CENTRE FOR DECISION RESEARCH & EXPERIMENTAL ECONOMICS

Discussion Paper No. 2015-20

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December 2015

Entry or Exit? The Effect of Voluntary Participation on Cooperation

CeDEx Discussion Paper Series
ISSN 1749 - 3293

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Entry or Exit?
The Effect of Voluntary Participation on Cooperation

10 December 2015

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Abstract:
We study the effects of voluntary participation on cooperation in collective action problems. Voluntary participation may foster cooperation through an entry mechanism, which leads to assortative selection of interaction partners, or an exit mechanism, whereby the opportunity to leave the partnership can be used as a threat against free-riders. We examine the effectiveness of these mechanisms in a one-shot public goods experiment. Voluntary participation has a positive effect on provision only through the exit mechanism. Assortative selection of interaction partners seems to play a minor role in our setting, whereas the threat of costly exit is a powerful force to discipline free-riding.

Keywords: collective action; cooperation; voluntary participation; exit; entry; experiment.

JEL Classification Numbers: C91, D02, H41

Acknowledgements: We thank Despoina Alempaki, Abigail Barr, Tim Cason, Dennie van Dolder, Simon Gächter, Benedikt Herrmann, Felix Kölle, Anita Kopanyi-Peuker, Xueheng Li, Maria Montero, Rebecca Morton, Tatsuyoshi Saijo, Heiner Schumacher, Martin Sefton, Chris Starmer, Aljaz Ule, and Jörg Weber for helpful discussions. We also received useful comments from workshop participants at the University of Aarhus and University of Amsterdam, and participants at the 2014 North-American ESA conference. We acknowledge support from the Leverhulme Trust (ECF/2010/0636), Center for Interdisciplinary Studies in Economics Psychology and Social Sciences (CISPES, Università degli Studi di Milano-Bicocca), and the University of Nottingham.

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1. INTRODUCTION

Collective action is at the heart of many activities of vital importance for human societies. However, many groups fall prey to free-riding incentives and struggle to foster and sustain cooperation (Olson, 1965; Dietz et al., 2003). Thus, the success of human cooperation relies on the effectiveness of mechanisms and institutions designed to restrain free-riding and promote cooperation (e.g., Rand and Nowak, 2013). A substantial amount of research has been devoted to the study of such mechanisms and institutions. Several authors have shown that cooperation can be sustained by (in)direct reciprocity and reputational spill-overs, if the prospects of future interactions are non-negligible (e.g., Roth and Murnighan, 1978; Dal Bó, 2005). Altruistic punishment and rewards have also been shown to effectively promote cooperation (e.g., Fehr and Gächter, 2000; Sefton et al., 2007). In this paper, we study an alternative mechanism to reciprocity, reputation, sanctioning and rewarding: voluntary participation to collective action.

Voluntary participation is a nearly ubiquitous characteristic of real-world social interactions: in many naturally occurring environments individuals can freely decide whether or not to enter into partnerships with others to engage in cooperative endeavors. Moreover, in most settings individuals are free to exit from partnerships, if they wish to do so. Voluntary associations, collectives, community groups, and collaborative institutions are typical real-world examples of organizations facing collective action problems where agents have the freedom to join in, or opt out from, participating in the common endeavors. And indeed voluntary participation is sometimes invoked to explain the relative success of such groups in solving collective actions dilemmas (see, e.g., Lin, 1990 for a discussion of the role of exit options in Chinese agricultural collectives in 1959-1961). However, while there is a consensus that voluntary participation may foster cooperation, little is known about the mechanisms underlying this effect. The aim of this study is to fill this gap in the literature, by investigating which of the two voluntary-participation mechanisms outlined above (entry or exit) is most conducive to cooperation in collective action situations.

There is a large, mostly theoretical, literature emphasizing the positive effects of voluntary participation on cooperation. On the one hand, some authors have argued that the positive effects of voluntary participation may operate through a mechanism of *entry*: the fact that participation in groups is not forced but voluntary may trigger a process of self-selection into groups that favors the inclusion of cooperators and the exclusion of free-riders. The literature has proposed different mechanisms that may lead to this process of assortative matching. For instance, some authors have suggested that cooperators may have observable characteristics ("green beards") that distinguish them from free-riders (e.g., Frank, 1987; 1988; Amann and Yang, 1998). If individuals are free to decide whether or not to enter into partnerships with others, they may use these observable characteristics to avoid partnerships with free-riders and favor partnerships with cooperators. Other models have instead proposed that assortative matching may be the result of a "false consensus bias", whereby individuals tend to project their own cooperative attitudes onto others (Ross et al., 1977).[1] If individuals suffer from a false consensus bias, cooperators will be more optimistic about the prospects of cooperation, and may thus be more likely than free-riders to join others in cooperative endeavors (e.g., Orbell and Dawes, 1991; Macy and Skvoretz, 1998).[2]

On the other hand, a different strand of literature emphasizes that voluntary participation may have a positive effect on cooperation through a mechanism of *exit*. Again, the existing literature suggests different possible mechanisms whereby this may happen. In some models, the possibility to quit partnerships is beneficial to cooperation simply because it allows cooperators who are willing to walk away from their partners, to avoid repeated interactions with free-riders and to reap instead the benefits of repeated interactions with other like-minded cooperators (e.g., Aktipis, 2004). Other authors emphasize instead the fact that the dissolution of partnerships may impose costs on all parties involved (e.g., Fujiwara-Greve and Okuno-Fujiwara, 2009; Izquierdo et al., 2010; Schumacher, 2013; Izquierdo et al., 2014). This gives group members a means to resist exploitation by free-riders, as the threat of costly exits may discipline opportunistic behavior and prevent free-riding.[3]

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[1] Several experimental studies have found evidence that individuals suffer from a false consensus bias across a variety of settings (e.g., Offerman et al., 1996; Selten and Ockenfels, 1998; Charness and Grosskopf, 2001; Heijden et al., 2007; Gächter et al., 2012; Blanco et al., 2014). For a discussion of whether the consensus effect is "truly" false, see Engelmann and Strobel (2000) and Engelmann and Strobel (2012).

[2] Other authors have shown that the presence of "loners", who refuse participation in public good groups, can have positive effects on cooperation if the ratio between private costs and benefits of contributing is more favorable in smaller than larger groups (e.g., Hauert et al., 2002; Semmann et al., 2003). See Fletcher and Doebeli (2009) for a discussion of the different theoretical mechanisms leading to assortative matching.

[3] In these models individuals are randomly matched from an infinite population to play a cooperation game in each period. At the end of each game, individuals decide whether or not to continue playing with the same partner. The individuals who quit partnerships, and their partners, join a pool of "unmatched players" who are randomly re-matched together at the beginning of each new period. This is costly because cooperators are able to sustain long-

Despite the many theoretical arguments proposing that voluntary participation may foster cooperation, only a few empirical studies (reviewed below) have so far examined the effects of voluntary participation on cooperation. Moreover, none of these studies have compared the relative effectiveness of mechanisms of entry and exit in promoting cooperation. In this paper, we present a one-shot, two-person public goods game experiment designed to disentangle the effects of entry and exit on cooperation. In our experiment we focus on two specific mechanisms whereby entry and exit may improve cooperation: a mechanism of assortative matching based on false consensus bias, and a mechanism of exit where the decision to walk away may impose costs on all interacting parties. To disentangle the effects of entry and exit, we contrast three treatments: a Baseline treatment, with forced participation in the public goods game; an Entry treatment where at the beginning of the game players choose between an outside option payoff and participation in the public goods game; and an Exit treatment where, after interacting in the public goods game, players can opt out of the game and secure an outside option payoff. In order to study the role of false consensus bias, in all treatments the public goods game was preceded by a sequential two-player prisoner's dilemma game which we use to measure subjects' cooperative types and optimism about cooperation.

Our results show that voluntary participation can have a strong, positive effect on cooperation. However, this positive effect is only observed when the exit option is available, whereas the entry mechanism does not have an effect on cooperation. These findings point to the crucial relevance of the exit option in fostering cooperation in collective action situations. The effectiveness of the exit option lies in the threat-value of exits: in our experiment subjects who decide to exit do so mainly to retaliate against free-riders. Subjects seem to anticipate this effect, and this generally increases contributions. In contrast, the entry mechanism does not have much bite in our experiment. This is not because our subjects are not affected by a false consensus bias: in fact, we observe a significant false consensus effect in our data. Rather, the entry option is unsuccessful because in our experiment decisions to enter the public goods game do not seem to depend on subjects' cooperation types or their optimism about cooperation.

Our paper contributes to the study of mechanisms and institutions that can help groups overcome collective action dilemmas. We show that the institution of voluntary participation can

term relationships when matched with other cooperators, and thus the pool of unmatched players is quickly overpopulated by free-riders, which makes being unmatched relatively unprofitable.

substantially increase cooperation, and may thus be either an effective substitute or complement for other mechanisms based – for instance – on reciprocity, reputation, sanctioning, and rewarding. As such, our paper directly contributes to the small experimental literature on the effects of voluntary participation in social dilemmas.[4] Ehrhart and Keser (1999) were among the first to study the effects of voluntary participation on public good provision. In their experiment, subjects are initially assigned to public good groups, but have then the opportunity to migrate to other groups, or create new ones. They observe a positive effect of voluntary participation on cooperation, in that contributions levels are above the theoretical prediction and closer to the socially efficient level. Hauk (2003) studies voluntary participation in repeated n-person prisoner's dilemma games where players can choose between playing the game and securing an outside option payoff, and finds a positive effect on cooperation. My and Chalvignac (2010) compare a standard repeated public goods game with a game with two stages: in the first stage subjects decide whether or not to participate in the game; in the second stage subjects who decided to participate choose a contribution level, whereas subjects who opted out receive an outside option payoff. They find a weak but positive effect of the opt-out option on contributions.[5, 6]

A key difference between the studies mentioned above and our experiment is that previous studies typically entail repeated interactions between subjects, where the decisions to participate in a future round of interaction are made after having observed the outcome of previous interactions. This makes it difficult, if not impossible, to identify the distinctive roles of entry and exit in promoting cooperation, as the two mechanisms are confounded in those experimental

[4] Another, less closely related, literature entails the study of endogenous group formation in social dilemmas (e.g., Riedl and Ule, 2002; Cinyabuguma et al., 2005; Page et al., 2005; Ahn et al., 2008; 2009; Maier-Rigaud et al., 2010; Charness and Yang, 2014). The main focus of this literature, however, is on the effects of mechanisms, such as voting, partner-selection and ostracism, that allow group members to regulate the participation of other individuals in their group. In contrast, the focus of our paper is on the decisions of the individual to self-select into or out of cooperative endeavors.

[5] Voluntary participation has also been studied in the context of team production games. Keser and Montmarquette (2011) let subjects decide whether to be paid according to piece-rate or team incentives. They find that, compared to a setting where subjects are forced to receive team incentives, voluntary participation in the team incentive scheme has a positive effect on effort when agents are symmetric in their productivities, but not when they are asymmetric.

[6] Also related are the experiments by Cason et al. (2002) and Cason et al. (2004), who study a two-stage, non-linear public goods game where, in the first stage, subjects can commit to free-ride by announcing their non-participation in the game, and in the second stage subjects who have not committed to free-ride choose a contribution level. In their setting, individuals who opt out from the game can still benefit from public good provision. They find less free-riding than predicted as periods progressed, and this is mostly due to the existence of spiteful behavior by subjects who participate in the game and contribute less than individually optimal in order to hurt those who have opted out.

designs. In contrast, our experiment is inspired by the theoretical arguments discussed above that emphasize the different effects that entry and exit may have on cooperation. Thus, our experiment is based on one-shot games where we can cleanly identify whether an entry or exit mechanism drives the effects of voluntary participation on cooperation.

In this sense, our paper is most closely related to the experiments by Orbell and Dawes (1993), who study non-repeated prisoner's dilemma games with an entry option (subjects can decide whether to cooperate, defect, or not play the game), and Wilson and Wu (2014), who study infinitely repeated prisoner's dilemma games where players have an option to unilaterally and irrevocably terminate the relationship and secure an outside option payoff. However, Orbell and Dawes (1993) only focus on entry effects and Wilson and Wu (2014) only focus on exit effects, whereas our experiment provides a unified framework where we can compare the relative effectiveness of entry and exit mechanisms on cooperation. Moreover, with our design we can study specific mechanisms underlying the effects of entry (false consensus bias) and exit (threat of retaliation against free-riding). In line with our results, Wilson and Wu (2014) find that the presence of an exit option can substantially increase cooperation. Orbell and Dawes (1993) find that entry can also have a positive effect on cooperation and efficiency. This result contrasts with our finding that the entry option is not effective in promoting contributions in our public goods game experiment. While the numerous differences between experimental designs make it difficult to precisely identify the source of this variation in experimental results, these discrepancies suggest that the specific details of the decision-making environment may play an important role in determining the effectiveness of the entry option. This may be an interesting issue for further research.

The paper progresses as follows. Section 2 introduces the experimental design and procedures. Section 3 presents the results and discusses the main findings. Section 4 concludes.

2. EXPERIMENT DESIGN AND PROCEDURES

2.1 Experiment design

Our experiment is based on a one-shot version of the following two-person public goods game (PGG). At the beginning of the game, subjects are randomly matched into two-person groups. In each group, subjects receive an endowment of 20 tokens each, and simultaneously decide whether to allocate these tokens to either a private or a group account. Each token a subject allocates to the private account earns 3 points to that subject, whereas each token allocated to the group account earns 2 points to each of the two subjects in the group.[7] Thus, the game contains a tension between private and collective interests: group payoffs are maximized when subjects allocate their whole endowment to the group account, resulting in a payoff of 80 points per subject. However, the optimal decision of a self-interested individual is to allocate all tokens to the private account, resulting in an equilibrium payoff of 60 points per subject.

We study different versions of this game across three between-subject treatments, where we vary whether and how subjects can voluntarily participate in the PGG. In a Baseline treatment there is no option of voluntary participation and subjects are required to participate in the PGG. In contrast, in our Entry and Exit treatments subjects choose whether or not to play the PGG. The two treatments differ in whether subjects can express their voluntary participation through a mechanism of entry (i.e., selection into the game) or exit (i.e., selection out of the game).

The Entry treatment is based on a two-stage game where, in the first stage, subjects simultaneously decide whether to participate in the PGG or take an outside option payoff of 61 points.[8] In the second stage, subjects learn their opponent's participation decision. If both subjects have chosen to participate in the game, subjects play the one-shot PGG and are paid accordingly. If at least one subject in the group has chosen not to participate in the PGG, then both subjects receive the outside option payoff.[9]

The Exit treatment is also based on a two-stage game, but the option of voluntary participation is only available in the second stage. In the first stage, subjects make a simultaneous contribution decision in the PGG. In the second stage, subjects learn their opponent's contribution and simultaneously decide whether to confirm or withdraw their participation. If both subjects confirm their participation, subjects are paid according to the contribution decisions of stage one. If at least one subject withdraws participation, then both subjects receive the outside option payoff of 61 points.

[7] Point earnings were converted to cash at a rate of 0.15 GBP per point.
[8] We set the value of the outside option payoff just above the Nash equilibrium payoff of the underlying PGG. We further discuss the theoretical implications of this choice below and in Section 2.2.
[9] Note that in this sense the public good is not truly non-excludable in our setting, because a player's choice not to take part in the game prevents both players from enjoying the benefits of public good provision.

We use the Exit treatment to study the effect of costly exits on cooperation. As we discussed in the previous section, the theoretical literature suggests that the freedom to reject a partnership has a positive effect of cooperation because it gives cooperators a means to discipline free-riders: given that exits impose costs on both those who reject the partnership and their potential partners, cooperators can use the threat of exit to restrain opportunistic behavior and encourage cooperation. In our experiment we capture the essence of this mechanism by specifying a relatively low outside option payoff, which make exits potentially costly. That is, if subjects decide to reject a partnership, this may lead to lower payoffs to both interacting parties, and thus players can use the threat of exit to deter free-riding.[10]

The Entry treatment allows us instead to study the effect of false consensus bias on cooperation. As discussed above, false consensus bias makes cooperators relatively more optimistic than free-riders about the prospects of interacting with a cooperator. If players are free to decide whether to participate in cooperative endeavors, false consensus bias may lead to a process of assortative matching whereby cooperators are more likely to self-select into the PGG than free-riders, with positive effects on cooperation.

To study the false consensus mechanism in more detail, one needs to (i) classify whether subjects are "cooperators" or "free-riders", and (ii) measure their relative optimism about the prevalence of cooperators in their session. To do this, in all treatments the PGG was preceded by a one-shot version of the sequential prisoner's dilemma game (PD). At the beginning of the game, the first-mover chooses whether to cooperate or defect. If the first-mover defects the game ends and players receive a payoff of 50 points each. If the first-mover cooperates then the second-mover chooses between cooperation (where players receive 70 points each) and defection (where first- and second-movers receive respectively 35 and 85 points). In the experiment, subjects were randomly matched in pairs and made decisions in both roles. Subjects did not learn which role they were actually assigned to until the end of the experiment. Thus, both choices were elicited in an incentive-compatible way. Moreover, subjects were asked to submit a prediction about the

[10] The exit option also eliminates the risk of positive contributions as subjects can always guarantee themselves a payoff no lower than the Nash equilibrium payoff. This is akin to the role of refunds in threshold PGG (e.g., Coats et al., 2009; Cartwright and Stepanova, 2015). However, while in the threshold PGG case the refund rule is implemented automatically, in our setting the decision of securing the outside option payoff is endogenous and likely to be triggered by observed differences in contributions between subjects. In this sense, we regard the willingness to discipline free-riding as the primary mechanism underlying the Exit treatment.

number of other participants in the session who would cooperate in the role of second-mover. This prediction was incentivized and subjects received 10 points if their guess was correct.

The PD game allows us to perform a more detailed test of the effect of false consensus bias on cooperation. First, based on their choices as second-mover, we can classify each subject as either a “cooperator” (if they cooperated) or “free-rider” (if they defected). Moreover, by eliciting subjects’ beliefs about others’ behavior in the role of second-mover, we can measure their estimate of the likelihood of meeting a cooperator, i.e. their “optimism” about cooperation.

2.2 Theoretical considerations

In the version of the PGG played in the Baseline treatment it is a dominant strategy for a rational and self-interested player to allocate all tokens to their private account. Thus, both players contribute zero tokens to the public good in the unique Nash equilibrium of the game, resulting in an equilibrium payoff of 60 points per subject.

Assuming common knowledge of rationality and self-interest, the option of voluntary participation does not lead to higher predicted contributions in the Entry treatment. To see this, consider the second stage of the Entry game. In the subgame where subjects make a contribution decision in the PGG, the optimal decision of a rational and self-interested player is to contribute zero tokens, yielding an equilibrium payoff of 60 points per player. By replacing this subgame with its subgame perfect equilibrium value, we obtain the following reduced game (Table 1).

Table 1: Reduced game with Entry

	PLAYER 2	
PLAYER 1	Participate	Do not participate
Participate	60, 60	61, 61
Do not participate	61, 61	61, 61

The reduced game has multiple pure-strategy equilibria and in any equilibrium at least one subject refuses to take part in the PGG. Indeed, in the reduced game players have a weakly dominant strategy not to participate in the PGG and take the outside option payoff of 61 points instead. Thus, if we refine the equilibrium set by requiring that players do not use weakly dominated strategies, only the equilibrium with mutual non-participation survives. Thus, the public good is not provided in equilibrium and each subject earns a payoff of 61 points.

In contrast, in the Exit treatment voluntary participation can lead to small, positive contributions in equilibrium. To see this, consider the subgames following the contribution stage. In any subgame, mutual non-participation is always an equilibrium, leading to a payoff of 61 for each player. However, other pure-strategy equilibria may also arise, some of which involve mutual participation, depending on the contributions made in the contribution stage. Specifically, there are three cases. First, in some subgames mutual participation would lead to payoffs that are strictly higher than 61 for both players. In these subgames, participating in the PGG is a weakly dominant strategy (within the subgame) for both players. Using weak dominance as a refinement, we select the equilibrium with mutual participation in these subgames. Second, in other subgames, mutual participation would lead to payoffs that are either equal to 61 for both players, or strictly lower than 61 for at least one player. In these subgames, any equilibrium involves a payoff of 61 for each player. Finally, in a third class of subgames, mutual participation would lead to a payoff of 61 for one player, and a payoff higher than 61 for the other player. In these subgames, participating in the PGG is a weakly dominant strategy (within the subgame) for the player who receives a payoff higher than 61 from participation, while the other player is indifferent between participation and non-participation. Thus there are three pure-strategy equilibria, one involving mutual participation and two involving non-participation by at least one player. In these subgames we select the equilibrium involving mutual participation on the grounds that this equilibrium is strictly preferred by one player while the other player is indifferent between equilibria.[11]

By replacing each subgame with its subgame perfect equilibrium value, we obtain a reduced game with five pure-strategy equilibria. Three equilibria involve symmetric contributions to the public good of respectively zero, one and two tokens. In the remaining two equilibria one player contributes zero tokens and the other player contributes one token. Note that in the two asymmetric equilibria and in the symmetric equilibrium with zero contributions at least one player earns a PGG payoff lower than 61. Thus, in the corresponding subgame perfect equilibria of the extended game players withdraw participation from the PGG and the public

[11] This has only minor implications for the set of subgame-perfect equilibria, as we discuss in the next footnote.

good is not provided. In the remaining two symmetric equilibria, both players earn at least 61 points from the PGG and thus they confirm their participation in the PGG in the corresponding subgame perfect equilibria of the extended game.[12]

Thus, according to standard predictions, voluntary participation has only a small positive effect on public good provision. Moreover, this positive effect obtains only when voluntary participation operates through the exit mechanism.

These predictions may change if we relax the assumption that all individuals are self-interested and assume that at least some individuals have other-regarding preferences.[13] In this case, positive contributions may emerge in equilibrium already in the Baseline treatment.[14]

The entry option has a further positive effect on contributions in that it allows assortative matching of other-regarding players in the PGG. In fact, if players know each other's preferences, the only subgame perfect equilibria with entry and positive contributions occur when two other-regarding players are matched together.[15] Self-interested players have instead a weakly dominant strategy (in the reduced game) not to take part in the PGG.[16] The entry option may have a positive effect on contributions even if players do not know each other's preferences, but suffer from a false consensus bias. In this case, players' decision whether to participate in the PGG is based on their expectations about the proportions of other-regarding and self-interested players in the population. If players suffer from a false consensus bias, other-regarding players are more optimistic than self-interested players about the chances of meeting another other-regarding player. Thus, other-regarding players may be relatively more likely to participate in the PGG than self-interested players, with a positive effect on contributions.[17]

[12] If in the subgames where mutual participation leads to a payoff of 61 for one player and a payoff higher than 61 for the other player we select the equilibrium with non-participation, the set of subgame-perfect equilibria changes slightly as there is now a sixth equilibrium involving symmetric contributions of three tokens to the public good.

[13] Indeed, predictions may also change if players simply have incomplete information about the preferences and rationality of their opponent (e.g., Kreps et al., 1982).

[14] For example, players may make positive contributions in equilibrium if they are sufficiently inequity averse. See Fehr and Schmidt (1999) for a proof.

[15] Of course, the details of this depend on the specific model of other-regarding preferences that one has in mind. In what follows we have in mind a model where public good provision is sustained by positive contributions by both players. This excludes, for example, the case of extremely altruistic preferences whereby a player would find it optimal to contribute to the public good even if their counterpart free-rides. In the latter case, there may be equilibria with entry and positive contributions even if one of the players has self-regarding preferences.

[16] When players know each other's preferences and a self-interested player is matched with an other-regarding player or with another self-interested player, both players have weakly dominant strategies (in the reduced game) not to participate in the PGG as they anticipate that the outcome of the PGG will be one where neither player contributes.

[17] See Orbell and Dawes (1991) for a model of selective cooperation when players suffer from false consensus bias.

The presence of other-regarding players may also strengthen the positive effects of exit on contributions. This is because players with other-regarding preferences may be willing to withdraw participation from the PGG even if this implies a sacrifice in their own material payoffs.[18] Thus, threats that are not credible for self-interested players may become credible if players have other-regarding preferences, and this may further discipline free-riders. Thus, equilibria with higher contribution levels may be sustained in Exit in the presence of other-regarding players.

2.3 Experiment procedures

The experiment was programmed in z-Tree (Fischbacher, 2007) and conducted at the University of Nottingham using students from a wide range of disciplines recruited through the online recruitment system ORSEE (Greiner, 2015). We conducted fourteen sessions: four sessions with a total of 68 subjects in each of Baseline and Exit, and six sessions with a total of 92 subjects in Entry. We over recruited in the Entry treatment to account for potential attrition of subjects out of the PGG. In fact, in twelve of the forty-six groups at least one subject chose not to take part in the PGG. Hence, also in Entry we observe contribution decisions from 68 subjects.

At the start of a session, subjects were randomly allocated to computer terminals and were given preliminary experimental instructions, which were read aloud.[19] Subjects were informed that the experiment consisted of two parts, but they did not receive instructions for part two (the PGG) until everyone had completed part one (the PD game). Subjects were then given part-one instructions, which were again read aloud. These instructions were followed by a series of control questions aimed at testing subjects' understanding of the PD game. Part one began once all subjects had answered all questions correctly. Subjects were then randomly matched in pairs and played the one-shot PD game described above.

When everyone had completed part one, and without receiving feedback on the outcomes of the PD game, subjects were given part-two instructions, which were read aloud. Again, the instructions were followed by control questions to probe subjects' understanding of the game.

[18] While this may not be the case for all types of other-regarding preferences, this may occur if players are motivated by reciprocity or inequity aversion. For example, a player with Fehr-Schmidt preferences and strong aversion to disadvantageous inequality ($\alpha > 5.67$) would withdraw participation whenever her contribution exceeds that of the other player.

[19] The experimental instructions are reproduced in Appendix A.

Part two began when everyone had answered all questions correctly. Subjects were then randomly matched into new pairs and played one of the three versions of the PGG described above.

At the end of part two, subjects were informed of their earnings from the two parts of the experiment. For part one, in each pair one of the subjects was randomly assigned the role of first-mover and the other subject the role of second-mover. One of the two parts was then randomly selected for payment, and subjects were paid accordingly in private and in cash while they were completing a short post-experimental questionnaire, where we elicited standard socio-demographic and attitudinal information. The questionnaire included a self-assessment of subjects' risk and trust attitudes. Risk attitudes were elicited using the German Socio-Economic Panel (SOEP) general risk question discussed in Dohmen et al. (2011), and trust attitudes were elicited using the World Values Survey (WVS) Trust question.[20] Sessions lasted approximately 60 minutes and earnings averaged GBP 9.13.

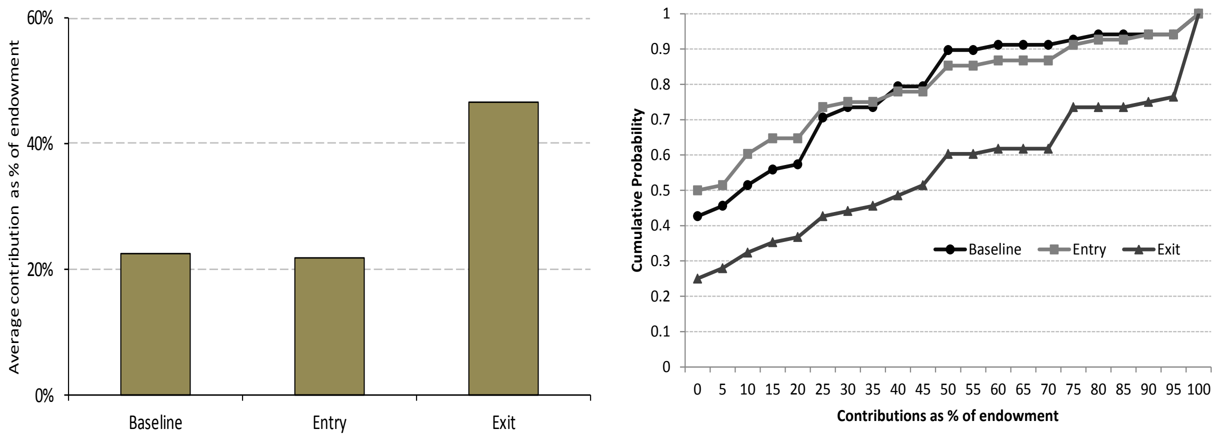
3. Results

3.1 Contribution behavior across treatments

Figure 1 summarizes the main result of the experiment. The left panel of the figure shows the average contributions to the public good as percentage of endowment in our three treatments. In the right panel of the figure we plot, for each treatment, the cumulative distribution function (CDF) of contributions as percentage of the subjects' initial endowment.

[20] The SOEP question reads: "*Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?*", and subjects answered on a Likert scale ranging from 0 ("risk averse") to 10 ("fully prepared to take risk"). The average response to the SOEP risk question was 5.64 (s.d. 2.12). The WVS Trust question reads: "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?*", to which subjects replied either by saying that they believe that "*most people can be trusted*" or that one needs "*to be very careful in dealing with people*". Responses to the WVS Trust question reveal that about 41% of our subjects believe that "*most people can be trusted*".

Figure 1: Contributions to public good across treatments



On average in Baseline subjects contribute about 22% of their endowment to the public good. The right panel of Figure 1 shows that a substantial fraction of subjects (43%) act as complete free-riders and make no contributions to the public good. Only 10% of subjects contribute at least half of their endowment, and only 6% contribute the entire endowment. This result replicates findings from previous one-shot public goods game experiment (e.g., Dufwenberg et al., 2011), and confirms that the prospects for cooperation among strangers are dismal in the absence of mechanisms that can discipline free-riding. The question is whether voluntary participation can be used as such a mechanism to improve cooperation.

Figure 1 suggests that the answer is positive, although the effectiveness of voluntary participation crucially depends on whether it operates through a mechanism of entry or exit. In particular, the mechanism of exit produces a more than two-fold increase in contributions relative to Baseline: in the Exit treatment subjects contribute on average 47% of their endowment.[21] Inspection of the right panel of Figure 1 reveals that the exit option has a dramatic impact on the distribution of contributions: the percentage of free-riders drops to 25%; 40% of subjects contribute at least half of their endowment; and 24% contribute their full endowment to the public good. We use Mann-Whitney and Kolmogorov-Smirnov tests to formally compare contributions between the Exit and Baseline treatments. In both cases the treatment differences are highly significant ($p \leq 0.002$, two-tailed; $n = 68$ per treatment).

[21] Average contributions in the Exit treatments are computed using subjects' first stage contribution decisions, regardless of whether these were confirmed or withdrawn in the second stage. In section 3.4 we analyze the effects of exit taking into account second stage exit decisions.

In contrast, voluntary participation has only a negligible impact on cooperation when it operates through a mechanism of entry. Average contributions in the Entry treatment are 22% of endowment. This is not significantly different from Baseline according to a Mann-Whitney test ($p = 0.522$, two-tailed; $n = 68$ per treatment).[22] The right panel of Figure 1 suggests that voluntary participation through entry has two contrasting effects on contribution behavior. On the one hand, the entry option somewhat increases the share of high contributions relative to Baseline (15% of subjects in Entry contribute at least half of their endowment). On the other hand, the entry option seems to encourage free-riding: in Entry half of subjects contribute zero tokens to the public good. However, these effects are small. In fact, we cannot detect statistically significant differences between Entry and Baseline using a Kolmogorov-Smirnov test ($p = 0.933$, two-tailed; $n = 68$ per treatment).[23, 24]

3.2 A robustness treatment: Entry_High

Overall, our results suggest that voluntary participation can promote cooperation and have a positive effect on public good provision. However, this positive effect is observed only when voluntary participation operates through a mechanism of exit. The entry mechanism does not seem to have bite in our setting as cooperation levels when the entry option is available are very similar to the case of forced participation.

A potential reason why the entry mechanism performs poorly in our setting is that the value we chose for the outside option payoff is too low to trigger a mechanism of assortative matching based on beliefs of cooperation. That is, when the value of the outside option payoff is low, even a pessimistic free-rider, who attaches a low probability to the event of meeting a cooperator, may find it profitable to self-select into cooperative groups. In fact, prima facie our data seem to support this conjecture. We observe very little selection in the Entry treatment as 86% of our subjects chose to take part in the PGG. Moreover, as noted in the previous sub-section, the entry option seems to increase the fraction of both high contributors and free-riders.

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[22] Contributions are significantly different between Entry and Exit (Mann-Whitney test $p = 0.000$, two-tailed; $n = 68$ per treatment).

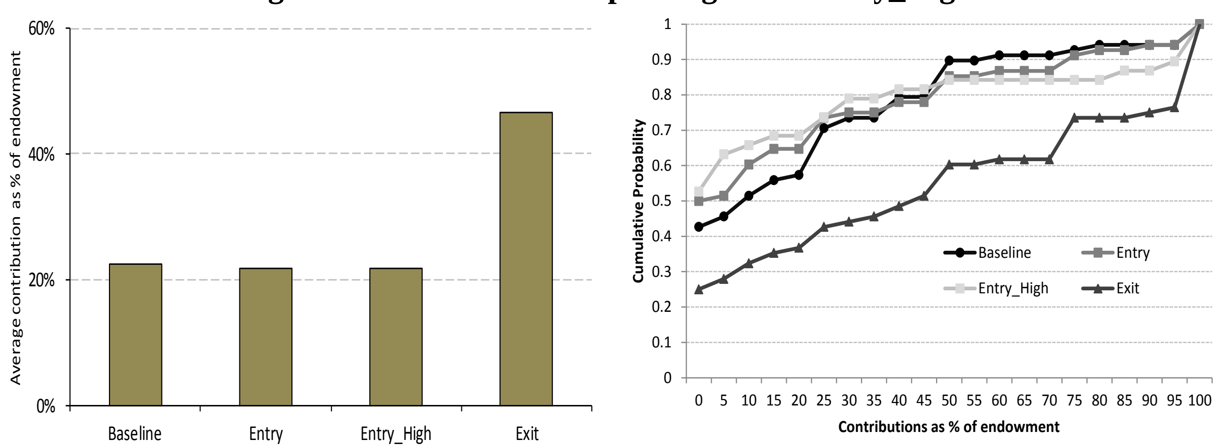
[23] Again, we detect significant differences between the distribution of contributions in Entry and Exit using a Kolmogorov-Smirnov test ($p = 0.002$, two-tailed; $n = 68$ per treatment).

[24] We refer the reader to Appendix B for an analysis of the impacts of entry and exit on earnings and efficiency.

To address this issue, we conducted an additional treatment with entry, *Entry_High*. This treatment is identical to the original Entry treatment except that the outside option payoff was set at 70 points, halfway between the Nash equilibrium payoff level and the joint-payoff maximizing level. We recruited an additional 154 subjects for the Entry_High treatment across eight sessions.[25] We observe substantial selection in Entry_High: only 50% of the subjects decided to take part in the PGG, whereas the remaining subjects chose to secure the outside option payoff. Overall, in fifty-four of the seventy-seven groups at least one subject did not take part in the PGG. Hence, in Entry_High we observe contribution decisions from 38 subjects in total.

Figure 2 shows the average contribution level and the CDF of contributions in Entry_High. For ease of comparison, the figure also reproduces the average contribution levels and CDFs of the other three treatments, which were already shown in Figure 1.

Figure 2: Contributions to public good in Entry_High



The substantially higher value of the outside option payoff does not improve the effectiveness of the entry mechanism. As in Baseline and Entry, also in Entry_High subjects contribute on average about 22% of the endowment. This is not significantly different from Baseline or from the original Entry treatment (Mann-Whitney test $p \geq 0.381$, two-tailed; n = 68 in Baseline and Entry, n = 38 in Entry_High).[26]

While the distribution of contributions in Entry_High is not significantly different from Baseline and Entry (Kolmogorov-Smirnov test $p \geq 0.356$, two-tailed; n = 68 in Baseline and

[25] This additional treatment used the same subject pool, recruitment and procedures as for the other treatments.
[26] Contributions are significantly different between Entry_High and Exit (Mann-Whitney test p = 0.001, Kolmogorov-Smirnov test p = 0.002, both two-tailed; n = 68 in Exit, n = 38 in Entry_High).

Entry, n = 38 in Entry_High), the right panel of Figure 2 reinforces the impression that voluntary participation through entry has two contrasting effects on contributions as it seems to encourage both more free-riding and more cooperation relative to Baseline. The fraction of full free-riders in Entry_High is 53%. At the same time, 16% of subjects contribute at least half of their endowment to the public good, with 11% contributing the whole endowment.

Overall, these data point to the limits of a mechanism of assortative matching based on different beliefs of cooperation between cooperators and free-riders. In our original Entry treatment we observe a negligible effect of voluntary participation on cooperation, but we also observe limited evidence of sorting into the game. In contrast, we observe substantial selection in the Entry_High treatment. Yet, we again find no effect of voluntary participation on cooperation. In the next sub-section we look further into the reasons for the failure of the entry mechanism as well as the reasons for the success of the exit mechanism.

3.3 The determinants of entry and exit

As discussed above, for entry to affect cooperation through an assortative matching mechanism, individuals must suffer from a false consensus bias whereby cooperators are more optimistic than free-riders about the likelihood of meeting another cooperator. If this bias is sufficiently strong, and if subjects act on these biased beliefs when they decide whether to enter the PGG, cooperators will be more likely than free-riders to self-select into the PGG. Within this framework, the limited effects of the entry mechanism on cooperation may be explained by two different reasons. First, subjects in our experiment may not suffer from a false consensus bias. Alternatively, they could display a false consensus bias, but they may fail to act on their biased beliefs when deciding to enter the PGG.

Our data from the PD game allows us to explore these alternative explanations. We use choices in the role of second-mover in the PD game to classify subjects as “cooperators” (if they cooperated) or “free-riders” (if they defected). Across our four treatments, we classify 42% of our subjects as cooperators and 58% as free-riders.[27] We use subjects’ beliefs about others’ behavior in the role of second-mover in the PD game to measure their optimism about the

[27] The classification of types in the PD game correlates well with contribution behavior in the PGG. A regression of subjects’ contributions in the PGG on PD type and treatment dummies shows that cooperators contribute about 14% more than free-riders and the difference in significant at the 1% level.

likelihood of interacting with a cooperator. On average, cooperators believe that 48% of the other subjects are also cooperators. In contrast, free-riders believe that only 31% of others are cooperators. This difference in beliefs is significant at the 1% level using a Mann-Whitney test (p = 0.000, two-tailed; cooperators n = 160, free-riders n = 222).[28] Thus, in line with the existing experimental evidence, our subjects display a false consensus bias.

We next use regression analysis to examine whether this bias in subjects' optimism about the prospects of meeting a cooperator affects their decision to enter the PGG. Table 2 reports marginal effects from logit regressions of entry decisions of subjects in the Entry and Entry_High treatments. In all models the dependent variable assumes value 1 if a subject chooses to participate in the PGG, and 0 otherwise. In model I we use as regressor a dummy variable assuming value 1 if a subject is classified as a cooperator in the PD game, and 0 otherwise. In model II we use instead our measurement of subjects' optimism, defined as a subject's estimate of the percentage of other participants in the session that act as cooperators in the PD game. In model III we include both the cooperator dummy and the optimism variable. In all models we also include a gender dummy (1 if subject is male), a dummy assuming value 1 if the subject studies Economics and 0 otherwise, and measurements of subjects' self-assessment of their risk attitudes (the SOEP general risk question) and trust attitudes (the WVS Trust question).

[28] This result holds also if we focus on the Entry and Entry_High treatments only. Here, cooperators and free-riders believe that, respectively, 47% and 31% of the others are cooperators, and the difference is significant at the 1% level using a Mann-Whitney test (p = 0.000, two-tailed; cooperators n = 94, free-riders n = 152).

Table 2: Logit regressions of the decision to enter the PGG

	I	II	III
Cooperator in PD game	0.003	--	-0.024
	(0.066)	--	(0.069)
Optimism in PD game	--	0.002	0.002
	--	(0.001)	(0.001)
1 if male	0.037	0.029	0.027
	(0.064)	(0.065)	(0.065)
1 if studies Economics	0.039	0.060	0.059
	(0.080)	(0.080)	(0.080)
SOEP risk loving	0.066***	0.066***	0.066***
	(0.015)	(0.015)	(0.015)
WVS high trust	0.047	0.036	0.036
	(0.064)	(0.065)	(0.065)
N	246	246	246

Note: Marginal effects of logit regressions, standard errors in parentheses. In all models the dependent variable assumes value 1 if a subject entered the PGG and 0 otherwise. Significance levels: *** 1%.

The regressions show that there is little evidence in our data of sorting based on cooperativeness or beliefs of cooperativeness. Subjects' cooperativeness, as captured by the cooperator dummy, has virtually no impact on the decision to participate in the PGG (model I). Subjects' degree of optimism has somewhat more success in explaining entry decisions, as shown in model II: an increase in optimism by 10 percentage points increase the likelihood to enter the PGG by about 2%, and the effect is marginally insignificant ($p = 0.152$). In model III we include both cooperativeness and optimism as explanatory variables, but neither reaches statistical significance at the 10% level. In fact, the cooperator dummy enters with a *negative* sign in the regression, indicating that, controlling for their degree of optimism, cooperators are actually less likely to enter the PGG than free-riders.[29] None of the other regressors are statistically significant in any of the models except the measurement of risk attitudes, which is positively related to the decision to enter: subjects who are more risk-loving are more likely to participate in the PGG, and the effect is significant at the 1% level in all models.

Overall, this analysis shows that, while our subjects do display a false consensus bias, they seem not to act on their biased beliefs about others' cooperativeness when deciding to enter the PGG. This explains the limited effectiveness of the entry mechanism in our experiment.

[29] We also ran an additional regression where we interacted the cooperator dummy with the optimism variable. The interaction term and the cooperator and optimism variables are all statistically insignificant in this regression.

We next turn to subjects' participation decisions in the Exit treatment. First, we note that the exit option is used quite frequently in our experiment. In 76% of groups at least one subject decided to withdraw their participation from the PGG. The exit option is predominantly used when subjects contribute more than their opponent: when this happens, subjects choose to exit in 80% of cases. On the contrary, subjects confirm their participation in the PGG in 90% of cases where their contributions are the same or lower than that of their opponent. This suggests that withdrawal decisions are mainly used to retaliate against free-riding.

We analyze these patterns of exit decisions more formally in Table 3, where we report marginal effects of a logit regression of exit decisions in the Exit treatments. The dependent variable assumes value 1 if a subject chose to participate in the PGG, and 0 otherwise. Among the regressors, we include a variable measuring the differences between subject *i*'s contribution and the contribution of their opponent *j*. The regression also includes the cooperator dummy and the control variables used in Table 2.

Table 3: Logit regressions of the decision to exit the PGG

Difference between *i*'s and *j*'s contributions	-0.069***
	(0.024)
Cooperator in PD game	0.104
	(0.148)
1 if male	0.086
	(0.154)
1 if studies Economics	0.242
	(0.171)
SOEP risk loving	-0.064
	(0.041)
WVS high trust	-0.052
	(0.173)
N	68

Note: Marginal effects of logit regressions, robust standard errors in parentheses, adjusted for intragroup correlation (PGG groups are used as independent clustering units). The dependent variable assumes value 1 if a subject exited the PGG and 0 otherwise. Significance levels: *** 1%.

The regression confirms that exit decisions are strongly influenced by differences in subjects' contributions. A one-token difference between contributions increases the likelihood of withdrawing participation by about 7%. The effect is statistically significant at the 1% level.

Subjects' cooperativeness does not explain the decision to exit the PGG. None of the other explanatory variables is statistically significant.

4. CONCLUSIONS

Our study has shed light on the effects of voluntary participation on cooperation. In a one-shot two-person public goods game, we have found that allowing players to voluntarily take part in the game can have a beneficial effect on contributions relative to a setting where participation is forced. However, our study also shows that the positive effects of voluntary participation mainly operate through a mechanism of exit: voluntary participation is most effective when subjects are let free to reject partnerships they are not satisfied with. This allows cooperators to shield themselves from exploitation by free-riders, as the threat of costly exit is powerful in disciplining free-riding and fostering higher contributions.

By contrast, voluntary participation does not foster cooperation when it operates through a mechanism of entry. In this study we have focused on a mechanism of assortative matching through entry driven by false consensus bias: if cooperators are more optimistic than free-riders about the prospects of meeting other cooperators, then the entry option may facilitate a process of self-selection whereby cooperators participate into the public goods game and free-riders stay out. In the experiment we do find evidence of a false consensus bias, but we also find that subjects do not seem to act upon their biased beliefs when they decide whether to enter in the public goods game. Thus the entry decisions of cooperators and free-riders are not statistically distinguishable from each other. As a consequence, the entry option is not successful in fostering public good provision.

While the entry mechanism that we have studied here does not seem to be successful in fostering cooperation, other mechanisms of voluntary participation through entry may be more effective in triggering assortative matching, with positive effects on cooperation. For instance, Aimone et al. (2013) study a modified public goods game where groups are formed based on subjects' willingness to sacrifice returns from private investments. They find that cooperators are more willing to sacrifice private investments than free-riders, which leads to assortative matching and increased public good provision.

Moreover, in natural environment individuals may rely on communication and other observable characteristics about their potential interaction partners to predict their cooperative inclination and hence decide whether or not to enter into partnerships with them. Some authors have argued that this may also lead to assortative matching of cooperative types (e.g., Frank, 1987; 1988; Amann and Yang, 1998). However, the empirical evidence suggests that individuals are only to some extent able to predict whether others are likely to cooperate. Belot et al. (2012), for example, ask subjects in an experiment to watch clips of a prisoner's dilemma game played on a TV show, and then predict the extent to which TV show contestants are likely to cooperate. While subjects estimate a higher likelihood of cooperation for cooperators than free-riders, the difference is small (7 percentage points). In line with this, van den Assem et al. (2011) find that contestants in a related TV show do not predict well the cooperative behavior of their opponents.

Though both the entry and exit mechanisms cannot be applied to non-excludible public goods such as clean air or national security, there are several naturally occurring settings in which goods are publicly provided only to members who voluntarily participate in such cooperative endeavors. Typical real-world examples are associations, clubs, workplaces, partnerships, and the like, in which individuals may have the freedom to join in, or opt out from, participating in the provision of (local) public goods.

In those and similar instances, cooperation among individuals is crucial while it is often characterized by intrinsic fragility due to the conflict between individual incentives and social optimal actions. Despite its fragility, in naturally occurring environments, a large variety of mechanisms are at work to foster cooperative outcomes. Scholars have explored a significant number of mechanisms conducive to cooperation.[30] Our study has focused on two fundamental participation mechanisms – namely entry and exit – in the attempt to uncover useful stylized patterns for the design of institutions aimed at overcoming under-provision of public goods. The development of such institutions is an intellectual journey that will require the understanding of "how diverse polycentric institutions help or hinder the (…) levels of cooperation of participants, and the achievement of more effective, equitable, and sustainable outcomes at multiple scales" (Ostrom, 2010, p. 665); such a journey seems far from reaching its end.

[30] Other mechanisms have recently been devised in literature, e.g. the "minimal approval mechanism" by Masuda et al. (2014) that entails a second stage in which players decide simultaneously if to approve or not their co-player contribution or to revert to the minimum contribution made in their two-player standard linear public goods game.

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APPENDICES (NOT FOR PUBLICATION)

Appendix A: Experimental Instructions

PRELIMINARY INSTRUCTIONS *(common to all treatments)*

Welcome! You are about to take part in a decision-making experiment. This experiment is run by the "Centre for Decision Research and Experimental Economics" and has been financed by various research foundations.

There are other people in this room, who are also participating in this experiment. Everyone is participating for the first time, and all participants are reading the same instructions. It is important that you do not communicate with any of the other participants during the experiment. If you have a question at any time, raise your hand and an experimenter will come to your desk to answer it.

This experiment consists of two parts: Part 1 and Part 2.

In each part of the experiment you will be asked to make one or more decisions, and will have a chance to earn money. Decisions that will be made in one part of the experiment will not affect decisions or earnings in the other part of the experiment.

You will be informed of any outcome (including your earnings) from Part 1 and Part 2 of the experiment only once everyone in the room has completed Part 2. Therefore everyone will make their decisions in Part 2 without knowing any outcome from Part 1.

Only one part of the experiment will be taken into account in determining your final earnings from today's experiment. At the end of Part 2, we will toss a fair coin. If the coin lands heads all participants in today's experiment will be paid according to their earnings from Part 1. If the coin lands tails all participants in today's experiment will be paid according to their earnings from Part 2. Your earnings will be paid out to you in private and in cash.

Shortly, you will receive detailed instructions about Part 1 of the experiment. You will receive detailed instructions about Part 2 once everyone in the room has completed Part 1.

If you have a question now, please raise your hand and an experimenter will come to your desk to answer it.

Part 1 - Instructions *(common to all treatments)*

General

In this part of the experiment you will be paired with one other person, randomly selected from the participants in this room. At the end of Part 1 the pair will be dissolved, and you will not be matched with this person again during this experiment.

Your earnings in Part 1 will only depend on your decisions and the decisions of the person you are paired with. All decisions are made anonymously and you will not learn the identity of the person you are paired with.

Your earnings in Part 1 will be calculated in points. At the end of Part 1 your point earnings will be converted into cash at the exchange rate of 15 pence per point. If Part 1 is selected for payment, you will be paid this amount in private and in cash at the end of the experiment.

The Decision Situation

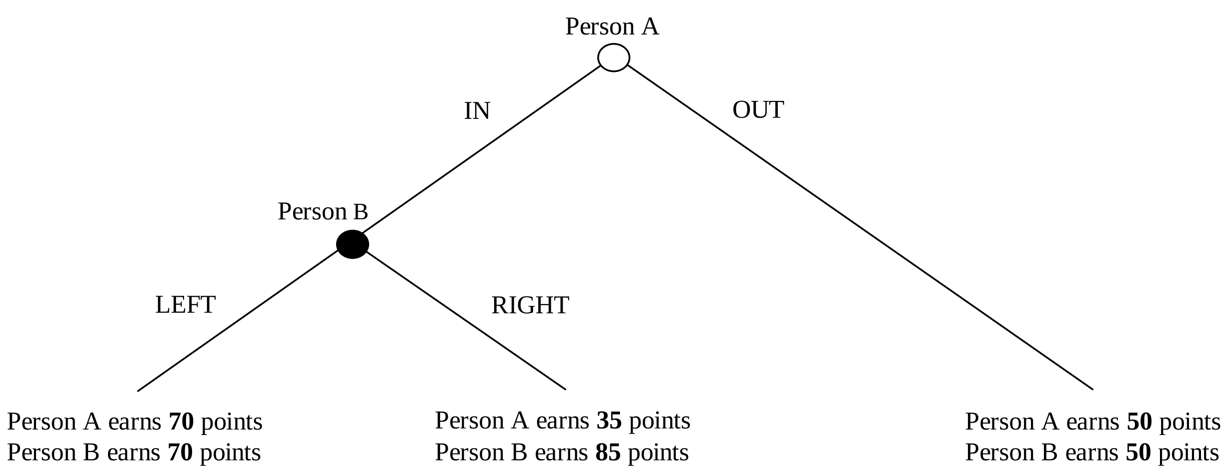
Your earnings in Part 1 of the experiment will depend on decisions made in the following decision situation. You will be in this decision situation only once (i.e. there is only one period in Part 1 of the experiment).

There are two people involved in the decision situation: 'Person A' and 'Person B'. Person A can choose between two options: IN or OUT.

If Person A chooses OUT, Person B has no choice to make, and both Person A and Person B earn 50 points each.

If Person A chooses IN, then Person B has a choice between two options: LEFT or RIGHT. If Person B chooses LEFT, both Person A and Person B earn 70 points each. If Person B chooses RIGHT, Person A earns 35 points and Person B earns 85 points.

The decision situation is illustrated in the Figure below.



How You Make Decisions

You will make decisions on the computer by completing a screen. The attached sheet shows what the screen will look like. We want to know what you would do in the role of Person A and what you would do in the role of Person B. Thus you will be prompted to make decisions in **both roles**. Only after you have made your decisions will the computer determine your actual role, “Person A” or “Person B”, and this will determine your relevant decisions for calculating earnings. The computer will select roles randomly: there is a 50% chance you will be Person A and the person you are paired with will be Person B, and a 50% chance you will be Person B and the person you are paired with will be Person A.

DECISION TASK 1: In the first input field you must make a decision in the role of Person A. You must choose between IN and OUT.

DECISION TASK 2: In the second input field you must make a decision in the role of Person B. We want to know what you as Person B would do if Person A chooses IN. You must choose between LEFT and RIGHT.

The screen also has a final input field for a **PREDICTION TASK**. Here you must enter a prediction about how many of the other participants in this room will choose RIGHT when they make a decision in the role of Person B.

Once you have completed the decision and prediction tasks you should click on the “Submit” button. You will then be prompted to either change or confirm your decisions and predictions. At this point, if you want to you will be able to go back and change your entries. Once you confirm your decisions and predictions you cannot change them. When everyone in the room has submitted and confirmed their decisions and predictions earnings will be calculated.

How Your Earnings Are Determined

First the computer will randomly determine your actual role in the decision situation. This will determine which of your choices (in Decision Task 1 or in Decision Task 2) is relevant for the computation of earnings:

- There is a 50% chance that you are Person A and the person you are paired with is Person B. In this case, your choice in Decision Task 1 and the other person’s choice in Decision Task 2 will be relevant.
- There is a 50% chance that you are Person B and the person you are paired with is Person A. In this case, your choice in Decision Task 2 and the other person’s choice in Decision Task 1 will be relevant.

The relevant decisions made by you and the person you are paired with will then be used to calculate earnings as shown in the Figure above.

In addition, you can earn points from the PREDICTION TASK. Your prediction in the PREDICTION TASK will be compared with the actual number of participants who chose RIGHT in the role of Person B. If your prediction is correct you will receive 10 additional points.

Your point earnings from the decision situation and the prediction task will then be summed and converted to cash at a rate of 15 pence per point. If Part 1 of the experiment is selected for payment, you will be paid this amount in private and cash at the end of the experiment.

We now want to check that each participant understands how their earnings from Part 1 will be calculated. To do this we ask you to answer some questions. In a couple of minutes the experimenter will check your answers. When each participant has answered all questions correctly we will continue with the experiment.

Questions

1. How many periods will there be in Part 1 of the experiment? ________

2. How many other people are you matched with in Part 1 of the experiment? ________

3. Suppose that the person you are paired with chooses OUT as Person A and RIGHT as Person B. Suppose you choose IN as Person A and LEFT as Person B. If the computer randomly determines that you are Person A and the person you are paired with is Person B ….

What will be your earnings from the decision situation? ________

What will be the other person's earnings from the decision situation? ________

4. Suppose that the person you are paired with chooses OUT as Person A and LEFT as Person B. Suppose you choose IN as Person A and RIGHT as Person B. If the computer randomly determines that you are Person B and the person you are paired with is Person A ….

What will be your earnings from the decision situation? ________

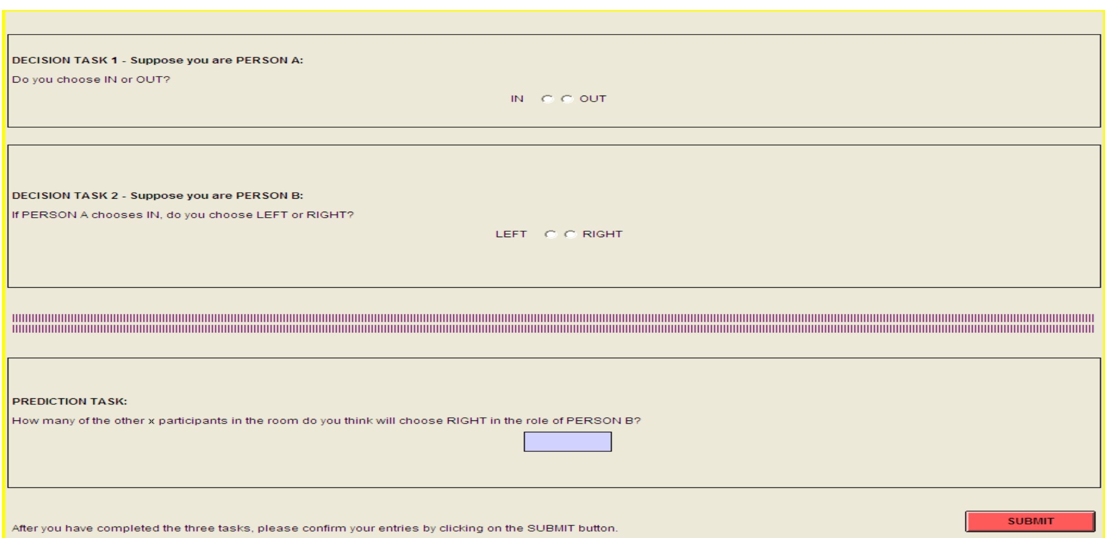
What will be the other person's earnings from the decision situation? ________

Beginning the Experiment

If you have any questions please raise your hand and an experimenter will come to your desk to answer it.

We are now ready to begin Part 1 of the experiment. Please look at your computer screen and begin making your decisions.

The Decision Screen



Part 2 - Instructions *(differences between treatments in brackets)*

General

In this part of the experiment you will be matched with one other person, randomly selected from the participants in this room, to form a group of two. At the end of Part 2 the group will be dissolved, and you will not be matched with this person again during this experiment.

Your earnings in Part 2 will depend on the decisions made within your group, as described below. Your earnings will not be affected by decisions made in other groups. All decisions are made anonymously and you will not learn the identity of the other participant in your group.

Your earnings in Part 2 will be calculated in points. At the end of Part 2 your point earnings will be converted into cash at the exchange rate of 15 pence per point. If Part 2 is selected for payment, you will be paid this amount in private and in cash at the end of the experiment.

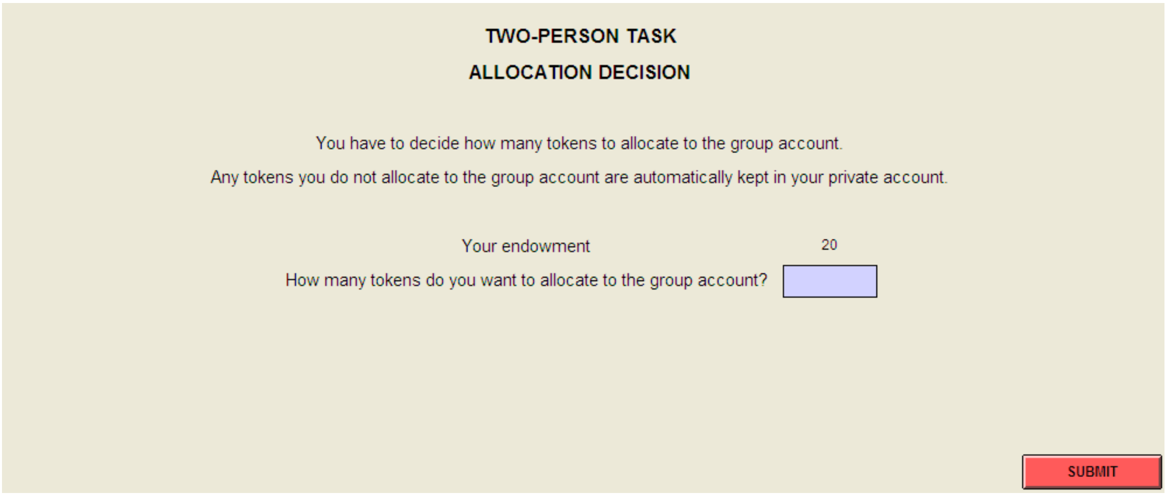
The Decision Situation

Your earnings in Part 2 of the experiment will depend on the decisions made in the following decision situation. You will be in this decision situation only once (i.e. there is only one period in Part 2 of the experiment).

At the beginning of the decision situation you will be endowed with 20 tokens. Similarly, the other member of your group will be endowed with 20 tokens.

You can use these tokens to earn points in a **Two-Person Task** where you and the other group member have to make the following allocation decision. You must choose how many of your 20 tokens to allocate to a group account and how many to keep in your private account. At the same time that you are making your decision the other member of your group must choose how many of his or her 20 tokens to allocate to the group account and how many to keep in his or her private account.

You will make your allocation decision on a screen like the one shown below. You must enter the number of tokens you allocate to the group account. Any tokens you do not allocate to the group account will automatically be kept in your private account.



Your earnings will be determined as follows:

For each token you keep in your private account you will earn 3 points.

For each token you allocate to the group account you and the other member of your group will earn 2 points each.

Similarly, for each token the other group member keeps in his or her private account he or she will earn 3 points, and for each token he or she allocates to the group account both group members will earn 2 points each.

Your point earnings will be the sum of your earnings from your private account and the group account.

Thus:

> **Your point earnings in the Two-Person Task = 3 x (number of tokens kept in your private account) + 2 x (total number of tokens allocated to the group account by yourself and the other member of your group).**

After you and the other group member have made a decision, you will be informed of the allocation decisions and earnings in your group.

We now want to check that each participant understands how their earnings from the Two-Person Task will be calculated. To do this we ask you to answer some questions. You will find these on the next page. In a couple of minutes the experimenter will check your answers. When each participant has answered all questions correctly we will continue with the experiment.

Questions

1. How many periods will there be in Part 2 of the experiment? _______

2. How many people are in your group (including yourself)? _______

3. Suppose the other group member allocates 0 tokens to the group account. If you allocate 0 tokens to the group account ….

How many tokens do you keep in your private account? _______

What will be your earnings from your private account? _______

What is the total number of tokens allocated to the group account? _______

What will be your earnings from the group account? _______

What will be your total earnings? _______

4. Suppose the other group member allocates 20 tokens to the group account. If you allocate 20 tokens to the group account ….

How many tokens do you keep in your private account? _______

What will be your earnings from your private account? _______

What is the total number of tokens allocated to the group account? _______

What will be your earnings from the group account? _______

What will be your total earnings? _______

5. Suppose the other group member allocates 2 tokens to the group account. If you allocate 18 tokens to the group account ….

How many tokens do you keep in your private account? _______

What will be your earnings from your private account? _______

What is the total number of tokens allocated to the group account? _______

What will be your earnings from the group account? _______

What will be your total earnings? _______

6. Suppose the other group member allocates 18 tokens to the group account. If you allocate 2 tokens to the group account ….

How many tokens do you keep in your private account? _______

What will be your earnings from your private account? _______

What is the total number of tokens allocated to the group account? _______

What will be your earnings from the group account? _______

What will be your total earnings? _______

[BASELINE:

What happens next?

In summary, the structure of Part 2 of the experiment is as follows:

Step 1 - You will be randomly matched with another person in this room to form a group of two. You and the other group member will be endowed with 20 tokens each.

Step 2 - You and the other group member will make an allocation decision in the Two-Person Task. You will choose how many of your tokens to allocate to a group account and how many to keep in your private account. You and the other group member will then be informed of the allocation decisions made in your group and the resulting earnings.

Step 3 - Your point earnings from Part 2 will be converted to cash at a rate of 15 pence per point. If Part 2 of the experiment is selected for payment, you will be paid this amount in private and cash.

Beginning the experiment

If you have any questions please raise your hand and an experimenter will come to your desk to answer it.

We are now ready to begin Part 2 of the experiment. Please look at your computer screen and begin making your decisions.]

[ENTRY:

Participation in the Two-Person Task is voluntary. If you do not wish to participate in the Two-Person Task you can opt for an **Individual Task**. In this case your 20 tokens will automatically be allocated to an individual account from which you earn 61 points in total. Similarly, the 20 tokens of the other group member will be allocated to his or her individual account from which he or she earns 61 points in total.

You and the other group member will choose whether to be paid according to the Two-Person Task or the Individual Task **before** you make an allocation decision in the Two-Person Task.

If both you and the other group member choose the Two-Person Task, then you and the other group member will have to decide how to allocate your tokens between the group account and the private account, and your earnings will be calculated accordingly.

If either you or the other group member chooses the Individual Task, you will not make an allocation decision in the Two-Person Task. Your 20 tokens will automatically be allocated to your individual account and your earnings will be 61 points.

What happens next?

In summary, the structure of Part 2 of the experiment is as follows:

Step 1 - You will be randomly matched with another person in this room to form a group of two. You and the other group member will be endowed with 20 tokens each.

Step 2 - You and the other group member will independently and privately choose whether to be paid according to the Two-Person Task or the Individual Task.

Step 3 – If both you and the other group member choose the Two-Person Task, you and the other group member will make an allocation decision. You will choose how many of your tokens to allocate to a group account and how many to keep in your private account. You and the other group member will then be informed of the allocation decisions made in your group and the resulting earnings in Part 2 of the experiment.

If either you or the other group member chooses the Individual Task, you will not make an allocation decision in Step 3. You and the other group member will earn 61 points each in Part 2 of the experiment.

Step 4 - Your point earnings from Part 2 will be converted to cash at a rate of 15 pence per point. If Part 2 of the experiment is selected for payment, you will be paid this amount in private and cash.

Beginning the experiment

If you have any questions please raise your hand and an experimenter will come to your desk to answer it.

We are now ready to begin Part 2 of the experiment. Please look at your computer screen and begin making your decisions.]

[EXIT:

Participation in the Two-Person Task is voluntary. If you do not wish to participate in the Two-Person Task you can opt for an **Individual Task**. In this case your 20 tokens will automatically be allocated to an individual account from which you earn 61 points in total. Similarly, the 20 tokens of the other group member will be allocated to his or her individual account from which he or she earns 61 points in total.

You and the other group member will choose whether to be paid according to the Two-Person Task or the Individual Task **after** you have made an allocation decision in the Two-Person Task and you have been informed of the decisions in your group and the corresponding earnings.

If both you and the other group member choose the Two-Person Task, then your allocation decisions will be implemented and your earnings confirmed.

If either you or the other group member chooses the Individual Task, then your allocation decisions will not be implemented. Your 20 tokens will automatically be allocated to your individual account and your earnings will be 61 points.

What happens next?

In summary, the structure of Part 2 of the experiment is as follows:

Step 1 - You will be randomly matched with another person in this room to form a group of two. You and the other group member will be endowed with 20 tokens each.

Step 2 - You and the other group member will make an allocation decision in the Two-Person Task. You will choose how many of your tokens to allocate to a group account and how many to keep in your private account. You and the other group member will then be informed of the allocation decisions made in your group and the resulting earnings.

Step 3 - You and the other group member will independently and privately choose whether to be paid according to the Two-Person Task or the Individual Task.

If both you and the other group member choose the Two-Person Task your allocation decisions in Step 2 will be implemented, and your earnings in Part 2 of the experiment will be as shown in Step 2.

If either you or the other group member chooses the Individual Task, your allocation decisions in Step 2 will not be implemented. You and the other group member will earn 61 points each in Part 2 of the experiment.

Step 4 - Your point earnings from Part 2 will be converted to cash at a rate of 15 pence per point. If Part 2 of the experiment is selected for payment, you will be paid this amount in private and cash.]

Beginning the experiment

If you have any questions please raise your hand and an experimenter will come to your desk to answer it.

We are now ready to begin Part 2 of the experiment. Please look at your computer screen and begin making your decisions.]

Appendix B: Earnings across treatments

We report here an analysis of earnings across treatments. In Baseline subjects on average earn 64.5 points, somewhat more than the Nash equilibrium outcome of 60 points, but substantially less than the joint-payoff maximizing level of 80 points. Computing efficiency as attained earnings in excess of the zero-contribution Nash equilibrium earnings as a percentage of maximum possible excess earnings, we find that in Baseline this is equal to $\frac{(64.5-60)}{(80-60)} = 22.5\%$. If we consider earnings conditional on both subjects in the group agreeing to participate in the game, we find that the exit option has a substantial beneficial effect compared to Baseline. The average earnings of the subjects who agreed to play the PGG in the Exit treatment are 76.37 points (an efficiency of 82%), which is significantly different from Baseline (Mann-Whitney test p = 0.000, two-tailed; n = 68 in Baseline, n = 16 in Exit). Average earnings in the treatments with entry are instead 64.34, both in Entry and Entry_High (an efficiency of 22%). This is not significantly different from Baseline (Mann-Whitney tests, Baseline vs. Entry, p = 0.545, two-tailed, n = 68 per treatment; Baseline vs. Entry_High, p = 0.301, two-tailed, n = 68 in Baseline, n = 38 in Entry_High). These results confirm the relative advantage of the exit option with respect to the entry option in our setting.

Of course, the use of the entry and exit options may also imply substantial costs if subjects choose to forgo positive levels of public good provision and prefer to secure the outside option payoff instead. To examine this, we also compute *realized* earnings in the Exit and Entry treatments as equal to subjects' PGG earnings if both subjects in the group agreed to participate in the game, and to the outside option payoff otherwise.[1] Average realized earnings in the Exit treatments are 64.6 points (an efficiency of 23%). This is not significantly different from Baseline (Mann-Whitney test p = 0.165, two-tailed; n = 68 per treatment). Thus, the extensive use of the exit option reduces the positive effects of voluntary participation. Average realized earnings in Entry are equal to 63.5 points (an efficiency of 17.5%), which is also not significantly different from Baseline (Mann-Whitney test p = 0.600, two-tailed; n = 68 in Baseline, n = 92 in Entry).

This latter set of results should be taken with caution as they are inevitably sensitive to the details of our experimental implementation, such as the specific value of the outside option payoff, or the fact that we implemented a one-shot version of the PGG rather than a repeated version of the game. In practice (as well as in the theoretical models discussed in the Introduction) the value of exit is partly determined endogenously, and may depend, among other things, on the expected time horizon of the interaction and individuals' discount factor, and all this may affect the efficiency consequences of the exit mechanism. Nevertheless, our findings point to a potential limitation of the exit mechanism. Subjects frequently recur to the exit option when this is available, even when doing so reduces joint payoffs. As a consequence, when one accounts for the costs of exits, realized earnings are not significantly different between settings with forced and voluntary participation.

[1] In doing this we only focus on our three original treatments and we do not include Entry_High in the analysis. The artificially high value of the outside option payoff in this treatment implies that not participating in the PGG is unlikely to lead to efficiency losses.