimated probability of voting for and of implementing competition depending on the expected increase in earnings from 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.[33]

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).

[33] In the online appendix we show that, controlling for the events of phase $r - 1$, the events of phase $r - 2$ do not have an impact on the expectations of phase r. Hence, it appears that subjects deem that their expectations from phase $r - 1$ already incorporate all the useful information from phase $r - 2$.

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	17.3**	(1.1)	21.6**	(0.6)	4.3**	(0.8)	1.5**	(0.3)
Phase × rule fixed effects	Yes		Yes		Yes		Yes	
Subject fixed effects	Yes		Yes		Yes		Yes	
R^2	0.075		0.101		0.025		0.80	
# 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 allowing for intra-organisation correlation. Asterisks indicate significance at 1 (**) and 5 (*) per cent.

However, updating is asymmetric. Subjects do not seem to update their expectations regarding contributions in one competition regime if their experience comes from the other regime. That is, they do not use counterfactual information to update their expectations.[34] Model III shows that this asymmetry in updating causes biased expectations concerning the impact of competition on contributions, with the direction of the 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).

[34] There are 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 observed surprisingly high contributions update their expected impact of competition down, and vice versa for surprisingly low contributions.

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 subjects expect competition to have particularly beneficial effects when contributions were surprisingly high with competition. The coefficient with value –4.7 shows the reverse case: subjects 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 voters 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 required. 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. Therefore, some individuals oppose competition even though they would benefit from it. Moreover, even with experience, this bias is not easily overcome because individuals tend to take their performance within a given institution as uninformative of their performance in the alternative institution. Hence, individuals in a highly cooperative group under no competition increase their expected performance under that institution but fail to see that their performance would also be high under competition, which leads them to further underestimate its benefits. 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 performance of its various work teams, or a minister of education who has an interest in the 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 welcome its introduction. This suggests that some caution might be in order and highlights the importance of carefully thinking about heterogeneity in preferences and cognitive biases because they lead to differences in the propensity to cooperate and the willingness to compete. This is particularly relevant 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., 2013).

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 appears to be that voters can signal their intentions to cooperate by approving (theoretically ineffective) sanctions (for similar results see Dal Bó et al., 2010; Markussen et al., in press). 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, although our intergroup competition regime has the desirable characteristic that it is revenue-neutral, which makes it inexpensive to implement as no additional resources are required, it does require that the transfer from the losing to the winning group is enforceable *ex post*. In many cases, the transfer could be enforced by a powerful central authority—such as the top management of an organization—but it might incur some costs in doing so.[35] In this respect, the voting rule used to implement intergroup competition might be crucial as it can affect the legitimacy of the institution and hence the cost of making transfers between groups.

Second, 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 on a "level playing field" 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

[35] Barring a powerful central authority, decentralized market mechanisms might be able to transfer resources form losing to winning teams (see footnote 6), but once again, managing such mechanisms might be costly.

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 (e.g., for tournaments between individuals, see Müller and Schotter, 2010). 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 is thus 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 the support of these groups is required.

Third, the popularity of intergroup competition may well depend on the characteristics of competitors and voters. Our sample is clearly not representative of the population at large. About two thirds of our participants are male and all are first-semester 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.

Fourth, 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 (for the popularity of informal sanctions, see Markussen et al., in press).

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 fosters 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.

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