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An experimental examination of the volunteer's dilemma ☆

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ABSTRACT

In a volunteer's dilemma, only one "volunteer" is needed to obtain a benefit for all. Volunteering is costly, and the symmetric Nash equilibrium involves randomization. These predictions have the intuitive property that volunteer rates decline with larger groups, but surprisingly, the probability of obtaining no volunteers is *increasing* with group size, even as the number of players goes to infinity. These predictions are evaluated in a laboratory experiment with a range of group sizes. Observed volunteer rates are lower with larger groups, as predicted, but the incidence of no-volunteer outcomes declines with group size, in contrast to theory. This reduction in no-volunteer outcomes for large groups can be explained by a one-parameter generalization of the Nash equilibrium that adds quantal response "noise" due to unobserved random effects. Significant individual heterogeneity in observed volunteer rates motivates the estimation of a heterogeneous equilibrium model with a distribution of propensities for volunteering.

1. Introduction

A classic paradigm in public economics is the voluntary contributions game in which each person in a group must decide whether to make a costly contribution that provides a benefit to all group members, or to "free ride" on others' contributions. In a "provision-point" version of this game, the public benefit is not obtained unless a pre-specified level of contributions is reached. There is a special category of voluntary contributions games where the provision point is that only a single contributor or "volunteer" is needed for the pubic good to be obtained. For example, it takes just one person to veto an undesired outcome under unanimity voting, but such vetoes may be politically costly. Similarly, all members of a legislative body may desire a pay raise, but each prefers that someone else incurs the cost of sponsoring the bill. Another example can be found in the behavior of a group of foraging animals in which one of them will occasionally look up and check for a predator. The one who issues an alarm is more likely to attract the attention of the predator but helps ensure the safety of others. It has been observed that ground squirrels check more frequently in the presence of kin (Murnigham et al., 1993).

The game where only one contribution is needed to provide the group benefit is known as the "volunteer's dilemma" (Diekmann, 1985, 1986). Specifically, let V denote the monetary payoff that all N members of a group receive if at least one of them decides to incur a cost C. If nobody volunteers, then all receive a lower payoff of $L < V$. It is assumed that $C < V - L$,

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so each person would prefer to volunteer if nobody else does. But if someone else is expected to volunteer, then each of the others would prefer to "free ride." Thus there are many asymmetric equilibria in which one person volunteers and the others do not, but coordinating on such equilibria may be difficult when decisions must be made quickly or simultaneously, as when bystanders must decide whether to rush in and attempt a risky rescue of someone in trouble.

In the volunteer's dilemma with payoffs that satisfy the assumptions made above, there is also a symmetric mixed-strategy Nash equilibrium in which each person volunteers with probability p. Not surprisingly, the equilibrium level of p is a decreasing function of the group size, N. This prediction is consistent with casual observation and is also seen in results from social psychology experiments with a staged "emergency" (Darley and Latane, 1968; Latane and Darley, 1970). This diminished tendency for members of large groups to intervene in staged emergencies has been attributed to a "diffusion of responsibility." Public awareness of this issue was heightened by the 1964 fatal stabbing of Kitty Genovese in the courtyard of her apartment complex in full view of a large number of neighbors (although the accuracy of some newspaper accounts has later been disputed). A less tragic outcome occurred when Teresa Saldana, who appeared in the 1982 film *Raging Bull*, was attacked by a crazed fan who had come to Los Angeles from Scotland to stalk her. Her screams attracted a group of bystanders, but only one man making a bottled water delivery charged in and risked injury or death to hold the assailant down until police arrived. The actress survived to continue with her career.

Even though the individual probability of volunteering declines with group size, it may be the case that the probability of getting *at least one* volunteer does not decline as the number of potential volunteers increases. This possibility may seem intuitive, but it is at odds with the symmetric Nash equilibrium. For example, if $V = \$1.00$, $C = \$0.20$, and $L = \$0.20$, it will be shown in the next section that the Nash prediction is for individual volunteer rates to decline from 3/4 to 1/2 as the group size increases from 2 to 3. So the chances of getting at least one volunteer goes from $1 - (1 - (3/4))^2 = 0.94$ for $N = 2$ down to $1 - (1 - (1/2))^3 = 0.88$ for $N = 3$. Moreover, as N goes to infinity, the Nash prediction for the probability of getting at least one volunteer falls to 0.75. Franzen (1995) tested this unintuitive prediction for group sizes ranging from 2 to 101. The volunteer rate fell from about 2/3 for small groups to about half that rate for large groups, and the probability of getting at least one volunteer was close to 1 for groups with 10 or more people. Subjects in this experiment completed a questionnaire and received results and monetary payments later by mail.

There can be considerable "noise" and confusion in a one-shot game, due to calculation errors and unobserved preference shocks, which may persist in repeated games with random matching. As a consequence, the probability of getting at least one volunteer could approache 1 for large groups. McKelvey and Palfrey (1995) proposed a generalization of the Nash equilibrium, the quantal-response equilibrium (QRE), which incorporates noise effects in an *equilibrium* framework that requires choice probabilities to be consistent with beliefs. The symmetric QRE prediction is that the probability of getting at least one volunteer will approach 1 for sufficiently large groups (Goeree and Holt, 2005). Equilibrium theories should be tested under conditions in which beliefs have had a chance to stabilize, and therefore this paper will report the results of repeated volunteer's dilemma games with random matching.[1] Note that it would be difficult for subjects to somehow coordinate on asymmetric equilibria with random matching, and therefore, our analysis will focus on the symmetric equilibrium predictions. In the online appendix, however, we do provide a detailed comparison of volunteer rate and variance predictions for symmetric and all possible asymmetric equilibria.

While theoretical explorations into the volunteer's dilemma are widespread, experimental evidence is relatively limited. Healy and Pate (2009) consider the effects of announced cost asymmetries, while others (i.e. Otsubo and Rapoport, 2008) examine a more dynamic volunteer's dilemma game with a finite horizon and a decreasing benefit of the public good over time. Otsubo and Rapoport find that subjects tend to volunteer earlier than predicted by theory, have difficulty coordinating on asymmetric equilibria, and volunteer more when the cost is lower. They also observe a large degree of heterogeneity across subjects in their free-riding behavior, a result that is featured in our data as well.[2] The decision of whether to volunteer or not depends on beliefs about others' decisions. Babcock et al. (forthcoming) consider the effects of gender sorting and find evidence that people believe that women are more likely to volunteer in mixed-gender groups. Finally, Bergstrom et al. (2015) consider an interesting variation in which one person, designated as the victim, receives a benefit if at least one other volunteers. They elicited utility payoffs from participants, using a timed mechanism to select a contributor. Subjects are motivated in part by interpersonal comparisons of volunteer decisions in this game.

[1] Many volunteers' dilemma situations (e.g. saving a victim) are not repeated. Random matching is a standard method of providing subjects with a series of 1-shot interactions in which they are able to learn about others' behavior in a general sense, without learning about the prior behavior of the specific people with which they are currently matched.

[2] Diekmann (1985) notes another unintuitive feature of the mixed-strategy Nash equilibrium in asymmetric volunteer's dilemma games. Since each person must be indifferent between their two decisions in order to be willing to randomize, the expected payoffs for volunteering and not volunteering must be equal. In a two-person game, an increase in one person's volunteer cost will not alter that person's predicted volunteer rate, since any change would cause the *other* person to no longer be indifferent. But the person whose cost has increased must be "induced" back to indifference by lowering the equilibrium volunteer rate of the person whose cost has not changed. Recall the numerical example given above ($V = \$1.00$, $C = \$0.20$, $L = \$0.20$), which produces a Nash volunteer rate of 0.75 with $N = 2$. It can be shown that a three-fold increase in one person's cost, from \$0.20 to \$0.60, will not alter that person's equilibrium volunteer rate but will reduce the *other person's* rate from 0.75 to 0.25. This absence of an "own–payoff effect" is unintuitive, and such effects have been observed and explained by a quantal-response approach in some other asymmetric 2×2 games with unique mixed-strategy equilibria (Goeree et al., 2003). Diekmann (1985) provides some evidence for own–payoff effects in 2-person volunteer's dilemma games, although the results for 5-person games were more ambiguous. As was the case with the Franzen (1995) experiment discussed above, these asymmetric-payoff experiments were done as one-shot games in which subjects filled out questionnaires and received results and payoffs by mail. More recently, Healy and Pate (2009) find experimental evidence that individual volunteer rates decrease both with an increase in own cost and a decrease in other group members' costs.