Coalition Formation in Public Goods Games: An experimental test with endogenous preferences

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Abstract

An individual's social preferences can help explain their cooperation in a public goods game. In this experiment we use an incentivized modified dictator game to estimate individuals social preferences. We find that subjects who give money to others in the modified dictator game have a higher probability of joining the coalition and contributing to the public good. Joining the coalition translates to contributing to the public good. In addition, higher MPCR (Marginal per capita return return from the public good) not only leads to an increase in coalition size, but also enhances the chance of more subjects joining the coalition and contributing to the public good. Further, we find that joining and contributing to the public good depend positively on coalition size.

Keywords: Coalition, Social Preference, Public Good
JEL Classification: H4, C7

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Introduction

Public goods are characterized by *non-rivalry*, meaning that more than one person can simultaneously benefit from them, and *non-exclusivity*, meaning that it is difficult to prevent any individual from enjoying their benefits. They simultaneously benefit many people and their creation requires the coordinated actions of people who will subsequently enjoy its benefits. Environmental protection, research and innovation, vaccination, health care services, highways, and public parks are just a few important examples. Due to the nature of public goods, they suffer from the free riding problem. Coalitions, subgroups of individuals who agree to act collectively to produce a public good, represent a possible solution to the public goods problem. International Environment Agreements (IEA) such as United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol are examples of existing coalitions.

In any public good provision problem, Marginal per capita return (MPCR) is an important determinant. MPCR is the ratio of marginal benefit to marginal cost of privately providing a public good. For every dollar a person spends on privately providing the public good, the MPCR measures how much the individual gets back. MPCR is assumed to be less than 1. High marginal per capita return (MPCR) leads to increased cooperation and decreased free riding (Chaudhuri, 2011). However Barrett (1994) and Kolstad (2012) prove in their theoretical setup that there is an inverse relationship between equilibrium Coalition Size and MPCR. This result is in contrast to recent experimental evidence which suggests the existence of large sized coalitions even in the presence of high MPCR (Burger and Kolstad, 2009; Kosfeld, Okada and Riedl, 2009). Upadhyay (2021) provides conditions required to ensure a positive relationship between coalition size and MPCR. In this paper we test theoretical predictions of her paper through a human subjects experiment. Individual's preferences are determined by an incentivised human subjects experiment.

Upadhyay (2021) investigates the role of social preferences in a two stage public good game. In the first stage, heterogeneous agents choose whether or not to join a coalition and in the second stage, the coalition votes using a majority voting rule on whether its members will contribute or not. Social preferences are assumed to be Rawlsian where payoffs are strictly increasing in both own earnings and the payoff of the least-well off member of society. The results show that individuals with prosocial preferences are more likely to join the coalition and upon doing so, also vote to contribute to the public good. The likelihood of joining and voting to contribute is also increasing in the return from public good (MPCR).

We use the theoretical model in Upadhyay (2021) and test the theoretical predictions of her paper. In the experiment we allow for endogenous preferences and estimate an individuals preference using modified dictator game. In the game, in-

dividuals divide money between themselves and the least well off person (from a previous experiment). Based on the outcomes of the task we measure how much an individual cares about the least well off person The experimental design allows us to use the outcomes from the incentivized task to measure if individuals with pro social preferences behave differently than others.

The main findings from our paper are as follows. Predictions of the theoretical model hold true. To be specific, individuals who give more money to least well off person or have pro social preferences are more likely to join the coalition and contribute to public good. Joining the coalition and contributing to the public good also positively depends on Coalition size and previous period's decision to contribute.

The primary motivation of our paper originates from the experimental testing of the 'free-rider' hypothesis, which highlights the deviations in behavior of individuals in real life with respect to findings borne from theoretical literature. While public goods theory predicts free riding and inefficient outcomes, experimental results find cooperation towards contributing toward a public good does exist with rates as high as 40-60 percent of the efficient level (Ledyard, 1995). These experimental results motivated research on the importance of mechanisms or institutional environment which can help in achieving the optimal outcome or reduce free riding. Communication between the participants (Isaac and Walker (1988), Ostrom (2000)) and exchange of chat messages between the participants regarding their strategies or intentions (Palfrey, Rosenthal and Roy, 2017) can increase contributions to a public goods game. use "Pledge-to-contribute" is another "commitment" mechanism to increase cooperation (Chen (1996) and (Kurzban et al., 2001)). Punishment can facilitate higher levels of cooperation by allowing people who contribute to punish "free-riders" (Ostrom et al. (1994) and Nikiforakis and Normann (2008)).

Our paper uses coalitions as a commitment mechanism to enhance cooperation (Barrett (1994),Hoel and Schneider (1997)). The standard models of coalition are unable to explain the existence of large-sized IEA (Barrett (2002), Finus and Maus (2008)). Also, there exists an inverse relationship between coalition size and gains from cooperation (Komisar, 1969; Barrett, 1994; Kolstad, 2012) [1]. For instance, higher participation was seen in Montreal Protocol (IEA on ozone depletion) where gains to cooperation were very small (Barrett, 2003). Recently researchers have started studying the impact of MPCR on coalition size using laboratory experiments. Large coalitions can exist even with high MPCR ((Burger and Kolstad, 2009),Kosfeld, Okada and Riedl (2009)). This, however is in contrast to another paper where authors find a trade-off between participation and commitment Dan-

[1] see Kolstad (2012) for a proof. The proof shows the size of the coalition to be an inverse of MPCR and establishes the essence of inverse relationship between gains from cooperation and coalition size

nenberg, Lange and Sturm (2014). The results from our paper point to existence of large sized coalitions even in presence of high MPCR.

Our paper also focuses on the importance of social preferences in explaining voluntary contributions in a public good game. Existing literature on social preferences encompasses different preferences. The models which include reciprocity assume individuals are willing to cooperate provided others in their group also cooperate (Fehr and Fischbacher, 2002; Charness and Rabin, 2002; Rabin, 1993). Individuals are also motivated to contribute towards public good because they care for equitable distribution of resources or equal outcomes (Fehr and Schmidt, 1999). In our paper we want to capture how much an individual cares about the least well off person. To test models of various social preferences, Charness and Rabin (2002) designed a range of experiments and found that people are concerned about increasing social welfare, especially for low-payoff recipients. In their experiment a number of social preferences are compared and it was found that that a combination of efficiency concerns and maximin preferences can explain the findings from the experiment (Engelmann and Strobel, 2004) [2] Incorporation of social preferences enables conditions under which a large coalition can exist even in the presence of high MPCR Upadhyay (2021).

Our experiment has three parts. In the first part individuals participate in a modified dictator game. Every individual has to distribute the points between themselves and a least well off person from previous experiment. This helps us in arriving at a measure of Rawlsian preferences which measures how much individuals care about the least well off person.

In the second and third part of the experiment, individuals have an option to either invest their endowment into a private project or a group project (public good in our experiment). For every round in part II, individuals make a choice whether to contribute their endowment to group project or not. In the third part, every individual has an option to join the coalition. In every round of Part III, individuals make two decisions: 1) whether to join the coalition or not; 2) coalition members vote whether to contribute to the group project. Individuals not in coalition decide independently whether or not to contribute to group project. Majority rule among the coalition members determine whether the coalition will contribute to the public good.

We find that higher MPCR has a significant and positive impact on individual's decision to join the coalition and contribute to the public good. Thus large-sized coalitions can exist in presence of high MPCR where individuals with pro-social preferences have a higher probability of joining the coalition as well as contributing to the public good. Individuals who pay more to the least well off person in Part I,

[2]Pure Rawlsian social preferences are, interpretable as maximin preferences where utility depends only the welfare of the least well-off member of society.

have a higher probability of joining the coalition and contributing to public good.

Our paper contributes to two strands of literature. First, our paper relates to research on experimental evidence on the relationship between coalition size and MPCR. Experimental evidence on the impact of MPCR on coalition size stands divided. Large coalitions can exist even with high benefits of cooperation (Burger and Kolstad, 2009). However, some papers find a trade-off between participation and commitment. Dannenberg, Lange and Sturm (2014) Coalitions with voluntary participation are less effective in facilitating cooperation compared to when all players are forced to participate. Their results confirm the pessimistic findings from the coalition formation theory where cooperation is either deep and narrow or shallow and broad (Barrett, 2002). In our results we find that higher MPCR leads to an increase in the probability of joining the coalition and contributing to the public good significantly.

Second, our paper exploits heterogeneity in a society to derive the threshold for individuals to contribute. Heterogeneous preferences can explain variation in cooperation in a society (Gunnthorsdottir, Houser and McCabe, 2007). In their voluntary contribution mechanism (VCM) public goods experiment, the authors classify the subjects into 'free riders' (contributes 30 % or less of his/her endowment) and 'cooperators' (contributes more than 30 %) based on their first round contribution. Also, in this paper, authors use first period's contribution in public good game to classify individuals as "free-riders" and "cooperators". This is close to our paper where we classify individuals into different types based on their outcomes in modified dictator game. Heterogeneous preferences can also be used to explain the decline in cooperation in these experiments due to the presence of free riders (Fischbacher and Gachter, 2010). Our results show that in a heterogeneous society, if individuals with pro-social preferences are present then public goods will be provided.

The paper is organized as follows: Section I summarizes the theoretical predictions of Upadhyay (2021). Section II discusses the experimental design. Section III discusses the results, Section IV concludes.

1 Model

Here we layout the model in Upadhyay (2021). $N = 1, 2, \cdots, n$ denotes the set of players. Each player has a unit endowment and participates in a two-stage public goods game. In Stage I, each player decides whether to join a coalition or not. Players that chose not to join the coalition are called *fringe members* and denoted by F. Before Stage II begins, size of the coalition is announced. Size of the coalition is denoted by M. In Stage II of the game, using majority voting rule, members of the coalition decide whether or not they will contribute to the public good. The

fringe members decide independently if they would like to contribute. Contributions are assumed to be binary, i.e., individuals in the coalition will either contribute their entire endowment or nothing depending on the outcome of the majority voting.

Each individual's payoff is a convex combination of a pecuniary and non-pecuniary component. Let λ_i be the weight of the pecuniary component. λ_i is private information and is also uniformly distributed between 0 and 1 [3]. The social preferences are assumed to be Rawlsian in the sense that players care about the player who gets the lowest pecuniary payoff. The action set of a player is denoted by $e_i \in \{0, 1\}$, where $e_i = 1$ implies that the players contribute to public good and $e_i = 0$, implies that they do not. The marginal per capita return (henceforth MPCR) for player i is denoted by $\gamma > 0$.

Non-pecuniary payoff or social preference in the model is measured by pecuniary payoff of the least well off person. When no one is contributing, everyone receives their endowment which is 1, in this case, payoff of the least well off person is also 1. In other scenarios, payoff of the least well off person is the total contributions from public good. The lowest pecuniary payoff of any $i \in N$ is given by γQ, i.e., individuals for whom $e_i = 1$. e_i denotes the strategy of player i and e_{-i} the strategy of the remaining players. Then the payoff of a player i is given by (Upadhyay (2021) :equation 1):

$$\pi_i(e_i, e_{-i}) = \begin{cases} \lambda_i(\gamma Q) + (1 - \lambda_i)\gamma Q = \gamma Q & \text{for } e_i = 1, Q > 1 \\ \lambda_i(1 + \gamma Q) + (1 - \lambda_i)\gamma Q & \text{for } e_i = 0, Q > 1 \end{cases} \tag{1}$$

The first term in each expression is the weighted pecuniary payoff and the second term is the non-pecuniary payoff.

We solve the model by using backward induction. The paper first solves for Stage II: decision to contribute. Coalition members decide to contribute using majority rule whereas fringe members decide independently. The action set of coalition members when they are voting is given by $v_i \in \{0, 1\}$ where $v_i = 1$ implies $i \in M$ votes to contribute to public good and $v_i = 0$ implies $i \in M$ does not vote. Comparing the payoff of coalition members when they vote to contribute v/s the payoff when they do not vote to contribute leads to Proposition 1(a). Similarly comparing the payoff of fringe members when they contribute v/s the when they do not contribute leads to Proposition 1(b). Proposition 1(a) suggests that individuals with lower weight on monetary payoff or those who have pro social preferences are more likely to vote to contribute to public good. Similarly, from Proposition 1(b) we find that individuals with pro social preferences are more likely to contribute to public good. Increasing MPCR increases the likelihood of individuals contributing to public good.

[3]The results are robust to specification for any distribution as discussed in her paper

Using the results from Stage I, the paper arrives at cutoff for joining the coalition. Action set of player when they are deciding to join the coalition is represented by $j_i \in \{0, 1\}$ where $j_i = 1$ implies $i \in M$ decides to join the coalition and $j_i = 0$ implies $i \in M$ does not join the coalition. Comparing the payoff from joining the coalition and the payoff from not joining the coalition leads us to Proposition II in the paper. According to proposition II, individuals with pro social preferences are more likely to join the coalition. Also, individuals who join the coalition, always contribute to public good. Also, an increase in γ or higher benefits of cooperation can increase the size of a coalition and also increase the likelihood by which an existing coalition will contribute to the public good. Hence the model is able to show that an increase in the benefits of cooperation i.e. MPCR leads to a bigger coalition size which also has a higher likelihood to contribute to the public good.

Based on the these two proposition, we test the following three hypothesis in our paper:

1. Hypothesis 1: Individuals with pro-social preferences are more likely to join the coalition and contribute to public good.

2. Hypothesis 2: An increase in MPCR will lead to more people joining the coalition, i.e. larger coalition size and also increase in likelihood of individuals contributing to public good.

3. Hypothesis 3: Number of contributors increase when we have more individuals who have pro social preferences or when we have higher MPCR.

2 Experiment Design

We will first discuss public goods game and modified dictator game. We will then talk about the sequence of events in our experiment.

2.1 Public goods game

We will first discuss the public good game. In each round everyone in the group was given 10 points[4]. Each group member has to decide on how to invest their 10 points in each round. They had option to invest all 10 points into their private account, or all 10 points into a group project. The points cannot be split between private account and the group project. Payoffs for participants is given by γQ in equation 1,when $e_i = 10$ and $10 + \gamma Q$ when $e_i = 0$. At the end of each round, subjects were informed about their earnings from both group project and private

[4]The theoretical model has an endowment of 1 unit, however here we use 10 points in order to make the calculation easier for participants to calculate their payoffs.

project in each round. The subjects were told about payoff of the least well off person from each round.

2.2 Public goods game with coalition

When individuals have the option to join coalition, we have a two stage public goods game. When participants have option to join coalition, they will make two decisions. They first decide whether to join the coalition or not and then decide whether to contribute to the public good. As described in Figure 1, participants have the following two decision:

1. Stage I: Participants decide to join the coalition.

2. Stage II: The coalition members vote to contribute to the group project. If majority of the participants vote to contribute, then the coalition contributes to the group project. Participants who are not in the coalition decide independently whether to contribute to the group project or not.

Figure 1, uses the same terminologies as in model of Upadhyay (2021). As in part II of the experiment, in each round everyone in the group was given 10 points. Each group member has to decide on how to invest their 10 points in each round. They had option to invest all 10 points into their private account, or all 10 points into a group project. For the coalition members if the majority was satisfied ($\geq m'$), everyone in the coalition invests in group projects. After participants decide to join the coalition or not, everyone in the group was informed about the size of the coalition. After coalition members vote to contribute and fringe members decide to contribute to the public good, participants were informed about their earnings from the project, earnings from the group project, their total earnings and earnings of the least well off person.

2.3 Modified dictator game

In the modified dictator game where subjects distributed 25 points between themselves and least well off person from previous experimental sessions. This was done to estimate the underlying social preferences of subjects in our experiment or how much they care about the "least well-off person". Table 1 list the possible options for the game.

In the table above when participants equally split between themselves (option 6)and others we classify them as type 2, since option 5 and 7 are close to option 6, they are also classified as type 2. Type 1 individuals are those who give more to the least well off person as compared to equal split. Whereas type 3 represents individuals who give less to the least well off person as compared to the equal split.

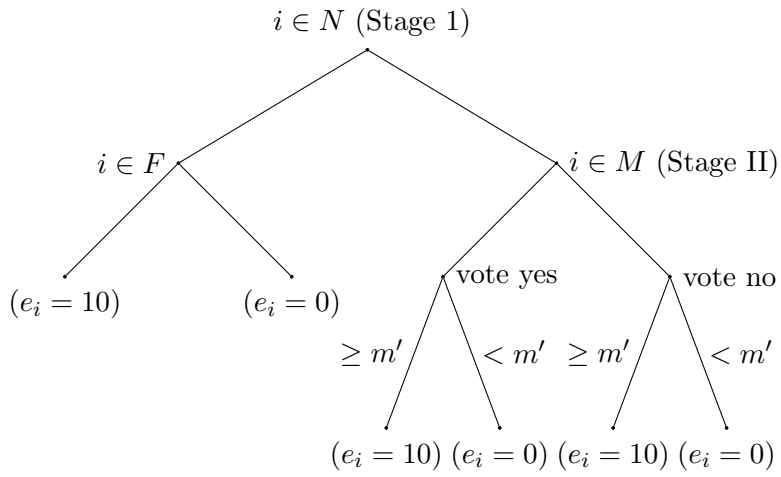

Figure 1: Game Tree: Stage I participants decide to join the coalition or not. In Stage II, participants in a coalition vote to contribute and if majority is satisfied, coalition contributes to public good. Fringe members decide to contribute independently. N: Total subjects in a group, F:Fringe members in the group, M: size of the coalition, m': majority in a coalition

Type 1 individual is someone who cares more about the least well off person as compared to his/her own payoff. Type 2 individual is someone who cares equally about the payoff of least well off person as well as their own payoff. Type 3 individual is someone who cares more about their own payoff as compared to the payoff of least well off person.

We use another measure to estimate an individual's social preference or how much they care about the least well off person. Instead of dividing the individuals into three types, we use the amount they give in dictator game as a measure of their social preferences. Individuals who give more money to the least well off person have pro social preferences.

We will be using both these measures of social preferences to test theoretical predictions of our model.

The distribution of individuals from first measure is given below:

As we can see, we only have 4 of type 1 individuals in our result. We present our results for measure 1 in following manner:

1. When all types are included
2. When we do not include type 1 individuals
3. Combining type 1 and type 2 (calling it type A). Type A represents individuals who care more or equally for the least well off person. Type B (previously type 3) are individuals who care more for themselves than the least well off person.

Table 1: **Modified Dictator game**

Options	Your payment (in points)	Least well of person's payment in points	Type
1	25	0	3
2	22.5	2.5	3
3	20	5	3
4	17.5	7.5	3
5	15	10	2
6	12.5	12.5	2
7	10	15	2
8	7.5	17.5	1
9	5	20	1
10	2.5	22.5	1
11	0	25	1

Table 2: **Distribution according to type**

Type	Frequency	Percentage
1	4	3.70
2	45	41.67
3	59	54.63

2.4 Sequence of events

The experiment consisted of three parts. The first part of the experiment was modified dictator game and consisted of 1 round. The other two parts were public goods experiment and in each round participants were in a group of 6 different people. These groups were changed after every period. The participants were paid for one random round in each part. Participants in Part II, played a public goods game for 8 rounds. After Part II was completed, participants were given separate instructions for Part III and then played 12 rounds of public goods game. In part III individuals had the option to join the coalition. At the end of each round, subjects were informed about their earnings from both group project and private project in each round.

Another important part of the design is MPCR. MPCR takes two values: low and high MPCR. Low MPCR takes value of 0.3 and high MPCR takes value of 0.7. This is done to analyse how changing MPCR affects decision to join the coalition and contribute to public good.

We had a total of 9 sessions with 12 subjects in each sessions. In the experiment,

participants were not informed about the type individuals were classified into based on the results from the modified dictator game. They were also told that their decision in any of the parts will not affect their results or decision in other parts.

The instructions for the experiment are in the appendix. The experiment was programmed using z-Tree. The subject pool consisted mainly of undergraduate students at Virginia Tech recruited through SONA. Subjects were paid $10 show up fee and earned money from one of the either rounds.The exchange rate in the experiment was 5 points for $ 1. On an average subjects received $20 from this experiment. The experiment was approved by IRB and subjects provided informed consent.

3 Results

Effect of MPCR on joining the coalition: Figure 2 reports that probability to join the coalition is higher when we have high MPCR [5].

Effect of MPCR on contributing to public good: As we can see in Figure 3, the probability of contributing to public good is higher when we have higher MPCR.

Contributing to the public goods based on joining the coalition : Figure 4 shows that, individuals who join the coalition contribute to the public good. This provides evidence for our theoretical prediction that individuals who join the coalition also vote to contribute to public good. The probability of joining the coalition is as high 1 in some periods.

Table 3 denotes the differences in mean for these key variables and also tests for statistical significant difference in the means under these two scenarios. The results point to the fact that probability of joining coalition, contributing to public good are higher under high MPCR. Coalition size is also highly significant with higher MPCR. This confirms that high MPCR promotes cooperation.

We next analyze how probability of joining the coalition and contributing to public good is dependent upon other factors. Since the decision to join the coalition/contribute to public good is binary (1 for yes, 0 for no), we use Probit to estimate our results. MPCR and social preferences (λ_i) are treatment variables. The model specification is as follows:

$$Y_{it} = \alpha_i + \beta_1 \text{type}_i + \beta_2 MPCR_t + \beta_3 \text{X}_{it} + \epsilon_{it}$$

- Y_{it}=Decision to join the coalition and decision to contribute to public good for individual i in period t.

[5]Individuals have the option to join the coalition only in Part III which begins from Round 10

– Yes = 1, No = 0

- type$_i$=Type of individual i based on the outcome in modified dictator game.
- MPCR$_t$= Marginal per capita return, varies over t.
- X_{it}: Last period's outcome of coalition size, own payoff, least-well off person's payoff, number of contributors.

We also use the model specified above to analyze the impact of the variables on Number of contributors. Here we use an OLS regression. The dependent variable becomes: Y_t = Number of contributors in a group in period t.

We use four models to test the impact of variables on decision to join the coalition, decision to contribute and number of contributors. Model 1 uses lag of number of contributors and Model 2 uses coalition size. We separate them as they are correlated. Model 3 and 4 also use lag of number of contributors and coalition Size respectively, however we do not include type 1 individuals. This was done because in the experiment we had 4 of type 1 individuals, 45 of type 2 individuals and 59 of type 3 individuals.

As mentioned before, we also use another measure to estimate an individual's preference. In that case we only have Model 1 and Model 2.

Table 4 shows the effect of independent variables on joining the coalition. Model 1 and Model 2 have all the individuals, whereas Model 3 and 4 has type 1 individuals removed. This was done because we only had 4 of type 1 individuals in our data set. From Table 4 we can see that when we switch from type 2 to type 3 (Model 3 and 4), there is a significant decrease in the probability to join the coalition. This means that pro social individuals (type 2) are more likely to join the coalition as predicted by our theoretical model. This in in line with Hypothesis 1. This provides support to Hypothesis 2. Last period's coalition size also has a significant and positive impact on decision to join coalition. [6]

Table 5 estimates the decision to join coalition with different specification. Here we do not divide individuals into different types. We use the amount individuals give to the least well off person in the modified dictator game. The amount given to the least well off person reflects their social preference and can have impact on decision to join coalition, however do not find any impact by using this variable on decision to join the coalition. High MPCR and lag of coalition size has a positive and significant impact on decision to join coalition.

Table 6 shows the effect of independent variables on contributing to the public good. Model 1 and Model 2 have all the individuals, whereas Model 3 and 4 has type 1 individuals removed. We can see that when we switch from type 2 to type

[6]Coalition size and number of contributors are highly correlated and hence we have two different models to analyze.

3 (Model 3 and 4), there is a significant decrease in the probability to join the coalition. We also find that when we switch from type 1 to type 3 (Model 1 and 2), there is a significant decrease in the probability to join the coalition. This provides further support to Hypothesis 1: individuals with pro social preferences are more likely to contribute to public good. High MPCR also has a positive and significant marginal effect on joining coalition. Coalition size also has a significant and positive impact on decision to join coalition.

Table 7 estimates the decision to contribute with different specification. Amount given to the least well off person is used to estimate how much an individual cares about the least well off person. We find that individuals who give more to the least well off person or who have pro social preferences are more likely to contribute. High MPCR and Coalition Size also has a positive and significant impact on decision to contribute.

Table 8 shows the effect of independent variables on number of contributors. Model 1 has individuals divided into three types, whereas Model 2 uses amount given to the least well off person as an estimate of social preference. We find that when we switch from type 1 to type 3 (Model 1), there is a significant decrease in the number of contributors. An increase in the amount given to the least well off person increases the number of contributors. Thus presence of pro social preferences increases contribution and hence the number of contributors, thereby supporting our Hypothesis 3. High MPCR also has a positive and significant effect on number of contributors, which provides further support to Hypothesis 3. Lag of payoff of least well off person also has a positive and significant impact on contributors. Coalition size has a significant positive effect on number of contributors.

Table 9 shows the effect of independent variables on decision to contribute and number of contributors for both part II and part III. Contribute-1 and Contributors-1 is for all individuals, whereas Contribute-2 and Contributors-2 is where type 1 is removed. There is a negative marginal effect(for decision to contribute) and negative effect(for contributors) when we switch from Part II to Part III. This result needs further analysis as we expect contributors to increase in presence of coalition. One of the reasons could be the effect of coalition size, when we try to include the coalition size, the variable is dropped due to colinearity. We saw in our previous analysis that coalition size effects the number of contributors. High MPCR also has a positive marginal effect(for decision to contribute) and positive effect(for contributors).

In summary, the results show that higher MPCR leads to increase in the coalition size. With high return from public good, probability of joining the coalition is significantly higher. As the theory model predicts, individuals who join the coalition also contribute to public good. Coalition size has a positive impact on decision to contribute. The results also point to the presence of social preferences in explaining

different cooperative behavior of individuals .

4 Conclusion

In this paper, we test the theoretical predictions of Upadhyay (2021). We find that theoretical predictions of the model hold true which confirms that an individuals' endogenous preference can help in explaining cooperative outcomes. Main findings from the experiment are as follows: first, we find that individuals with pro social preferences (who care more about the least well- off person) have a higher probability to join the coalition and upon joining they contribute to public good. Second, higher MPCR ensures more individuals join the coalition and contribute to public good, thereby establishing a positive relationship between coalition size and MPCR. Third, size of the coalition also impacts an individual's decision to contribute to public good. Higher coalition size leads to increased contribution levels for both coalition members and fringe members. In, general, the results point to the importance of heterogeneous society and MPCR in ensuring existence of large sized coalitions.

We are hopeful that this body of work will lead to novel policy making in the arena of public good provision in the real world. One way of directing our findings towards higher contribution levels in any public good- highlighting the present and probable future benefits from a public goods to players involved in the sanctioning of environmental laws. This would provide to be a great incentive for the same to ratify to the sanctioned law. To identify other-regarding preferences in a society, the social planner can use an estimate based on data on tax, volunteering statistics from Bureau of Labor Statistics among others to draw a society's aspiration for the well-being of the needy.

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Appendix

Appendix for Experimental results

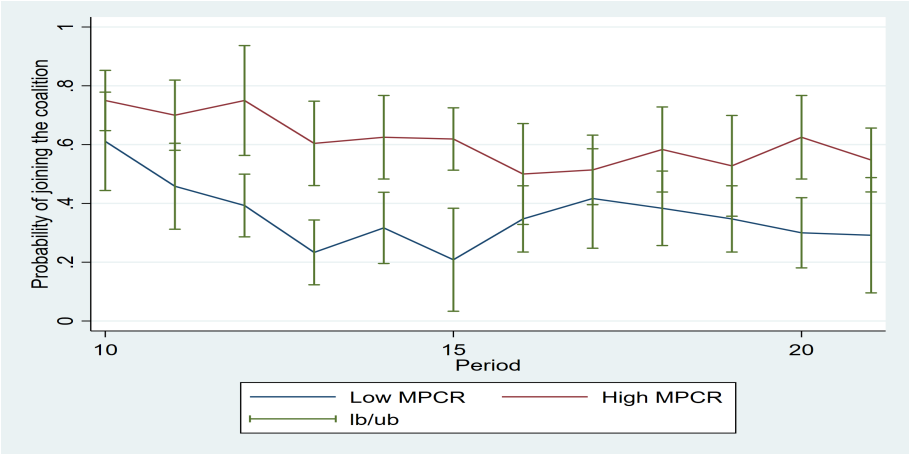

Figure 2: Time trends:Joining the coalition with respect to MPCR

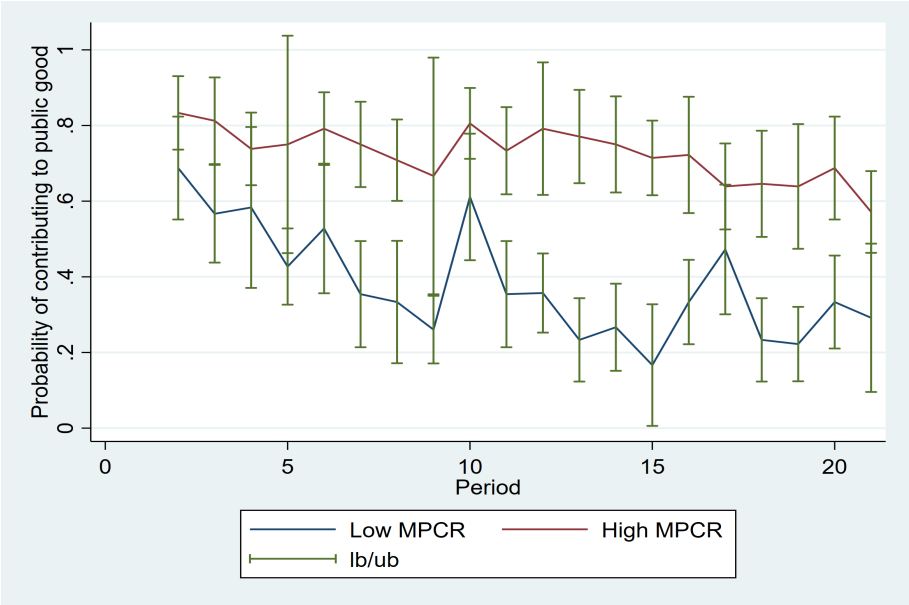

Figure 3: Time trends:Contribute to Public Good with respect to MPCR

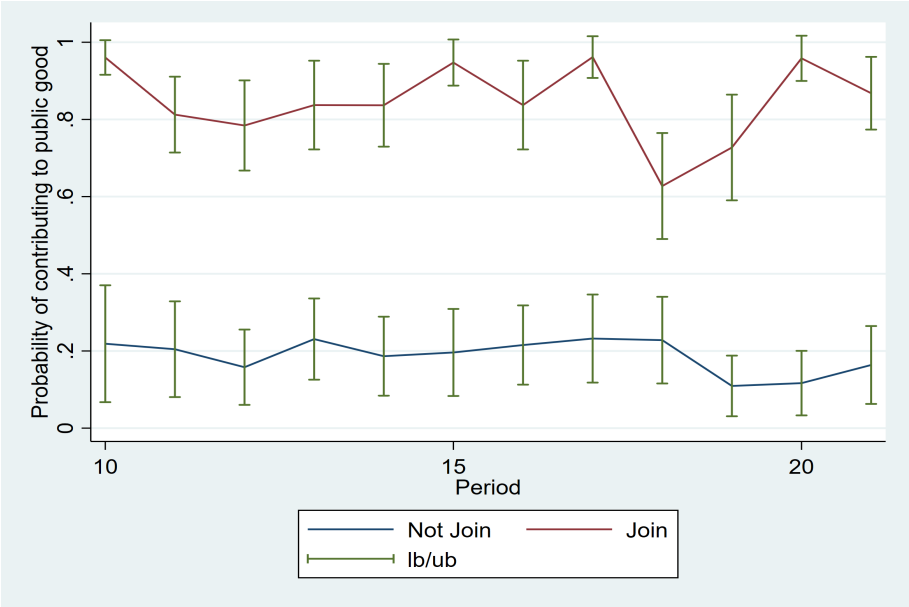

Figure 4: Time trends:Contribute to Public Good with respect to Join

Table 3: Descriptive Statistics with low and high MPCR

	Low MPCR	High MPCR	Difference
Join the Coalition	0.358	0.611	-0.252***
			(0.0269)
Contribute to Public good	0.316	0.698	-0.382***
			(0.0257)
Contribute to Public good (Coalition)	0.316	0.698	-0.382***
			(0.0257)
Coalition Size	2.151	3.664	-1.513***
			(0.0633)

Notes: Standard errors in parentheses. $***p < 0.01, **p < 0.05, *p < 0.10$

Table 4: Joining the Coalition

	(1) Model_1	(2) Model_2	(3) Model_3	(4) Model_4
type 2 (type 1 as base)	0.0229	0.0162	0	0
	(0.228)	(0.228)	(.)	(.)
type 3 (type 1 as base)	-0.0996	-0.109	0	0
	(0.228)	(0.227)	(.)	(.)
type 3 (type 2 as base)	0	0	-0.122*	-0.126*
	(.)	(.)	(0.0600)	(0.0600)
High MPCR (low MPCR as base)	0.239***	0.245***	0.241***	0.249***
	(0.0372)	(0.0379)	(0.0383)	(0.0391)
Lag of Contribute to Public good (Coalition)	-0.0310	-0.0343	-0.0220	-0.0277
	(0.0403)	(0.0361)	(0.0412)	(0.0370)
Lag of Payoff of least well off person	-0.000647	-0.00188	-0.000694	-0.00231
	(0.00148)	(0.00159)	(0.00154)	(0.00164)
Lag of Number of Contributors(Coalition))	0.0127		0.0134	
	(0.0122)		(0.0126)	
Lag of Coalition Size		0.0344*		0.0408**
		(0.0156)		(0.0157)
Type 1 removed			Y	Y
Observations	1188	1188	1144	1144

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All predictors at their mean value. Dependent: Join(1:Join, 0:Not Join)

Model 1 and 2 have all the types, Model 3 and 4 have type 1 removed.

Table 5: Joining the Coalition (different specification)

	(1) Model-1	(2) Model-2
Amount given to least well off person	0.0130	0.0134
	(0.00775)	(0.00780)
High MPCR (low MPCR as base)	0.240***	0.246***
	(0.0375)	(0.0382)
Lag of Contribute to Public good (Coalition)	-0.0327	-0.0357
	(0.0405)	(0.0363)
Lag of Payoff of least well off person(coal)	-0.000663	-0.00189
	(0.00148)	(0.00160)
Lag of Number of Contributers(Coalition)	0.0131	
	(0.0123)	
Lag of Coalition Size		0.0349*
		(0.0157)
Observations	1188	1188

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All predictors at their mean value. Dependent: Join(1:Join, 0:Not Join)

Table 6: Contributing in Coalition

	(1) Model_1	(2) Model_2	(3) Model_3	(4) Model_4
type 2(type1 as base)	-0.144	-0.177	0	0
	(0.122)	(0.136)	(.)	(.)
type 3(type 1 as base)	-0.311*	-0.351**	0	0
	(0.123)	(0.136)	(.)	(.)
type 3 (type 2 as base)	0	0	-0.166**	-0.172**
	(.)	(.)	(0.0527)	(0.0550)
High MPCR (low MPCR as base)	0.391***	0.204***	0.385***	0.202***
	(0.0334)	(0.0381)	(0.0340)	(0.0388)
Lag of Contribute to Public good (Coalition)	-0.00124	-0.00284	0.00247	0.000298
	(0.0413)	(0.0346)	(0.0418)	(0.0351)
Lag of Payoff of least well off person(coal)	-0.000225	0.000717	0.0000472	0.00103
	(0.00193)	(0.00135)	(0.00196)	(0.00137)
Lag of Number of Contributers(Coalition)	0.00592		0.00581	
	(0.0141)		(0.0144)	
Coalition Size		0.168***		0.166***
		(0.0164)		(0.0166)
Type 1 removed			Y	Y
Observations	1188	1188	1144	1144

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All predictors at their mean value. Dependent: Contribute(1:Yes, 0:No)

Model 1 and 2 have all the types, Model 3 and 4 have type 1 removed.

Table 7: Contributing in Coalition (different specification)

	(1)	(2)
	Model_1	Model_2
Amount given to the least well off person	0.0218***	0.0231***
	(0.00633)	(0.00670)
High MPCR (low MPCR as base)	0.394***	0.207***
	(0.0334)	(0.0383)
Lag of Contribute to Public good (Coalition)	-0.00179	-0.00241
	(0.0418)	(0.0348)
Lag of Payoff of least well off person(coal)	-0.000298	0.000691
	(0.00194)	(0.00137)
Lag of Number of Contributers(Coalition)	0.00656	
	(0.0143)	
Coalition Size		0.170***
		(0.0165)
Observations	1188	1188

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All predictors at their mean value. Dependent: Contribute(1:Yes, 0:No)

Table 8: Number of Contributors

	(1) Model1	(2) Model2
type 2 (type 1 as base)	-0.200	0
	(0.155)	(.)
type 3(type 1 as base)	-0.396**	0
	(0.150)	(.)
Amount given to the least well off person	0	0.0180*
	(.)	(0.00900)
High MPCR (Low MPCR as base)	1.024***	1.024***
	(0.0849)	(0.0848)
Lag of Payoff in Coalition	-0.0123	-0.0120
	(0.00833)	(0.00851)
Lag of Payoff of least well off person0.0164*	0.0162*	
	(0.00793)	(0.00814)
Coalition Size	0.860***	0.860***
	(0.0309)	(0.0307)
Constant	0.288	-0.147
	(0.156)	(0.131)
Observations	1188	1188

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

OLS, dependent variable: Number of contributors

Model 1 based on types, Model 2 based on amount given to least well off person

Table 9: Contribution and Contributors: Full Sample

	(1) Contribute_1	(2) Contribute_2	(3) Contributors_1	(4) Contributors_2
Part3 (part 2 as base)	-0.0981***	-0.0971***	-0.540***	-0.542***
	(0.0272)	(0.0275)	(0.0648)	(0.0671)
type2(type 1 as base)	-0.174	0	-0.127	0
	(0.121)	(.)	(0.0919)	(.)
type3(type 1 as base)	-0.312*	0	-0.333***	0
	(0.123)	(.)	(0.0908)	(.)
type3(type 2 as base)	0	-0.138**	0	-0.206*
	(.)	(0.0472)	(.)	(0.0867)
High MPCR (low MPCR as base)	0.373***	0.374***	2.222***	2.217***
	(0.0290)	(0.0295)	(0.0549)	(0.0555)
Lag of Payoff for subjects	0.0000758	0.000154	-0.000306	-0.000345
	(0.00106)	(0.00109)	(0.00292)	(0.00299)
Type 1 removed		Y		Y
Constant			2.621***	2.498***
			(0.0966)	(0.0944)
Observations	1944	1872	1944	1872

Standard errors in parentheses and clustered at subject level, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All predictors at their mean value (Model 1 and 3). Dependent: Contribute (1:Yes, 0:No)

OLS (Model 2 and 4), dependent variable: Number of contributors

Model 1 and 2 have all the types, Model 3 and 4 have type 1 removed.

Instructions

Page 1: Instructions

Welcome to the experimental session. You will be paid $10 for participating, you may earn additional money based on the decisions you make in the experiment. Your earnings will be paid in cash at the end of the session. You will complete a number of rounds in the experiment and your earnings from two randomly determined rounds will be paid to you. **You are not allowed to communicate with others during the experiment.**

Violation of this rule will lead to the exclusion from the experiment and all payments. If you have questions, please raise your hand. A member of the experimenter team will come to you and answer them in private. Cell phones are not allowed during the experiment.

Page 2: Instructions

We will not speak of Dollars during the experiment, but rather of points. Your whole income will first be calculated in points. At the end of the experiment, the total amount of points you earned will be converted to Dollars. Each 5 points is worth $1. So, if you earn 50 points you will receive $10 in addition to the $10 you get for participating.

The experiment consists of 2 sections. You will have the opportunity to make money from both the sections. First, we will give details on first section of the experiment. You will learn about the second section after you have completed the first.

Page 3: Instructions for **Section I**

You will make a single decision in Section 1. Your task is to allocate points between yourself and a person who participated in a previous experiment but earned the lowest amount of money of anyone in their session. If you allocate points to them then, after today's experiment is over, they will be asked to come back to the lab to get any additional money you allocated to them. They will not, however, find out that you were the person who allocated points to them. The other person does not have a decision to make – the money you both get from your decision depends on you alone.

Page 4: Instructions for Section I

Your decision will not affect the payoff of any other person in this room and vice versa. You will be asked to allocate 25 points between yourself and the person with the lowest earnings from a previous experiment. The possible payments are given in the table below:

Page 5: Instructions for Section II

Let's begin with the second section of the experiment.

The second section of the experiment consists of 2 parts. In each part there will be a number of rounds. You will be paid for one random round in each part. We will start by explaining the first part. You will receive separate instructions for part 2 after you have finished part 1. Note that your decision from Section 1 of the experiment, which you already completed, will not affect your payoff from this section, but will be added to your total earnings for the experiment at the end.

Page 6: Instructions for Part I

This part will have 8 rounds, and, in each round, you will be required to make a

Table 10: **Modified Dictator game**

Options	Your payment (in points)	Least well of person's payment in points
1	25	0
2	22.5	2.5
3	20	5
4	17.5	7.5
5	15	10
6	12.5	12.5
7	10	15
8	7.5	17.5
9	5	20
10	2.5	22.5
11	0	25

decision.

The decision situation.

You will be a member of a group consisting of 6 people. In each round everyone in your group will be given 10 points. Each group member has to decide on how to invest their 10 points in each round. You can invest all 10 points into your private account, or all 10 points into a group project. The points cannot be split between private account and the group project.

Page 7: Instructions for Part I

Your earnings from your **private account**. **You will earn one point for each point you put into your private account**. You can either put 0 points or 10 points into your private account. For example, if you put 10 points into your private account (and therefore do not invest in the group project), your earnings from private account will amount to exactly 10 points. If you put 0 points into your private account, your earnings from private account will be 0 points. No one except you earns something from your private account.

Page 8: Instructions for Part I

Here is information about your earnings from the group project. Both group members who do put their points in the group project and those who do not put their points in the group project will receive an equal number of points from the group project.

The earnings for each group member will be determined through a conversion rate. There will be two conversion rates in the experiment as described below.

Case 1) **Earnings from the project** = 30% multiplied by the sum of all contributions. Example 1: If everyone in your group of 6 participants contributes 10 points then, the sum of all contributions to the project is 60 points. Here the conversion rate is 30

Example 2: If four members of the group contribute 10 points each, then sum of contributions is 40 points. You and everyone in your group each earn 30% of the total contributions of 40, which is 12 points.

Case 2) Earnings from the project = 70% (0.7) multiplied by the sum of all contributions.

Example 1: If everyone in your group contributes 10 points then, the sum of all contributions to the project is 60 points. Here the conversion rate is 70

Example 2: If four members of the group contribute 10 points each, then the sum of contributions is 40 points. You and everyone in your group each earn 70% of the total contributions (40 points), which is 28 points.

Remember that you also get earnings from your private account, so in any round Total Earnings = earnings from your private account + earnings from the group project

Page 9: Instructions for Part I

Points to remember

Case 1 (30% earnings from the group project) and Case 2 (70% earnings from the group project) will occur in random order for the 8 rounds. Please pay attention to the amount of earnings from the group project in each round.

Your total earning: Your total earnings are the sum of your earnings from your private account and that from the project.

If you contribute to the project: In this case, you would have invested nothing in your private account and your earnings will solely depend on the earnings from the group project. Example 1: Total earnings= Earnings from your private account (0 points) + Earnings from the project (30% of sum of all contributions). Example 2: Total earnings= Earnings from your private account (0 points) +Earnings from the project (70% of sum of all contributions).

If you do not contribute to the project: In this case, you would have invested the 10 points in your private account and your earnings will include that 10 points in addition to the earnings from the groups project.

Example 1: Total earnings= Earnings from your private account (10 points) +Earnings from the project (30% of sum of all contributions). Example 2: Total earnings = Earnings from your private account (10 points) +Earnings from the project (70% of sum of all contributions).

To reiterate, income from the project goes up if more people contribute to the project. On the other hand, Income from your private account is only dependent on your contribution. At the end of each round, you will be informed about your earnings and how many people contributed to the project.

Page 11: Instructions for Part II

We now move to the instructions for Part II. In Part II, you all will have an option to join a coalition which decides together whether every coalition member will contribute to the group project or not. In this part thus, you will make two decisions in each round.

In stage 1, you will decide whether or not to join a coalition. In stage 2, your decision will depend on whether you decided to join the coalition or not.

If you do not join the coalition, your decision is independent of other group members: you decide independently whether to invest 10 points in your private account or in the group project. If you do join the coalition, then members of the coalition collectively decide whether all members will contribute or not contribute to the group project.

Page 12: Instructions for Part II

Remember that in stage 1 every group member decides whether or not to join the

coalition. At the end of stage 1, you will know how many members in the group of 6 participants have decided to join the coalition.

How do coalitions make decisions in stage 2?

Every group member who joins the coalition will vote on whether members of the coalition will invest all 10 points in the group project or not. **If half or more than half the people in the coalition vote to put "points in the group project" then everyone's points in the coalition go into the group project**.

Example 1: If the coalition consists of 5 members and 3 of them vote to contribute their 10 points, then each of the 5 members will put 10 points in the group project. Example 2: If the coalition consists of 4 members and 2 of them vote to contribute their 10 points, then each of the 4 members will put 10 points in the group project.

Once you join the coalition, you remain in it until the round ends. You are free to make a different decision in each round about whether to join the coalition or not.

Remember that you also get earnings from your private account, so in any round Total Earnings = earnings from your private account + earnings from the group project

Page 13: Instructions for Part II

Let's give you some scenarios as examples and your earnings in each one of them.

Suppose that the group project's conversion rate is 30%.

Also, suppose three people in the group join the coalition and that two out of these three people vote to contribute to the group project. In this case, everyone in the coalition contributes their 10 points to the group project.

Last, suppose that 2 out of the remaining 3 people the group who are not in the coalition also contribute to the group project. Thus, there are now 5 people contributing to the group project. The sum of everyone's contributions is 50 (5 multiplied by 10=5x10).

Scenario 1: you are a member of the coalition of 3 people that collectively decided to contribute to the group project.

Since you contributed to the project, your earnings for the round will be (Earnings from your private account = 0 points) + (Earnings from the group project or 30% of the sum of everyone's contributions=0.3x50) Earnings for the round=0+15 =15 points

Scenario 2: you are one of the two people who did not join the coalition but decided to contribute to the group project

The sum of everyone's contributions is 50 (5 multiplied by 10=5x10). In this scenario your calculation for Earnings for the round will exactly be the same as above.

Earnings for the round= (Earnings from your private account = 0 points) + (Earnings from the group project or 30

Recall when you contribute to the group project (as in scenarios 1 and 2), your earnings for the round will be the earnings from the group project.

Page 14: Instructions for Part II

Let's give you another example of two other scenarios below and your earnings in each one of them.

Suppose that the group project's conversion rate is 30

Also, suppose three people in the group join the coalition and that one out of these three people vote to contribute to the group project. In this case, no one in the coalition

contributes their 10 points to the group project.

Last, suppose that 2 out of the remaining 3 people the group who are not in the coalition also contribute to the group project. Thus, there are now 2 people contributing to the group project. The sum of everyone's contributions is 20 (2 multiplied by 10=2x10).

Scenario 3: you are a member of the coalition of 3 people that collectively decided not to contribute to the group project.

Since you do not contribute to the project, your earnings for the round will be (Earnings from your private account =10 points) + (Earnings from the group project or 30

Earnings for the round=10 + 6 =16 points

Scenario 4: you did not join the coalition and decided not to contribute to the group project

The sum of everyone's contributions is 20 (2 multiplied by 10=2x10). In this scenario your calculation for Earnings for the round will exactly be the same as above.

Earnings for the round will be (Earnings from your private account =10 points) + (Earnings from the group project or 30% of the sum of everyone's contributions=0.3x20) =10+6=16 points

Recall when you do not contribute to the group project (as in Scenario 3 and 4), you earn both from private account and group project.

Page 15: Instructions for Part II Points to remember:

Case 1 (30 % earnings from the group project) and Case 2 (70% earnings from the group project) will occur in random order for the 10 rounds. Please pay attention to the amount of earnings from the group project in each round.

In each round you have the option to join a coalition. The coalition decides together whether to contribute to the group project or not. If half or more than half the people in the coalition vote to put "points in the group project" then everyone's points in the coalition go into the group project.

Your total earning: Your total earnings are the sum of your earnings from your private account and that from the project

If you contribute to the project: In this case, you would have invested nothing in your private account and your earnings will solely depend on the earnings from the group project. Example 1: Total earnings= Earnings from your private account (0 points) + Earnings from the project (30Example 2: Total earnings= Earnings from your private account (0 points) +Earnings from the project (70

Remember if you join the coalition, you contribute to the project if half or more than half the people in the coalition vote to put "points in the group project".

If you do not contribute to the project: In this case, you would have invested the 10 points in your private account and your earnings will include that 10 points in addition to the earnings from the group project.

Example 1: Total earnings= Earnings from your private account (10 points) +Earnings from the project (30Example 2: Total earnings = Earnings from your private account (10 points) +Earnings from the project (70

Remember if you join the coalition, you do not contribute to the project if half or more than half the people in the coalition vote to not put "points in the group project".

To reiterate, income from the project goes up if more people contribute to the project. On the other hand, Income from your private account is only dependent on your contribution. At the end of each round, you will be informed about your earnings and how many people contributed to the project.

Participants play a quiz before they began to play the game in Part III