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More than Words: Communication in Intergroup Conflicts

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Abstract

Numerous studies suggest that communication may be a universal means to mitigate collective action problems. In this study, we challenge this view and show that the communication structure crucially determines whether communication mitigates or intensifies the problem of collective action. We observe the effect of different communication structures on collective action in the context of finitely repeated intergroup conflict and demonstrate that conflict expenditures are significantly higher if communication is restricted to one's own group as compared to a situation with no communication. However, expenditures are significantly lower if open communication within one's own group and between rivaling groups is allowed. We show that under open communication intergroup conflicts are avoided by groups taking turns in winning the contest. Our results do not only qualify the role of communication for collective action but may also provide insights on how to mitigate the destructive nature of intergroup conflicts.

Keywords: Communication, Conflict, Experiment, Rent-seeking

JEL-classification: C72; C91; C92; D72; D74;

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1. Introduction

A substantial amount of resources is allocated for rivalry, conflict, and rent-seeking activities which typically lack any direct productive value (Krueger, 1974; Mohammad and Whalley, 1984; Congleton, 1986). In 2009, in the USA, companies, labor unions, and other organizations spent $ 3.48 billion to lobby Congress and federal agencies.[1] Likewise, Angelopoulos et al. (2009) estimate that in the Euro area 18 percent of the collected tax revenues are extracted as rents. R&D competition, where firms tend to imitate each other's research strategies (Dasgupta and Stiglitz, 1980), electoral competition through strategic allocation of campaign resources (Snyder, 1989), and expenses for socio-political conflicts are other examples of economic behaviors which involve personal and social costs that could be reduced if institutions are designed such that the perverted incentives of rent-seeking are avoided.

A large number of studies suggest that communication may have the power to mitigate collective action problems (Isaac and Walker, 1988; Ostrom et al., 1992, 1994; Ledyard, 1995). Observations from laboratory experiments where communication is studied in a controlled manner indicate a large positive impact of communication on cooperation in social dilemmas (for meta-analyses of this literature see (Sally, 1995) and more recently (Balliet, 2010)). While this suggests that communication may be a universal means to mitigate collective action problems, little is known about the consequences of communication for collective action problems that do not have the features of a social dilemma but of intergroup rivalry or conflict.

[1]http://www.opensecrets.org/lobby/index.php; retrieved on May 28, 2010.

There are reasons to believe that the impact of communication is less clear in intergroup conflicts. Groups face internal incentive problems that may undermine the achievement of their goal setting. In particular, two contrarian forms of cooperation are expected to play a role: (i) Cooperation within groups, which occurs if group members manage to avoid free-riding and spend resources on conflict expenditures to increase the chance that their own group wins, and (ii) cooperation between rivaling groups, which occurs if members of the rivaling groups achieve mutual understanding to avoid unnecessary waste of resources on conflict expenditures. Therefore, communication may enhance cooperation within groups, leading to intensified intergroup rivalry that increases socially wasteful conflict expenditures. Yet, communication may at the same time help to establish cooperative agreements between rivaling groups, leading to reductions in combined conflict expenditures.

In this study, we use laboratory methods to test the impact of different communication structures on conflict expenditures in an intergroup contest game characterized by these two forms of cooperation and conflict. We chose an experimental setting because it renders it possible to unpack the complex decision problem characteristic of a multilevel conflict into a simple experimental design. This design allows systematic examination of various communication structures which may shift the focus between these two forms of cooperation keeping other variables constant. The studied game is based on Tullock's contest model (Tullock, 1967, 1980) where two parties compete for one indivisible prize which is equally distributed among the members of the winning party. The probability of winning the prize for each party is equal to the proportion of its investment out of the total investments by all parties. When the game is played with groups as conflict parties it includes elements of a public good as all individual players have an opportunity to free-ride on the conflict expenditures of their own group members.

We study the intergroup conflict in four different treatments. In all treatments, two groups of four players compete for one prize for 20 periods. In the baseline treatment, no communication is possible. In the restricted communication treatment, players can communicate via online chat with their own group members but not with the members from the rivaling group. In the open communication treatment, players can communicate via online chat with their own group members as well as with the members from the rivaling group. In addition, we present a treatment with restricted communication and peer-punishment where players can punish their own group members.

Our results show that players waste large amounts of money on conflict expenditures above the standard equilibrium level in all treatments. However, there are vast and significant differences in conflict expenditures between treatments. We find that conflict expenditures are significantly higher in the restricted communication treatment (582 percent above the standard equilibrium level) than in the no communication treatment (404 percent above the standard equilibrium level). At the same time, we find that conflict expenditures are significantly lower (41 percent above the standard equilibrium level) if there is open communication within and between groups compared to the restricted communication and the no communication treatment. We observe that conflict expenditures are similar in the case of restricted communication if group members are given the additional possibility to punish their own group members. While conflict expenditures are shown to depend on the communication structure, communication independent of its structure leads to conformist behavior. In all treatments with communication, the dispersion of individual conflict expenditures is smaller than in the treatment without communication.

Our econometric analysis reveals that communication shifts the focus of conditional behavior from one's own party to the behavior of the conflicting party. Importantly, we find that groups decrease conflict expenditures in the consecutive period after winning the conflict in the open communication treatment. This suggests that conflict expenditures are omitted by rivaling groups to take turns in winning the conflict. A content analysis of the communication exchanged in this treatment corroborates this conjecture. Turn taking proves to be a widely applicable cooperation strategy as it has been observed among individuals in a range of institutions outside the laboratory in environments such as in inshore fisheries (Berkes, 1992) or farmer-governed irrigation systems (Ostrom, 1990). While our results dovetail with earlier observations pertaining to individual behavior, we provide novel empirical evidence showing that the turn-taking behavior may evolve and maintain cooperation also between groups of unrelated individuals in finitely repeated interactions.

Our paper is related to other experimental work studying contest games and team tournaments. The literature on contest games shows, like our study, that conflict expenditures typically exceed the opportunistic benchmark (Isaac and Reynolds, 1988; Millner and Pratt, 1989; Shogren and Baik, 1991; Potters et al., 1998; Öncüler and Croson, 2005; Parco et al., 2005; Konrad, 2009).[2] These studies, however, do not investigate intergroup conflict

[2]For surveys on theoretical work on contest models consult (Nitzan, 1994) and more recently (Konrad, 2007).

but individuals competing against each other. More closely related to our study are Abbink et al. (2010) who do not investigate communication but study contests between groups, showing that conflict expenditures dramatically increase if players have an option to punish their own group members. Our paper qualifies their findings insofar as we show that the detrimental effect of punishment on conflict expenditures is not present if players have an opportunity to communicate with their own group members.

The literature on team tournaments has shown that competition between teams increases team members' efforts in the absence (Nalbantian and Schotter, 1997; van Dijk et al., 2001) and presence of communication (Sutter and Strassmair, 2009). Sutter and Strassmair (2009) also demonstrate that effort levels depend on the type of communication. They find that the invested effort level is highest if communication is restricted within team, lowest if there is no communication, and in between if there is open communication within and between teams. Their findings are thus similar to findings showing that allowing for (more) communication (within and between teams) may have socially undesirable effects due to collusion between market participants (McCutcheon, 1997; Kandori and Matsushima, 1998; Aoyagi, 2007). In contrast, our study demonstrates in the context of collective action that open communication can have socially desirable effects due to its capability to help rivals in avoiding unproductive conflict expenditures whereas restricted communication can have socially undesirable effects because it increases conflict expenditures even when compared to the no-communication situation.

Finally, our paper is also related to the literature on intergroup conflicts in social psychology starting from the seminal Robbers Cave experiment (Sherif et al., 1961) to numerous structural and motivational approaches proposed to investigate the impact of intergroup competition on human cooperation (Bornstein and Ben-Yossef, 1994). This has consequently led to various laboratory (Bornstein and Erev, 1994) and field (Erev et al., 1993) studies on intergroup conflicts in social dilemmas. The finding that competition against another group in social dilemmas increases within group cooperation is regarded as an exceptionally robust result in the social psychology literature (for an overview see Bornstein 2003).

The remainder of the paper is organized as follows. In section 2, we introduce the experimental design. In section 3, we characterize several benchmark expenditure levels relaxing the assumption that communication may enhance cooperation and coordination only through self-interested opportunism. After presenting and analyzing the data in section 4, we conclude in section 5 with a brief discussion of our results.

2. Experimental Design

Our conflict model between two rivaling groups is based on Abbink et al. (2010). Our experimental design consists of four treatments with varying communication structures and opportunities to punish. In the baseline treatment (NOCOM), the contest game is implemented without communication opportunities between participants. This treatment serves as a control condition and creates a clean benchmark that is used to assess the effects of different communication structures.

The restricted communication treatment (REST) allows participants to send messages within their own group, but rules out all explicit means to communicate between participants that belong to distinct conflict parties. The open communication treatment (OPEN) offers an open communication forum for all participants from the two conflict parties. This is to say that all messages are public for all members in both groups. The fourth treatment (REST+PUN) combines intra-group communication with an opportunity to punish one's own group members, but not members of the other group.

The conflict between the two groups (**X** and **Y**) with four members in each group was repeated for 20 identical periods with a partner matching protocol to capture the dynamic pattern of group conflicts, meaning that both the composition of groups and conflict pairs stayed intact throughout the whole game. Participants' experimental identities used to inform other group members about individual expenditures were reshuffled after each period to rule out reputation effects. At the beginning of all 20 periods, each group member received an endowment of 1000 monetary units (MUs) and had an opportunity to contribute any integer amount x_i to a group account. Any MU not contributed to the group account automatically remained in the participant's private account.

After all participants in both groups had made their individual contribution decisions the winner of the contest was probabilistically determined on grounds of the relative total expenditures between the two rivaling groups. A prize of 4000 MUs was allocated to the group with a probability that equals the total number of MUs invested by individuals belonging to the same conflict party divided by the sum of MUs invested by all participants. The prize was equally distributed among all members of the winning party independent of their individual investments to capture the non-rival and non-excludable nature of group specific rent-seeking that creates intra-group free-riding incentives. After assigning the probability of winning for both groups the random procedure determining the contest outcome was visualized through a wheel of fortune that informed all participants whether their group had lost or won the contest. Consequently, the prize money of 1000 MUs per group member was transferred to participants' cumulative accounts in the winning group. If both groups did not invest any MUs then the prize was not assigned to any group.

In REST+PUN, after being informed of the contest outcome, individual expenditures, and earnings of their fellow group members as well as the total expenditures by the competing group, participants could assign a maximum of 500 deduction points toward their own group members. Punishment was costly. Each deduction point cost the punisher 1 MU and reduced the earnings of the receiver by 3 MUs. Participants could refrain from punishing by entering '0' in the corresponding field on their computer screen. An experimental rule guaranteed that no participant could incur negative payoffs due to received punishment points. The possibility to assign punishment points was, however, guaranteed after all possible outcomes by allowing subjects to procure negative earnings through the cost of punishment. Participants were not informed about the individual punishment decisions of other subjects. They neither knew who punished them nor whether and how strongly other group members were punished.

2.1. Experimental procedures

The main characteristic of our experimental design is the controlled variation of communication structures. In all treatments, except NOCOM, participants were brought together in an on-line chat before each decision period. Open-ended communication allows participants to exchange ideas, coordinate behavior, and discuss the expected strategy of other participants, while preserving full anonymity among the participants and isolating the effect of mere textual exchange of messages from visual or verbal cues such as vocal intonation, facial expression, and body language. In the chat room, participants were free to discuss anything, except for restrictions against threats and offers of side-payments, revelation of one's true identity, and insulting language. Chat room messages were monitored in real time to guarantee proper conduct during the experimental sessions. Each communication stage lasted for 90 seconds.

The experiment was conducted at the laboratory of the Max Planck Institute of Economics in Germany. The experiment was programmed and run using the z-Tree (Fischbacher, 2007). A total number of 224 participants (125 women, 83 men, 16 missing data on gender) in ten sessions participated in the experiment. Participants were mainly undergraduate students from a wide range of academic disciplines. Upon arriving at the laboratory, participants were randomly assigned to their cubicles preventing communication and visual interaction. They were given detailed instructions and a number of control questions on paper. Instructions were read aloud including the examples. The experiment began after participants had answered all control questions correctly. After the experiment participants were paid privately in cash according to their performance. On average, the experiment lasted 90 minutes. Earnings per participant ranged from €10.50 to €23.50 with an average of €16.

3. Benchmark Expenditures

The number of repeated periods in all experimental treatments was common knowledge. Thus, the risk-neutral Nash equilibrium (RNNE) in each game stage coincidences with the only subgame perfect Nash equilibrium of the finitely repeated game. Let X and Y denote the sum of expenditures by individual players in their respective groups whereby the prize is allocated to group **X** with a probability of $X/(X+Y)$ and to group **Y** with a probability of $Y/(X+Y)$. Assuming that the participants are only motivated by their own material welfare the payoff function for a representative player i in group X can be written as

$$\Pi_i = E_i + \frac{X}{X+Y}1000 - x_i, \tag{1}$$

where E denotes the player's initial endowment. Taking the partial derivative subject to the player's decision to invest in the group account derives the first-order condition $(X+Y)^2 = 1000X$. Taking into account the fact that the contest is symmetric between groups, the material payoff maximization equivalently yields $(Y+X)^2 = 1000Y$ for a representative player in group Y. In equilibrium, the conflict parties have equal aggregate investments $X^* = Y^*$ such that the equilibrium benchmark is 250 MUs per conflict party.

The standard prediction pertains only to groups as conflict parties, but leaves open the question how individual team members should share the burden. Consequently, any combination of investments by four group members that adds up to 250 MUs constitutes an equilibrium. The social dilemma structure within each group is due to the fact that the prize is shared equally among all group members. This creates intra-group tensions emblematic to situations characterized by models of team rent-seeking.

The standard subgame perfect equilibrium prediction is affected neither by communication opportunities nor by the opportunity to punish. Despite the non-binding and non-verifiable nature of communication, substantial arguments exist to revise the theoretical kernel that is used to predict individual behavior when allowing for communication. In light of experimental findings, one of the most conspicuous outcomes in the literature (Ostrom et al., 1994; Ledyard, 1995; Bochet et al., 2006) is that communication enhances cooperativeness. This has consequently inspired refinements of economic theory (Rabin, 1994; Farrell, 1995; Crawford, 1998) showing that the dissemination of useful information both about the other players' preferences and intentions increases the likelihood of establishing stable cooperative agreements among independently acting players. Yet, the debate is still ongoing as to why communication affects outcomes in diversely structured problems of strategic interaction. A comprehensive review of existing evidence suggests that the expression of voluntary, though non-binding, commitments and the development of joint group identity that supports the salience of shared social values seem to drive the observed effects of communication (Bicchieri, 2002; Bicchieri and Lev-On, 2007). In view of this literature, we expect that communication potentially changes the individuals' reference point for optimal behavior in our experiment.

Instead of opportunistically maximizing their own self-interest, individuals may express compassion toward other persons with whom they are able to share their thoughts about the correct behavioral approach and appropriate expenditure targets. That is, individuals may consider maximizing the joint payoff of their own group members or of those with whom they are engaged in communication. Following a similar approach as in Sutter and Strassmair (2009) we derive the optimal expenditures under different communication structures relaxing the assumption that communication may enhance cooperation and coordination only through self-interested opportunism.

Consider the restricted communication structure (REST), in which conflict parties are allowed to communicate with their own group members, but have no explicit means to send messages to participants that belong to opposing conflict party. Assuming that participants are motivated to maximize the joint welfare of their own group the payoff function for a representative group can be written as

$$\Pi_X = E + \frac{X}{X+Y}4000 - X, \tag{2}$$

where E denotes the sum of players' initial endowments within their respective group. Applying the same solution concept as in the case of self-interested opportunism, the first-order conditions for groups **X** and **Y** are $(X+Y)^2 = 4000X$ and $(Y+X)^2 = 4000Y$, respectively. Hence, the equilibrium optimal joint expenditure under the assumption that all other members of the group are maximizing the same target is 1000 MUs per conflict party.

Comparing the equilibrium expenditures between self-interested opportunism and an attempt to maximize the joint group welfare, it can be seen that the expenditure level most benefitting the group is higher than the level most beneficial for an individual. At the same time, all expenditures above 1000 MUs are harmful to the group. Yet, such excessive levels of expenditures are not completely unexpected. Should the intra-group communication encourage intergroup hostility that manifests the willingness to harm the opposing party, group members may consider maximizing the difference in payoffs between their own and the rivaling group. Such spiteful and malevolent motivations to reduce someone's payoff without any direct benefit to oneself or without directly reciprocating unfair action are not entirely uncommon in the economic literature (Herrmann et al., 2008; Herrmann and Orzen, 2008; Leibbrandt and López-Pérez, 2008) and thus may also play a role in environments characterized by group contests.

Assuming that the individuals are jointly maximizing the payoff difference between their own and the rivaling group the payoff function for a representative group can be written as

$$\Pi_X = (\frac{X}{X+Y}4000 - X) - (\frac{Y}{Y+X}4000 - Y). \tag{3}$$

Applying the same solution concept as above one derives the first order-conditions $(X + Y)^2 = 8000X$ and $(Y + X)^2 = 8000Y$ for both conflict parties. Solving this system of equations yields an equilibrium of 2000 MUs.

Consider next the intergroup communication structure (INTER) that offers open communication forum to all participants across the two conflict parties. Following the same line of argumentation as above and assuming that participants are motivated to maximize the joint payoff of those with whom they are engaged in communication the payoff function can be written as

$$\Pi = E + (\frac{X}{X+Y}4000 - X) + E + (\frac{Y}{Y+X}4000 - Y). \tag{4}$$

Considering the function re-written for both conflict parties as $\frac{4000(X+Y)}{X+Y} - (X + Y)$ and following the same procedures as above one recognizes that the joint payoff is maximized at the smallest possible positive level of expenditures, meaning that one of the individuals engaged in intergroup contest invests 1 MU to secure the presentation of the exogenous prize.

It is straightforward to see that the social efficiency is maximized at the smallest positive level of total expenditures. All investments above the minimum are socially wasteful independent of the communication structure or punishment opportunities. However, notice that all considered benchmark expenditures are aggregate quantities and do not allow us to shed light on question how expenditures should be divided within and between conflict parties. Individual free-riding incentives are present within the conflict party under any conceivable aggregate benchmark. A particularly convoluted decision problem is created when aiming to maximize the social efficiency as coordination is required not only within a conflict party but also between groups. An array of possible strategies to achieve a stable collusion between conflict parties to maximize the social welfare and their empirical relevance are discussed in the results section.

4. Results

The main scientific object of the study is to characterize the consequences of distinct communication structures on socially wasteful conflict expenditures. We begin the analysis by studying the differences between restricted and open communication structures on conflict expenditures and compare them to the case where no communication is possible (Result 1). Then, we study the effect of intra-group punishment in conjunction with restricted communication (Result 2) and the impact of communication on conformity (Result 3). Thereafter, we investigate the mechanisms that are at play in our treatments (Result 4). Finally, we consider the contents of communication and characterize different types of arguments and how they affect the outcomes of collective conflict behavior (Result 5).

Table 1 sets the stage for our analysis and provides an overview of the mean per-period conflict expenditures averaged over all periods across conflict parties in each treatment. A very large effect between different communi-

Table 1: Summary statistics on group expenditures by treatment

Treatment	Group expenditures (average)	Std.	Conflict pairs	Subjects
No-communication	1012.05	319.94	6	48
Restricted communication	1456.41	336.21	8	64
Open communication	352.87	390.90	8	64
Restricted com. + punishment	1396.07	492.49	6	48

cation structures on group contributions is observed. We find that conflict expenditures are more than fourfold in REST as compared to OPEN (Wilcoxon rank-sum test (two-tailed): Z=-3.151, n=16, p=0.002).[3] In addition, we find that conflict expenditures are significantly larger in REST as compared to NOCOM (WRS: Z=-2.066, n=14, p=0.039) and that conflict expenditures are significantly lower in OPEN as compared to NOCOM (WRS: Z=-2.324, n=14, p=0.020). The joint null hypothesis that the observations in these three treatments are drawn from identical populations is clearly rejected (Kruskall-Wallis two-tailed test: $\chi^2 = 13.119$, df=2, p=0.001). Mean group expenditures in all three treatments exceed the expected group expenditures based on the risk-neutral Nash-equilibrium (250 MUs). While mean group expenditures in OPEN are closest to the selfishness and social efficiency predictions, in the REST treatment mean group expenditures (1456.41 MUs) lie between the benchmarks that subjects maximize aggregated group outcome (1000 MUs) and the difference in outcomes between rivaling groups (2000 MUs).

Figure 1 depicts the temporal pattern of mean conflict expenditures in

[3]Notice that in our dataset each conflict pair (two rivaling four-person groups) constitutes a statistically independent observation used to evaluate the statistical significance of experimental results.

the 20 periods of all conflict parties in NOCOM, REST, and OPEN. We observe that the suggested sharp treatment differences in table 1 are robust over time. First, the dashed line for REST is always above the straight line for NOCOM. Second, the dotted line for OPEN is always below the straight line for NOCOM. Appendix A provides the temporal patterns for all conflict pairs separately and illustrates that our treatment differences are unlikely to be driven by outlier groups.

Figure 1 about here

Result 1. The effect of communication on conflict expenditures depends on the communication structure. Communication within conflict parties increases conflict expenditures, whereas open communication between conflict parties decreases conflict expenditures as compared to the no communication treatment.

The finding that communication spurred group members in REST to increase their conflict expenditures is consistent with the hypothesis that within group communication helps group members to establish a norm of no free-riding. Yet, group discussions frequently cover aspects of human behavior well beyond agreeing upon the level of contributions. Communication forums are used to establish group specific internal norms, as well as rhetorical sanctions for those who preach the mutual understanding. Parallel to verbal sanctions, recent studies have shown that a considerable fraction of individuals is willing to incur costs to punish free-riders which can help to mitigate collective action problems in the context of common-pool resources

(Ostrom et al., 1992) and public goods (Fehr and Gächter, 2000) but intensify such problems in the context of intergroup contests (Abbink et al., 2010). It has been suggested that communication (or "non-monetary" punishment) and monetary punishment can be independently used to establish a norm of no free-riding (Masclet et al., 2003) but that the social welfare is higher if individuals have the possibility to sanction both informally and formally (Noussair and Tucker, 2005). We were interested whether the opportunity to communicate with group members functions as a complement or substitute for costly punishment in intergroup contests.

Table 1 suggests that communication and punishment work as substitutes in the context of intergroup contests. The mean group conflict expenditure is not higher but insignificantly lower in REST+PUN as compared to REST (1396 vs. 1456 tokens; Wilcoxon rank-sum test: Z=-0.129, n=14, p=0.897). In figure 2, we observe that there is also no clear difference in the temporal patterns of these two treatments. Moreover, costly punishment in conjunction with free-form communication appears to primarily create a hypothetical threat that is rarely used in practice. Actual punishments were meted out only in two percent of all potential events. The rareness of punishment in conjunction with communication is in line with the contents of our communication protocols where participants oftentimes express their distrust on the usefulness of punishment. Similar findings pertaining to the combination of punishment and communication are reported in Janssen et al. (2010).

Figure 2 about here

Result 2. Conflict expenditures do not further increase when individuals have an opportunity to sanction their own group members in conjunction with restricted communication.

We complete the aggregate level analysis by examining the within-group dispersion of contest expenditures. Figure 3 depicts the development of median absolute differences in contest expenditures over all periods in all treatments. Following the same procedure as with the average expenditures, we reject the joint null hypothesis that the measures of dispersion for NOCOM, REST, OPEN, and REST+COM are drawn from identical populations (Kruskall-Wallis two-tailed test: $\chi^2 = 11.969$, df=3, p=0.007). We are similarly able to reject the null hypothesis of identical populations using pairwise comparisons for NOCOM vs. REST (Wilcoxon signed rank test: Z=-3.098, n=14, p=0.002), NOCOM vs. OPEN (WSR: Z=-2.324, n=14, p=0.020), and NOCOM vs. REST+PUN (WSR: Z=-2.882, n=14,p=0.004). In comparison, no significant difference in within-group dispersion between treatments with communication is found (Kruskall-Wallis two-tailed test: $\chi^2 = 0.638$, df=3, p=0.727).[4]

Figure 3 about here

We provide further evidence on the effect of communication structures in group contests by examining the responsiveness of conflict parties to opponents' behaviour in each pair across treatments. Figure 4 displays average group level contest expenditures in each conflict pair during the last five periods of the experiment. From the figure it is clear that the possibility of

[4]Other measures of statistical dispersion - range and coefficient of variation - yield qualitatively similar results for within group variation.

intergroup communication had a marked effect on the likelihood to achieve a stable coalition between conflicting groups. Remarkably, in five out of eight pairs the agreement of cooperation through mutual communication opportunity is sustained even in the last period of interaction.

Figure 4 about here

Despite considerable variation in group contributions between and within treatments, conflict parties' expenditures appear to reflect their opponents' behavior. To assess this intuition, we apply single measure random effect intraclass correlation coefficients that account for the fixed degree of relatedness among paired conflict parties in our experimental design. The coefficients are calculated using data that is aggregated over all periods in the group in question. A value of 0.825 ($p < 0.000$) is obtained when pooling the data over all treatments. Yet, more detailed examination reveals a strong divergence in behavior between treatments. Computation of intraclass correlation coefficients separately for each treatments yields a value of 0.014 (p=0.477) for NOCOM, a value of 0.631 (p=0.027) for REST and a value of 0.951 ($p < 0.000$) for OPEN and a value of 0.853 (p=0.004) for REST+PUN. The illustrated behavioral patterns and statistical tests offer support for the observation that communication, independent of its structure, prepares the ground for conformist behavior that follows the goals mutually agreed upon the members of the discussion forums.

Result 3. Communication, independent of its structure, prepares the ground for conformist behavior in group conflicts.

Table 2: Determinants of group expenditures in period t by treatment

Conflict expenditures by group in round t				
Independent variables (Fixed effects)	No Com.	Restricted Com.	Open Com.	Restricted Com. + punishment
Own group expenditures in period t-1	0.222**	0.125*	-0.022	0.025
	(.067)	(.063)	(.055)	(.078)
Opponent's expenditures in period t-1	0.064	0.124*	0.185**	0.261**
	(.067)	(.063)	(.055)	(.078)
Conflict outcome in period t-1 [1=win]	-49.473	-0.409	-104.325**	-79.687
	(41.560)	(101.819)	(33.125)	(148.65)
Period	-11.016**	-24.132**	-0.079	-40.256**
	(3.732)	(8.566)	(2.997)	(12.032)
Constant	853.876**	1348.997**	329.95**	1465.36**
Random intercepts				
Group	Yes	Yes	Yes	Yes
Observations	228 (12)	304 (16)	304 (16)	228 (12)
Log-likelihood	-1625.02	-2451.67	-2163.89	-1864.04

Multilevel regression coefficients of the determinants of contributions to group account in treatments with and without communication opportunity. The benchmark value for the outcome dummy is win in the previous period. **Significant at 1%; *Significant at 5%; +Significant at 10%. Numbers in parenthesis indicate standard errors.

To investigate the determinants of observed group contributions, we build various multilevel regression models to account for the fact that both individuals and conflict parties undergo repeated measurements and each conflict pair creates a cluster of related groups. Our particular interest is to analyze the extent to which group behavior is guided by the decisions within the own group vis-à-vis the decisions made by the opponent group in the preceding rounds. Results in table 2 provide evidence that the nature of conditional behavior is grounded on the structure of communication. In NOCOM, participants are inclined to only take into account the preceding action within their own group ($p < 0.01$). They neither reckon with the available information regarding the opponent's behavior nor with the conflict outcome. This picture dramatically changes in treatments with communication.

In REST, the regression coefficients for the lagged expenditures within and across groups reveal that group behavior is conditioned on the preceding action both within the own group and the opposing group ($p < 0.05$). The higher the opponents' expenditures in the preceding period, the higher the combined group expenditures are within the own conflict party. The latter relationship also occurs in REST+PUN ($p < 0.01$). This suggests that intra-group communication is likely to mediate vicious circles of tensioned group responses which lead to the socially wasteful dissipation of resources. In contrast, in OPEN we observe that the regression coefficients indicate a significantly negative effect of winning the prize in the previous round on current group expenditures ($p < 0.01$). Furthermore, we find that under intergroup communication conditional behavior is restricted to the preceding action in the opposing group ($p < 0.01$) and not affected by the outcome within one's own group. Combining these findings with the picture of behavior that emerges from figure 4, we are able to supplement the intuition with econometric evidence. The observed behavioral patterns suggest that the stable collusion between conflict parties under open communication structure takes place through suggestions to take turns in winning the contest.

Result 4. Communication shifts the focus of conditional behavior from one's own party to the behavior of the conflicting party. In the case of open communication, winning the contest decreases conflict expenditures in the subsequent period, suggesting that conflict parties cooperate by taking turns winning the contest.

To better understand the motives behind individual decisions we con-

Table 3: Determinants of individual expenditures in period t by treatment and time frame

	Conflict expenditures by individual in period t							
	No communication		Restricted communication		Open communication		Restricted com. + punishment	
Independent variables (fixed effects)	Periods 1-20 (1)	Periods 17-20 (2)	Periods 1-20 (3)	Periods 17-20 (4)	Periods 1-20 (5)	Periods 17-20 (6)	Periods 1-20 (7)	Periods 17-20 (8)
Own expend.	0.117**	0.118	0.086	0.063	-0.010	-0.049	0.128	-.087
in t-1	(.038)	(.094)	(.778)	(.136)	(.351)	(.090)	(.162)	(2.580)
Group expend.	0.027	0.060	-0.001	-0.023	-0.007	0.124**	-0.037	0.058
in t-1	(.019)	(.040)	(.021)	(.041)	(.016)	(.035)	(.043)	(.646)
Rival's expend.	0.015	-0.003	0.025**	-0.002	0.043**	0.096**	0.037	0.012
in t-1	(.016)	(.032)	(.008)	(.022)	(.010)	(.027)	(.012)	(.037)
Contest outcome	-11.695	-21.627	1.157	-47.308	-25.939**	-27.442+	-44.689+	-103.22+
in t -1 [1=win]	(10.05)	(27.03)	(13.40)	(34.10)	(6.24)	(15.04)	(23.84)	(54.59)
Period	-2.783**	-16.174	-6.595**	19.112+	-0.053	-7.710	-17.554**	15.135
	(.904)	(10.88)	(1.125)	(10.562)	(.566)	(6.370)	(2.177)	(19.452)
Gender	-26.016	-32.370	-1.266	-30.538	11.950	20.441	-7.049	15.135
	(29.54)	(37.28)	(13.55)	(27.92)	(13.22)	(15.74)	(26.75)	(54.65)
Constant	223.08**	458.237*	317.70**	-58.724	78.711	167.316	490.127*	170.042
	(40.86)	(207.20)	(60.90)	(244.69)	(38.17)	(118.07)	(490.13)	(499.17)
Random intercepts								
Group	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Subject	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	912	192	1216	256	1216	256	608	128
	(12) (48)	(12) (48)	(16) (64)	(16) (64)	(16) (64)	(16) (64)	(8) (32)	(8) (32)
Log-likelihood	-5846.77	-1261.99	-8204.94	-1707.63	-7456.17	-1569.229	-4173.73	-869.85

Multilevel regression coefficients of the determinants of individual expenditures in treatments with and without communication opportunity. The benchmark value for the outcome dummy is win in the previous period; male for the gender dummy. **Significant at 1%; *Significant at 5%; +Significant at 10%. Numbers in parenthesis indicate standard errors.

struct regression models with individual conflict expenditures as the dependent variable. The models control for individual and group level heterogeneity, period effects, and gender. We present for all four treatments two models, one for all periods and one for the last four of the 20 periods. The estimation of lagged variables on individual data mainly reflects the results observed on group level data. While observing only a limited amount of path dependency in respect to one's own previous decisions, we find that the individual behavior is characterized by imperfect conditional cooperation in which subjects condition their behavior with a different source of feedback in different treatments. For example, in NOCOM we observe that individuals condition their conflict expenditures mainly on their own behavior in the preceding period (Model 1) and that in OPEN individual behavior is mainly conditioned on the conflict expenditures of the rivaling group and the contest outcome in the preceding period (Model 5).

By examining the dynamic pattern of individual contributions separately for the last quintile of the experiment, we statistically corroborate that conflict expenditures do not significantly drop towards the end of the game. Quite on the contrary, we observe that conflict expenditures even increase in REST ($p < 0.10$) and REST+PUN (*n.s.*). The four models (2,4,6,8) for the last quintile of the experiment suggest that our findings are robust and that treatment differences in conflict expenditures are unlikely to diminish if the game was continued for larger number of periods. The observation that conflict expenditures increase in treatments with intra-group communication when advancing toward the final period stands in sharp contrast with the common end-game effect where free-riding steeply increases when subjects know that the interaction is soon to reach its final stage (Selten and Stoecker, 1986; Andreoni, 1988). The reversed end-game behavior suggests that the dissipation of resources in intergroup conflicts far above the equilibrium expenditures cannot solely be explained by future concerns but require understanding of group dynamics behind the individual responses that indicate heightened willingness to engage in socially costly conflict.

In table 3, we also control for gender. A number of recent studies have suggested that men both have a higher desire for competitiveness than women (Niederle and Vesterlund, 2007) and may perform better in competitive environments (Gneezy et al., 2003). While our experiment does not require psychical effort or intellective skill, it can be understood as an abstract contest in which competitive effort choices are elicited. At the same time, it is to note that several previous studies have also found that women exhibit higher risk aversion under uncertainty (Eckel and Grossman, 2008). Should the potential gender difference in risk attitudes play a role in our experiment, the effect would, however, be parallel with the willingness to compete. Based on our experimental data, we find no evidence for gender differences in conflict expenditures, neither in the treatment without communication nor in our three treatments with communication ($p > 0.10$).

4.1. Analysis of communication

The result section finishes with a content analysis of communication in our three communication treatments. We study which kind of arguments different communication structures invoke and how these arguments influence individual expenditure decisions. Completing the quantitative analysis with analyzing the contents of the communication opens opportunities to directly observe the argumentative process underlying the strategic use of communication. Our approach to this analysis follows recent developments in the

Table 4: Categories of classified messages and their descriptions

C1	Concrete proposal	Explicit proposal to contribute certain amount
C2	Equal terms within group	Proposal to choose equal contributions within group
C3	Unequal terms within group	Proposal to choose unequal contributions within group
C4	Other's shoes	Attempt to understand desires and intentions of the other group
C5	Conditional decision	Proposal to condition on other likely contribution
C6	Forward looking argument	Proposal that recognizes the expected course of future interaction
C7	Individual commitment	Promise to commit to a certain individual contribution
C8	Proposal to take turns	Proposal to take turns between groups to win the competition
C9	Proposal to guarantee equal chance	Symmetric contributions between groups to guarantee equal probability of winning

economics literature combining the quantitative and qualitative methods of social science (Cooper and Kagel, 2005).

We developed a coding system for different types of arguments based on both ex-ante theoretical considerations and reading through parts of the conversations to establish empirically relevant categories of argumentation. The full list of considered categories including their labels and detailed descriptions is shown in Table 4. In the second stage, two research assistants were independently trained to code the messages for each communication platform in each period, assigning a tick for all the categories that showed up in the given communication period. The level of agreement between coders was assessed by computing the average Cohen's kappa coefficients across all 9 cat-

Table 5: Relative frequency of classified categories

Category	Relative average frequency of coding			Measure of agreement
	REST	OPEN	REST+PUN	
Concrete proposal	.98 (.91)	.77 (.94)	.98 (1.00)	.59
Equal terms within group	.25 (.41)	.48 (63)	.21 (.71)	.54
Unequal terms within group	.06 (.03)	.09 (13)	.06 (.00)	.48
Other's shoes	.54 (.25)	.10 (.13)	.58 (.42)	.59
Conditional decision	.13 (.03)	.02 (.00)	.16 (.25)	.25
Forward looking argument	.22 (.28)	.08 (.19)	.16 (.21)	.34
Individual commitment	.19 (.19)	.18 (.06)	.17 (.17)	.58
Proposal to take turns	.03 (.00)	.17 (.63)	.13 (.17)	.25
Proposal to guarantee chance	.01 (.00)	.15 (.56)	.02 (.04)	.32
Number of observations	320 (16)	160 (8)	240 (12)	Avg.=.44

Measure of agreement indicates the Cohen's kappa coefficient between two independent coders. Numbers in parenthesis refer to observed frequencies during the first communication period. Note that the open communication platform consist of eight individuals in two four person groups, whereas restricted communication platforms consist of four persons.

egories. We find a fair agreement across categories (Average=.44, Std.=.15) with considerable differences between single categories varying from .25 to .59 such that the greatest variance comes from the most infrequent categories. Finally, we averaged the data across independent coders to minimize the total error in categorization. All reported results relying on the categorization of communication protocols are based on averaged values.

Table 5 presents the relative frequency of the nine classified categories in REST, OPEN, and REST+PUN as well as the measure of agreement between the two coders. The numbers in parentheses illustrate the frequencies that a given category was discussed in the first period of communication. We observe that concrete contribution proposals are most frequently discussed whereas other categories such as 'unequal terms within group' are only rarely discussed. We furthermore find that some categories are frequently discussed throughout all periods whereas other categories are more often discussed

Table 6: Estimated effects of communication categories on group expenditures

	Total expenditure		
Independent variables	REST	OPEN	REST+PUN
Concrete proposal	239.19	265.67+	455.17
Equal terms within group	114.17	-504.34**	-428.01**
Unequal terms within group	∅	-215.68	∅
Other's shoes	23.77	214.14	-63.75
Conditional decision	55.81	∅	-49.26
Forward looking argument	59.29	∅	-279.07+
Individual commitment	227.39*	-139.63	203.80
Proposal to take turns	∅	-308.80*	-190.11
Proposal to guarantee equal chance	∅	112.82	∅
Period	-31.04**	-29.35**	-56.39**
Constant	1349.33**	953.94**	1782.86**
Number of observations	320	160	240
Number of groups	16	8	12

Feasible generalized least square estimates with heteroskedastic and correlated error structure for the effects of communication categories. ∅ Category excluded from the analysis if the frequency of observations was $< .10$. **Significant at 1%; *Significant at 5%; +Significant at 10%.

in the first period. For example, the category 'equal terms within group' occurred more often in discussions in the first period than in consecutive periods. We also observe that the content of communication is different across treatments. In particular, the two categories discussing forms of cooperation between conflict parties ('proposal to take turns' and 'proposal to guarantee equal chance') were often discussed already in the first period in OPEN ($frequency > 0.56$) but rarely in the other two treatments ($frequency < 0.17$).

In table 6, we estimate the total conflict expenditures on the occurrence of different communication categories applying feasible generalized least squares with random effects on the subject level to account for heteroskedasticity across panels. We observe that in REST the category 'individual commitment' is a significant factor predicting conflict expenditures whereas the other communication categories do not play a significant role. In contrast, in OPEN the categories 'equal terms within group' and 'proposal to take turns' have a significant negative effect on conflict expenditures. Tables 5 and 6 provide further evidence that conflict expenditures in OPEN are lower than in the other treatments because subjects discussed and successfully followed the strategy of taking turns.

5. Conclusions

In this study, we provide evidence challenging the view that communication is a universal means to mitigate collective action problems and show the relevance of communication structures in intergroup conflicts. We demonstrate that communication per se is not a panacea. In particular, in situations like intergroup conflicts it can even intensify the waste of resources on conflict expenditures. Our study may help to understand the behavioral mechanism leading to substantial social inefficiencies observed in many areas of human social interaction.

We find that conflict expenditures are significantly lower if there is open communication within and between rivaling groups as compared to when there is no communication. By combining econometric analysis with the contents of our communication platforms we are able demonstrate that this outcome is due to mutual understanding between conflict parties to take turns in winning the conflict. This finding complements a variety of field observations (Ostrom, 1990; Berkes, 1992), supporting the importance of turn taking as a strategy maintaining cooperative behavior in human societies.

This study shows that conflict expenditures, in particular, in the restricted communication treatments are well above the standard economic prediction, even towards the end of the game. This finding is in line with the appearance of the 'homo rivalis' (Herrmann and Orzen, 2008), a concept assuming that in environments characterized by the simultaneous existence of efficiency enhancing reciprocity and competitive motives, participants' contributions are mainly driven by rivalrous attitudes and less by fairness or reciprocity. Yet, the observation that groups in the open communication treatment are frequently able to completely avoid socially wasteful conflict expenditures supports concepts that take into account how communication can shift the individual reference points for optimal behavior.

Our findings may have policy implications. One possible example of such implications is provided in the area of public funding of innovation activities. The reported success of innovation races that offer monetary prizes to spur innovation has recently led to a surge in indivisible incentive prizes typically worth millions of dollars.[5] As a response to this development catalyzed by private-sector groups and charitable organizations, governments around the world are now becoming keen to start offering prizes to encourage publicly funded innovation races. At the same time, incentives that encourage research teams to compete for an indivisible prize are likely to attenuate the exchange of information between researchers before the innovation threshold justifying the prize is reached. Our results indicate that the geared transition toward cash prizes in public innovation funding needs to be considered soberly to avoid socially wasteful replication of similar research strategies.

The finding that open communication can significantly reduce conflict ex-

[5]See The Economist, Aug 7th 2010 (pp. 63-64), on the recent surge in innovation prizes.

penditures suggests that policy makers and managers may be able to soften inter-group conflicts by providing an open communication infrastructure between rivaling groups, thus reducing resource waste. We have to acknowledge both the competitive nature nature of human behavior in intergroup conflicts and the capability to cooperate in avoiding unnecessary rivalry given a suited institutional environment.

References

Abbink, K., Brands, J., Herrmann, B., Orzen, H., 2010. Intergroup conflict and intra-group punishment in an experimental contest game. American Economic Review 100, 420–47.

Andreoni, J., 1988. Why free ride? strategies and learning in public goods experiments. Journal of Public Economics 37, 291304.

Angelopoulos, K., Philippopoulos, A., Vassilatos, V., 2009. The social cost of rent seeking in europe. European Journal of Political Economy 25, 280–299.

Aoyagi, M., 2007. Efficient collusion in repeated auctions with communication. Journal of Economic Theory 134, 61–92.

Balliet, D., 2010. Communication and cooperation in social dilemmas: A meta-analytic review. Journal of Conflict Resolution 54, 39–57.

Berkes, F., 1992. Success and failure in marine coastal fisheries of turkey, in: Making the Commons Work: Theory, Practice, and Policy, D.W. Bromley (eds.), Institute for Contemparary Studies, San Francisco.

Bicchieri, C., 2002. Covenants without swords: group identity, norms, and communication in social dilemmas. Rationality and Society 14, 192–228.

Bicchieri, C., Lev-On, A., 2007. Computer-mediated communication and cooperation in social dilemmas: an experimental analysis. Politics, Philosophy & Economics 6, 139–168.

Bochet, O., Page, T., Putterman, L., 2006. Communication and punishment in voluntary contribution experiments. Journal of Economic Behavior & Organization 60, 11–26.

Bornstein, G., 2003. Integroup conflict:individual, group and collective interests. Personality and Social Psychology Review 7, 129–145.

Bornstein, G., Ben-Yossef, M., 1994. Cooperation in intergroup and single-group social dilemmas. Journal of Experimental Social Psychology 30, 52–67.

Bornstein, G., Erev, I., 1994. The enhancing effect of intergroup competition on group performance. International Journal of Conflict Management 5, 271–283.

Congleton, R.D., 1986. Rent-seeking aspects of political advertising. Public Choice 49, 249–268.

Cooper, D.J., Kagel, J.H., 2005. Are two heads better than one? team versus individual play in signaling games. American Economic Review 95, 477–509.

Crawford, V., 1998. A survey of experiments on cooperation via cheap talk. Journal of Economic Theory 78, 286–298.

Dasgupta, P., Stiglitz, J., 1980. Industrial structure and the nature of innovative activity. Economic Journal 90, 266–93.

van Dijk, F., Sonnemans, J., van Winden, F., 2001. Incentive systems in a real effort experiment. European Economic Review 45, 187–214.

Eckel, C.C., Grossman, P.J., 2008. Men, women, and risk aversion: Experimental evidence, in: Handbook of Experimental Economics Results; edited by Charles R. Plott and Vernon L. Smith, Elsevier.

Erev, I., Bornstein, G., Galili, R., 1993. Constructive intergroup competition as a solution to the free rider problem: A field experiment. Journal of Experimental Social Psychology 29, 463–478.

Farrell, J., 1995. Talk is cheap. The American Economic Review, Papers and Proceedings 85, 186–190.

Fehr, E., Gächter, S., 2000. Cooperation and punishment in public goods experiments. American Economic Review 90, 980–994.

Fischbacher, U., 2007. z-tree: Zurich toolbox for ready-made economic experiments. Experimental Economics 10, 171–178.

Gneezy, U., Niederle, M., Rustichini, A., 2003. Performance in competitive environments: Gender differences. The Quarterly Journal of Economics 118, 1049–1074.

Herrmann, B., Orzen, H., 2008. The appearance of homo rivalis: Social preferences and the nature of rent seeking. Technical Report 2008-10. The Centre for Decision Research and Experimental Economics, School of Economics, University of Nottingham.

Herrmann, B., Thöni, C., Gächter, S., 2008. Antisocial punishment across societies. Science 319, 1362–1367.

Isaac, R.M., Reynolds, S.S., 1988. Appropriability and market structure in a stochastic invention model. The Quarterly Journal of Economics 103, 647–71.

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

Janssen, M., Holahan, R., Lee, A., Ostrom, E., 2010. Lab experiments for the study of social-ecological systems. Science 328, 613–617.

Kandori, M., Matsushima, H., 1998. Private observation, communication and collusion. Econometrica 66, 627–652.

Konrad, K.A., 2007. Strategy in Contests - An Introduction. Technical Report 2007-01. WZB-Markets and Politics Working Paper No. SP II.

Konrad, K.A., 2009. Strategy and Dynamics in Contest. Oxford University Press, Oxford.

Krueger, A., 1974. The political economy of the rent-seeking society. American Economic Review 64, 291–303.

Ledyard, J., 1995. Public goods: A survey of experimental research, in: The Handbook of Experimental Economics; Kagel, John H. and Roth, Alvin E. (eds.), Princeton University Press, Princeton.

Leibbrandt, A., López-Pérez, R., 2008. The Envious Punisher: Understanding Third and Second Party Punishment with Simple Games. IEW - Working Papers iewwp373. Institute for Empirical Research in Economics.

Masclet, D., Noussair, C., Tucker, S., Villeval, M.C., 2003. Monetary and nonmonetary punishment in the voluntary contributions mechanism. American Economic Review 93, 366–380.

McCutcheon, B., 1997. Do meetings in smoke-filled rooms facilitate collusion? Journal of Political Economy 105, 330–50.

Millner, E.L., Pratt, M.D., 1989. An experimental investigation of efficient rent-seeking. Public Choice 62, 139–151.

Mohammad, S., Whalley, J., 1984. Rent seeking in india: Its costs and policy significance. Kyklos 37, 387–413.

Nalbantian, H.R., Schotter, A., 1997. Productivity under group incentives: An experimental study. American Economic Review 87, 314–41.

Niederle, M., Vesterlund, L., 2007. Do women shy away from competition? do men compete too much? The Quarterly Journal of Economics 122, 1067–1101.

Nitzan, S., 1994. Modelling rent-seeking contests. European Journal of Political Economy 10, 41–60.

Noussair, C., Tucker, S.J., 2005. Combining monetary and social sanctions to promote cooperation. Economic Inquiry 43, 649–660.

Öncüler, A., Croson, R., 2005. Rent-seeking for a risky rent - a model and experimental investigation. Journal of Theoretical Politics 17, 403–429.

Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, New York.

Ostrom, E., Gardner, R., Walker, J., 1992. Covenants with and without a sword: Self-governance is possible. The American Political Science Review 86, 404–417.

Ostrom, E., Gardner, R., Walker, J., 1994. Rules, Games and, Common-Pool Resources. University of Michigan Press, Ann Arbor.

Parco, J.E., Amaldoss, W., Rapoport, A., 2005. Two-stage contests with budget constraints: An experimental study. Journal of Mathematical Psychology 49, 320–338.

Potters, J., de Vries, C.G., van Winden, F., 1998. An experimental examination of rational rent-seeking. European Journal of Political Economy 14, 783–800.

Rabin, M., 1994. A model of pre-game communication. Journal of Economic Theory 63, 370–391.

Sally, D., 1995. Conversation and cooperation in social dilemmas: A meta-analysis of experiments from 1958 to 1992. Rationality and Society 7, 58–92.

Selten, R., Stoecker, R., 1986. End behavior in sequences of finite prisoner's dilemma supergames: A learning theory approach. Journal of Economic Behavior & Organization 7, 47–70.

Sherif, M., Harvey, O., White, B.J., Hood, W.R., Sherif, C.W., 1961. Intergroup conflict and cooperation: the Robbers Cave experiment. University of Oklahoma Book Exchange, Norman.

Shogren, J.F., Baik, K.H., 1991. Reexamining efficient rent-seeking in laboratory markets. Public Choice 69, 69–79.

Snyder, J.M., 1989. Election goals and the allocation of campaign resources. Econometrica 57, 637–660.

Sutter, M., Strassmair, C., 2009. Communication, cooperation and collusion in team tournaments - an experimental study. Games and Economic Behavior 66, 506–525.

Tullock, G., 1967. The welfare costs of tariffs, monopolies, and theft. Western Economic Journal 5, 224–232.

Tullock, G., 1980. Efficient rent-seeking, in: Towards a Theory of the Rent-seeking Society; J. Buchanan, R. Tollison and G. Tullock (eds.), Texas A & M University Press, Collece Station.

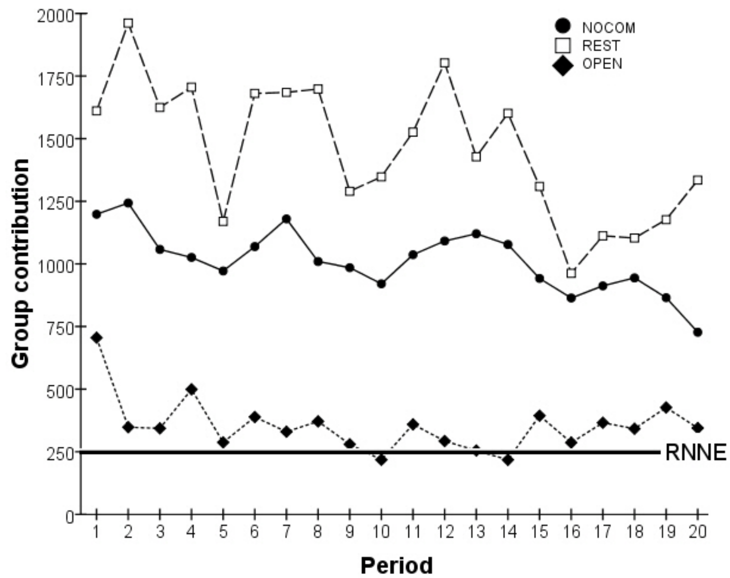


Figure 1: Group level average expenditures over time

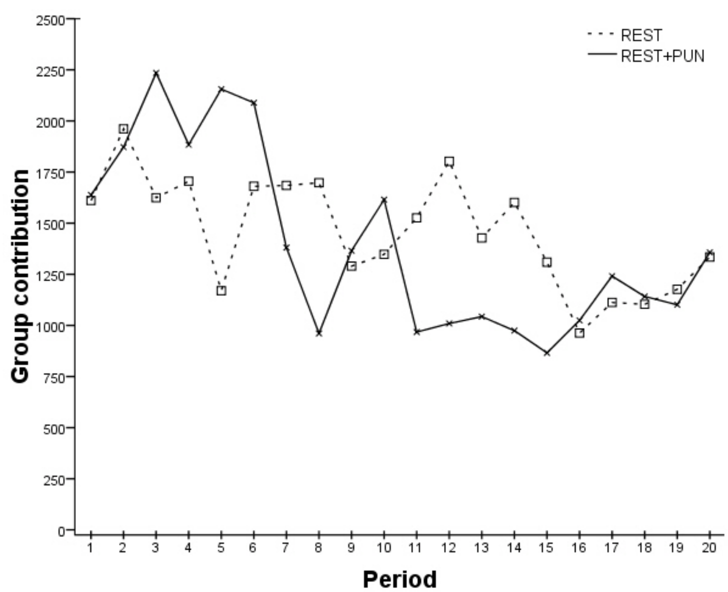


Figure 2: Group level average expenditures over time with and without punishment

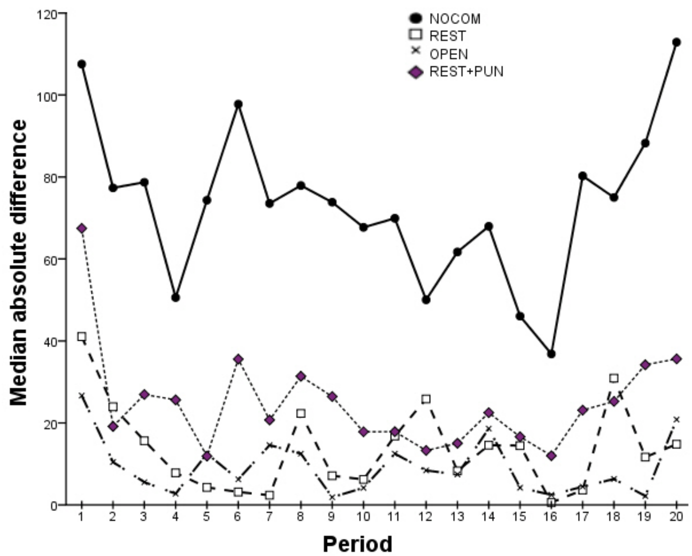


Figure 3: Median absolute differences in individual contributions by treatment

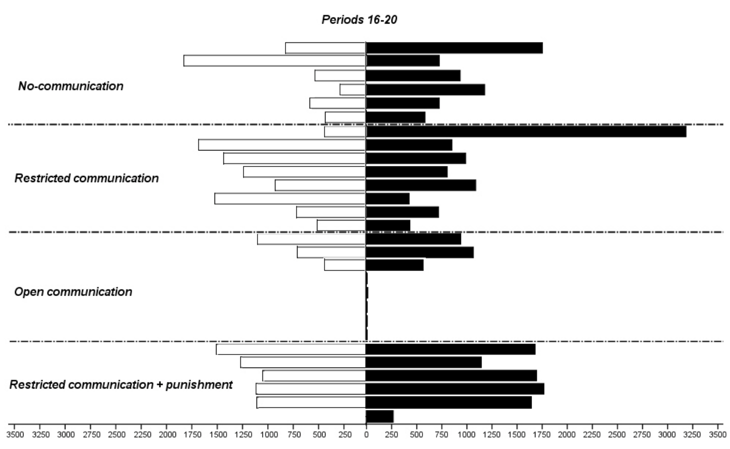
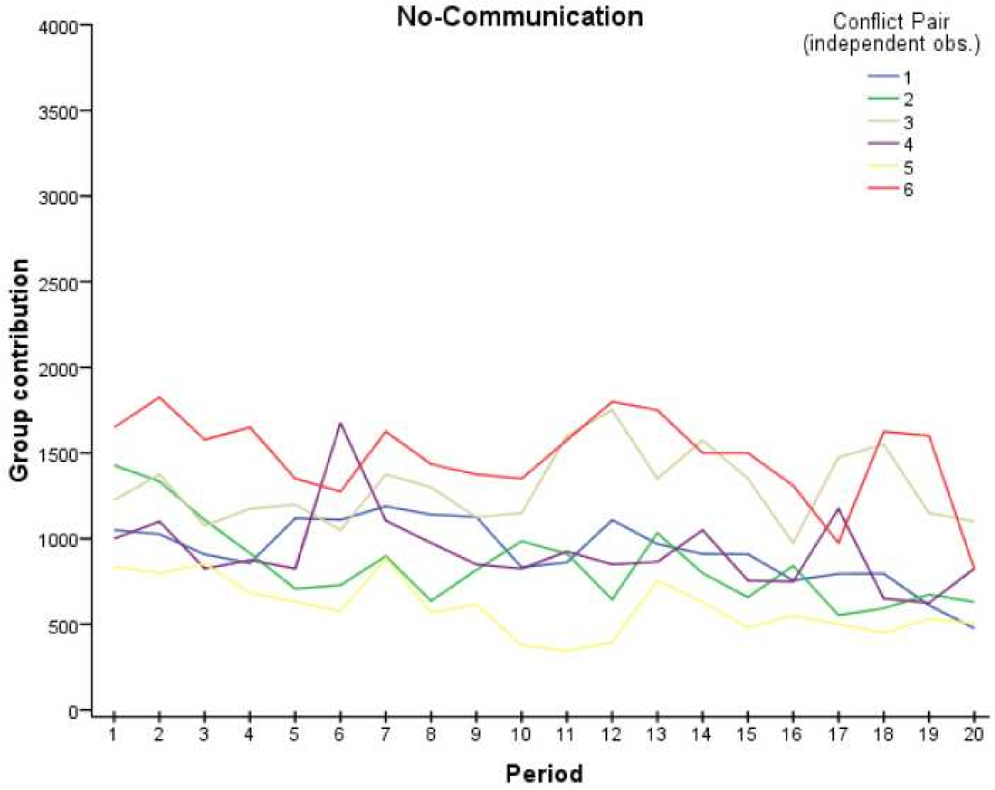


Figure 4: Average conflict expenditures per conflict party in MUs

Appendix A


No-Communication
Conflict Pair
(independent obs.)
1
2
3
4
5
6
Group contribution
0
500
1000
1500
2000
2500
3000
3500
4000
Period
1
2
3
4
5
6
7
8
9
10
11
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17
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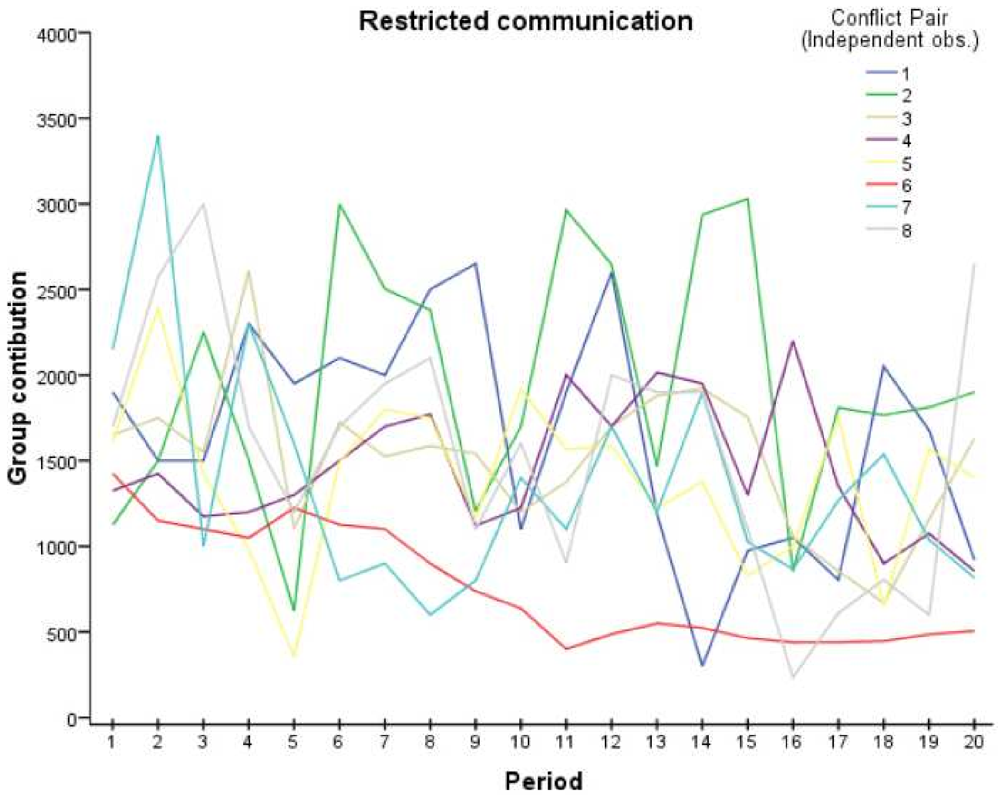
19
20


Restricted communication
Conflict Pair
(Independent obs.)
1
2
3
4
5
6
7
8
Group contibution
0
500
1000
1500
2000
2500
3000
3500
4000
Period
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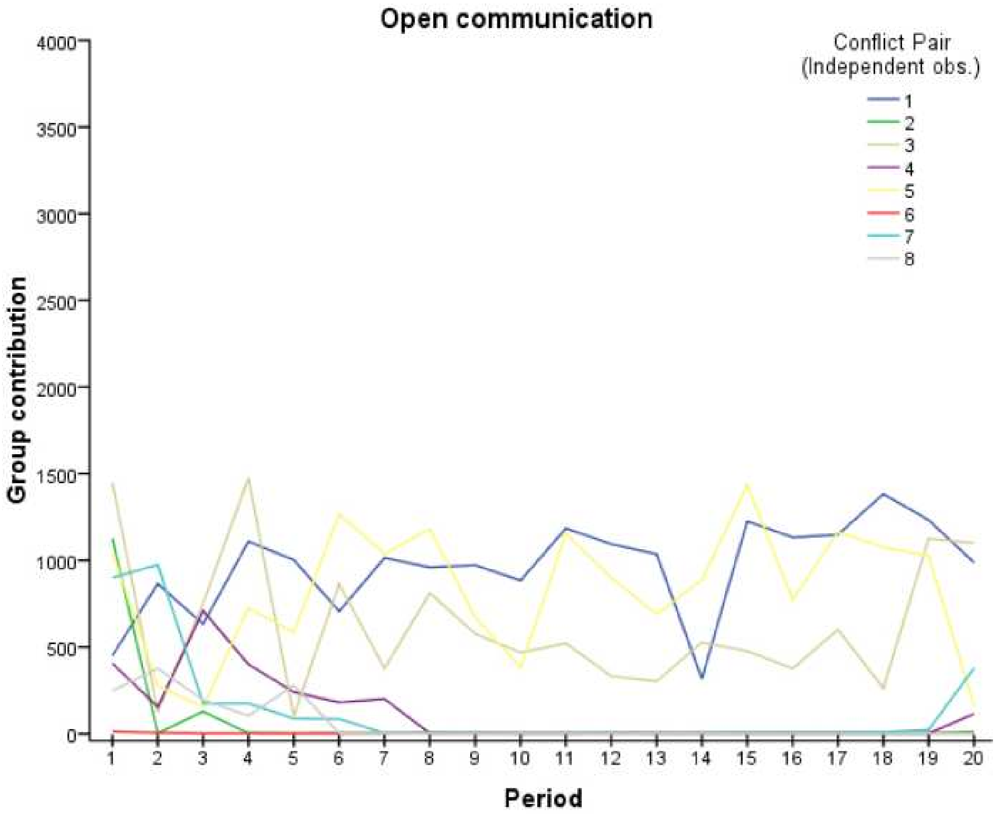
Open communication
Conflict Pair
(Independent obs.)
1
2
3
4
5
6
7
8
Group contribution
Period
0
500
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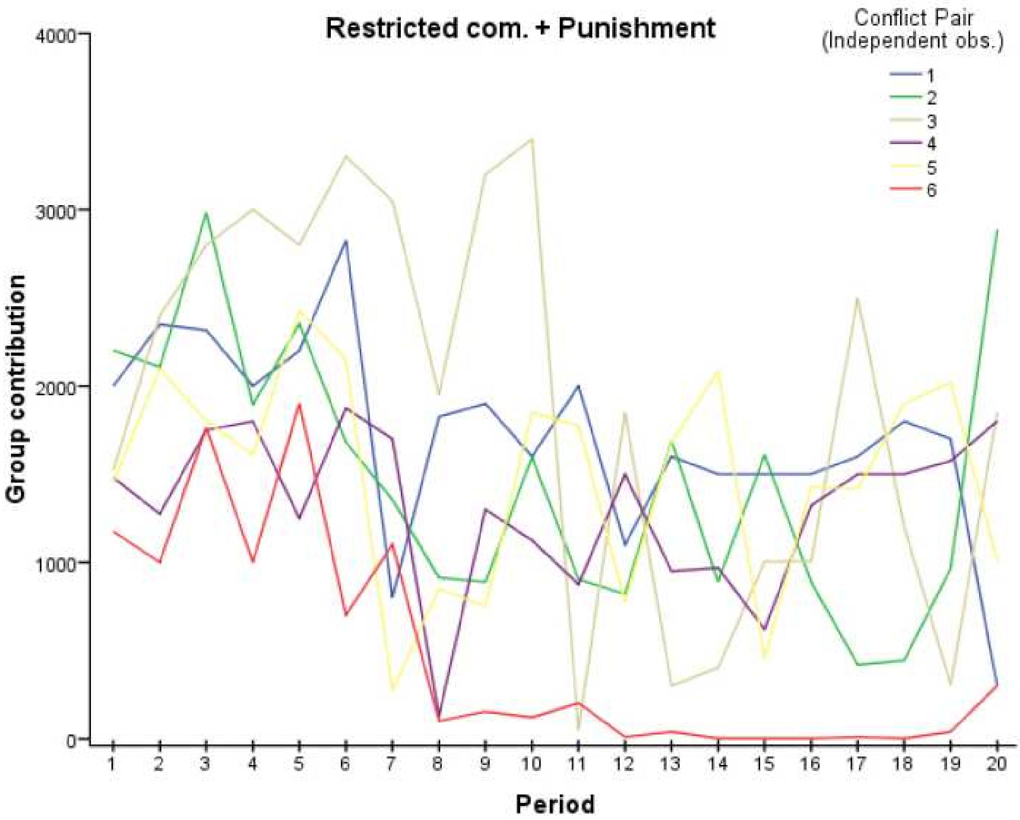
1500
2000
2500
3000
3500
4000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20


Restricted com. + Punishment
Conflict Pair
(Independent obs.)
1
2
3
4
5
6
Group contribution
Period
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1000
2000
3000
4000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Appendix B

Instructions

Thank you for coming! You are now about to take part in an experiment on decision making. You have earned 2.50 Euro for showing up on time. Reading carefully the following instructions and taking part in the experiment you can earn a considerable amount of money depending both on your own decisions and on the decisions of others.

These instructions and the decisions to be made are only for your private information. During the experiment you are neither allowed to communicate in the laboratory nor with someone outside the laboratory. Please switch off your mobile phone. Any violation of these rules will lead to exclusion from the experiment and all payments. If you have any questions regarding the rules or the course of this experiment, please raise your hand. An experimenter will assist you privately.

During the experiment all decisions and transfers are made in points. Your total income will be calculated in points and at the end of the experiment converted to Euros at the following rate:

25 Points = 0.01 Euro

The experiment consists of twenty (20) consecutive decision periods. Your total earnings will be determined as a sum of your earnings from all these periods.

At the beginning of the experiment, participants will be divided into groups of four (4) individuals. During the experiment you will interact with your own group members and one other group of four participants. The composition of the groups will stay the same in each period. This means that you interact throughout the experiment with the same people both within your own group and in the other group. You will never be informed about the real identity of other participants in this experiment; neither will they know with whom they interact. Your total earnings will be privately paid in cash at the end of the experiment.

Experiment

At the beginning of each period all participants are endowed with 1000 Points. You can then use these points to invest in '**contest tokens**' for your team. Each contest token you buy costs you 1 point and you can purchase up to 1000 of these tokens. Any points you do not invest into contest tokens will simply be added to your point balance and are yours to keep. Likewise, your team colleagues and your opponents will have the chance to buy contest tokens in exactly the same way.

Contest for a prize

In each 20 periods, there will be contest for a prize between your own group and another group. **The prize is worth 4000 points - 1000 for each team member - and your chances of winning the prize depend on how many contest tokens your team has bought and how many contest tokens your opponents have bought**. As soon as everybody has chosen how many contest tokens to buy, a lottery wheel will determine whether your team or your opponents win the prize.

Lottery wheel

The lottery wheel is divided into two shares with different colours. One share belongs to your group and the other share belongs to the other group. The size of your share and the size of the other group's share on the lottery wheel are exact representations of the number of contest tokens bought by your group and the other group. For instance, if your team and your opponents have each bought the same number of contest tokens, each team gets a 50 percent share of the lottery wheel. If your team has bought twice as many contest tokens as the other group has, your team gets two thirds of the wheel and the other group gets one third of the wheel.

Once the shares of the lottery wheel have been determined, the wheel will start to rotate and after a short while it will stop at random. Just above the lottery wheel there is an indicator at the 12 o'clock position. If the wheel comes to a halt such that the indicator points at your group's share your group wins. If the wheel comes to a halt such that the indicator points at the other group's share, the other group team takes the prize and your group loses.

Short summary

Your chances of winning the prize increase with the number of contest tokens your group buys. Conversely, the more contest tokens the other group buys, the higher the probability that you lose. If one of the groups does not buy any contest tokens, the other group wins the prize with certainty. If nobody buys any contest tokens, no lottery takes place and nobody receives the prize.

Your total earnings

Your total earnings from the experiment will be determined as a sum of your earnings from your private points balance and income from the contest. This combined points balance will accumulate over all 20 periods.

Additional instructions for restricted communication treatment

Communication

At the beginning of each period, before you and your group members decide how many contest token you buy, you will have an opportunity to communicate with the other members of your group. The communication takes places in a chat forum and lasts at maximum 90 seconds. A clock will show you how much time you have left in the communication period. Should you need less than 90 seconds to communicate with the other group members, you can advance to a next stage by pressing the ‘OK’ button on your computer screen. Please notice that the participants in the other group have an equal chance to communicate with each other during the 90 seconds.

You and other members of your group are invited to use your keyboards to type messages to one another. At the beginning of the experiment a letter A, B, C or D has been assigned to you. When you type a message to communication platform, your identification letter will appear before the message. This letter will remain fixed during the whole experiment. You can indicate in the text of a message that the message is intended primarily for a particular team member, for instance by typing “I agree with you, C.” However, any message sent to your fellow group members will automatically appear on the screens of all members of your group (but not on those of members of the other team).

Communication Rules

During a communication period, you can discuss anything you like; including what you think is the best approach to the experiment, what you plan to do, or what you would like others to do. However, there are two important restrictions on the types of messages that you may send.

(1) You may not send a message that attempts to identify you to other team members. Thus, you may not use your real name, nicknames, or self-descriptions of any kind (“Tom Smith here,” “I’m the guy in the red shirt sitting near the window,” “It’s me,

Sandy, from French class," or even "As a woman [Latino, Asian- American, etc.], I think…").

(2) There must be no use of abusive language, and threats or promises pertaining to anything that is to occur after the experiment ends.

The team organizing this experiment will screen your messages. If your message is found to violate either rule, you may be excluded from the payment in this experiment.

Additional instructions for open communication treatment

Communication

At the beginning of each period, before you and your group members decide how many contest token you buy, you will have an opportunity to communicate with your group members and the members of the other group. The communication takes places in a chat forum and lasts at maximum 90 seconds. A clock will show you how much time you have left in the communication period. Should you need less than 90 seconds to communicate, you may advance to a next stage by pressing the 'OK' button on your computer screen. Please notice that all participants have an equal chance to communicate with each other during the 90 seconds.

You and other members of your group are invited to use your keyboards to type messages to one another. At the beginning of the experiment a letter A, B, C or D has been assigned to you. When you type a message, your identification letter, as well as your group number (which is either 1 or 2) will automatically appear before the message. The identification letter and number will remain fixed during the whole experiment. You can indicate in the text of a message that that message is intended primarily for the other group for instance by saying "I agree with group 1", or to a particular member of your or the other group, for instance by typing "I agree with you, C 1." However, any message sent to your and the other group members will appear on the screens of all members of your and the other group

Communication Rules

During a communication period, you can discuss anything you like; including what you think is the best approach to the experiment, what you plan to do, or what you would like others to do. However, there are two important restrictions on the types of messages that you may send.

1. You may not send a message that attempts to identify you to other team members. Thus, you may not use your real name, nicknames, or self-descriptions of any kind ("Tom Smith here," "I'm the guy in the red shirt sitting near the window," "It's me, Sandy, from French class," or even "As a woman [Latino, Asian- American, etc.], I think…").
2. There must be no use of abusive language, and threats or promises pertaining to anything that is to occur after the experiment ends.

The team organizing this experiment will screen your messages. If your message is found to violate either rule, you may be excluded from the payment in this experiment.

Additional instructions for restricted communication + punishment treatment

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At the end of each decision period, after the lottery wheel has come to a halt and the winning team is determined, you will see how much each member in your group invested into a group account. **You will now make a decision whether to decrease the earnings of your group members by assigning deduction points to them** (not to members of the other group). Notice that all members in your group have the same opportunity.

Your task is to decide how many deduction points you want to assign to each other member in your own group. You may assign up to 500 points in total in each period. If you do not want to change the earnings of a specific group member, you have to enter 0 into a corresponding input field on your computer screen. **Each deduction point you assign costs you 1 point and will decrease the earnings of its target by 3 points.** Similarly, the other members in your group an opportunity to assign deduction points to you. Each received deduction point will decrease your earnings by 3 points.

All deductions from the earnings after the contest stage will be determined as a sum of assigned and received deduction points from the current period. There is only one exception to this rule. Should the cost of **received** deduction points exceed the individual earnings after the contest stage, earnings will be reduced to zero. Nevertheless, a participant has always to incur the costs of all deduction points he/she **assigns.**

Control questions

a) If my group buys 1000 contest tokens, and the other group buys 2000 contest tokens in a period, what is the probability for my team to win the prize? _______________

b) If my group buys 0 contest tokens, and the other group buys 1 contest tokens in a period, what is the probability for my team to win the prize? _______________

c) If I buy 300 contest tokens, and my team wins the prize how many points do I collect in this period? ________________

d) If I buy 300 contest tokens, and each of my group members buys 200 contest tokens, how many points do I collect in this period if my team wins the prize? ____________
How many points do each of my group members collect in this period? _____________

e) If I buy 150 contest tokens, and the other team wins the prize in this period, how many points do I collect in this period? __________