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Economics Department

Annarita Colasante
Aurora García-Gallego
Andrea Morone
Tiziana Temerario

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Annarita Colasante
Universitat Jaume I & LEE
Department of Economics
guardiag@uji.es

Aurora García-Gallego
Universitat Jaume I & LEE
Department of Economics
mgarcia@eco.uji.es

Andrea Morone
Universitat Jaume I & LEE
Department of Economics
amorone@uji.es

Tiziana Temerario
Università degli Studi di Bari
Dpto. di Economia, Management e Diritto d'impresa
tiziana.temerario@gmail.com

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Abstract

We study whether intra-group competition fosters cooperation even when cooperate is not a dominant strategy. We arranged an experimental Public Good Game comparing contributions in a risky treatment with contributions in a baseline standard treatment. The intra-group competition was induced by assigning different marginal per capita return (MPCR) in accordance to the size of the contribution itself. Results show that risky MPCR are detrimental for cooperation, while intra-group competition significantly reduces free riding.

Keywords: cooperation; public good; intra-group competition; uncertainty

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The utopia of cooperation: does intra-group competition drive out free riding?

Annarita Colasante[a]

Aurora García-Gallego*[a]

Andrea Morone[a, b]

Tiziana Temerario[b]

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[a] LEE and Department of Economics, Universitat Jaume I, Avda. Sos Baynat s/n, 2006-Castellón, Spain.
* Corresponding autor: Department of Economics, Universitat Jaume I, Avda. Sos Baynat s/n, 12006-Castellón (Spain). Email: mgarcia@uji.es,
[b] Dipartimento di Economia, Management e Diritto d'impresa, Università degli Studi di Bari, Largo Abbazia Santa Scolastica 53, 70124-Bari, Italy.

1. Introduction

It is a well-documented fact that groups often fail to coordinate on the socially optimal outcomes (Ochs, 1995). Many scholars have studied coordination and cooperation failure. Both theoretical (Cooper and John, 1988; Cassar, 2007; Van Huyck et al., 1997) and experimental (Van Huyck et al., 1990; Van Huyck et al., 2002) works have addressed this topic with the aim of shedding some light on the complex dynamics of public goods social dilemmas. Under this approach abundant evidence about inter-group competition smoothing the process of group coordination has aroused (Bornstein et al. 2002, Cárdenas and Mantilla 2015, Böhm and Rockenbach 2013, for example). Markussen et al. (2013) show that inter-group competition increases contributions to the public goods, and stimulates intra-group cooperation. In line with these results, in a field experiment Augenblick and Cunha (2015) tested groups of Democratic donors providing them with information about contributions of members in their own group (Democrats) or contributions of members in the competing group (Republicans). Findings show that inter-group competition results in higher contributions. The aim of the present investigation is to verify whether intra-group rather than the inter-group competition may play a role in the sustainability of cooperation.

One of the biggest issues when addressing the problem of contribution to public goods is whether the rivalry among players – i.e. competition – may affect the extent of the contribution itself – i.e. cooperation. There are two kinds of competition: inter and intra-group competition. The former refers to competition between groups while the latter refers to competition among subjects in the same group. Let us take an example. Imagine the mayors of three towns competing for a brand new hospital or airport to be built in their own town. Indeed, every mayor would like the hospital or the airport to be placed as closer as possible to his/her town. Obviously, the closer is the hospital or the airport to the town the higher is the return for the citizens of the town. Suppose that, in order to solve the dilemma, the government decides to build the hospital or the airport in, or closer to, the town that contributed more. Will competition trigger higher contributions?

In a simulation study, in which subjects have to decide whether allocating the endowment on either a private or a public project, Bissey et al. (2003) report a negative correlation between cooperation and competition. In case of high competition, the whole contribution did not allow the public good to be produced, and investments in the public goods were significantly higher in case of no competition.

Our aim is to analyze the level of cooperation in different groups by focusing on the intra-group competition in the provision of a public good. We compare the effect of this competition with a risky treatment and with a baseline standard public good. We introduce the intra-group competition by assigning different MPCR according to the level of contribution.

The paper is organized as follows. Section 2 includes a brief review of the literature that motivates the paper. We explain in Sections 3 and 4 the main details of the experimental design. Section 5 shows the data analysis. Section 6 concludes.

2. Literature review

Our paper is motivated by at least two important strands of the literature. The first is the one related with public goods in a non-market context (seminal references are Bockstael and McConnell, 1993; Haab and McConnell, 2002; Smith and Van Houtven, 1998). As pointed out by Dawes (1980), the social dilemma that represents a public good results from the situation in which a group shares a non- excludable and non-rival outcome, and in which everybody have to decide whether to contribute. In the public group environment, each subject faces a social dilemma: on the one hand, the individual interest related to the personal profit and, on the other hand, the group interest linked to the common outcome. From an individual point of view, it is better not to contribute or "free ride" in order to maximise personal gains[1], assuming that individuals are rational and selfish, as economic theory requests. However, the socially desirable result (Pareto-efficient) is achieved only when all subjects contribute. Indeed, in such a case all individuals obtain the greatest aggregate payoff. Many effort has been done to find a solution for the free-riding problem: the introduction of a costly punishment (Fehr and Rockenbach, 2003), voluntary participation depending on the share of defectors (Semmann et al., 2003) and increasing MPCR (Colasante and Russo, 2016).

The second strand of the literature that motivates this paper is the one dealing with *competition*. Competition has long been trusted to correct for irrational behaviour (Arrow, 1987). However, as pointed out by Slembeck and Tyran (2004) empirical evidence is mixed in that some anomalies disappear in market settings while others are surprisingly persistent (Knez et al., 1985; Camerer, 1987; Cox and Grether, 1996; List, 2003; Hnug and Plot, 2001; Budescu and Maciejovsky, 2005). Free riding cannot be

[1] Such is the game-theoretic prediction since 'not to contribute' is a dominant strategy in the one-shot and in the finitely repeated version of the game.

considered an anomaly, since it is a well-known result from rational behaviour: *"For that which is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest; and only when he is himself concerned as an individual. For besides other considerations, everybody is more inclined to neglect the duty which he expects another to fulfil."* (Aristoleles, 1996).

Public good dilemmas with inter-group competition has been extensively analysed under the framework of step-level public goods games[2] (see Rapoport and Bornstein, 1987). The inquiry on the inter-group competition by using different social dilemma games leads to an important result: competition is a powerful tool to foster cooperation.

Bornsten and Ben-Yossef (1994) analysed the effect of inter-group conflict in a prisoner's dilemma game and they found out that the contribution is significantly higher when there is competition.

Bornstein et al. (2002) studied the effect of inter-group competition on behaviour in the minimal-effort game[3] and they observe that inter-group competition improved collective efficiency. Looking at the literature on PGG, one of the first contribution to the effect of competition is that by Tan and Bolle (2007). They analyse the effect of competition with and without monetary incentive and they detect a stronger effect of competition with monetary reward. Puurtinen and Mappes (2009) confirm that competition fosters cooperation even in a simple one shot game. Finally, an interesting contribution is by Markussen et al. (2014) where they ask to vote for competition. The majority of subjects shown a preference for competition and this led to a higher level of cooperation.

All these previous work have a common conclusion: inter-group competition endorses cooperative behaviour.

Even if our study has a similar motivation, it is substantially different. We will analyse a public goods game with intra-group competition in which the dominant strategy is to not to contribute and the Pareto efficient outcome is not an equilibrium.

[2] "In step-level […] public goods a funding threshold has to be reached before the good can be provided. […] The step-level public good game differs strategically from the linear public good game. In the one-shot linear public good game, the dominant strategy is not to contribute at all. In the one-shot step-level public good game multiple Nash equilibria exist. An inefficient Nash equilibrium involves nobody contributing. There are efficient Nash equilibria in pure strategies where three of the *n* players contribute (i.e., there are exactly enough contributions to reach the threshold)." (Schram et al., 2008).

[3] The group with the higher minimum won the competition and its members were paid according to the game's pay-off matrix. The members of the losing group received a zero payoff.

The aim of this paper is twofold: first of all, investigate if the intra-group competition has a strong impact on cooperation and, secondly, to verify if cooperation increases even when not cooperate is a dominant strategy.

In order to address our research question, we need to employ a competition institution that does not produce any mutation to the standard public goods game (i.e. subjects have to play a public goods game and not a step-level public goods game). To score our goal it appears natural to change the institution of competition. Unlike what considered in previous researches where subjects have competed for the public good, in our experiment subjects will compete for a better *individual* marginal return. Indeed, we consider three different MPCR (i.e. α_{HIGH}, α_{MEDIUM}, α_{LOW}) which are assigned endogenously according to the level of contribution. In other words, the subject with the highest contribution will receive the highest *individual* marginal return; the subject with the second highest contribution will receive the second highest *individual* marginal return, and so on, until the subject with the smallest contribution level will receive the smallest *individual* marginal return. Slembeck and Tyran (2004) proposed this competition institution in order to promote rationality in the three-door anomaly.

3. Framework and research questions

To study whether the effect of competition can promote cooperation even when cooperate is not a dominant strategy, we propose a repeated public good by assuring that the dominant strategy for each subject is not to contribute, and that the Pareto efficient outcome is not an equilibrium. This set up does not affect the equilibria space of the game. Let Π_i be the reward obtained by individual *i* in one period, this reward is be given by:

$$\Pi_i = e_i - c_i + \alpha_i \sum_{j=1}^{n} c_j \qquad i \neq j$$

where: e_i is the initial endowment, c_i is the contribution individual *i* makes to his/her group, α_i is the *individual* marginal return that the individual *i* receives. We run five treatments:

Treatment 1 (*T1*): an imperfect and certain information public goods game with partner matching protocol; this is the control treatment, in which α is fixed and equal to 0.6 for all subjects;

Treatment 2 (*T2*): an imperfect and uncertain information public goods game with partner matching protocol and risky α values; in this treatment each member is randomly ranked from one to three, regardless the size of his/her contribution, in a fashion that the first one receives α_{HIGH} the second one receives α_{MEDIUM} the third one receives α_{LOW};

Treatment 3 (*T3*): the same as *T2* but with different values of MPCR.

Treatment 4 (*T4*): intra-group competition public goods game with partner matching protocol In this treatment each member is ranked in accordance to the size of his/her contribution to the public good; subjects know that the first-highest contributor gets α_{HIGH} as return from the project, the second-highest contributor gets α_{MEDIUM} and the lowest contributor gets α_{LOW};

Treatment 5 (*T5*): the same as *T4* but with different values of MPCR.

In Table 1 there is a summary of the MPCR values in all treatments. We have chosen these values in order to test for the effect of implicit risk in the return. Thus, observe that values of α are such that risk is higher in *T2* than in *T3*, since the variability from high to low MPCR is higher in *T2*. Therefore, comparing *T2* and *T3* we should test for the effect on risk in the level of contributions to the public good.

	T1	*T2*	*T3*	*T4*	*T5*
α_{HIGH}	0.6	0.9	0.75	0.9	0.75
α_{MEDIUM}	0.6	0.6	0.6	0.6	0.6
α_{LOW}	0.6	0.3	0.45	0.3	0.45

Table 1: summary of the MPCR in each treatment

With respect to measuring the degree of intra-group competition, values of MPCR are such that in competition within the group is higher in *T5* than in *T4*. Thus, a comparison between these two treatments should highlight the effect of the degree of intra-group competition in the contribution levels of subjects.

It is important to underline that ties are possible in all treatments. When a tie occurs, the involved subjects get the average MPCR computed as follow: if we observe two "high" both subjects gets the average between α_{HIGH} and α_{MEDIUM}; in the case in which we observe two "low", we assign to both players the average between α_{LOW} and α_{MEDIUM}.

In treatments *T2* to *T5*, the α will depend on subjects' rank. The subject with the highest rank will receive the highest return α; the subject with the second highest rank will receive the second highest α, and so on, until the subject with the smallest rank will receive the lowest α.

In order to keep not to contribute as a dominant strategy and to assure that the Pareto efficient outcome will not be equilibrium, the following conditions have to be satisfied.

$$0 < \alpha_{min} \ldots < \ldots < \alpha_i < \ldots < \alpha_{max} < 1 \qquad (1)$$

$$n\alpha_{max} > \ldots > n\alpha_i > \ldots > n\alpha_{min} > 1 \qquad (2)$$

$$n\alpha_{aveg} < 1 + (n\text{-}1)\ \alpha_{min} \qquad (3)$$

Where $\alpha = \{\alpha_{min}, \ldots, \alpha_i, \ldots, \alpha_{max}\}$ is an ordered vector of marginal returns ($\alpha_{min,}$ α_{aveg} and α_{max} are the minimal α, average α and maximal α respectively) and n is the number of the subjects in each group.

The main idea is to promote cooperation, i.e. to increase the contribution amount in the group by ranking the level of contribution. In this way, we assume that, in order to get the highest MPRC, subjects would contribute more with respect to the condition in which the MPCR is fixed.

Our treatments are specifically designed to answer the following questions:

(1) Do subjects contribute less to the public good when its marginal value (α) is risky, rather than certain and the minimum α
   a. does not allow for efficiency gains?
   b. does allow for efficiency gains?

(2) Do subjects contribute more to the public good when facing *intra-group competition*?

To address question 1a and 1b, we compare *T1* with *T2* and *T3* respectively. To address question 2, we compare *T1* with *T4* and *T5*.

4. Experimental Procedures

A total of 360 undergraduate students from the Universitat Jaume I, Castellón (Spain) participated to the public good experiment. Upon entering the laboratory, they were randomly assigned to visually isolated computer terminals. The instructions (see appendix) were distributed y hardcopy. Each player received an endowment of 100 ECU, and had to decide – privately and anonymously – whether to keep the money for her/himself or to make any contribution (between 0 and 100) for her/his team's benefit.

The participants played 10 rounds of the game and the number of the rounds to be played was made known in advance. Subjects were informed of the matching protocol used, and it was carefully explained to the participants. Subjects had no opportunity to communicate within or between groups during the whole session.

In all treatments, subjects had perfect information about the contribution of other players in the same group at the end of each period, meaning that the contribution of all participants in the same group was public information within the group. Moreover, they had information about MPCR changes in depending on the treatment. In particular, participants in the control treatment (*T1*) knew that MPCR was the same for all subjects. Participants in the treatments with uncertainty (*T2* and *T3*) knew that the MPCR was randomly assigned and, therefore, that it was independent of the contribution. Finally, participants in the competition treatments (*T4* and *T5*) knew that the MPCR was proportional to the contributions and, therefore, that there was competition within the group.

In all treatments, at the end of each period, participants received feedback on their partner's contribution, the income from the project and their corresponding payoff. Average earnings per subject were around 12€.

At the end of period 10, we elicited each subject attitude towards risk. To do that, we implemented the *Lottery Panels risk elicitation task* of Sabater and Georgantzis (2002) where subjects choose their preferred lottery from each panel.[4] Figure 1 shows the four panels.

The higher the winning probability of the lottery chosen, the more risk averse the subject is. Risk neutral and risk loving subjects will choose the riskier option available to them. Furthermore, under standard assumptions, expected utility maximizers would choose weakly riskier options as we move from panel 1 to panel 4.

Figure 1: The Lottery Panels risk elicitation task

However, while this is the expected pattern under standard uni-parametric expected utility models, it is not necessarily true that all subjects monotonically choose

[4] For every lottery, the alternative outcome is a zero payoff. For a more detailed explanation of the tests, see García-Gallego et al. (2012).

lower probabilities as we move from panel 1 to panel 4. In fact, 25% of them usually violate this pattern. The work by García-Gallego et al. (2012) shows that the average choice across panels and the sensitivity of choices across panels are the two principal components describing a subject's behavior in this task. Given that using the second component would require either a bi-parametric expected utility model or a non-expected utility framework, we use the first component alone, a subject's choice average, to describe subjects' risk aversion.

5. Data Analysis and main Results

We ran two sessions for each of the five treatments. Each session involved 36 participants. Because of the partners design, this yields 24 independent observations per treatment.

Table 2 and Figure 2 summarize our results. Contributions are higher in the treatments with intra-group competition compared to the baseline and the treatments with uncertainty. Moreover, by comparing *T1*, *T2* and *T3*, we observe that contributions in the baseline are at least as higher as the levels in the treatments with uncertainty in all but the last period.

This is confirmed also by looking at the descriptive statistics, where it is easy to see that the mean (and median) contributions are higher in *T1* than in *T2*, the difference being significant at 1% level (the *p*-value is 0.0032; two-sided Wilcoxon rank-sum test). The mean (and median) contributions are also higher in *T1* than in *T3*, but the difference is not significant (*p*-value equal to 0.1509 from a two-sided Wilcoxon rank-sum test).

Treatment	***Mean***	***Median***	***SD***
T1	36.87	30	31.29
T2	29.80	20	28.95
T3	35.31	25	32.51
T4	67.92	80	34.31
T5	55.68	60	33.70

Table 2: Descriptive statistics of average group contributions

Figure 2: Mean of average group contributions over time.

Additionally, mean (and median) contributions are lower in *T2* than in *T3*, the difference being significant at 1% level (the *p*-value is 0.0019; two-sided Wilcoxon rank-sum test). This gives us our first result.

Result 1: *There is an inverse causal relationship between uncertainty and willingness to contribute to the public good. That is, reducing the level of uncertainty in the MPCR of the public good make the contribution levels to increase.*

Looking at the intra-group competition treatments, we apply a two-sided Wilcoxon rank-sum test and test for differences in the contribution levels. Specifically, we obtain that contributions are significantly higher in *T4* and *T5* than the rest of the treatments (*T1*, *T2*, and *T3*). More precisely, comparing *T1* with *T4* (the Z-value is -3.780; the *p*-value is 0.0002) the difference is significant at $p \leq 0.01$. By comparing *T1* with *T5* (the Z-value is -2.948; the *p*-value is 0.0032) the difference is significant at $p \leq 0.05$. Comparing *T1* with *T4* and *T5* allows us stating our second result.

Result 2: *There is a direct causal positive relationship between intra-group competition and willingness to contribute to the public good. Specifically, intra-group competition enhances subjects' contributions.*

Finally, we compare *T4* with *T5* and obtain that, on average (and median), contributions are lower in *T5* than in *T4*, the difference being significant at almost 1% level (the *p*-value is 0.0102 from a two-sided Wilcoxon rank-sum test). This gives us our third result.

Result 3: *Higher competition within the group results in higher subjects' contributions to the public good.*

To examine whether the significant difference among treatments, detected at the independent group level, persists at the individual level, Table 3 reports the results of linear mixed regressions using all individual choices stratified by group and subject. Regressors are four treatment dummies (*T2*, *T3*, *T4*, and *T5*), the time trend (*Period*), a dummy to isolate the end game effect (*LastPeriod*), and two dummies to isolate subjects' risk attitude (*AveragePannel1&2*, and *AveragePannel3&4*).

In the first model, the coefficients of the two competition treatments (*T4*, and

T5) are positive and significant, i.e. competition among subjects promotes contribution. In *T4* the positive relationship between competition and contribution is stronger than in *T5*. Additionally, the coefficients of the two treatments with uncertainty (*T2* and *T3*) are negative and, respectively, significant and not significant – i.e. introducing a risky MPCR reduces significantly contributions in *T2* when risk is high (Dickinson, 1998; Levati and Morone, 2013). In *T3* (involving a low level of risk) contribution is not affected (confirming Levati et al., 2009) – implying that results 1 and 2 are confirmed also at an individual level. Furthermore, we can report that there is a time effect, since the variables *Period* and *LastPeriod* are both significant (see also Figure 2). Finally, we report that we observe a positive correlation between subjects' contribution and risk attitude elicited in panels 1 and 2; and a negative correlation with risk attitude elicited in

	Model 1		Model 2		Model 3		Model 4	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
T2	-6.774***	1.691	-12.45***	3.617	-7.446***	1.785	-4.275	4.272
T3	-1.137	1.693	-6.665*	3.617	-2.241	1.785	4.764	4.304
T4	30.94***	1.692	12.23***	3.617	29.10***	1.785	34.90***	4.217
T5	18.91***	1.989	-7.118**	3.617	16.42***	1.785	17.23***	4.548
Period	1.246***	0.218	-1.240***	0.412				
LastPeriod	-8.490***	2.087			-13.83***	3.991		
AveragePannel1&2	9.323***	2.824					24.79***	5.984
AveragePannel3&4	-8.219***	2.948					-20.30***	5.686
T2 x Period			1.046*	0.583				
T3 x Period			0.927	0.583				
T4 x Period			3.421***	0.583				
T5 x Period			4.714***	0.583				
T2 x LastPeriod					7.488	5.644		
T3 x LastPeriod					6.727	5.644		
T4 x LastPeriod					19.53***	5.644		
T5 x LastPeriod					23.92***	5.644		
T2 x AveragePannel1&2							-25.30***	9.177
T3 x AveragePannel1&2							-32.34***	9.275
T4 x AveragePannel1&2							-13.95	8.597
T5 x AveragePannel1&2							-13.03	8.449
T2 x AveragePannel3&4							25.53***	8.896
T3 x AveragePannel3&4							21.99**	10.12
T4 x AveragePannel3&4							7.870	8.531
T5 x AveragePannel3&4							18.02**	8.877
Constrant	29.73***	2.034	43.70***	2.557	38.26***	1.262	33.08***	2.980
Observations	3,600		3,600		3,600		3,600	

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Linear mixed-effects regressions on individual contribution decisions

panels 3 and 4. This suggests that the more risk the subjects take attracted by a higher risk-return, the more they contribute.

Interactions are studied in Models 2, 3, and 4 of Table 3. The interaction between time trend and treatments are reported in Model 2. The parameter of the interaction is highly significant in *T4* and *T5* and weakly or not significant in *T2* and *T3* respectively, meaning that the time trend depends on the treatments. More precisely the distance between contributions *T1 – T4* and *T1 – T5* increases significantly over time.

In Model 3 we analyse whether the end game effect is treatment sensitive. The parameters of the interaction are highly significant in *T4* and *T5* and not significant in *T2* and *T3*. There is a statistically significant difference in subjects' behaviour in the last period across treatments. Model 4 shows that also subjects' risk attitude is treatment dependent.

6. Conclusion

The purpose of this paper was twofold: first, investigating whether uncertain payoff from a public good may increase competition and, second, whether intra-group competition triggers contributions to the public good.

In order to address the first problem, we have compared a baseline treatment with a fixed MPCR to two risky treatments with different values of MPCR, randomly assigned to group members. Not only risky returns appear to be detrimental for contributions, but we also detect an inverse causal relationship between risk and contribution. However, this effect is significant only when risk is high.

In order to test the impact of intra-group competition on cooperation, we have arranged two additional treatments in which different values of MPCR where assigned to group members in accordance to their own contribution to the public good. As expected, intra-group competition triggers higher contributions even though free riding was the majority strategy.

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Appendix: Instructions (translated from the original in Spanish)

Treatment 1(Control Treatment)

Thank you very much for being here. The instructions are identical to all participants. Read them carefully. If you have any questions or concerns, please raise your hand and we will answer your questions individually. During the session, it is strictly forbidden to communicate with the other participants.

The unit of experimental money will be the ECU (Experimental Currency Unit), where 100 ECU = €10. At the end of the session one of your decisions will be randomly chosen. Note that all choices are equally likely. The experimental payoff corresponding to the selected decision will be calculated, converted to Euros, and paid to you (privately) in cash.

The Experiment

The experiment consists of 10 independent periods, in which you will interact with 2 other participants in the session. The 3 of you form a group that will remain THE SAME in all periods. The identity of the participants of your group will not be revealed to you at all during the whole session.

At the beginning of each period, each participant receives an endowment of 100 ECU. In any period, each of the members of a group has to take a decision.

Every period, you have to decide **how much of your endowment you want to contribute to a common project**. Your contribution decision must be not smaller than 0 ECU and not greater than 100 ECU. Furthermore, it must be an integer number. Whatever you do not contribute, you keep it for yourself ("ECU you keep").

In every period, your earnings consist of two parts:

(1) the "ECU you keep"= [100 – your contribution] ECU;

(2) the “income from the project”.

The “income from the project” is calculated by adding up the contributions of the 3 members of your group and multiplying the resulting sum by a number that we call α. That is:

Income from the project = [Your contribution + Your partners’ contribution] × α

The multiplier α is equal to 0.6.

[Treatments 2 and 4] The multiplier α can be either 0.9 or 0.6 or 0.3, *[Treatments 3 and 5:* The multiplier α can be either 0.75 or 0.6 or 0.45*]*, where each value is equally likely. You have to decide about your contribution *without* knowing the value of α.

The income from the project is determined in the same way for every member of a group; this means that you all receive the same income from the project, regardless of the size of your individual contributions.

[Treatment 2] The income from the project is determined as follows: each member is randomly ranked from one to three, regardless of the size of his/her contribution. The first one receives α=0.9 *[Treatment 3:* α=0.75*]*, the second one receives α=0.6 and the third one receives α=0.3 *[Treatment 3:* α=0.45*]*. However, cases of equal rankings are solved as followed:

- If all the three members are ranked as first, they receive α = (0.9 + 0.6 + 0.3) /3 = 0.6 *[Treatment 3:* α=(0.75+0.6+0.45)/3=0.6*];*
- If two members are ranked as first, they both receive α = (0.9 + 0.6)/2=0.75 *[Treatment 3:* α=(0.75+0.6)/2=0.675*]* and the third member receives α=0.3 *[Treatment 3:* α=0.45*]*;
- If two members are ranked as third, they both receive α=(0.6 + 0.3)/2=0.45 *[Treatment 3:* α=(0.6+0.45)/3=0.525*]* and the first ranked member receives α=0.9 *[Treatment 3:* α=0.75*]*.

[Treatment 4] The income from the project is determined as follows: members in the group will be ranked in accordance to the size of their individual contributions. The first-highest contributor gets α=0.9 *[Treatment 5:*α=0.75*]* as return from the project;

the second-highest contributor gets α=0.6 and the lowest contributor gets α=0.3 *[Treatment 5:* α=0.45*]*. If more than one member makes the same contribution (that is, they are equally ranked), the return per capita will be calculated as follows:

- if all the three members make the same contribution, they receive α = (0.9 + 0.6 + 0.3) /3 = 0.6 *[Treatment 5:* α=(0.75+0.6+0.45)/3=0.6*]*;
- If two members make the highest contribution (they both are ranked as first), they receive α = (0.9 + 0.6)/2=0.75 *[Treatment 5:* α=(0.75+0.6)/2=0.675*]* and the third member receives α=0.3 *[Treatment 5:* α=0.45*]*;
- If two members make the lowest contribution (they are ranked as third), they receive α=(0.6 + 0.3)/2=0.45 *[Treatment 5:* α=(0.6+0.45)/2=0.525*]* and the first-highest contributor receives α=0.9 *[Treatment 5:* α=0.75*]*.

EXAMPLE: If the sum of the contributions of the three members is 60 ECU, each member receives an income from the project equal to (0.6 × 60) = 36 ECU.

[Treatments 2 and 4] EXAMPLE: If the sum of the contributions of the three members is 60 ECU, the contributor ranked as first receives an income from the project of (0.9 × 60) = 54 ECU *[Treatments 3 and 5:* (0.75 x 60) = 45 ECU*];* the second receives (0.6 × 60) = 36 ECU and the third (0.3 × 60) = 18 ECU *[Treatments 3 and 5:* (0.45 x 60)=27 ECU*]*. However, for instance:

- if all the members are equally ranked they receive (0.6 × 60) = 36 ECU per capita;
- if two members are ranked as first, they both receive [(0.9 + 0.6)/2 × 60] = 45 ECU *[Treatments 3 and 5:* [(0.75 + 0.6)/2 x 60] = 0.67 x 60= 40.2 ECU*]* per capita; the third receives (0.3 × 60) = 18 ECU *[Treatments 3 and 5:* (0.45 x 60) = 27 ECU*]*;
- if two members are ranked as third, they both receive [(0.6 + 0.3)/2 × 60] = 27 ECU *[Treatments 3 and 5:* [(0.6+ 0.45)/2 x 60 = 0.525 x 60 = 31.5 ECU*]* per capita; the first receives (0.9 × 60) = 54 ECU *[Treatments 3 and 5:* (0.75 x 60) = 45 ECU*]*.

At the end of each period you will receive information about the contribution of your partners and your corresponding period-earnings.

Before the experiment starts, you will have to answer some control questions to verify your understanding of the rules of the experiment.

Please remain seated quietly until the experiment starts. If you have any questions please raise your hand.