Tournaments for the endogenous allocating of prizes within workteams - Theory and experimental evidence*

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Abstract

We present a model where compensation within a workteam is determined endogenously by the use of a rank-order tournament. Team members compete in their efforts for the right to propose the distribution of a prize within the team. The implementation of a proposal requires the approval of other team members. Failure to reach an agreement is costly and the role of proposer rotates in the order of members' efforts. We show in an experiment that tournaments elicit higher efforts than random determination of the proposer role. Proposers get a significantly larger share of the prize than non-proposers.

JEL classification: C72, C91, C92, J33

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1. Introduction

Since the seminal paper by Lazear and Rosen (1981) on rank order tournaments as optimum labor contracts, personnel economics has put a lot of emphasis on the optimal design of tournaments as competitive compensation mechanisms (for overviews see Gibbons, 1998; Lazear, 1999; Prendergast, 1999; Harbring and Irlenbusch, 2003). Traditionally, tournaments provide payments or promotions which serve as prizes given to the winners, i.e. in the context of the labor market to the employees with the highest work effort. Typically, prizes and their distribution among competing employees are exogenously determined, but not subject to bargaining among competing employees.

In this paper, we address a situation in which the prize is endogenously allocated within a team of workers in a bargaining process. We will present a model - and an experimental test of it - in which members of a team have to provide effort which will be rewarded by a fixed prize, conditional on the joint effort meeting a certain threshold. The prize is then distributed among team members in a bargaining process. Members compete in a tournament for the right to propose the distribution of the prize. The member with the highest effort, i.e. the one with the highest contribution to the joint team effort, can make a proposal how to divide the prize. The proposal is implemented if a certain quota (either simple majority or unanimity of team members) is reached. Any time the quota is failed, team members face bargaining costs in the form of a shrinking prize and the right to propose the distribution of the prize rotates in the order of members' efforts. That means that after the member with the highest effort, it is the turn of the member with the second highest effort, and so on. If all members had their turn, the member with the highest effort can make an ultimate proposal. If this final proposal is rejected, the prize has been used up through the costs of delay and bargaining.

The structure of the model represents a combination of a threshold public good game (see Palfrey and Rosenthal, 1984, for an early theoretical discussion and

Croson and Marks, 2000, for a survey of experimental results) with an alternating offer bargaining game (Rubinstein, 1982) with a shrinking pie. The combination of both types of games has not been considered in the literature, so far, but seems to reflect quite well the strategic situation introduced at Austrian universities, for instance. The new Austrian law on the organization of universities, which is in effect since 2004, has changed the traditionally centralized system of allocating money to and also within research departments. The new law requires the chancellor of a university to write a contract with a specific research groups (of about 10 to 30 academics) which specifies the targets to be met by the research group concerning its research output in a given period. If the target is failed, research group members with limited contracts have a lower probability of getting renewal and the research group as a whole has a chance next to zero to get additional resources, like a pay rise for its members or more money for research assistants or equipment. If the target is met (or, even better, clearly surpassed), the chancellor can allocate additional resources to the research group. However, the distribution of the additional resources within the group has to be decided within the group itself. A chairperson of the research group - who is elected by the members of the research group - can allocate these resources within the research group, given that he gets sufficient (but legally not specified) support for his proposal within the group.

In our model, we will study the incentives of using a tournament in efforts for the right to propose the allocation of a prize, i.e. in our above example a tournament in research output to become the chairperson within a research group. We will compare our tournament design with the incentives for providing effort in case the right to propose the allocation is determined randomly. We will show in our game-theoretic analysis and with the help of an economic experiment that the tournament design elicits significantly higher efforts.

The rest of the paper is organized as follows. The model and its implications for effort choices and allocation decisions are presented in section 2. The experimental implementation of the model and its results are reported in sections 3 and 4. Section 5 concludes.

2. The model

2.1. Basic structure of the model

Consider a team with three members ($n = 3$) who play a two-stage game. The first stage of the game is a threshold public good game. The second stage is a modified alternating offer bargaining game, which is played only if the threshold is reached in the first stage. At the beginning of stage one, each member i receives an endowment E and has to choose an effort $e_i \leq E$. If joint workteam effort $\left(\sum_{n=1}^{3} e_n\right)$ falls short of a given threshold T (with $E < T \leq 3E$), there is no second stage of the game and each member i receives as final payoff

$$\pi_i(e_i | \sum e_n < T) = (E - e_i) \,. \qquad (1)$$

If joint effort passes the threshold, such that $\sum e_n \geq T$, the team receives a prize P. By setting $P > 3E$, we guarantee that it is in any case collectively efficient to reach or surpass the threshold. In the second stage of the game, then, the prize P has to be distributed among the team members in the following way (see Table 1 for a summary of the bargainig process). Let us denote the member with the highest effort in the first stage of the game member H (with effort e_h), the one with the median effort member M (with e_m) and the one with the lowest effort member L(with e_l). In case two (or three) members choose an identical effort level, their role in the second stage of the game is determined by a random draw.

Proposal	Size of prize	Member to make proposal#	Member to accept or reject
1st ($\mathbf{p_H}$)	P	H	M (and L)#
2nd ($\mathbf{p_M}$)*	$3P/4$	M	L (and H)#
3rd ($\mathbf{p_L}$)*	$P/2$	L	H (and M)#
4th ($\widetilde{\mathbf{p_H}}$)*	$P/4$	H	M (and L)#
	zero*		

* only if all previous proposals rejected
\# addition in brackets refers to the UNANIMITY-model (see section 2.2.)

Table 1. Sequence of bargaining in the second stage of the game

Member H can propose a vector $\mathbf{p_H} = \begin{pmatrix} p_h & p_m & p_l \end{pmatrix}$, which allocates p_h to himself, p_m to member M, and p_l to member L, and which satisfies the condition $p_h + p_m + p_l = P$. If member M accepts $\mathbf{p_H}$, it is implemented (by a simple majority vote of member H proposing and member M accepting it) and stage two is finished. Otherwise, the prize shrinks to $3P/4$ and member M can propose a vector $\mathbf{p_M}$, with property $p_h + p_m + p_l = 3P/4$. Member L has to accept or reject $\mathbf{p_M}$. In case of rejection, member L proposes a new vector $\mathbf{p_L}$ (with $p_h + p_m + p_l = P/2$), with member H deciding on acceptance or rejection. In case of rejection, member H can make a final proposal of a vector $\widetilde{\mathbf{p_H}}$, with $p_h + p_m + p_l = P/4$. If $\widetilde{\mathbf{p_H}}$ is rejected by member M, every member gets a prize of zero and the allocation process of stage two is finished. Final payoffs after playing the second stage are then given as follows (with $i \in \{h, m, l\}$).

$$\pi_i(e_i | \sum e_n \geq T) = (E - e_i) + \frac{\sum e_n - T}{3} + p_i \qquad (2)$$

The first term on the right hand side of equation (2) equals the remaining endowment after subtracting efforts. Exerting effort has constant marginal costs in our case and is equivalent to providing a public good for the members of the team. Withholding own effort is beneficial for own payoffs, but diminishes the chance of meeting the threshold, which is inefficient for the team as a whole. The second and third term on the right hand side capture the collective and individual gains from meeting the threshold. The second term is derived from the surplus of joint effort above the threshold. This surplus is shared equally among all team members, which resembles an equal bonus for all team members for having passed the threshold. Note, however, that the second term entails no efficiency gains from reaching the threshold, but is a mere (and equal) redistribution of excess effort to team members.[1] The third term represents the individual gain from the prize to be distributed in the team. The actual individual gain depends on the outcome of the bargaing process in the second stage of the game.

[1] In principle, it would also have been possible to drop the second term altogether, meaning that excess effort (above the threshold) is wasted, which is often used in experimental public goods games. However, by including the second term we capture the idea that there are at least some gains from providing the threshold public good (i.e. getting the prize) which are shared equally. It is noteworthy that the theoretical analysis of the game and its equilibria do not depend upon the inclusion or exclusion of the second term.

2.2. Variations of the model

The basic model introduced in the previous subsection will be referred to as the MAJORITY-model. Note that the model does not strictly catch the characteristics of majority voting, because even if member L supported member H's first proposal, thereby providing a simple majority of supporters, the proposal would not be implemented if member M voted against it. Hence, in this model we always have a powerless minority (i.e. the member not being allowed to vote on the proposal) which can be exploited by a powerful majority of team members. The term MAJORITY is particularly used because it provides a contrast to the first variation of this model, called the UNANIMITY-model. UANIMITY adds to the MAJORITY-model the requirement of unanimous support to implement proposals in the second stage of the game. That means that any proposal of member i needs to be accepted by both other members j and k (with $i \neq j \neq k$), which both have to vote simultaneously on member i's proposal. The UNANIMITY-model serves to examine the consequences of different voting rules on both efforts in the first stage of the game and the distribution of the prize, respectively the frequency of failing a settlement, in the second stage of the game.

A second variation of the MAJORITY-model concerns the order of making proposals in the second stage of the game. Instead of making the order contingent on the order of efforts in the first stage, one can determine the order randomly, irrespective of efforts. That means that at the beginning of the second stage (if it is reached) the three members are randomly ordered, and the first member can make the first (and possibly fourth) proposal, and the second and third member the second, respectively third, proposal. We will call this model the RANDOM-model. By comparing the MAJORITY- with the RANDOM-model, one can determine the influence of the tournament on effort choices in the first stage and allocation decisions in the second stage of the game.

2.3. Equilibrium strategies

In the following, we present the equilibrium strategies of choosing efforts and allocations of the prize in four propositions, assuming risk neutrality of team members. We relegate the proofs of the propositions to the Appendix, but provide only the basic intuition of the propositions and the comparative statics of the three models here.

Proposition 1: In the MAJORITY-model, there is a single equilibrium in efforts which satisfies $\sum e_j \geq T$. All workteam members choose maximum effort $e_i = E$ in the first stage of the game. In the solution of the second stage of the game, the randomly determined member H allocates $p_h = P/2$ to himself and $p_m = P/2$, respectively $p_l = 0$ to the other members. Member M accepts the allocation immediately.

Proof: see Appendix A1.

Proposition 2: In the UNANIMITY-model, there are two types of equilibria which satisfy $\sum e_j \geq T$: Either all team members choose the maximum effort $e_i = E$ (if $T \geq 2\frac{5}{8}E$ or $P \geq 8(T-E)$) or two members choose maximum effort and the third member contributes either zero (if $E < T \leq 2E$ and $P < 8E$) or contributes just the amount necessary to reach the threshold (if $2E < T \leq 3E$ and $P < 8(T-E)$). For both types of equilibrium efforts it holds that member H allocates $p_h = P/2$ to himself and $P/4$ to the other two team members who both accept the allocation.

Proof: see Appendix A2.

Proposition 3: In the RANDOM-model, there are infinitely many equilibria with $\sum e_n = T$, but none with $\sum e_n > T$. The randomly determined member H allocates $p_h = P/2$ to himself and $p_m = P/2$ to the randomly determined member M, but zero to member L. This allocation is accepted by member M.

Proof: see Appendix A3.

Proposition 4: In all three models, there is a single equilibrium with the property $\sum e_n < T$. In this equilibrium, all team members choose zero effort $e_i = 0$. The second stage of the game is not reached in this case.

Proof: see Appendix A4.

In the MAJORITY-model maximum effort of all team members is elicited, if the threshold is reached. The prospect of becoming proposer (member H) in the second stage of the game induces a 'race to the top' in effort levels. Since member L receives nothing from the prize in the second stage, team members abstain from reducing their effort below the maximum level E.

The situation is different in the UNANIMITY-model, because requiring unanimous support for a proposal guarantees a quarter of the prize ($P/4$) both for members M and L (with member H allocating $P/2$ to himself). The relatively stronger position of member L is responsible for having only two members choosing maximum effort, but the third one free riding completely, if the prize is not sufficiently high or the threshold is rather low. The two members with maximum effort have an equal chance of becoming member H (who receives $P/2$), which prevents them from reducing effort below E. If the prize or the threshold are sufficiently high, the tournament induces maximum effort of all team members, which coincides with the effort predictions from the MAJORITY-model.

Equilibrium effort choices in the RANDOM-model are characterized by satisfying $\sum e_n = T$. Since effort choices have no influence on the role (of H, M or L) in stage two of the game, it is an individually dominant strategy to reduce own effort (if possible) to the level where joint effort equals exactly the threshold. Allocation decisions are identical to those in MAJORITY, because RANDOM also requires simple majority in the second stage of the game.

Considering those cases where $\sum e_n < T$, the collectively efficiency-enhancing property of the prize (due to $P > 3E$) makes it a dominant strategy for member i to choose a positive effort, if and only if his chosen effort *alone* can raise the joint team effort to or above the threshold. If this is not the case, free riding ($e_i = 0$) is a dominant strategy and the only equilibrium choice if $\sum e_n < T$.

3. Experimental design

In the experimental test of our models, we have set $E = 100$, $T = 196.5$, and $P = 393$. Table 2 summarizes the predictions on efforts and the allocation of the prize which can be derived for these parameters and the three different models. We exclude the equilibrium of all members choosing zero effort, in which case the threshold, and thus the second stage of the game, is not reached. The three models represent our three treatments, which are denoted in the same way as the models. The experimental instructions - which were framed as neutral as possible and refrained from using words like 'workteam' or 'effort' - can be found in Appendix A5.

parameters	$E = 100$	$T = 196.5$	$P = 393$
		treatment	
predictions on	MAJORITY	UNANIMITY	RANDOM
vector of efforts	$\begin{pmatrix} 100 \\ 100 \\ 100 \end{pmatrix}$	$\begin{pmatrix} 100 \\ 100 \\ 0 \end{pmatrix}$	$\begin{pmatrix} e_1 \\ e_2 \\ e_3 \end{pmatrix}$ $s.t. \sum e_n = 196.5$
average effort	100	$66.\dot{6}$	65.5
p_h (p_h/P)	196.5 (0.50)	196.5 (0.50)	196.5 (0.50)
p_m (p_m/P)	196.5 (0.50)	98.25 (0.25)	196.5 (0.50)
p_l (p_l/P)	0 (0.00)	98.25 (0.25)	0 (0.00)

Table 2. Parameters and predictions for the experiment

The choice of parameters is, of course, arbitrary, but was motivated by the following considerations. We have opted for such a set of parameters which yields in UNANIMITY an equilibrium with two team members exerting maximum effort and the third one free riding completely, given that the threshold is reached. By this we ensured different effort predictions between MAJORITY and UNANIMITY, in addition to the different predictions on allocation decisions. Since the second type of equilibrium in UNANIMITY is identical to the one in MAJORITY, we thought it to be more interesting to examine experimental behavior under different theoretical equilibria. The threshold T was chosen such that the effort predictions in case of reaching the threshold were are very close to each other in RANDOM ($\sum e_n = 196.5$) and UNANIMITY ($\sum e_n = 200$). This allowed us to check whether the requirement of unanimity or the random determination of the proposer role has a stronger influence on efforts. Finally, the uneven value of T was chosen such that team members could not coordinate on (identical) integer numbers to reach the threshold exactly. The prize was simply set as double the threshold. From Table 2 we can deduct the following hypotheses about behavior in the experiment.

Hypothesis 1: Average efforts are higher in MAJORITY than in the other two treatments. Average efforts in UNANIMITY and RANDOM do not differ significantly.

Hypothesis 2: The number of subjects exerting maximum effort is higher in MAJORITY than in UNANIMITY, and higher in UNANIMITY than in RANDOM.

Hypothesis 3: The shares allocated to group members H, M and L do not differ between MAJORITY and RANDOM, but there are significant differences to the shares for members M and L in UNANIMITY.

The experiment consisted of 6 identical rounds. The repitition was chosen in order to allow for learning in the course of the experiment. At the beginning of the experiment, participants were randomly assigned to groups of three subjects which stayed in the same group for the whole experiment. This so-called partner design was known to participants. Each group member was labeled either member 1, member 2 or member 3. Effort choices of single members could be identified by other members through this label. If the threshold was reached, group members were also informed about who could make the proposal for distributing the prize in stage two of a given round and who could make the decision on acceptance or rejection of the proposal. In case of identical effort levels, roles were assigned randomly. When making, respectively accepting or rejecting, proposals, the respective members were informed about each members' effort in stage one and the proposed share of the prize allocated to each member. At the end of stage two, each member got informed about the outcome of the bargaining process in stage two and his payoff from the entire round.

In total, we had 189 participants, 63 in each treatment. This yielded 21 independent observations per round and treatment. Experimental sessions were run computerized (with the help of z-Tree, Fischbacher, 1999) in October 2003 and January 2004 at the University of Innsbruck, with most participants being undergraduate students of economics, business administration, law, medicine or psychology. Sessions lasted on average 50 minutes. Average earnings were about 15 Euro per participant.

4. Experimental results

4.1. Aggregate data

Before examining the development of behavior round by round, we start by presenting aggregate data from all 6 rounds. Table 3 reports effort levels, the relative frequency of reaching the threshold and of subjects exerting maximum effort, the relative shares allocated to group members H, M and L in the first proposal[2] and the relative frequency of rejecting the first proposal. From the figures in Table 3 we can derive the following results, which are related to the corresponding hypotheses from the previous section.

[2] Actual allocations (after acceptance of a proposal) are at most 1.5 percentage points higher (for members M and L) or lower (for members H) than the ones indicated in Table 3, where all proposals - accepted and rejected ones - are considered.

Averages per round	MAJORITY	UNANIMITY	RANDOM
Effort (std.dev.)	80.0 (19.6)	77.7 (14.2)	70.8 (13.2)
Effort, given $\sum e_j \geq 196.5$	85.1	82.0	75.0
Relative frequency of $\sum e_j \geq 196.5$	0.86	0.90	0.85
Relative frequency of $e_i = 100$	0.41	0.29	0.18
First proposal			
p_h (p_h/P)	176.4 (0.45)	153.0 (0.39)	151.7 (0.39)
p_m (p_m/P)	144.3 (0.37)	126.7 (0.32)	130.7 (0.33)
p_l (p_l/P)	72.3 (0.18)	113.3 (0.29)	110.5 (0.28)
Share of first proposals rejected	0.16	0.17	0.10

Table 3. Average data (aggregated over all 6 rounds)

Result 1: Average efforts are highest in MAJORITY. Both overall average efforts and average efforts in case the threshold is reached are significantly smaller in RANDOM than in either MAJORITY or UNANIMITY ($p < 0.02$ in any pair wise comparison; two-sided Mann-Whitney U-test). There is no significant difference in efforts between MAJORITY and UNANIMITY. The standard deviation of efforts is larger in MAJORITY than in UNANIMITY ($p < 0.1$) and in RANDOM ($p < 0.05$).

Result 2: The number of subjects exerting maximum effort ($e_i = 100$) is significantly higher in MAJORITY (where it is observed in 41% of choices) than in UNANIMITY (29%), and significantly higher in UNANIMITY than in RANDOM (18%) ($p < 0.05$ in any pair wise comparison; χ^2-tests).

Result 3: Proposals for the allocation of the prize are significantly different between MAJORITY and the other two treatments ($p < 0.01$), but do not significantly differ between RANDOM and UNANIMITY (Kruskal-Wallis-test). Members H and M receive significantly higher shares in MAJORITY than in the other treatments, whereas member L receives a significantly lower share in MAJORITY.

Result 1 shows that our Hypothesis 1 has been borne out only partially. As predicted, efforts are significantly higher in MAJORITY than in RANDOM, with average efforts in the former being about 14% higher than in the latter. This is a clear indication that introducing a rank-order tournament for the right to propose the allocation of the prize induces higher efforts, which comes at the cost of higher variance of efforts, though. The prediction that efforts in UNANIMITY would be lower than in MAJORITY and close to those in RANDOM failed. Efforts in UNANIMITY are significantly larger than in RANDOM and not significantly lower than in MAJORITY. This means that the requirement of unanimity has no significantly negative effect on efforts, compared to MAJORITY. Rather, the tournament design in UNANIMITY induces higher efforts compared to RANDOM, without implying significantly higher variance of efforts in UNANIMITY. There is no significant difference between any of the three treatments concerning the relative frequency of reaching the threshold, ranging from 85% in RANDOM to 90% in UNANIMITY.

Result 2 is a straightforward confirmation of the qualitative prediction of Hypothesis 2. The two treatments with the tournament induce maximum effort most often, whereas random determination of the proposer role leads to the lowest frequency. According to the predictions of the models we should have expected 100% of subjects exerting maximum effort in MAJORITY, and about 66% of subjects in UNANIMITY. Actual frequencies fall short of this benchmark, particularly in the early rounds. But in the next subsection we will show that the frequency of subjects with $e_i = 100$ shows a strong positive trend across rounds in the treatments with the tournament, but not in RANDOM.

Result 3 is mainly at odds with the predictions from Hypothesis 3. Proposed shares differ significantly between MAJORITY and RANDOM, but they are not significantly different between RANDOM and UNANIMITY. In particular, shares for proposers are significantly larger in MAJORITY than in the other two treatments (with $p_h = 0.45P$ in MAJORITY, but $p_h = 0.39P$ in RANDOM and UNANIMITY; $p < 0.01$ in pair wise comparisons; two-sided Mann-Whitney U-test with average shares within groups as units of observation). Shares for member M (L) are significantly larger (smaller) in MAJORITY than in the other two treatments ($p < 0.01$ in any case; two-sided Mann-Whitney U-test). Proposed shares for members M or L are not significantly different between RANDOM and UNANIMITY.

Considering the order of proposed shares for members H, M and L *within* a given treatment, we find that the order $p_h > p_m > p_l$ is significant in all treatments ($p < 0.01$; Page test for ordered alternatives), even though we would have predicted $p_h = p_m$ in MAJORITY and RANDOM, respectively $p_m = p_l$ in UNANIMITY. Obviously, proposers do not exploit their advantageous position in full (since they demand less than $P/2$ on average), but they allocate significantly more to themselves than to the other group members, in particular in MAJORITY. The lower proposals for p_h in RANDOM and UNANIMITY, compared to MAJORITY, seem to be driven by two different forces: The need to get unanimous support for one's proposal induces members H in UNANIMITY to propose relatively lower shares for themselves in order to offer the other two group members higher shares, thereby increasing the probability of acceptance (as will be discussed in detail below). A majority of proposers in RANDOM faces the (theoretically irrelevant) moral dilemma of having an opportunity to exploit the role of proposer without necessarily having contributed the highest amount to the public good. Even though they propose more for themselves than for the other group members, proposers do not exploit their advantageous position as much as proposers do in MAJORITY.

Interestingly, proposers in MAJORITY and RANDOM care considerably for the 'powerless' member L who has no influence over the implementation of the first proposal. Whereas the payoff-maximizing choice would have been to offer $p_l = 0$, proposers allocate on average about 18% (28%) of the prize to members L in MAJORITY (RANDOM). Several motivations, strategic and non-strategic ones, might be advanced to explain such behavior. Altruism (Andreoni, 1990) or inequality aversion (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Fehr and Schmidt, 1999) are prominent non-strategic motives. However, the exact influence of these subject-specific characteristics can not be estimated in the framework of our experiment. The situation is different as far as strategic motives are concerned. Allocating a larger share to the powerless member L could raise the probability of member M accepting the proposal. This, in turn, would make seemingly altruistic behavior pay off for the proposer.

In the bottom row of Table 3, we have indicated the relative frequency of rejecting the first proposal. It ranges from 10% in RANDOM to 17% in UNANIMITY[3], but the rejection rates are not significantly different between any two treatments. This is a noteworthy result, because in UNANIMITY proposals need unanimous support of *both* other workteam members, whereas only member M has to consent in RANDOM and MAJORITY. Hence, the voting rule itself does not seem to have a genuine influence on rejection rates. In order to explore the reasons for accepting or rejecting the first proposal in more detail, we have run a probit regression of the decision to accept (= 1) or reject (= 0) the first proposal on the proposed shares p_m and p_l and actual effort levels (e_m and e_l) of members M and L. Though theoretically irrelevant, effort levels have been included because they could play a role if a sunk cost effect influences the acceptance/rejection decision. Equity theory (Walster et. al., 1973), for instance, would assume that outcomes (allocations to group members) tend to be proportionally related to members' inputs (efforts). Our regression results are shown in Table 4.

dependent variable: acceptance (= 1) of first proposal			
independent variables	MAJORITY	UNANIMITY	RANDOM
p_m	0.072**	0.069*	0.068**
p_l	0.040**	0.117**	0.063**
e_m	-0.019	0.021	-0.023
e_l	0.002	-0.087	-0.020
McFadden R^2	0.25	0.46	0.55

** (*) significant at $p < 0.05$ ($p < 0.1$).

Table 4. Determinants for acceptance of first proposal

We find no significant influence of effort levels on acceptance decisions in any treatment, as one would have expected on the basis of theoretical reasoning. Proposed shares for both members *M and L*, on the contrary, turn out to have a significantly positive influence on the probability to accept a proposal. This is not

[3] In absolute frequencies, 11 groups reached no agreement in RANDOM, 17 in MAJORITY and 19 in UNANIMITY. Of these groups, all but three managed to reach an agreement on the second proposal. One group in RANDOM and one in UNANIMITY agreed on the third proposal, whereas one group in UNANIMITY failed to reach an agreement even on the fourth proposal.

only true in UNANIMITY, where both other members have to decide on acceptance, but also in MAJORITY and RANDOM, where only member M decides on acceptance or rejection. Hence, from the viewpoint of the proposer there is a clear strategic motive to offer the powerless member L (in treatments MAJORITY and RANDOM) a reasonable amount, because that (besides offering member M larger amounts) leads to a higher likelihood of member M accepting the proposal. Obviously, even when controlling for the share of member M, member M cares in his acceptance decision for the share of the powerless member L.[4]

4.2. Development of behavior across rounds

4.2.1. Effort levels

Figure 1 shows the development of average efforts in the course of the six rounds of the experiment. Average efforts start out at almost the same level in all three treatments. In MAJORITY, effort levels increase significantly from round 1 to round 3 ($p < 0.02$ from round t to round $t+1$; two-sided Wilcoxon signed ranks test), staying rather stable until round 5 and falling (insignificantly) in round 6. Effort levels in UNANIMITY increase from round 1 to round 2 ($p < 0.01$; two-sided Wilcoxon signed ranks test) and stay rather constant afterwards. There is no significant difference in effort levels between MAJORITY and UNANIMITY in any round. The development of efforts is different in RANDOM. Efforts never increase significantly, but remain in the narrow range from 71.1 to 73.5 in rounds 1 to 5, after which we observe a significant decline ($p < 0.01$; two-sided Wilcoxon signed ranks test). Effort levels in RANDOM are significantly smaller than those in either MAJORITY or UNANIMITY in rounds 3 to 6 ($p < 0.05$; two-sided Mann-Whitney U-test).

[4] This result is qualitatively very similar to what Güth et al. (2003) have found in a large-scale newspaper experiment on a one-shot three-person ultimatum game (of Güth and van Damme, 1998). Güth et al. also found that responders in the three-person ultimatum game (equivalent to our members M) are *ceteris paribus* more likely to accept a proposal if the powerless dummy (our member L) is given a larger share. Our game is different from the three-person ultimatum game, though, because it has a first stage of providing effort in order to be able to play the second stage and because it has, in principle, the structure of an alternating offer game with a shrinking pie in case of rejection.

Figure 1 about here

The significant increase of efforts in the early rounds of MAJORITY and UNANIMITY indicates that subjects learn rather quickly that it is advantageous to provide high effort levels in order to have a chance to become proposer. Given that the determination of the proposer role is random in RANDOM, it is no surprise that we find no competition for the role of proposer in this treatment.

The higher average effort levels in MAJORITY and UNANIMITY are mainly due to the change of efforts from round t to round $t+1$, contingent on the role in round t. Specifically, subjects who were members L or M in round t increase their effort from round t to round $t+1$ significantly more often than members H ($p < 0.01$; χ^2-tests), as can be seen in Figures 2 through 4, where we have pooled data from all six rounds.[5]. On the contrary, in RANDOM there is no difference in reaction patterns of members H, M or L. Rather, the most frequent pattern is to keep effort levels constant, irrespective of member type.

Figures 2 through 4 about here

Figure 5 shows the relative frequency of subjects exerting the maximum effort of $e_i = 100$. Whereas this frequency is rather stable - and lowest - in RANDOM, it shows a significantly increasing trend both in MAJORITY and UNANIMITY ($p < 0.05$ in both treatments; Page test for ordered alternatives). From round 2 on, MAJORITY has the highest relative frequency, which is significantly larger than in UNANIMITY in rounds 3, 5 and 6 ($p < 0.05$; χ^2-test) and than in RANDOM from round 3 on ($p < 0.01$; χ^2-test). Relative frequencies in UNANIMITY are larger than in RANDOM from round 4 on ($p < 0.01$; χ^2-test).

Figure 5 about here

[5]Single data for two consecutive rounds each are qualitatively almost identical, such that members L and M in MAJORITY and UNANIMITY increase their efforts, whereas members H keep them basically constant. Given that data for two consecutive rounds each do not provide additional insights, we abstain from reporting these data.

Note that from round 3 on the increase of subjects choosing $e_i = 100$ in MAJORITY and UNANIMITY is *not* correlated with an increase in the overall average effort levels, as can be seen from Figure 1 above. This is due to a simultaneous and significant increase of the standard deviation of subjects contributions from round 3 on ($p < 0.05$ in both treatments). Hence, the tournament design does not only lead to higher contributions, compared with random determination of the proposer role in RANDOM, but also to a larger variance of effort levels within the groups which are exposed to the tournament design.

4.2.2. Allocation of the prize

Figures 6 through 8 show the development of proposed shares for members H, M and L separately. In general, the figures show that the shares proposed in RANDOM and UNANIMITY are rather close to each other across all rounds, but that the proposals are quite different from the ones in MAJORITY. An interesting feature of our data is the fact that the standard deviation of offers in round 1 in a given group is significantly positively correlated with the overall standard deviation of offers within that group from round 2 through round 6 ($r = 0.77$ with $p < 0.01$ in MAJORITY; $r = 0.53$ with $p < 0.05$ in UNANIMITY, and $r = 0.39$ with $p = 0.1$ in RANDOM). This implies that the first proposal within a group has a significant influence on proposals in consecutive rounds. The more equal are proposals in round 1, the more equal they are in rounds 2 through 6.

Figures 6 through 8 about here

Finally, it seems interesting to look at how offers are related to effort levels. In RANDOM, we find that the average standard deviation of offers is significantly negatively correlated with effort levels ($r = -0.45$, $p < 0.05$; with groups as units of observations), meaning that the more unequal the offers are the lower are effort levels. However, in MAJORITY or UNANIMITY, we do not find such a significant correlation (with $r = -0.07$ and $p = 0.7$ in MAJORITY, respectively $r = -0.06$

and $p = 0.8$ in UNANIMITY). Hence, when the proposer role is 'earned' through effort (in MAJORITY and UNANIMITY), unequal offers do not go hand in hand with lower efforts. Instead unequal offers seem to be acceptable and have no significant negative effects on effort within a group. When the proposer role is determined randomly, however, unequal offers tend to induce lower effort.

5. Conclusion

We have studied the effects of tournaments on the efforts of workers when the allocation of the tournament's prize is not exogenously fixed (by an employer), but has to be decided endogenously within a workteam (of employees). Our models and the experimental results have shown that the use of tournaments for allocating a prize within a team elicits higher effort levels than if the right to propose an allocation is randomly determined. Our experimental data, however, also clearly suggest that higher efforts with tournaments may come at the cost of higher variance in effort levels and higher variance in the shares of the prize allocated to single team members. This is particularly true if the tournament design is combined with the option of a majority exploiting a powerless minority of group members. Tournaments in combination with the requirement of unanimity for implementing a proposal have been shown experimentally to reduce the variance in efforts and shares of the prize, yet without reducing average effort levels significantly. The theoretically expected effort reducing effect of unanimity has not been substantiated in our experiment. It seems as if the incentive effects of the tournament compensated for the possibly negative effects of applying a unanimity rule. The effort increasing effect of the tournament is mainly driven by inducing 'losers' in the tournament to raise their effort levels.

The situation of endogenously allocating a prize within a team through members of the team (instead of through a superior, like an employer) may reflect the conditions in academia, for instance, quite well, where outstanding research teams may receive additional funds which have to be allocated among the members of the research team. Recently introduced reforms concerning the allocation of funds to researchers and research teams at Austrian universities actually allow for such an endogenous allocation, replacing the old system of a central authority allocating the money to and within different teams. Yet, the Austrian University Law does not address the possibility of linking the endogenous allocation process to a tournament in research (and teaching) efforts. Our results, however, suggest that it might be worth considering tournaments for the institutional design of teams in cases where resources (like research money) have to be allocated endogenously within (research) teams.

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Figures

Figure 1. Average efforts

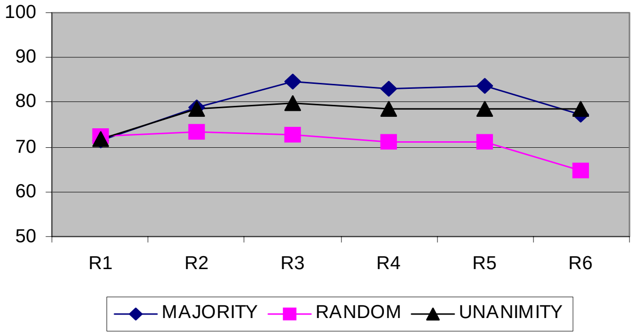


Figure 2. MAJORITY - Change of effort

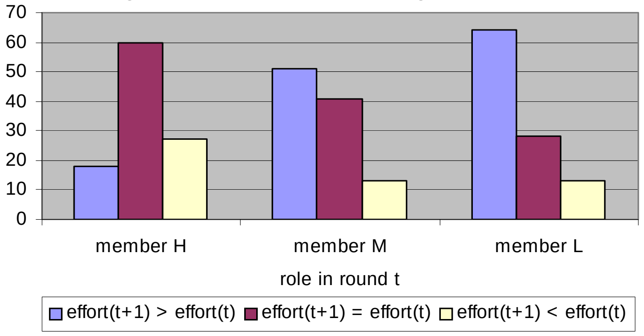
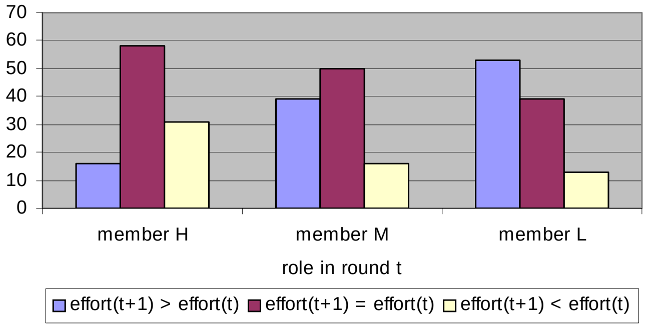


Figure 3. UNANIMITY - Change of effort



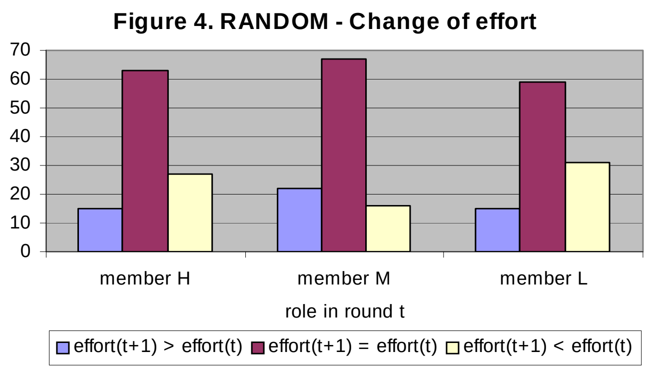


Figure 4. RANDOM - Change of effort
70
60
50
40
30
20
10
0
member H
member M
member L
role in round t
effort(t+1) > effort(t)
effort(t+1) = effort(t)
effort(t+1) < effort(t)

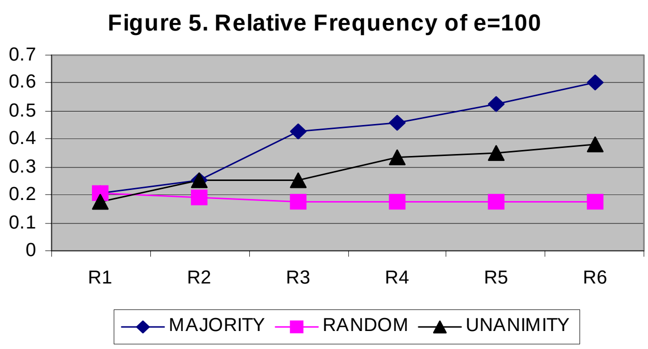


Figure 5. Relative Frequency of e=100
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
R1
R2
R3
R4
R5
R6
MAJORITY
RANDOM
UNANIMITY

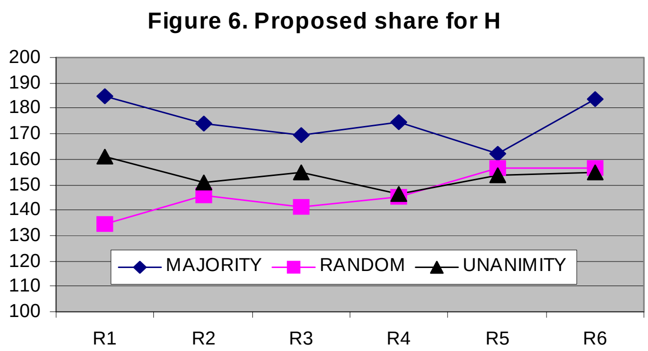


Figure 6. Proposed share for H
200
190
180
170
160
150
140
130
120
110
100
R1
R2
R3
R4
R5
R6
MAJORITY
RANDOM
UNANIMITY

Figure 7. Proposed share for M

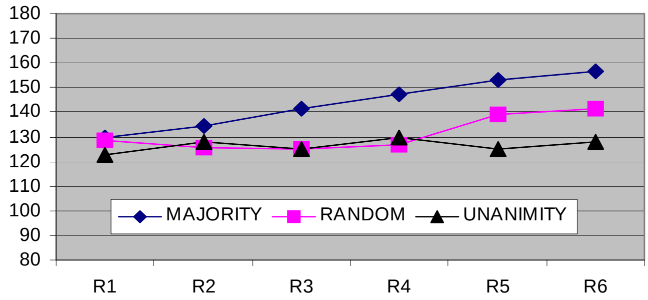
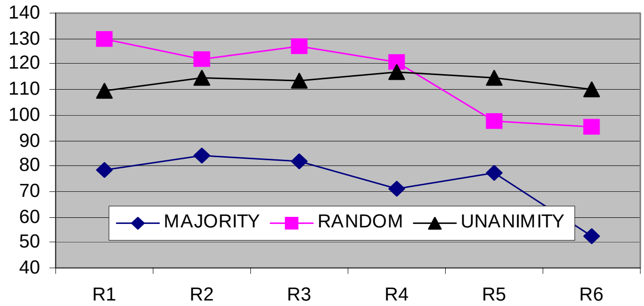


Figure 8. Proposed share for L



Appendix

A1 Proof of proposition 1 (MAJORITY)

A1.1 Allocation of the prize (stage two)

By applying backward induction, we see that in the last move of stage two, i.e. the fourth proposal (see Table 1), member H proposes $P/4$ for himself and zero to the other two members. Assuming that in case of indifference between acceptance and rejection a member accepts a given proposal, member M accepts the fourth proposal. In the third proposal, member L proposes $P/4$ to himself and to member H, with the latter accepting. In the second proposal, member M proposes $P/2$ to himself and $P/4$ to member L who accepts. As a consequence, the first proposal allocates $P/2$ both to the proposer, member H ($p_h = P/2$), and the responder, member M ($p_m = P/2$), but nothing to member L ($p_l = 0$). Member M accepts this proposal.[6]

A1.2 Effort levels (stage one; given $\sum e_n \geq T$)

Step 1. First, we show that $e_i^* = e_j^* = e_k^* = E$ is an equilibrium. In step 2 we will, then, show that there is no other equilibrium which satisfies $\sum e_n \geq T$. Recall that $E < T \leq 3E$ and that $P > 3E$. We let $\sum e_{-i} = e_j^* + e_k^*$ and show that $E(\pi_i(e_i^*)) > E(\pi_i(e_i))$ for any $e_i < e_i^*$, where $E(\cdot)$ denotes the expected value of $(\cdot)$. Since in case of identical efforts within a workteam the roles are allocated randomly, we have to calculate expected values when roles are determined randomly. Choosing maximum effort is optimal if

$$E(\pi_i(e_i^*)) = \frac{2}{3}\frac{P}{2} + \frac{\sum e_{-i} + e_i^* - T}{3} > E - e_i + \frac{\sum e_{-i} + e_i - T}{3} = \pi_i(e_i) \quad \text{(A1.1)}$$

[6] If we assumed member M to reject a proposal in case of indifference between acceptance and rejection, member H would propose in the fourth proposal $P/4 - \varepsilon$ to himself and $\varepsilon > 0$ to member M, which member M would accept. Backward induction would then still yield the first proposal to be $P/2$ for member H and member M each, with member M accepting.

Note that reducing member i's effort from e_i^* to e_i implies that member i will be assigned the role of member L in the second stage of the game, and, thus, will get nothing from the prize. Hence, the right hand side of equation (A1.1) includes no term for the allocation from the prize, whereas the expected share from the prize is captured in the first term on the left hand side. After some rearranging of terms in (A1.1), we can see that the inequality in (A1.1) is satisfied if

$$e_i > -\frac{P - 2E}{3} \tag{A1.2}$$

The right hand side of (A1.2) is negative due to $P > 3E$. Since e_i is taken from the interval $[0, E]$, it follows that $E(\pi_i(e_i^*)) > E(\pi_i(e_i))$ for any $e_i < e_i^*$. This holds also for the case where member i's reduction of effort would cause a failure to reach the threshold (such that $\sum e_{-i} + e_i < T$), in which case member i earns $\pi_i(e_i) = E - e_i$, which is even smaller than the right hand side of inequality (A1.1). Hence, no workteam member has an incentive to reduce his effort below E.

Step 2. In step 1 it has been shown that if two members choose maximum effort, it is the best response for the third one to choose maximum effort as well. Hence, we have to examine all other possible cases, where at most one member chooses maximum effort.

(i) If $e_i \leq e_j < e_k = E$ (satisfying $\sum e_n \geq T$), it is optimal for member i to increase his effort to $e_i^+ = e_j + \varepsilon$, which will yield $P/2$ from the allocation of the prize instead of the (at best) expected share of $P/4$ (if $e_i = e_j$) or of zero (if $e_i < e_j$). The gain of $P/4$ is larger than the arbitrarily small costs of investing ε (if $e_i = e_j$) and the gain of $P/2$ is larger than the maximally necessary increase for $e_i^+ > e_j$.

(ii) Any combination of efforts with $e_i \leq e_j \leq e_k < E$ (satisfying $\sum e_n \geq T$) cannot be an equilibrium in the first stage. To prove this claim, we show that

member i (who would be member L in case of such a combination) can raise his expected profit by choosing effort $e_i^* = E$, which makes him member H and guarantess $P/2$ from the allocation of the prize. Let $e_i = e_i^* - \varepsilon$, then $E(\pi_i(e_i^*)) > E(\pi_i(e_i))$ for any ε, which rules out any combination of efforts with $0 \leq e_i \leq e_j \leq e_k < E$ (satisfying $\sum e_n \geq T$) as an equilibrium. The upper limit of $E(\pi_i(e_i))$ is given for the case of $e_i = e_j = e_k < E$, since in this case member i has a two thirds chance of receiving half of the prize.

$$\pi_i(e_i^*) = \frac{P}{2} + \frac{\sum e_{-i} + e_i^* - T}{3} > \frac{2}{3}\frac{P}{2} + \frac{\sum e_{-i} + e_i - T}{3} + E - e_i = E(\pi_i(e_i)) \quad \text{(A1.3)}$$

Rearranging terms and considering that $\varepsilon = e_i^* - e_i$, inequality (A1.3) is satisfied if $P/4 > \varepsilon$, which is true since $P > 3E$ and $\varepsilon \leq E$.■

A2. Proof of proposition 2(UNANIMITY)

A2.1 Allocation of the prize (stage two)

By applying backward induction, we see that in the last move of stage two, the fourth proposal (see Table 1), member H proposes $P/4$ for himself and zero the other two members. We assume that in case of indifference between acceptance and rejection both other members accept the proposal. This yields as the third proposal (made by member L) $p_l = P/4$, $p_h = P/4$ and $p_m = 0$. The second proposal is, then $p_m = P/4$, $p_l = P/4$ and $p_h = P/4$. Finally, the first proposal (by member H) is $p_h = P/2$, $p_m = P/4$ and $p_l = P/4$, which is accepted by members M and L.

A2.2 Effort levels (stage one; given $\sum e_n \geq T$)

For determining the equilibrium effort choices in UNANIMITY, we have to consider the range in which the threshold is set.

A2.2.1 Condition $E < T \leq 2E$

Step 1. There are two types of equilibria in this condition, depending upon the size of the prize. Type one (with $P < 8E$) has two members choosing maximum effort ($e_i^* = e_j^* = E$) and the third member chooses no effort at all ($e_k^* = 0$). Type two (with $P \geq 8E$) has all members choosing the maximum effort ($e_i^* = e_j^* = e_k^* = E$).

Starting with the first type, we show that member i (or, likewise, member j) has no incentive to reduce his effort level to $e_i < e_i^* = E$ $(= e_j^*)$ (subject to $\sum e_n \geq T$) and, second, that member k has no incentive to raise effort to $e_k > e_k^* = 0$.

(i) Member i.

Case (1). Let $e_i = e_i^* - \varepsilon$ (with $\varepsilon > 0$), and $e_i + e_j^* \geq T$.

$$E(\pi_i(e_i^*)) = \frac{1}{2}\frac{P}{2} + \frac{1}{2}\frac{P}{4} + \frac{e_i^* + e_j^* - T}{3} > \frac{P}{4} + E - (e_i^* - \varepsilon) + \frac{e_i^* - \varepsilon + e_j^* - T}{3} = \pi_i(e_i) \quad \text{(A2.1)}$$

The first two terms on the left hand side of the inequality capture the expected share from the prize of either being member H or M (which is randomly determined in equilibrium). The third term is the surplus from joint effort. The first term on the right hand side is the share from the prize (as member M), given that member i reduces his effort below E. Collecting terms we arrive at the following inequality to satisfy condition (A2.1).

$$P > \frac{16\varepsilon}{3} \quad \text{(A2.2)}$$

To meet the threshold (i.e. $e_i + e_j^* \geq T$), ε must meet the following condition (recall that $E < T < 2E$): $\varepsilon < 2E - T$. In order to meet the property of an equilibrium (i.e. neither member i nor j having an incentive to deviate from $e_i^* = e_j^* = E$), the prize must fulfill the following condition (besides our assumption $P > 3E$):[7]

$$P > \frac{16}{3}(2E - T) \quad \text{(A2.3)}$$

[7] If condition (A2.3) is violated, there are no equilibria of efforts which satisfy $\sum e_n \geq T$. Note that the second type of equilibrium (with all members choosing maximum effort) satisfies condition (A2.3).

Case (2). Let $e_i = e_i^* - \varepsilon$ (with $\varepsilon > 0$), and $e_i + e_j^* < T$.

$$E(\pi_i(e_i^*)) = \frac{1}{2}\frac{P}{2} + \frac{1}{2}\frac{P}{4} + \frac{e_i^* + e_j^* - T}{3} > E - e_i = \pi_i(e_i) \qquad \text{(A2.4)}$$

Collecting terms, we arrive at the condition

$$\frac{3P}{8} > \frac{E-T}{3} - e_i, \qquad \text{(A2.5)}$$

which is satisfied due to $3P/8 > 9E/8 > E$ and $(E-T)/3 - e_i < E$ because of $T < 2E$ and $e_i \geq 0$.

(ii) Member k.

Let $e_k > e_k^* = 0$. Given $e_i^* = e_j^* = E$, it is straightforward to see that any effort level e_k with $0 < e_k < E$ is strictly dominated by e_k^*. This is so, because the share of the prize is in any of these cases $P/4$ (see A2.1), but any positive effort level below the maximum level decreases member k's payoff by $2e_k/3$. Thus, the only reasonable alternative to $e_k^* = 0$ is to consider $e_k^{\tilde{}} = E$ (which would cause a random determination of the roles for allocating the prize). Therefore, we have to check the following inequality.

$$\pi_k(e_k^*) = \frac{P}{4} + \frac{\sum e_{-k} - T}{3} + E - e_k^* > \frac{1}{3}\frac{P}{2} + \frac{2}{3}\frac{P}{4} + \frac{\sum e_{-k} + e_k^{\tilde{}} - T}{3} = E(\pi_k(e_k^{\tilde{}})) \qquad \text{(A2.6)}$$

This inequality is satisfied and $e_k^* = 0$ is member k's optimal effort if

$$P < 8E. \qquad \text{(A2.7)}$$

Otherwise, the best reply for member k to $e_i^* = e_j^* = E$ would be to choose $e_k^{\tilde{}} = E$ himself, which constitutes the second type of equilibrium in UNANIMITY, where the threshold is reached and where also condition (A2.3) is satisfied.

Step 2. Now we show that there are no equilibria other than those presented in step 1 which satisfy $\sum e_n \geq T$. Any set of effort levels with $E > e_i > e_j > e_k \geq 0$ (and $\sum e_n \geq T$) can not be an equilibrium, because member k has an incentive to deviate to $e_k^{'} = e_i + \varepsilon$. This guarantees him $P/2$ instead of $P/4$ in the allocation of the prize at additional costs smaller than $2E/3$.[8] Given that $P > 3E$, it is in any case profitable for member k to choose $e_k^{'}$ instead of e_k, because $P/4 > 2E/3$.

Finally, we have to consider the set of effort levels with $E = e_i > e_j > e_k \geq 0$.[9] Given e_j and e_k, it suffices to show that member i's effort e_i constitutes no equilibrium choice, because member i could reduce his effort to $e_i^{'} = e_j + \varepsilon$, since that would still yield him $P/2$ from the allocation of the prize, but at costs reduced by $2(e_i - e_i^{'})/3$.

A2.2.2 Condition $2E < T \leq 3E$

Step 1. The set of efforts with $e_i^* = e_j^* = e_k^* = E$ is the first type of equilibrium in this condition. The second type is given by the set of efforts $e_i^* = e_j^* = E$ and $e_k^* = T - 2E$. First we will show that both sets constitute an equilibrium, in step 2 we will argue that there are no other equilibria which satisfy $\sum e_n \geq T$.

Consider the first set with all team members choosing maximum effort. If member i reduces his effort to $e_i = e_i^* - \varepsilon$ (with $\varepsilon > 0$), this yields the payoff on the right hand side of inequality (A2.8), whereas the expected payoff from choosing e_i^* is shown on the left hand side of (A2.8).

$$E(\pi_i(e_i^*)) = \frac{P}{3} + \frac{\sum e_{-i} + e_i^* - T}{3} + E - e_i^* > \frac{P}{4} + \frac{\sum e_{-i} + e_i - T}{3} + E - e_i = \pi_i(e_i) \quad \text{(A2.8)}$$

[8] Maximal costs are given if $e_k^* = 0$ and $e_k^{'} = E$. Note that the additional expenses of E are partly recovered by the (additional) redistribution of the surplus joint effort (above T), which is $E/3$ (given $e_k^* = 0$ and $e_k^{'} = E$).

[9] If condition (A2.3) is violated, the set of efforts with $E = e_i > e_j > e_k = 0$ might be a candidate for an equilibrium. However, this is not possible, as shown in the text.

Rearranging terms and taking into account that $P > 3E$ and that $\varepsilon = (E - e_i) \leq 3E - T < E$, all members choosing maximum effort is, therefore, an equilibrium if

$$P > 8(E - e_i) \text{ or } T \geq 2\frac{5}{8}E. \tag{A2.9}$$

If $P < 8(E - e_i)$ and $T < 2\frac{5}{8}E$ it is an equilibrium if two members choose maximum effort ($e_i^* = e_j^* = E$) and the third one $e_k^* = T - 2E$. Any deviation of team members below their equilibrium effort levels would cause the joint team effort to fall below the threshold, which yields a lower payoff than if the threshold is reached. An increase of effort levels is only possible for member k, which makes sense only if condition (A2.9) is satisfied (with $P > 8(E - e_k)$), yielding the first type of equilibrium with $e_i^* = e_j^* = e_k^* = E$.

Step 2. First we argue that there are no equilibria - other than the one with all subjects choosing maximum effort (if condition A2.9) is satisfied - in which the joint team effort is strictly larger than the threshold. If $\sum e_n > T$, member k with the lowest effort has an incentive to reduce his effort to $e_k^{'} = e_k - \varepsilon$ such that $\sum e_n = T$, which would yield him a higher payoff by $2\varepsilon/3$. Therefore, we can concentrate on all sets of effort which satisfy $\sum e_n = T$.

(i) If $e_i = e_j = e_k < E$ or if $e_i < e_j = e_k < E$, member k, for instance, has an incentive to raise his effort by a small amount $\varepsilon > 0$, because that would yield $P/2$ from the prize instead of an expected $P/3$ (if $e_i = e_j = e_k$) or $3P/8$ (if $e_i < e_j = e_k$), with the difference between both shares clearly being larger than an arbitrarily small ε.

(ii) If $e_i < e_j < e_k < E$ of if $e_i < e_j < e_k = E$ it holds that $e_j > E/2$ for any combination of e_i and e_k (given that the threshold $T > 2E$ is reached). Hence, the costs of increasing effort to $e_j = E$ are at most $E/3$ (this is smaller than $E/2$ due to the fact that one third of the increase in efforts is redistributed in equal parts among all team members), whereas the gains from it are $P/4$ (if $e_i < e_j < e_k < E$),

respectively $P/8$ (if $e_i < e_j < e_k = E$) which are in both cases larger than $E/3$ due to $P > 3E$.■

A3. Proof of proposition 3 (RANDOM)

A3.1 Allocation of the prize (stage two)

The same result as in MAJORITY (see A1.1) applies, since the allocation process is completely identical.

A3.2 Effort levels (stage one; given $\sum e_n \geq T$)

Step 1. First we show that the set of effort levels which satisfies $\sum e_n = T$ are an equilibrium. In step 2 we argue that the equilibria of step 1 are the only ones.

Let $\sum e_n = T$ and $e_i^* \in [0, E]$. Then member i has neither an incentive to (1) increase his effort to $\bar{e}_i = e_i^* + \varepsilon$ nor to (2) reduce his effort to $\underline{e}_i = e_i^* - \varepsilon$.

Case (1). An increase of effort reduces member i's payoffs for any $\varepsilon > 0$, because

$$E(\pi_i(e_i^*)) = \frac{P}{3} + E - e_i^* > \frac{P}{3} + E - e_i^* - \varepsilon + \frac{\varepsilon}{3} = E(\pi_i(\bar{e}_i)) \tag{A3.1}$$

Case (2). A reduction of effort causes joint effort fall to short of the threshold, which results in payoffs of $E - \underline{e}_i$ for member i, which is smaller than $\pi_i(e_i^*)$, because due to $P/3 > E$ and $e_i^* \leq E$ the following condition holds.

$$\pi_i(e_i^*) = \frac{P}{3} + E - e_i^* > E - \underline{e}_i = \pi_i(\underline{e}_i) \tag{A3.2}$$

Step 2. Consider any set of effort levels which satisfies $\sum e_n > T$. Let us define the surplus joint effort as $s = \sum e_n - T$. Then, for any member i there is an incentive to reduce his initial effort level e_i to $\underline{e}_i = e_i - s$ (if $e_i \geq s$) or to $\underline{e}_i = 0$ (if $e_i < s$), because

$$\pi_i(\underline{e}_i) = \frac{P}{3} + E - e_i + s > \frac{P}{3} + E - e_i + \frac{s}{3} = \pi_i(e_i).■ \tag{A3.3}$$

A4. Proof of proposition 4

In case no single member can increase his effort such that the threshold is reached (which is the case for all sets of efforts with $\sum e_n < T - (E - e_{\text{min}})$, where e_{min} denotes the minimum effort in a team), the payoffs $\pi_i(e_i) = E - e_i$ are maximized by setting $e_i = 0$. Exerting no effort at all dominates all other choices, as long as no single member can choose an effort to reach the threshold in the group.

To complete the proof of Proposition 4, we have to show that all sets of effort levels with $T - (E - e_{\text{min}}) < \sum e_n < T$ can not be an equilibrium in any of our models, because at least the member with the minimum effort level, e_{min}, has an incentive to increase his effort to satisfy $\sum e_n = T$. In the following, we denote the payoff of the member with the (initially) lowest effort level with π_{min}.

It is sufficient to show that there is one effort level $e > e_{\text{min}}$ which yields a higher payoff than $\pi_{\text{min}}(e_{\text{min}}) = E - e_{\text{min}}$ for the member with the initially lowest effort. If this member chooses $\bar{e}_{\text{min}} = E$, the threshold T is passed. The expected gain from reaching the threshold is at the minimum $P/3$ (which is the case if the other members had chosen $e_j = e_k = E$), which is in any case larger than the maximum payoff $\pi_{\text{min}}(e_{\text{min}}) = E - e_{\text{min}}$, in case $e_{\text{min}} = 0$.■

A5. Experimental instructions for the MAJORITY-treatment (translated from German)

Welcome to the experiment! In this experiment, we are interested in studying economic decision making. All the money you are going to earn in this experiment will be paid to you in private immediately after the experiment.

This experiment has 6 rounds, which have two stages each. There will be groups of 3 subjects each who interact with each other in these 6 rounds. Note that group composition is fixed throughout the whole experiment, that is you interact always with the same two persons. The personal identities of these two other persons, nor your own one, will not be revealed, neither during the experiment nor afterwards.

Stage 1:

In stage 1 of each round, you get an endowment of 100 tokens, which can be spent in two different ways. Either you keep it in your own account or you allocate it to a group account. Any combination of tokens given into your own account or the group account is possible. The tokens put in both accounts only need to sum up to 100.

The private account.

Each token in the private account will be credited 1:1 to your earnings and will be converted into Euro at a fixed exchange rate (see end of instructions for conversion rate). Note that your earnings from the private account will be paid to you whether or not the second stage of a round is reached.

The group account.

Your contributions as well as the contributions of the other two group members are added up. There is a threshold of 196.5 tokens.

1) If this threshold is failed, you are paid your tokens in your private account in this respective round and there is no second stage in this round.

2) If the threshold is met or passed, there will be a second stage in the respective round in which there are 393 tokens (twice the threshold) to be distributed within your group in a way explained below. The difference between the sum of contributions to the group account in your group and the threshold will be redistributed in equal parts to all group members (i.e. each group member receives one third of this surplus).

At the end of stage 1 all group members will be informed about the other members' allocations to the group and private account and whether the second stage has been reached. Group members will receive a number (either 1, 2 or 3) at the beginning of the experiment which will be kept throughout the experiment. By the member number you will be able to track the decisions of other group members.

Stage 2:

This stage will be played if the threshold has been met or passed in your group account. In this stage, group members have to divide 393 tokens in the following way. If group members agree on a certain division, each member receives the agreed share.

How to reach an agreement?

The group member with the maximum contribution to the group account (in stage 1 of a round) will be called member A in stage 2. The member with the second highest contribution will be denoted member B, and the member with the lowest contribution is named member C. In case of identical contributions of two or three members in stage 1, there will be a random assignment to the respective names.

Member A can make a proposal how to distribute the 393 tokens among all three group members, allocating tokens to member A, B, and C. When making his proposal, member A is informed about the contributions of the other members in stage 1 of the round. Member B who also gets the information on the others' contributions can, then, decide whether to accept or reject member A's proposal. If member B accepts, member A's proposal is implemented and the respective tokens are given to the respective members, thereby ending stage 2. If member B rejects, he can make a new proposal. But the sum to be distributed shrinks to 75% of the initial amount, i.e. to 294.75 tokens. Now it is member C's turn to accept or reject member B's proposal. If member C accepts, member B's proposal is implemented and stage 2 is finished. If member C rejects, he can make a new proposal how to distribute 50% of the initial amount, i.e. 196.5 tokens. Member A has to decide on acceptance or rejection. If member A accepts, member C's proposal is implemented, otherwise member A can make a - final - proposal how to distribute 25% of the initial amount, i.e. 98.25 tokens. Member B has to accept or reject this final proposal. In case of rejection, all group members receive zero, otherwise member A's proposal is implemented. The whole process is summarized in the following Table.

Proposal	Amount to be distributed	Member to make proposal#	Member to accept or reject
1st ($\mathbf{p_H}$)	393	A	B
2nd ($\mathbf{p_M}$)*	294.75	B	C
3rd ($\mathbf{p_L}$)*	196.5	C	A
4th ($\widetilde{\mathbf{p_H}}$)*	98.25	A	B
	zero*		

* only if all previous proposals rejected

The exchange rate has been set at **100 token = 1.5 Euro.**