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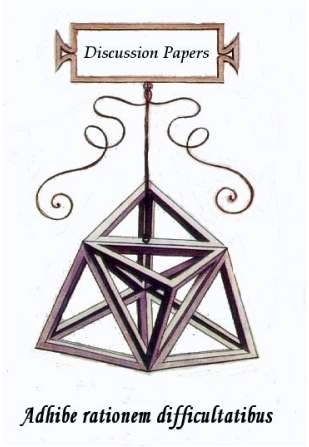

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Voluntary Partnerships For Equally Sharing Contribution Costs - Theoretical Aspects and Experimental Evidence

Discussion paper n. 309

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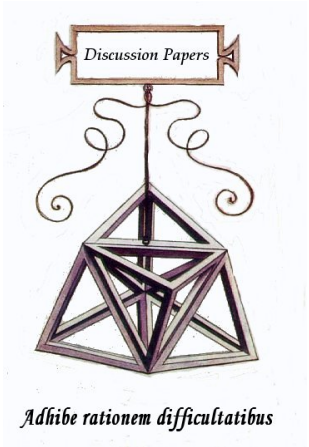
Discussion paper

n. 309



Irene Maria Buso, Daniela Di Cagno, Werner Gueth, Lorenzo Spadoni

Voluntary Partnerships For Equally Sharing Contribution Costs - Theoretical Aspects and Experimental Evidence

Abstract

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Keywords: Public Good, Group Formation, Group Size, Experiments

JEL CLassification: C92, H41, D85

Voluntary Partnerships For Equally Sharing Contribution Costs

- Theoretical Aspects and Experimental Evidence -

Irene Maria Buso* Daniela Di Cagno† Werner Gueth‡
Lorenzo Spadoni§¶

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1 Introduction

Since voluntarily providing public goods is questioned by free-riding incentives, there is strong interest in how institutional devices can overcome or at least weaken free-riding incentives. In this regard, we propose and analyze theoretically and experimentally a mechanism letting contributors voluntarily join a partnership whose members equally share the contribution costs. However, whether such a partnership emerges and can sustain cooperation is not guaranteed, particularly due to second-order free-riding (e.g., Dannenberg et al., 2014, Kosfeld et al., 2009).

The mechanism asks participants to freely choose whether to join or abstain from the partnership (which may or may not be formed) sequentially. Then, being aware of whether there exists a partnership and of its size and whether one belongs to it, all contributors independently choose contributions. So free-riding is possible by not joining the partnership and by not contributing. However, the members of a partnership are committed to equally share their total contribution cost. Opportunistic reasoning does not preclude joining a partnership. In the case of a stable partnership (Selten and Güth, 1982), no partner would benefit from unilaterally opting out (internal stability), and no outsider would gain by unilaterally opting in (external stability). The coordination problem arising from the potential multiplicity of stable partnerships is avoided by imposing sequentiality of partnership formation. We experimentally test theoretical predictions using a setting with groups of 4 players and a marginal rate of technical substitution ($MPCR$) equal to 0.4. This setup allows for the formation of stable partnerships with the coexistence of three partners and one outsider, where the former should fully contribute whereas the latter free-rides. Moreover, unstable partnerships can emerge, such as grand partnerships where everybody should fully contribute or small partnerships where both partners and outsiders should free-ride.

Paradigmatic examples of cost-sharing partnerships can be found in trade unions. These unions are financed by their members to negotiate with employers about work conditions and wages. For example, national trade unions in Europe have significantly improved employment conditions not only for their members but have also provided benefits to all employees.[1] Another example related to our mechanism is found in international treaties committing countries to provide global public goods, such as environmental protection or military security. In these cases, countries decide to join or do not join international coalitions (or alliances) whose members share the burden of providing the public good (Barrett, 2003, Morgenstern et al., 2007). The benefits of the public good provided are not restricted to coalition members but are extended to non-signatory countries.

In such coalitions, members typically enter or exit sequentially due to the entry of new partners and the exit of former ones over time. Our design closely mirrors this structure by allowing potential members to enter the partnership sequentially.[2]

Our study contributes to the experimental literature on endogenous sub-group formation in public goods games. Following the definition provided by Dannenberg and Gallier (2020), we investigate an institutional setting where cooperation benefits are global, but the institution is exclusive: the benefits of cooperation are not restricted to partners, but are also enjoyed by non-members, while the institution rules (cost-sharing) only apply to members. While most experimental investigations on endogenous sub-group formation focus on institutions that enforce compliance of their members up to the socially optimal level (see Dannenberg and Gallier, 2020 for a review), our approach allows contributors to voluntarily determine whether to join the partnership or not. It leaves contribution choices free and only commits partners to share their joint contribution costs equally.[3] Similar to our approach, Dannenberg et al. (2014) study endogenous contributions by allowing the restriction of partner contributions

[1] In the USA, unions have reacted to this social dilemma by employers negotiating only closed-shop agreements, which exclude non-unionized employees from enjoying union-negotiated improvements. In the case of closed-shop collective wage negotiations, usually all permanent employees become union members (see Booth, 1985 or Naylor and Cripps, 1993).

[2] Experimentally McEvoy et al. (2010) study sequential coalition formation, but let the order of joining and not joining be endogenously determined.

[3] According to the definition provided by Dannenberg and Gallier (2020), we assume cooperation benefits to be global but explore an institutional setting that is exclusive (where the commitment benefits not only partners but also non-members, and the institution only applies to members).

to an endogenously determined minimum level. However, it is important to note that while the minimum level mechanism is unable to prevent exploitation within the coalition, our mechanism guarantees equal treatment within the partnership. Additionally, the success of the minimum contribution mechanism in sustaining cooperation is sensitive to the presence of low contributors (Dannenberg et al., 2014, Kurzban et al., 2001), whereas the averaging of contributions in our mechanism mitigates the negative effect of such extreme contribution behaviors.

Our research addresses two main questions: Does voluntary formation of cost-sharing partnerships effectively discourage free-riding, as theoretically predicted, especially among partners when the partnership is stable? How do behaviors during partnership formation influence contribution decisions? Our data indicate that reducing free-riding incentives through a voluntary commitment to cost-sharing significantly enhances public good provision and prevents the decline of contributions over time. Notably, partners contribute more than outsiders, even when the theory predicts free-riding for both categories. Interestingly, on average, stable and larger partnerships do not have all partners contributing maximally, while outsiders contribute more than minimally. Furthermore, subjects do not always join partnerships as predicted by theory, though we observe a greater willingness to join partnerships than what optimal behavior dictates.

This paper develops as follows: Section 2 presents the game form and the theoretical predictions; Section 3 describes the experimental design and research questions; Section 4 informs about our results and Section 5 concludes.

2 Game form and theoretical predictions

Let $n(\geq 3)$ denote the group size, i.e., the number of contributors, which allows for partnerships smaller than the grand ones ($m = n$). When a partnership is formed with at least $m(\geq 2)$ partner(s), we refer by i to partners and, when $m < n$, by j to its outsider(s). The payoff of an outsider j is given by:

$$e - c_j + \alpha C \quad with \quad 0 < \alpha < 1 < n\alpha$$

Here, α represents the MPCR (Marginal Per Capita Return), $C = c_1 + \ldots + c_n$ denotes the total contribution, $e = 25$ represents the same individual endowment for all n players, and c_j represents player j's contribution, which is restricted between 5 and 20 (including the extremes) to ensure that participants always gain both from what they leave for themselves $(e - c_j)$ and from the public good (αC).

Partners i earn always the same, namely:

$$e - \frac{C(m)}{m} + \alpha C.$$

with $C(m) = \sum_{i=1}^{m} c_i$, i.e., how much all partners contribute in total. To derive optimal behaviors we proceed by backward induction. In case of common and anticipated opportunism, outsiders j free-ride (due to $\alpha < 1$), i.e.,

$$c_j^*(m) = 5.$$

Instead for partners i the optimal contribution is m-dependent via:

$$c_i^*(m) = \begin{cases} 20 \quad if \quad m\alpha > 1 \\ \\ 5 \quad if \quad m\alpha < 1 \end{cases} .$$

When the partnership is formed sequentially one decides whether to join or not, aware of how many of the preceding contributors in the sequence have joined. Our experiment considers groups with four players ($n = 4$): first each player ($k = 1, \ldots, n$) makes nine binary choices, each for a specific possible position (1^{st}, 2^{nd}, 3^{rd}, 4^{th}) in the sequence and the number of those who have joined before. Each binary choice is denoted as $\delta_k \in \{0, 1\}$, where $\delta_k = 1$ indicates willingness to join and $\delta_k = 0$ escludes joining.[4]

We refer to the list of these nine binary decisions δ_k of contributor k as $k's$ (partnership) profile. After eliciting the profile of all contributors $k = 1, ..., n$ a random sequence is drawn via an unbiased random event which determines, according to the n profiles, whether there is a partnership or not, denoted by $m = \emptyset$ or $m \neq \emptyset$, respectively, the size $m = \sum_k \delta_k (\geqslant 2)$ of the partnership, and who is a partner and, for $m < n$, who are the outsiders.

For $m\alpha < 1$ an opportunistic partner i would free-ride, $c = 5$, whereas i would maximally contribute, $c = 20$, when $m\alpha > 1$. Outsiders j always free-ride due to $\alpha < 1$. One will

[4]When being last in the sequence and nobody has joined before, any joining decision would result in $m \leq 1$, and no partnership. we do not ask subjects for a decision in this case (denoted by "X" in Table 1).

opportunistically join the partnership when own joining is pivotal, i.e., when own joining increases m from $m\alpha < 1$ to $(m+1)\alpha > 1$. Own joining and thereafter contributing maximally in case of $m\alpha > 1$ improves the equal payoffs of all partners i and even more what outsiders earn. Partnerships of size m^* with $(m^*-1)\alpha < 1 < \alpha m^*$ are externally (no outsider wants to opt in) and internally (no partner gains by unilaterally opting out) stable and render each partner pivotal to avoid free-riding incentives of partners: if one partner opts out, the partners would not contribute maximally anymore. Instead when m^*, no outsider j would want to opt in.

The theoretical coexistence of $m^* = n-1$ partners and one outsider for the group size $n = 4$, and $\alpha = .4$, so that $m^* = 3$ does not as such confirm individual optimality of all n contributors which requires backward induction also in the (not) joining phase.

Table 1 presents the optimal δ^*-profile predicting stable partnerships of size m^* when anticipating the different contribution incentives of outsiders and partners as well as the optimal (not) joining choices of those later in the sequence. The first in the sequence never joins, the second one only when the first one has not joined before, etc., in line with backward induction applied to both phases, contributing and joining.

$n = 4$ & $\alpha = .4$				
how many have joined before you	your position in the sequence			
	4th	3rd	2nd	1st
0	X	0	1	0
1	0	1	0	
2	1	0		
3	0			

Table 1: The sequentially rational profiles $\delta^* \in \{0,1\}$ with "X" excluding a choice when both, $\delta = 0$ and $\delta = 1$, imply $m = \emptyset$.

Universal $\delta_k = 0$ for all positions in the sequence by all n contributors is also an equilibrium outcome since its common expectation renders each choice $\delta_k \in \{0,1\}$ ineffective. This equilibrium, however, fails to be perfect (Selten, 1975): in a slightly perturbed game all choices in Table 1 have small positive probabilities of being decisive so that optimally reacting

as in Table 1 is the only optimal profile.

3 Experimental design

The experiment comprises 12 rounds, each consisting of two stages, the joining and the contribution stage. Each round proceeds as follows: in the first stage, participants engage in sequential choice elicitation to decide whether or not to join the partnership in the 9 different cases of Table 1. Then, the computer randomly draws a sequence and determines whether a partnership is formed or not, its size, and which participants are partners or outsiders. At the end of the first stage, participants are informed whether the partnership has been formed within their group or not. In the case of $m \neq \emptyset$, they are also informed of the partnership's size (m) and whether they are a partner or an outsider.

In the second stage, participants independently choose their individual contribution. Additionally, participants are asked, without any incentives, about their beliefs regarding others' contributions, distinguishing whether they are partners (if a partnership exists) or outsiders (if $m < n$). Each participant has an endowment of 25 ECU (experimental currency unit) and can choose to contribute any integer amount between 5 and 20 ECU.[5] Each ECU is converted to euro at an exchange rate of 1 ECU = 0.50 euro. As partners share their total contribution costs equally, they earn the same, even when their individual contributions differ.

After each round, participants are reminded of the outcome of the partnership formation process in the first stage, and they receive information about their own payoff. Additionally, they are prompted with their own contribution and provided with information about the total contribution of the group. If they are partners, they also receive information about the total contribution within the partnership. Participants then proceed to play another round after receiving this feedback information, until they reach the final round. At the end of the experiment, participants are asked to provide their demographic information and other personal details, including their gender, age, field of study, geographic region, number of past

[5]To guarantee that participants earn a proper portfolio of what they keep for themselves and what they gain from public good provision.

experiments, and self-reported perception of the experiment's ease.

We collected this rather rich and informative data from 48 subjects who participated in 2 sessions using the experimental methodology, described in Buso et al. (2021), and conducted as lab-like online sessions. Participants played the 12 rounds, being aware that they would not interact with the same group members in two consecutive rounds. The rematching group size (of which participants were unaware) was 8. At the end of the experiment, only one randomly selected round was paid. Subjects received, on average, 15.7 euros in addition to the show-up fee of 6 euros.

Participants were paid via Prolific (Palan and Schitter, 2018), and each session lasted, on average, 90 minutes. The experiment was programmed in oTree (Chen et al., 2016) and conducted with student participants from Luiss Cesare Lab. Participants were recruited via Orsée (Greiner, 2015) among students of Economics, Law, and Political Science. None of the participants took part in more than one session.

4 Results

This section first analyzes the evidence of individual joining behaviors and then the resulting partnership formation, before considering contribution choices.

4.1 Partnership formation

We compute an indicator from individual joining profiles (see Table 1), the "*share of ones*," representing the individual willingness to join. This indicator is the average number of $\delta = 1$ choices.[6]

In this section, we first illustrate the evidence regarding the willingness to join, and then we report on partnership formation. Since the partnerships formed in the experiment result from a randomly drawn sequence, we simulate all possible sequences of partnership formation to assess the differences between actual and simulated partnerships.

[6]The *share of ones* is the number of $\delta = 1$-choices divided by 9 (the total number of δ-choices).

Willingness to Join

The average *shares of ones* is 54%, exceeding its theoretical prediction of $\frac{m^*}{9} = \frac{1}{3}$. Table 2 reveals a strong willingness to join, even when not joining, i.e., in the cases of $\delta = 0$ in Table 1. This remarkable tendency is hardly in line with opportunism. Figure 1 reveals a slight decrease in the willingness to join across rounds.

$n = 4$ & $\alpha = .4$				
how many have joined before you	your position in the sequence			
	4th	3rd	2nd	1st
0	X	0.32	0.42*	0.62
1	0.42	0.54*	0.59	
2	0.64*	0.66		
3	0.65			

Table 2: Relative frequency of $\delta = 1$ for each choice cell in Table 1. The cells with $\delta = 1$ being optimal are identified by *.

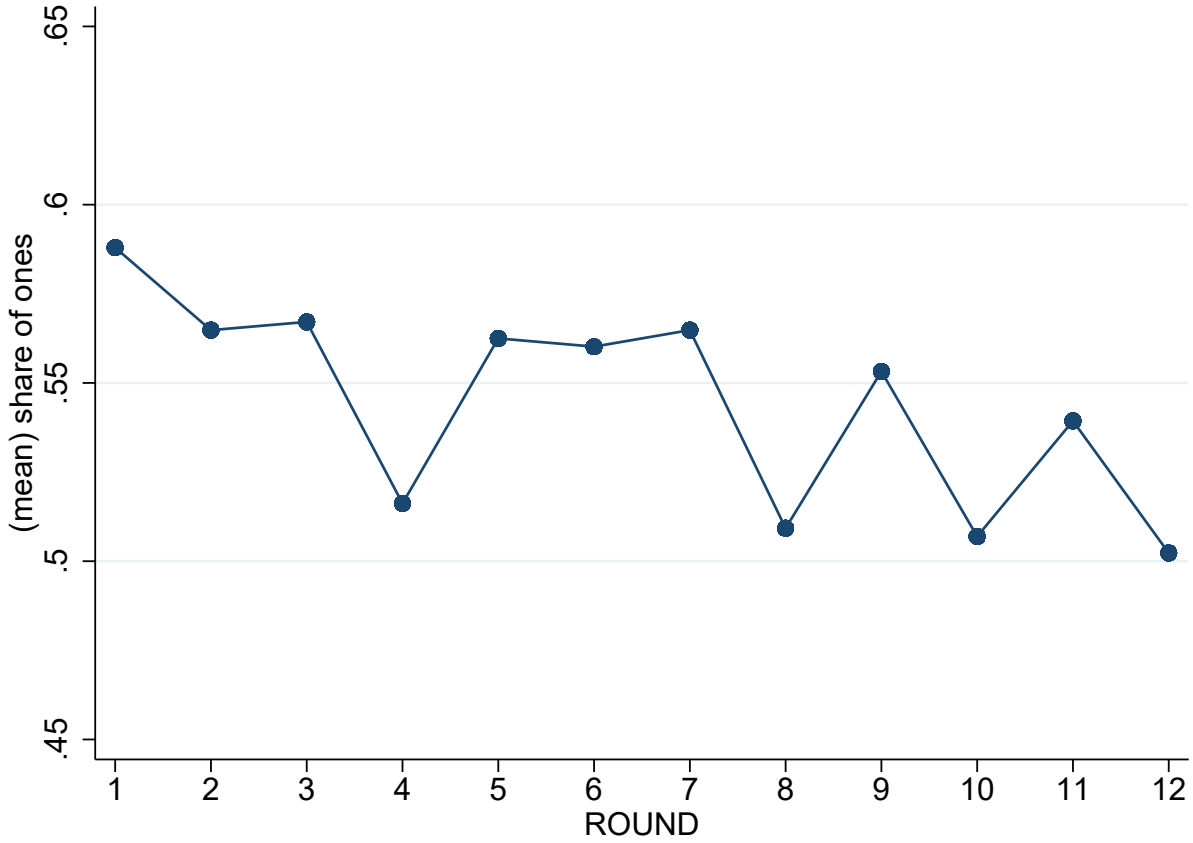

Figure 1: Dynamics across rounds of average *shares of ones*.

The dynamics of the average *shares of ones* across all 48 participants, as displayed in Figure 1, is statistically analyzed via the regression results in Table 3, demonstrating inertia of the individual willingness to join, a path dependence which is evident for both regression models: Regression (1) reveals a significantly positive relationship between the *shares of ones* in successive rounds, and Regression (2) indicates a negative relationship between not being a partner in round $t-1$ and the *shares of ones* in the following round t, and a positive relationship between being a partner of the grand partnership ($m = 4$) in $t-1$ and the *shares of ones* in t.[7]

[7]In Appendix B, we provide details about individual joining profiles to account for individual heterogeneity in joining behavior.

Depvar: individual share of ones at round t		
	(1)	(2)
	$n = 4$ & $\alpha = .4$	$n = 4$ & $\alpha = .4$
Share of ones $t-1$	0.45***	
	(0.04)	
No Partnership $t-1$ (baseline):		
- m=2 & member $t-1$		-0.01
		(0.03)
- m=2 & no member $t-1$		-0.05*
		(0.03)
- m=3 & member $t-1$		0.01
		(0.03)
- m=3 & no member $t-1$		-0.01**
		(0.04)
- m=4		0.06**
		(0.03)
Dummy Final Round	-0.04	-0.03
	(0.04)	(0.04)
Demographics	✓	✓
Round dummies	✓	✓
Session Number	✓	✓
Observations	528	528
Number of individuals	48	48
Number of groups	6	6

The model used is a multilevel one, with two nested levels: individual and matching group. Demographic controls include gender and age of the participant, field of study, geographic region, number of past experiments, self-reported easiness of experiment.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: Regression of the willingness to join.

Actual and Simulated m-frequencies

For our specific parameter constellation $n = 4$ and $\alpha = 0.4$, partnerships are formed, on average, 75% of the time, a tendency which is rather stable over time (see Figure 2).[8]

Table 4 compares the sizes of actually formed partnerships, i.e., those resulting from the actually applied random sequence, with the simulated ones, via using the respective individual joining profiles for all possible sequences. Overall the two measures are quite similar, but the frequency of $m = 2(3)$ partnerships is higher (smaller) than the simulated frequency.[9]

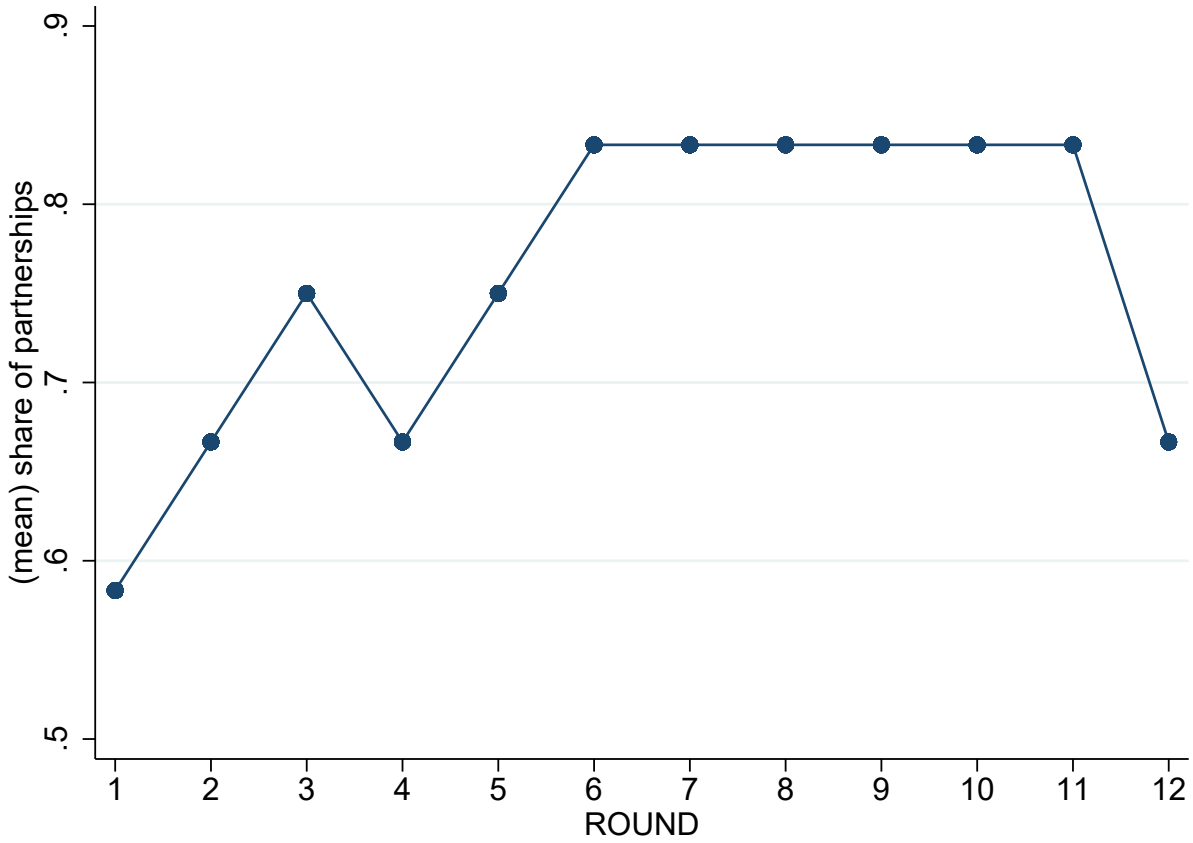

Figure 2: Dynamics across rounds of actual partnerships.

[8]Appendix B presents detailed dynamics of different partnership sizes.

[9]Simulated partnerships from 12 rounds involving 48 subjects result in 576 individual profile choices. These choices can be applied to 24 possible sequences, generating a total of 13,824 observations.

	$n = 4$ & $\alpha = .4$			
	overall	m=2	m=3	m=4
actual	0.75	0.33	0.25	0.17
simulated	0.72	0.26	0.33	0.13

Table 4: Proportion of actual and simulated partnerships.

4.2 Contribution behaviour

Figure 3 presents contribution behavior after partnership formation, distinguishing between the overall contribution dynamics and those of partners and outsiders. Average contributions to the public good remain stable over time, due to partners contributing consistently more than outsiders.[10]

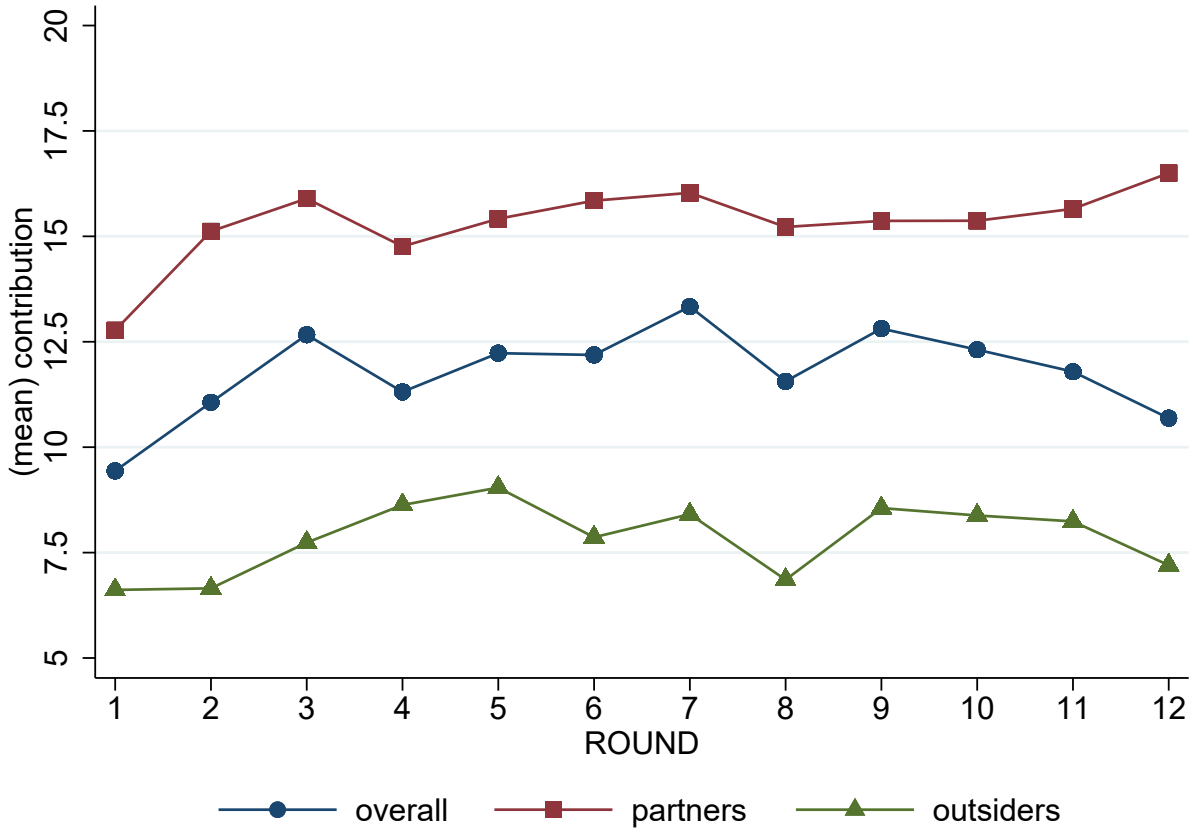

Figure 3: Dynamics across rounds of contributions.

[10]Appendix C presents average contribution dynamics depending on the partnership outcome.

Overall, establishing a partnership, i.e., $m \geq 2$, boosts aggregate contributions. Table 5 reports contribution shares around 47%, with partners contributing on average 52% of their endowment. Compared to data from the meta-analysis of linear public good experiments by Zelmer (2003), these percentages may seem large, but one has to consider that at most 80% (20 ECU) and at least 20% (5 ECU) of the endowment (25 ECU) could be contributed in our setup. Table 5 confirms what is shown in the contribution dynamics of Figure 3: partners' contributions consistently exceed those of outsiders. Interestingly, contributions of dyadic partners are in line with partner contributions in larger partnerships although dyadic partners should free-ride (contribute 5) whereas partners of larger ones should contribute 20. Moreover, the average percentage of free-riding (contributing 5) is higher among outsiders than for partners. Without partnerships, i.e., $m = \emptyset$, free-riding is more frequent (56%) than when a partnership exists (27%), the opposite holds for full contributions.

	outsiders			partners			Overall	
	m						with p.ship	general
	$\emptyset$	2	3	2	3	4		
Mean	8.1	7.80	6.54	14.85	15.98	15.13	12.97	11.78
Std. Err.	0.39	0.45	0.62	0.61	0.44	0.58	0.30	0.26
n. of cases	140	96	37	96	111	96	436	576
# contr.=5	79 (56%)	54 (56%)	30 (81%)	16 (17%)	3 (3%)	14 (15%)	117 (27%)	196 (34%)
# contr.=20	9 (6%)	5 (5%)	2 (5%)	45 (47%)	52 (47%)	44 (46%)	148 (34%)	157 (27%)

Table 5: Contribution behavior.

Table 6 presents regressions aiming to explore how individual contributions across 12 successive periods are related to partnership formation, i.e., to the individual willingness to join, to being partner or outsider, and to the size of the partnership. We measure willingness to join by *share of ones* in the first round and use it as an explanatory variable. Model (1) shows that the willingness to join significantly enhances contributions, while Model (2) substantiates that partners contribute significantly more, irrespective of the partnership size. Surprisingly, there is a positive endgame effect.

Depvar: Contribution at round t		
	(1)	(2)
	$n = 4$ & $\alpha = .4$	$n = 4$ & $\alpha = .4$
Share of ones in round 1	9.53***	
	(0.86)	
No partnership (baseline):		
- non-partner & m=2		-0.20
		(0.60)
- partner & m=2		5.41***
		(0.60)
- non-partner & m=3		-1.12
		(0.84)
- partner & m=3		7.14***
		(0.57)
- partner & m=4		6.67***
		(0.59)
final round	2.07**	2.05**
	(0.99)	(0.87)
Demographics	✓	✓
Round dummies	✓	✓
Session dummies	✓	✓
Observations	576	576
Number of individuals	48	48

Dependent variable is the individual's contribution in a given round of play; the model used is a multilevel one, with two nested levels: individual and matching group. Demographic controls include gender and age of the participant, field of study, geographic region, number of past experiments, self-reported easiness of experiment.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6: Regression of contribution behavior.

Partners' beliefs can account for their higher, than outsiders, but smaller than possible

contribution. Table 7 reveals their partners' beliefs about other partners' contributions have a significantly positive effect on their contributions. Additionally, when $m < n$, inequity aversion can account for partners shying away from contributing maximally.

	Depvar: Contribution at round t		
	(1)	(2)	(3)
	$n = 4$ & $\alpha = .4$	$n = 4$ & $\alpha = .4$	$n = 4$ & $\alpha = .4$
	$m = 2$	$m = 3$	$m = 4$
belief on partner(s)	0.94***	0.80***	0.82***
	(0.09)	(0.09)	(0.08)
belief on outsider(s)	0.06	0.06	
	(0.09)	(0.07)	
Demographics	✓	✓	✓
Round dummies	✓	✓	✓
Session number	✓	✓	✓
Observations	96	111	96

Dependent variable is the individual's contribution in a given round of play; the model used is a multilevel one, with two nested levels: individual and matching group. Belief partner(s) contribution is how much a partner believes other partner(s) to contribute; belief outsiders is how much an insider believes outsider(s) to contribute. Demographic controls include gender and age of the participant, field of study, geographic region, number of past experiments, self-reported easiness of experiment.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: Regression of contribution behavior with beliefs as regressors.

5 Conclusions

We propose an institutional mechanism wherein contributors not only voluntarily contribute to the public good but also decide whether to join a (sub)group whose partners equally share

the contribution cost. We focus on the issue of public good provision, aiming to enhance contributions through a mechanism that allows contributors to commit on a voluntary basis. Before deciding how much to provide for the public good, contributors sequentially choose whether or not to join a partnership whose members equally share their total contribution costs.

Our theoretical analysis suggests that this mechanism should lead to contributions above free-riding levels, as partners within stable partnerships are expected to contribute fully while outsiders free-ride. Experimental testing confirms that voluntarily formed cost-sharing partnerships do emerge and are effective in sustaining cooperation. According to our data, partnerships are formed with approximately 75% probability and effectively enhance stable voluntary cooperation, resulting in a contribution share around 47% of the endowment.

Unlike most previous studies on the endogenous emergence of partnerships, neither members nor outsiders are forced to implement the optimal contribution choice. This allows us to study the interplay between partnership formation and contribution behaviors. We observe that partners consistently contribute significantly more than outsiders, which qualitatively aligns with theoretical predictions. Interestingly, however, individual joining and contribution behavior seems not always strictly guided by monetary incentives: willingness to join in the first stage is higher than theoretically predicted and hardly in line with the opportunistic reasoning illustrated by theory. The participants who are more willing to join a partnership tend to contribute more to the public good, irrespective of the partnership size, and partners contribute more than outsiders even when the partnership is $m = 2$, where minimal contribution of partners would be optimal. This latter finding may suggest that voluntary partnership formation leads to self-selection of unconditional cooperators within the partnership and enhances reciprocity toward other partners willing to cooperate.

Our data do not show any decay of cooperation over time, which is typically observed in standard public goods games. The average contributions resulting from this institutional mechanism are not only higher than in a standard public goods game but also stable over rounds. Additionally, we observe a positive endgame effect, instead of the usually negative one. Overall, this experimental test demonstrates, in line with the theory, the effectiveness of the institutional mechanism in sustaining cooperation.

Finally, the experimental data also reveal a wide heterogeneity of individual behavior that is not always consistent with benchmark predictions. Future research should delve deeper into understanding the interindividual differences and behavioral patterns in the context of partnership formation for providing public goods. This could offer valuable insights for policy design and shed light on the decision-making process behind cooperative choices.

Statements and Declarations

The authors gratefully acknowledge the financial support of the Max–Planck-Institute for Research on Collective Goods, Kurt Schumacher Straße 10, 50113 Bonn, Germany.
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of Human Subjects

The authors confirm that all procedures were conducted in accordance with relevant laws and institutional guidelines, and that the appropriate institutional committee(s) approved them. Informed consent was obtained from all subjects participating in the experiment. Privacy rights were respected by informing participants that they would be monitored (but not recorded) using a webcam, and obtaining their acceptance of this condition.

Data Availability Statement

The data used to support the findings of this study are available upon request. Interested researchers may request access to the data by contacting the corresponding author: lorenzo.spadoni@unicas.it.

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Appendix

A. Accounting for individual joining behaviors

As we find many possible profiles and even the same *share of ones* allows for multiple *profiles*, we present in Table 8 only the optimal profile and the profiles with a percentage share of at least 5% of all $48 \times 12 = 576$ profiles in each condition.

5 different profiles emerge (in addition to the optimal one). Profile 1, "always joining", seems to capture unconditional cooperation and can be rationalized by strong efficiency concerns. Instead Profile 2, "never joining", could be due to not wanting to voluntarily engage in collective action, even when profitable. Profiles 3, 4, and 5 aim at the $m = n$ grand partnership when is still possible. There is also a tendency of not joining when $m = n$ is no longer possible.

Table 10 summarizes the percentages of the five more frequent (and optimal) joining profiles. Altogether the five frequent profiles account for 46.75% of the profiles in the data set. Across conditions, there are significant shares of "always joining" (14.5%) and "never joining" (13%) profiles which even increase in the last rounds (from 7 to 12) whereas optimal joining profiles are missing. Table 10 also reports the percentage of subjects adopting the same profile at least 6 times. This finding suggests inertia in the *share of ones* even at the individual level.

$n = 4$ and $\alpha = .4$									
Joining Profile 1					Joining Profile 2				
How many have joined before you	Your position in the random sequence				How many have joined before you	Your position in the random sequence			
	4th	3rd	2nd	1st		4th	3rd	2nd	1st
0	X	1	1	1	0	X	0	0	0
1	1	1	1		1	0	0	0	
2	1	1			2	0	0		
3	1				3	0			
Joining Profile 3					Joining Profile 4				
How many have joined before you	Your position in the random sequence				How many have joined before you	Your position in the random sequence			
	4th	3rd	2nd	1st		4th	3rd	2nd	1st
0	X	0	0	1	0	X	0	0	1
1	0	0	1		1	0	1	1	
2	1	1			2	1	1		
3	1				3	1			
Joining Profile 5					Optimal Profile according to theory				
How many have joined before you	Your position in the random sequence				How many have joined before you	Your position in the random sequence			
	4th	3rd	2nd	1st		4th	3rd	2nd	1st
0	X	0	1	1	0	X	0	1	0
1	0	1	1		1	0	1	0	
2	1	1			2	1	0		
3	1				3	0			

Table 8: Joining profiles with at least 5% of the overall choices (576).

$n = 4$ & $\alpha = .4$												
	≥ 1	≥ 2	≥ 3	≥ 4	≥ 5	≥ 6	≥ 7	≥ 8	≥ 9	≥ 10	≥ 11	≥ 12
Profile 1	48	21	16.7	14.5	14.5	14.5	10.4	10.4	8.3	4.1	4.1	4.1
Profile 2	37.5	25	18.75	16.7	12.5	12.5	8.3	8.3	6.25	2.1	2.1	2.1
Profile 3	18.75	14.6	10.4	6.25	6.25	0	0	0	0	0	0	0
Profile 4	25	12.5	10.4	8.3	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Profile 5	20.1	16.7	14.6	8.3	6.25	6.25	6.25	6.25	4.1	2.1	2.1	0

Table 9: Percentage of subjects using profiles in Table 8 at least 1,2,...,12 rounds.

type of choices	$n = 4$ & $\alpha = .4$		
	% choices		% subjects
	All Rounds	Rounds 7-12	
According to theory	0	0	0
Profile 1 (always join)	14.5	17	14.5
Profile 2 (never join)	13	17	12.5
Profile 3	5	4.2	0
Profile 4	6.25	3.1	2.1
Profile 5	8	11.1	6.25
total	46.75	52.4	30

Table 10: Frequency of Joining Profiles

B. Partnerships formation dynamics

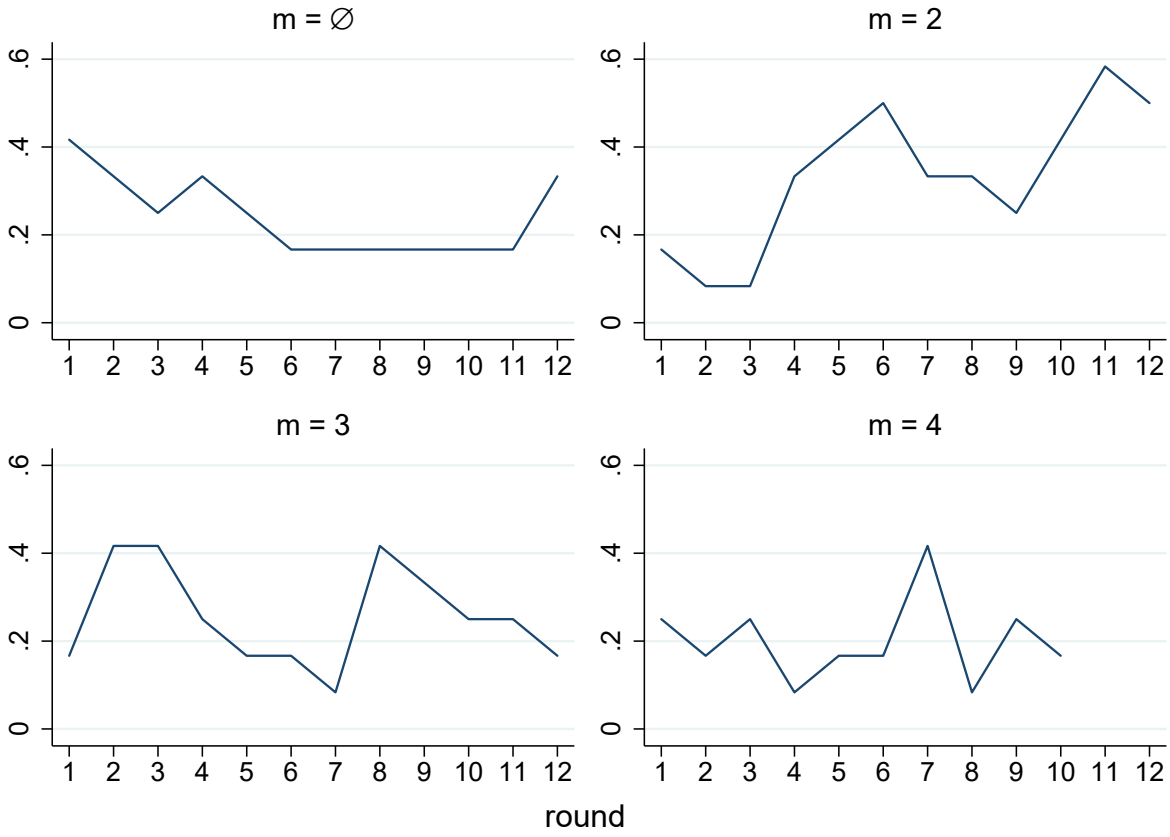

Figure 4: Dynamics of the frequencies of partnership sizes.

C. Contribution dynamics

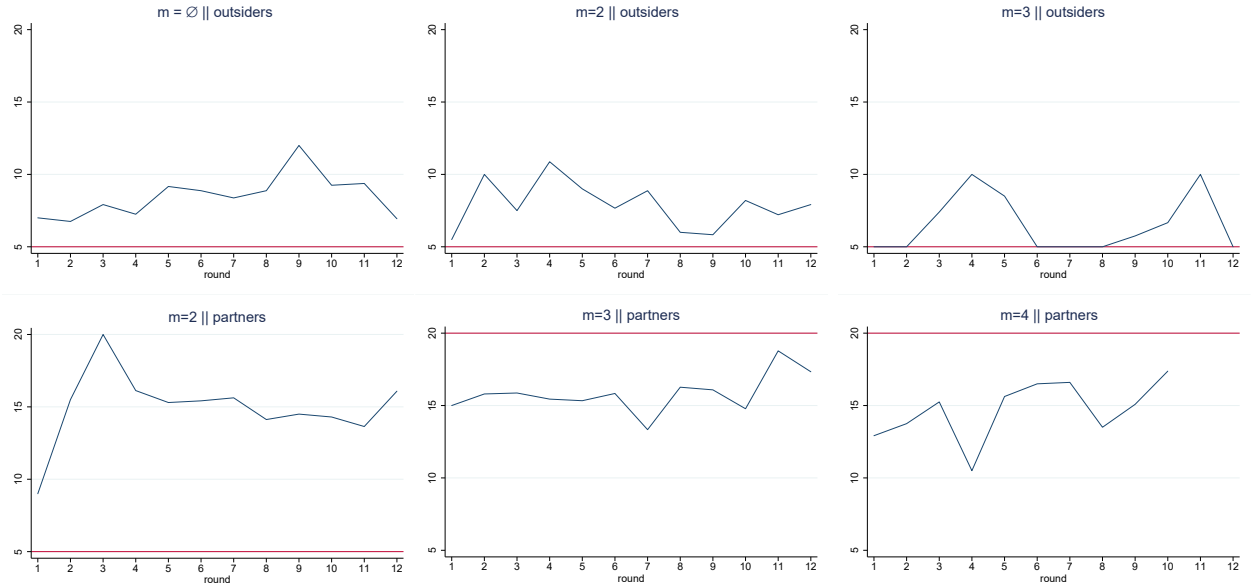

Figure 5: Average contribution dynamics depending on the partnership outcome. Red lines represent the predicted values.

D. Instructions

ISTRUZIONI

Descrizione generale dell'esperimento

Benvenuti a questo esperimento!

Nel corso di questo esperimento, completamente informatizzato, voi e gli altri partecipanti dovrete prendere alcune decisioni. Le vostre decisioni e quelle degli altri partecipanti determineranno il vostro guadagno per l'esperimento che verrà calcolato come spiegato di seguito.

In aggiunta al vostro guadagno per l'esperimento riceverete 6 euro per la vostra partecipazione e per la compilazione di un breve questionario alla fine dell'esperimento.

L'esperimento si compone di 12 round.

In ciascun round avrete l'opportunità di guadagnare gettoni sperimentali (ECU) che verranno convertiti alla fine dell'esperimento in euro al tasso di 1 ECU= 0,5 euro.

Alla fine dell'esperimento il computer selezionerà casualmente un solo round per il pagamento che verrà effettuato tramite Prolific. I dati dell'esperimento (le vostre decisioni) rimarranno anonimi nel senso che gli sperimentatori non saranno mai in grado di collegare il vostro nome alle vostre scelte.

All'inizio dell'esperimento il computer ti raggrupperà in modo casuale con altri 3 partecipanti tra quelli presenti in questa sessione dell'esperimento. Tu e gli altri soggetti selezionati formerete quindi un gruppo di 4 in ogni round.

Nota bene: Alla fine di ogni round la composizione del gruppo di cui fai parte verrà modificata in modo tale che almeno un membro del gruppo sia diverso rispetto al round precedente. In ogni caso non verrete mai a conoscere l'identità degli altri partecipanti al vostro gruppo né durante la sessione né in seguito.

In ogni round dell'esperimento dovrete prendere due tipi di decisione: la prima riguarda la decisione di partecipare o meno ad una "Iniziativa" relativa a un "Progetto" comune a tutti i membri del vostro gruppo; la seconda riguarda quanto contribuire al "Progetto".

Dopo avere effettuato tali scelte dovrete rispondere in ogni round ad alcune domande la cui risposta non influenza in alcun modo i vostri guadagni.

Alla fine di ciascun round il computer vi comunicherà quale è il vostro guadagno in ECU per quel round. Alla fine dell'esperimento il computer selezionerà casualmente uno dei round per il pagamento e ve lo comunicherà, ricordandovi il guadagno che avete realizzato in tale round e che costituisce il vostro guadagno per l'esperimento. Prima del pagamento vi verrà chiesto di rispondere ad un breve questionario anonimo e non incentivato.

E' importante che leggiate con attenzione le istruzioni e capiate il modo in cui i vostri guadagni sono collegati alle vostre decisioni e a quelle degli altri. Per essere sicuri di ciò, all'inizio dell'esperimento, vi verranno proposte alcune domande di controllo per verificare se avete capito come il computer calcolerà i vostri guadagni.

Per qualsiasi dubbio rivolgetevi agli sperimentatori via chat o attraverso il microfono e qualcuno vi risponderà subito privatamente.

La decisione di aderire all' "Iniziativa" relativa al Progetto

In ogni round tu e gli altri membri del tuo gruppo dovrete scegliere uno dopo l'altro se volete partecipare o meno all'"Iniziativa" comune.

NB.: L'ordine in cui ciascuno di voi prenderà effettivamente tale decisione è stabilito casualmente dal computer.

Prima che il computer ti comunichi in che ordine prenderai effettivamente la tua decisione (cioè se sarai il primo, il secondo, il terzo o il quarto del tuo gruppo) dovrai dichiarare se intendi partecipare o non partecipare **per ogni possibile ordine che ti venga assegnato e sulla base di quanti membri del tuo gruppo hanno deciso di partecipare all' "Iniziativa" prima di te.**

Una volta dichiarate le tue scelte per ogni situazione possibile, il computer selezionerà l'ordine di decisione effettivo e eseguirà ciò che avevi dichiarato di volere fare nello scenario corrispondente a quello verificatosi.

Il computer ti informerà se si è realizzata o meno l'"Iniziativa" tra i partecipanti del tuo gruppo, quanti di voi partecipano ad essa e se tu ne fai parte o no.

Ricordate che la partecipazione all' "Iniziativa" è volontaria per ciascuno di voi. Di conseguenza, potrebbe avvenire che meno di due partecipanti al vostro gruppo vogliano partecipare all'"Iniziativa", in tal caso l'"Iniziativa" non verrà intrapresa.

La decisione di quanto contribuire al "Progetto"

All'inizio di ogni round ciascuno di voi riceverà una dotazione di 25 ECU che dovrete decidere, indipendentemente e simultaneamente agli altri partecipanti, se e in che misura utilizzare per contribuire ad un "Progetto" comune. *NB: dovete scegliere un ammontare di contribuzione al "Progetto" compresa tra 5 e 20 ECU.*

Il vostro guadagno dal "Progetto" è calcolato in ogni round come segue:

(a) se avete deciso di partecipare all'"Iniziativa", ed essa viene intrapresa, il vostro guadagno è dato da:

la vostra dotazione – [(la vostra contribuzione + la contribuzione degli altri partecipanti all'iniziativa) il numero dei partecipanti all'iniziativa)] + α (la vostra contribuzione + la contribuzione degli altri membri del gruppo).

Fate attenzione quindi che in questo caso la vostra contribuzione effettiva sarà diversa da quella dichiarata e pari alla media delle contribuzioni con cui tu e gli altri partecipanti all'iniziativa avete deciso in modo indipendente di contribuire al "Progetto".

(b) se avete deciso di non partecipare all'Iniziativa, o essa non è stata intrapresa, il vostro guadagno è dato da:

la vostra dotazione – la vostra contribuzione + α (la vostra contribuzione + la contribuzione dei membri del vostro gruppo).

In tutti i round il valore di α sarà pari a 0,4.

Buon lavoro.

ENGLISH VERSION

INSTRUCTIONS General Description of the Experiment

Welcome to this experiment!

In this experiment, completely computerized, you and the other participants will make choices. Your choices and those of the other participants will determine your earnings for the experiment according the rules that will be explained in these instructions.

In addition to the earnings for the experiment, you will receive 6 euros for showing up and answering a short questionnaire at the end of the experiment.

The experiment consists of 12 rounds.

You have the opportunity to earn points (ECU) in each round that will be converted into Euro at an exchange rate of 1 point= € 0.5.

At the end of the experiment, one round is randomly selected for payment. The payment will be implemented using Prolific. The data of the experiment (your choices) are anonymous: the experimenter will not be able to connect your name to your choices.

At the beginning of the experiment, you will be randomly matched by the computer with other 3 participants. You and the other selected participants will form a group of 4 in each round.

Note that after each round the composition of the group will change such that you will always interact with a group different from the group of the previous round for at least one participant. Note that you will not learn who the other members of your group are, neither during nor after today's session.

In each round you will make two types of choices. First, you will decide to join or not an "Initiative" related to a "Project" common to all the group members; the second choice will concern how much to contribute to the "Project".

After these choices, in each round you will be asked to answer few questions whose answers will not have any relevance for your earnings.

After each round you will learn the number of points (ECU) earned in that round. At the end of the experiment it will be shown on the screen which round has been drawn for payment and you will be recalled about the points earned in that round which will be your earnings for the experiment. Before the payment, you will be asked to answer few questions not relevant for the payment and that will preserve your anonymity. It is very important that you completely understand the instructions and the way your earnings are related to

your decisions. In order to check your understanding, at the beginning of the experiment we will ask you to answer some questions about payoff calculation. If at any point during the experiment you have a question, please contact the experimenters using the chat or the microphone, and you will be answered privately.

The decision to join the "Initiative" related to the "Project"

In each round you and the other group members will choose sequentially whether to join or not the "Initiative".

Note that the position in the sequence for you and the other group members will be chosen randomly by the computer.

Before you are let aware of your actual position in the sequence (i.e., if you are the first, the second, the third or the fourth, you will be asked whether you want to join or not the "Initiative" for every possible position in this sequence and **for every possible number of participants that have already joined the group before you.**

Once you have chosen whether to join or not in every possible scenario, the actual position in the sequence for each of you will be randomly drawn, and choices in the corresponding scenario will be implemented.

The computer will inform you about the existence of the "Initiative" in your group, how many group members are part of it, and if you are in.

Remember that participating to the "Initiative" is voluntary. Hence, it may happen that less than two members of your group choose to join; in this case, the "Initiative" will not exist.

The decision of how much to contribute to the "Project"

Each of you will be endowed with 25 points at the beginning of each round. You will choose simultaneously and independently whether and how much to contribute to a "Project" with your endowment: each of you have to choose an integer amount between and including 5 and 20 to devote to the "Project".

Your earnings from the "Project" in each round will be calculated as follows:

(a) If you chose to join the "Initiative" and this exists, your earnings are equal to:

Your Endowment– [(your contribution + the contribution of the other member(s) of the "Initiative") / the member of the "Initiative" including you)] + α (your contribution + the contribution of the other group members).

Note that in this case your actual contribution may be different from the amount you stated and it will be equal to the average contribution of the members of the "Initiative".

(b) If you chose to not join the "Initiative" or if this does not exist, your earnings are equal to:

Your Endowment– your contribution + α (your contribution + the contribution of the other group members).

In every round the value of alpha will be equal to 0.4.