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Revisiting the volunteer's dilemma: group size and public good provision in the presence of some ambiguity aversion

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Abstract

Conventional game theory dictates that in a volunteer's dilemma, the probability of public good provision decrease in group size. However, experimental evidence does not support this: the probability of public good provision approaches one in large groups. I build a theoretical model addressing this puzzle, where a fraction of the group has maximin preferences, while the rest are expected utility maximizers. In small groups, the probability of public good provision may decrease with group size, but it reaches one in larger groups. While randomization is common in small groups, larger groups have some individuals who always volunteer, and others who never volunteer (another experimentally observed phenomenon).

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1. Introduction

The volunteer's dilemma, a term coined by Diekmann (1985), is a game where one individual in a group needs to provide a collective good at a cost to himself. The good is provided as long as any one individual in the group steps up ("volunteers"). All individuals would prefer to incur the cost of volunteering, and thereby getting the good, to not getting the good at all. However, each individual may hope that someone else in the group will volunteer, so that he can free ride on the volunteer's contribution. The game has a number of asymmetric pure strategy equilibria, in each of which one member of the group volunteers and the others do not. More attention is typically focused on the symmetric mixed strategy equilibrium, because of the difficulty of co-ordination among multiple pure strategy equilibria.

The standard application of the volunteer's dilemma is to a group witnessing an accident or a crime and hoping that someone else in the group reports it or helps the victim. However, other groups, which are formed deliberately – perhaps a panel of experts constituted to weigh in on an issue – are also subject to the volunteer's dilemma, as members of such groups may free ride on the information provided by a more attentive or hardworking member. This assumes that group members find it personally costly to pay attention, but all want the best decision to be reached.

A puzzle in the traditional game theoretic solution to the volunteer's dilemma is that the probability that the collective good is *not* provided *increases* in group size (the effect of a large number of other group members is to reduce individual volunteering to an extent that cancels the effect of having more potential volunteers in a large group). However, this is not borne out by experimental evidence. As Diekmann (1985) noted, Darley and Latane's (1968) experiments (in which they measured the likelihood of subjects reporting what they believed to be an epileptic fit, as a function of the number of other people that the subjects believed heard the fit) imply that in large groups, the probability of non-provision of the collective good (here, help to the presumed epileptic) actually approached zero. (The probability that the good *was* provided reached .99 in 5-member groups). Recent experimental work on the volunteer's dilemma (Goeree et al 2017) shows similar results. Instead of increasing in group size, the probability of non-provision of the public good decreases in group size for groups larger than a limit, and can reach zero in large groups. Kopanyi-Peuker (2019) and Hillenbrand et al. (2020) find similar results in their experiments.

Goeree et al address this puzzle using the concept of quantal response equilibrium. The idea there is that if individuals choose their own probability of volunteering as a function of beliefs about others' volunteering probabilities, random noise might generate the observed deviations from Nash equilibrium predictions. In addition, Goeree et al find that in large groups, there are usually some individuals who always volunteer, and others who never do so, while randomization is more common in smaller groups.

I focus on explaining the puzzle that the probability of public good provision reaches one in relatively large groups despite the Nash equilibrium predictions, using a different approach from Goeree et al. Instead of assuming that the group members are all alike, I explore the impact of having a fraction of people with maximin preferences in the group. These individuals believe that other players will, with probability one, take an action which leaves the maximin individual with the lowest possible payoff. Accordingly, maximin individuals choose strategies which minimize the worst possible harm that could come to them. The other players are standard risk neutral expected income maximizers. I show that while, in a small enough group, the probability of public good provision may fall in group size, it will reach one in large groups (consistent with experimental results). My results are also consistent with (i) more than one individual volunteering in large enough groups, so that there may be wasteful duplication of effort, (ii) some individuals in large groups never volunteering (instead of randomizing between volunteering and not volunteering), while others always do so. Moreover, the coordination problem noted previously, of how to determine who volunteers, is solved in my model even without any kind of communication – it is easy to show that those with maximin preferences always volunteer.

My paper thus adds to the theoretical literature seeking to explain the gap between standard theory on the volunteer's dilemma, and experimental results. Besides Goeree and Holt (2017), Tutic (2014) also discusses a possible theoretical explanation for why the probability of non-provision may actually decrease with group size, using the concept of "procedurally rational players" (in which a player randomly plays either "cooperate" or "defect" and in future periods sticks with the strategy which was more profitable the first time around). That paper shows that if all players are "procedurally rational" in this manner, the probability that the public good is provided goes up with group size.

Besides the papers already mentioned, the economics literature on the volunteer's dilemma includes, among others, Franzen (1995) (who, again, found that the public good was always provided for large enough group sizes, specifically those with more than 9 people), Healy and Pate (2018), Hillenbrand and Winter (2018), Frommell et al (2018), Patel and Smith (2018), and Campos-Mercade (2019, 2020). Healy and Pate (2018) consider a different type of asymmetry between group members from the type I consider. Specifically, they assume that group members have asymmetric costs of volunteering and show that this can increase volunteering: nonetheless, co-ordination problems can stop the group from realizing efficiency gains. Hillenbrand and Winter (2018) investigate the effect on the game if members are uncertain about the size of the group, showing that a mean-preserving spread of possible group size increases cooperation. Frommell et al (2018) performed an experiment where multiple "dictators" could either give, or not give to a recipient. They found that while each dictator reduced the probability of giving in the presence of more dictators, the recipient's earnings still increased with the number of dictators (another variant of the puzzle that public good provision probability may not fall in group size). Patel and Smith (2018) incorporate guilt sensitivity into the volunteer's dilemma, showing that it increases volunteering, and may even result in individual cooperation probabilities increasing in group size over certain ranges. Campos-Mercade (2020) models a dynamic game where group members choose how early or late to help someone. He finds that while individual helping probabilities decrease (and helping times increase) in group size, the probability that the victim is helped at all goes up for larger groups. Campos-Mercade (2019) focuses on how the standard volunteer's dilemma changes with the introduction of some types who would never volunteer, even if they were alone (he calls them "immoral types" while "moral types" are simply the standard volunteer's dilemma players, who would have volunteered if they were the only ones to do so). He then examines if helping increases or decreases when group size increases above one. To the best of my knowledge, mine is the first paper where standard players account for the presence of some maximin preference individuals in the group.

Since I assume that some people have maximin preferences, I now briefly discuss some experimental literature on the significance and frequency of maximin preferences (a couple of other papers which present experimental evidence on this are discussed in Section 2.4). Engelmann and Strobel (2004) found, using distribution experiments, that a high proportion (about 53%) of their subjects had maximin preferences. Sutter et. al (2010) examine the social preferences of children and adolescents and find that while the proportion of maximin preferences among boys stays relatively constant at about 7%, that for girls varies from 30-60%, increasing as the girls get older. Kerschbamer and Muller (2017) find, using a large heterogeneous German sample, that about 5% of their sample showed maximin preferences. In Guha (2019), I find maximin behavior among roughly 28% of my sample.

The evidence above shows that a significant proportion of individuals in any group is likely to have maximin preferences. However, there is wide variation in the proportion of maximin individuals across groups. Accordingly, in the model I develop, the fraction of maximin individuals is not a fixed constant. It can vary according to a distribution. Expected utility maximizers are able to calculate the mean of the distribution, thus estimating the expected proportion of maximin individuals. However, maximin individuals themselves only consider the worst-case scenario (as standard for those with maximin preferences). Thus, each maximin individual puts a 100% probability weight on the worst possible outcome – that he himself is the only maximin individual in the group, and thus, that there is no one else who will volunteer for sure.

This relates my paper to Hanany et al. (2018) who discuss an incomplete information environment where players may not know the extent to which other players are ambiguity averse. However, I also discuss the case where expected income maximizers know the proportion of maximin individuals, without knowing whether a specific individual has maximin preferences (maximin individuals, true to their preferences, continue to consider only the worst case scenario despite knowing this proportion as well).

The rest of the paper is organized as follows. Section 2 starts with a brief description of the results in a standard volunteer's dilemma, and then moves on to my model and results. I also briefly discuss what parameter values might be consistent with some experimental results obtained in other papers. In Section 2.4, I compare my predictions against the predictions of a model with a proportion of "unconditional cooperators" and discuss some evidence against the unconditional cooperators explanation. I briefly discuss manipulation of various aspects of my model. I also discuss some testable implications of my model, which could hopefully be explored in future experiments. Section 3 concludes.

2. The Model

2.1 The Problem in a standard volunteer's dilemma

Consider a group of size n, where individuals have homogeneous preferences and are all risk neutral expected income maximizers. Any individual i in the group must choose between volunteering and not volunteering. His payoffs from doing so are as follows.

Table 1: Individual payoffs in a volunteer's dilemma

	If at least one other individual volunteers	If none of the others volunteer
Volunteering	1-c	1-c
Not volunteering	1	0

Here, $0<c<1$. Thus, by volunteering an individual incurs a cost of c, while this is enough to ensure that the public good, which carries a benefit of 1, be provided. Clearly, the individual does not have a dominant strategy: he would prefer to free ride if at least one other person in the group volunteers, but would prefer to volunteer if no one else does. As already mentioned, there are n pure strategy Nash equilibria, in each of which one individual in the group volunteers while the others free ride. However, these equilibria involve the problem of coordination, since the group members do not communicate to determine the identity of the volunteer.

Consider the symmetric mixed strategy equilibrium where each individual volunteers with a probability of v. For randomization, we must have (from Table 1)

$$1 - c = 1 - (1 - v)^{n-1}$$

Or

$$v = 1 - c^{1/(n-1)} \quad (1)$$

We can easily verify that v is decreasing in group size, n.

The probability that *no one* volunteers, so that the public good is not provided, is

$$p = (1 - v)^n = c^{n/(n-1)} \quad (2)$$

From the RHS of (2), this probability is increasing in group size, n, which contradicts experimental results.

2.2 A model with some maximin preference individuals

Now suppose that a fraction α of the individuals in the group have maximin preferences, where α is drawn from a distribution with cdf F and mean E(α). These individuals always attach full weight to the worst possible outcome and choose the strategy that maximizes their worst case scenario payoff. From Table 1, we can see that the worst possible payoff from not volunteering is 0, while the worst possible payoff from volunteering is 1-c. As $c<1$, such individuals always choose to volunteer.

The informational assumptions about α are that no one knows α for sure. Moreover, a maximin preference individual also attaches full weight to the worst possible outcome while making estimates about the proportion of maximin individuals. The worst possible outcome is that she herself is the only maximin preference individual, so that she cannot rely on any other member to also share maximin preferences (and thus definitely volunteer). Thus, she acts as if she is the only maximin preference individual in the group. However, expected utility maximizers correctly calculate E(α). While not knowing the actual proportion of maximin individuals, they can thus make an expected estimate.

How does the knowledge that a proportion of the group comprises of maximin preference individuals affect the majority of others, who are standard expected utility maximizers? This depends on group size.

Observation 1. *If* $n \geq 1 + \frac{1}{E(\alpha)}$*, standard expected utility maximizers never volunteer.*

Proof. If $n \geq 1 + \frac{1}{E(\alpha)}$, we have E(α)(n-1)≥1. Thus, a standard expected utility maximizer in a group of size n expects that there will be at least one maximin preference individual in the rest of the group, and that therefore the public good will be provided. Thus, he free rides with probability one. *QED*

We will analyze the volunteering behavior of expected utility maximizers in smaller groups in Proposition 1. However, before that, we note

Observation 2. *In a group of size* $n \geq \frac{1}{\alpha}$*, the public good is always provided. In a group of size* $\frac{j}{\alpha}$ *,j>1, the number of individuals volunteering is at least j. Thus, there is duplication of effort.*

Proof. If $n \geq \frac{1}{\alpha}$, α*n*≥1, so that there is at least one individual with maximin preferences, who always volunteers so that the public good is provided. [Note that if *α≥E(α),* this threshold is smaller than the threshold in Observation 1, so that expected utility maximizers may also be volunteering with nonzero probability. However, if α is significantly smaller than its expectation, the threshold in Observation 1 may be smaller so that expected utility maximizers may have stopped volunteering before the group size reaches 1/α]. If $n \geq \frac{j}{\alpha}$, where *j*>1, there are multiple individuals with maximin preferences in the group, all of whom volunteer (recall that each maximin individual acts as if she is the only one with such preferences in the group). In addition, in case we have $\frac{j}{\alpha} < 1 + \frac{1}{E(\alpha)}$, expected utility maximizers may also be volunteering with nonzero probability. While this does not affect public good provision, it is wasteful as more than one person has to incur the cost of volunteering. Note that, unlike in the asymmetric Nash equilibria of the standard model, there is no coordination problem as all maximin individuals would prefer to volunteer. *QED*

To study the volunteering behavior of standard expected utility maximizers in smaller groups, we now impose the following assumption, which entails that the cost of volunteering not be too large compared to the expected proportion of individuals who do *not* have maximin preferences.

Assumption 1. *E(α)<1-c.*

Proposition 1. *In small groups where* $n < 1 + \frac{1}{E(\alpha)}$*, standard expected utility maximizers randomize between volunteering and not volunteering, subject to Assumption 1. Their* *probability of volunteering decreases in n, and the probability of public good provision may either increase or decrease in n up to the limit n = 1/α.*

Proof. Consider a standard expected utility maximizer, i, in a group where $n < 1 + \frac{1}{E(\alpha)}$. The probability that this individual attaches to there being a maximin preference individual in the rest of the group is E(α)(n-1)<1. Thus, the expected benefit to i from volunteering is $(1 - E(\alpha)(n-1))(1-v)^{n-1}$. This is the benefit from the public good (1) times the probability that there is no maximin preference individual among the other members *and* that none of the other members volunteer (where v continues to denote the probability that a group member with standard preferences volunteers). For randomization, this must be equated to the cost of volunteering. Thus, we have

$$\big(1 - E(\alpha)(n-1)\big)(1-v)^{n-1} = c \qquad (3)$$

Or

$$v = 1 - \left(\frac{c}{1-E(\alpha)(n-1)}\right)^{1/(n-1)} \qquad (4)$$

Assumption 1 ensures that *v* lies between 0 and 1. Note that (i) the probability of volunteering is decreasing in group size, (ii) the rate of volunteering is lower than predicted by the Nash equilibrium probabilities in equation (1).

The probability that the public good is *not* provided is the probability that there is *no* maximin preference individual in the group *and* that none of the expected utility maximizers volunteer. This is

$$p = (1-\alpha n)(1-v)^n = (1-\alpha n)\left(\frac{c}{1-E(\alpha)(n-1)}\right)^{n/(n-1)} \qquad (5)$$

It can be readily checked that while the term $\left(\frac{c}{1-E(\alpha)(n-1)}\right)^{n/(n-1)}$ increases in n, the term 1-αn is decreasing in n. However, as n reaches 1/α, the public good is always provided as with probability 1, there is an individual with maximin preferences in the group. Before this limit is reached, the probability of the public good not being provided may, but need not, increase in group size. [Table 2 illustrates this for cases where the actual proportion of maximin individuals may be either greater, less, or equal to its expectation.] *QED*

Table 2: A comparison of the model's predictions with Nash predictions for c=.1,E(α)=.2

n	v under Nash predictions	v under model predictions (standard players),E(α)=.2	p under Nash predictions	p under model predictions, α=.2	p under model predictions, α=.3	p under model predictions, α=.1
2	.9	.875	.01	.0093	.00625	.0125
3	.684	.6	.031	.0256	.0064	.0448
4	.536	.37	.046	.0315	0	.0945
5	.438	.16	.056	0	0	.209

6	.37	0	.063	0	0	.4
9	.25	0	.075	0	0	.1
10	.226	0	.077	0	0	0

Table 2 compares the model's predictions with standard Nash equilibrium predictions for c = .1 and E(α) = .2, for three possible cases. In Case 1, expected utility maximizers correctly predict the value of α so that α=E(α). In Case 2, the actual proportion of maximin individuals is greater than expected. For both Cases 1 and 2, we have $\frac{1}{\alpha} < 1 + \frac{1}{E(\alpha)}$. In Case 3, the actual proportion of maximin individuals is sufficiently below expected so that we have $\frac{1}{\alpha} > 1 + \frac{1}{E(\alpha)}$. The probability that standard players volunteer is lower in the model than in the traditional Nash framework, for a given group size. Intuitively, this captures the greater likelihood that standard players can free ride on maximin players, who always volunteer. Moreover, for a given group size, the probability of standard players volunteering just depends on their expectations of α rather than on the actual value of α. Their probability of volunteering decreases in group size. In Cases 1 and 2, the probability that the public good is not provided is also, for the given parameters, lower under the model predictions. Instead of increasing continuously in group size, as in the Nash predictions, here, p increases as group size increases from 2 to 4 when α=.2, and from 2 to 3 when α=.3, and then becomes 0. Notice that this is because maximin preference individuals start volunteering for sure, even though standard utility maximizers also volunteer with some probability until the group size reaches 6. In contrast, in Case 3, with α=.1, the probability that the public good is not provided for a given group size is, for group sizes less than 10, actually higher than the Nash predictions. This reflects the fact that expected utility maximizers greatly reduce their volunteering probabilities as they overestimate the proportion of maximin individuals. Moreover, the probability of non-provision, in Case 3, first increases in n (reaching a maximum at n = 6, that is, $1 + \frac{1}{E(\alpha)}$) and then decreases, finally reaching 0 at n=10. The decreasing range corresponds to the range where expected utility maximizers are no longer volunteering, while the probability of there being a maximin individual in the group is steadily going up.

2.3 Discussion

So far, we have assumed that the actual proportion of maximin individuals is not known for sure. If we drop this assumption, then we have *E(α) = α.* Expected income maximizers now know α (without knowing whether a specific individual in a group is maximin). Maximin individuals also know α, but they assume the worst case scenario (that no one else in their group has maximin preferences). Then, the relevant column of Table 2 is column 5, while columns 6 and 7 become irrelevant. Thus the prediction for c=.1 and α=.2 is that the good is provided with probability one in groups of size 5 and above, even though standard expected income maximizers stop volunteering when the group size reaches 6. More generally, the implication would be that there is always some positive probability that the public good will be provided as standard expected income maximizers volunteer with positive probability until a threshold group size of 1+1/α, while the threshold group size at or above which a maximin individual volunteers for sure is smaller (1/α).

Franzen (1995) finds that the public good in a volunteer's dilemma type game is always provided at group sizes larger than 9. In the framework of my model, this is consistent with $\alpha = .1$ (irrespective of the value of c). Healy and Pate (2018) focus on cases where different potential volunteers in a group have different volunteering costs. Nonetheless, they also consider symmetric cost cases. In the low-cost symmetric case they consider, their parameters translate (in terms of my model) into $c = .25$. They find volunteering rates of .514 in two-person groups and of .259 in six-person groups. In terms of my model, these results would be consistent with $E(\alpha) = .486$ and $\alpha = .259$ (assuming $c = .25$).

2.4 Further Issues

I explore a number of issues in this sub-section, such as (i) whether the predictions of my model differ from those of a model with a proportion of "unconditional cooperators", and whether there is any reason to prefer one explanation to the other; (ii) how the predictions of my model change by changing players' beliefs or varying the extent of ambiguity; and (iii) the testable implications of my model, which could be explored in future experimental work.

2.4.1Unconditional Cooperators

As mentioned in the introduction, Campos-Mercade (2019) has a model where some players never volunteer, even if alone, while others act like the standard volunteer's dilemma players. Consider turning that model around so that, instead, players were either "standard" or "unconditional cooperators" – the latter always having a dominant strategy of volunteering. This can be modeled by the unconditional cooperators obtaining a benefit b from personally volunteering – a psychological benefit because of altruism or "warm glow" – in addition to the utility of 1 that all individuals get if the public good is provided. Then, if an unconditional cooperator volunteers, he obtains $1+b-c$, whereas if he does not, but the good is still provided, he obtains 1. Thus, as long as $b>c$, it is a dominant strategy for these types to volunteer. If the proportion of these types is α, and if – as in my model – the standard players are unsure about the proportion but can estimate $E(\alpha)$, then would the predictions of this model differ from the predictions of my model (with maximin players)?

The two models will have some similarities. For instance, in a big enough group, public good provision probability should reach one as the chances of having at least one unconditional cooperator increase in a big group. As in my model, standard players should also have this expectation and increase their free-riding accordingly for large group sizes.

Nonetheless, the predictions will also differ in some respects. Kopanyi-Peuker (2019) finds experimentally that volunteering is sensitive to costs of volunteering (c) only in small groups, but not in large groups. Interestingly, my model also predicts this; however, the "unconditional cooperators" model does not. I explain this difference in the next two paragraphs.

As unconditional cooperators' psychological benefit from personally volunteering is independent of group size, an increase in c beyond b uniformly changes their incentives so that volunteering does not remain a dominant strategy (Kopanyi-Peuker considers fairly big increases in costs, to the point where c reaches 0.8). In that event, these players would also only want to volunteer when no other player does, so that the predictions would then follow the standard Nash predictions, and the probability of having at least one volunteer in large groups would fall below 1 (no one can be relied upon to definitely volunteer).[1]

In my model, however, an increase in c will not change the incentives of maximin players, as long as $c<1$ (which remains true for Kopanyi-Peuker's experiment: the cost is never raised above the benefit from the public good). Since $1-c>0$, the worst possible payoff from volunteering exceeds the worst possible payoff from not volunteering, and the maximin players will therefore continue to volunteer with probability one. Thus, in large groups, where there is at least one maximin player, an increase in c will not change volunteering: maximin players will still volunteer, while standard players will not. In smaller groups, the increase in c will reduce the probability with which standard players volunteer (and also such groups are less likely to have a maximin player). Thus, these predictions match Kopanyi-Peuker's findings.

Moreover, experimental evidence does not appear to support differences in altruism as an explanation for differences in volunteering rates. For instance, Vesterlund et al (2017) find experimentally that women tend to volunteer more often than men, but they find that altruism, agreeableness, or risk aversion cannot account for these differences (Kopanyi-Peuker 2019 also finds that women volunteer more often than men). On the other hand, while neither of these studies has tested whether ambiguity aversion could explain the difference in volunteering rates, interestingly, Schubert et al (2000) experimentally finds that women are more ambiguity averse than men (they have lower certainty equivalents for lotteries with unknown or uncertain probabilities). It would be interesting to experimentally test both for attitudes to ambiguity and for volunteering propensities, a subject to which I return in my discussion on the testable implications of my model.

2.4.2 Manipulating beliefs and ambiguity

I briefly consider how varying (i) ambiguity, and (ii) beliefs about α will affect the predictions of my model.

First, consider a variation in beliefs. Suppose that $E(\alpha)$ can be lowered. For instance, in an experiment this can be done if the experimenter tells the subjects results of studies which show that a very high proportion of people care about maximizing expected income (the experimenter does not need to discuss the concept of ambiguity aversion or maximin players). This can also be done from a policy perspective, simply by not emphasizing findings on ambiguity aversion. Thus, standard players may think that people are very unlikely to be maximin players. According to my model, this would mean that standard players would continue volunteering even in moderately-sized groups. Maximin players would not be affected: they would always volunteer. Interestingly, when Vesterlund et al changed the composition of their groups visibly, changing from mixed-gender groups to single-sex groups, the men in single sex groups increased their volunteering, because of a belief that women are more likely to volunteer than other men. The change to a single-sex group reduced the men's propensity to free ride. (Vesterlund et al did not examine the effect of group size on volunteering).

[1] I have made the plausible assumption that psychological benefit from personally volunteering does not exceed the benefit from the public good being provided ($b<1$).

Secondly, consider a reduction in ambiguity, while keeping E(α) constant (instead of a mean-preserving spread, consider a mean-preserving contraction). The lower limit of the distribution of possible values of α would increase from 0 to some $\underline{\alpha}$ >0, while the upper limit of the distribution would shrink. Now, this would not affect standard players, who only care about E(α). Note, however, that subject to Assumption 1, it would also not affect maximin players. They put 100% weight on the worst possible outcome – that the fraction of maximin players is at its minimum value, $\underline{\alpha}$. Then, they expect a payoff of $\underline{\alpha}$ from not volunteering (they continue to assume that standard players don't volunteer), and 1-c from volunteering; thus volunteering is always a better strategy given $\underline{\alpha}$<E(α)<1-c (by Assumption 1). Thus, maximin players would always volunteer even with a reduction in ambiguity.

2.4.3 Testable Implications

It would be interesting to design an experiment to test some implications of my model in future work. The experiment would need to have one stage to elicit attitudes to ambiguity, and another in which subjects were assigned to groups of varying sizes and made to play a volunteer's dilemma type game.

Then, my model would predict that (i) players who are more averse to ambiguity should display greater tendency to volunteer, (ii) in large groups, any maximin type individuals should be the only ones volunteering, (iii) the group size at which "standard" players stop volunteering should go up if standard players are made to believe that maximin behavior is in general very low, (iv) increasing costs of volunteering should affect volunteering in small groups but not in large ones, and should not reduce volunteering by maximin players (as long as c<1).

3.Conclusion

I investigate the effect of introducing a fraction of maximin expected utility (MEU) maximizers into a group playing a volunteer's dilemma game, the majority of which comprises of standard expected utility maximizers. I find that doing so helps explain why, contrary to traditional game theory, the probability that the public good is not provided does not increase in group size, at least for large groups. My model has the feature, noted by experimental studies, that the probability that the collective good is provided tends to one as group size increases. The threshold group size at which this happens is relatively small if the proportion of maximin individuals in the population is high and is large otherwise. It also has the feature – as in Goeree et al's data – that in large groups, some individuals never volunteer. Moreover, in large enough groups, some effort may be wasted as too many individuals always volunteer, while one volunteer would have sufficed (an inefficiency also noted by Archetti (2009) in biological volunteer's dilemma games).

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