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Volunteering under population uncertainty ☆

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ABSTRACT

There is ample evidence that the number of players can have an important impact on the cooperation and coordination behavior of people facing social dilemmas. With extremely few exceptions, the literature on cooperation assumes common knowledge about who is a player and how many players are involved in a certain situation. In this paper, we argue that this assumption is overly restrictive, and not even very common in real-world cooperation problems. We show theoretically and experimentally that uncertainty about the number of players in a Volunteer's Dilemma increases cooperation compared to a situation with a certain number of players. We identify additional behavioral mechanisms amplifying and impairing the effect.

1. Introduction

Modern societies become increasingly dispersed, and networks of social interaction that are commonly taken for granted are constantly replaced by more anonymous and short-lived social encounters. Even though those now diminishing close-knit groups have been identified as the nucleus of cooperative environments (Coleman, 1994; Putnam, 1995), the prevalence of cooperative behavior in modern societies is surprisingly high. People take care of refugees after humanitarian crises and natural disasters. Programmers provide others with open source software. Interested writers publish articles on Wikipedia, and activists take part in risky political campaigns. Even more surprising these outbursts of collective action often happen in fairly unstructured, spontaneous, and rapidly changing environments. Very naturally, individual information about personal costs and benefits, ties between actors, or the dimensions of problems entailed in the system is limited in those grassroot endeavors. We will refer to this multifaceted and rather blurred perception of the environment as *environmental uncertainty*.

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Perhaps most importantly, we often have no or only partial information about how many other individuals are willing *and* able to engage. While we may have an intuition about the number of other potential "volunteers", the exact number is usually unknown. This *population uncertainty*, which is a particular flavor of environmental uncertainty, has profound consequences for the nature of strategic interaction. In his seminal theoretical contribution to the understanding of population uncertainty, Myerson (1998) shows that assuming common knowledge about group sizes is by no means an innocent assumption (see also Myerson, 2000): relaxing this assumption has profound consequences for predicted behavior. Myerson (1998, 2000) develops the general class of Poisson games to study population uncertainty in large groups. This class of games has received considerable attention in political science, where it is used to model voter decisions when the number of voters is unknown (Nunez, 2010) or to model macro-economic outcomes, e.g., when the number of innovators is unknown (Makris, 2008; Milchtaich, 2004).[1] While population uncertainty has been studied in many contexts, the literature on cooperation is surprisingly mute on this issue. With very few exceptions, it assumes common knowledge about who is a player and how many players are involved in a certain situation.

The goal of this paper is therefore to analyze the effect of population uncertainty on cooperation, both theoretically and experimentally. More specifically, we will study volunteering behavior as a particular kind of cooperation.

We introduce population uncertainty to the Volunteer's Dilemma (Diekmann, 1985), a well-known coordinate-to-cooperate game. In the Volunteer's Dilemma, a group of people can enjoy the benefits of volunteering if at least one group member volunteers to provide a public good. Providing the good, however, is associated with an indivisible cost, which is smaller than the gains every member of the group receives. Effects of different (certain) group sizes are well understood in the Volunteer's Dilemma (e.g., Franzen, 1995; Goeree et al., 2017), which makes it particularly suitable for the study of population uncertainty.[2]

In our experiment, we compare volunteering behavior under a certain group size (CERTAIN) with volunteering behavior under uncertain group size where the mean of the group size is identical to the certain group size. We consider two uncertainty treatments where we vary the variance of the distribution of possible groups sizes. Further, we vary the costs of volunteering in order to study interaction effects between group size uncertainty and incentives.

Our game-theoretical model of these coordinate-to-cooperate situations predicts a higher volunteering rate under population uncertainty (see Section 2). However, population uncertainty may have additional psychological effects, which would have consequences for the direction of the effect. Kerr (1989) finds that perceived self-efficacy is decreasing in larger groups, which then leads to lower levels of cooperation in social dilemmas. Since population uncertainty might lead to a downward biased perception of the population size, this is likely to mitigate cooperation in some situations.

Consequently, the perception of the probability of oneself "making a difference" or being "critical" (Rapoport, 1987) is paramount to understanding cooperation and coordination under population uncertainty. We have good reasons to believe that in fact the perceived and not the objective criticality plays the decisive role to explain coordination and cooperation under population uncertainty (Chen et al., 1996).

We model perceived criticality as a direct consequence of pessimistic beliefs about objective probabilities.[3] We thus go beyond the work of Au et al. (1998) and Au (2004), who provide suggestive evidence that population uncertainty has a negative effect on perceived criticality, but do not model the perceived criticality as a direct consequence of pessimism. Their prediction is experimentally corroborated by Au (2004), who shows that cooperation rates are indeed lower in a sequential threshold public-goods game with an uncertain group size. In contrast, our model predicts higher volunteering rates under population uncertainty. However, the fundamental difference between their setup and ours lies in the fact that in their case, successful cooperation requires more than one person.

The evidence for public-goods and common-pool resource games is less conclusive. Cooperation in linear public-goods experiments are not effected by population uncertainty (Kim, 2016), but are increasing in the non-linear counterpart. The exploitation of a common-pool resource decreases under population uncertainty (Au and Ngai, 2003), which may in part be explained by a convergence of diverse sharing norms to the equal division rule (de Kwaadsteniet et al., 2008).

Our results show that population uncertainty indeed fosters cooperation (see Section 4). This contrasts with many findings on the more general topic of environmental uncertainty, where uncertainty usually leads to a reduction of cooperation levels (e.g. Rapoport et al., 1992; Van Dijk et al., 2004). Further, we find an interesting effect suggesting that many subjects are only willing to contribute if others also do, even though one cooperator is sufficient and efficient. Finally, we find evidence that population uncertainty shifts actions away from self-regarding motives to pro-social motives and that population uncertainty shifts the normative perspective of what is appropriate to do.

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[1] Population uncertainty is studied more thoroughly in other contexts. In auctions (e.g., see Harstad et al., 1990) population uncertainty is shown to increase bids by and large, even though there are situations where this is reversed. This increase can at least in part be traced back to individual risk preferences (e.g., Haviv and Milchtaich, 2012). Moreover, population uncertainty influences equilibrium spending in contests theoretically and experimentally (Lim and Matros, 2009; Boosey et al., 2017). Ioannou and Makris (2017) study population-size uncertainty in a coordination game of strategic complementarities. Further, even very well known economic results like the optimal pricing behavior in a Bertrand competition change with population uncertainty (Ritzberger, 2009).

[2] To avoid any confusion, we think it is important to stress the difference between cooperation/volunteering and coordination. In our terminology, cooperation/volunteering is the individual choice to do something for the good of the group. Coordination, on the other hand, requires at least two actors to (implicitly) agree on who is doing what. The VOD may thus be understood as a coordinate-to-cooperate game.

[3] Mansour et al. (2006) provides evidence for pessimistic beliefs in simple coin toss experiments. Au (2004) also shows that some subjects abstained from investing in a threshold public good out of fear that the group size would be too small.