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Toward a delineation of the circumstances in which cooperation can be sustained in environmental and resource problems ☆

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ABSTRACT

Play in standard laboratory Public Good games suggests that on average, humans are quite prone to cooperate. Yet cooperation is often absent in real world social dilemmas, including many environmental problems. We propose that this discrepancy arises because in the Public Good game, the worst freeriders can do is to not contribute to the public account, while in many real world environmental situations freeriders can even appropriate contributions made by others before the public good is produced. We introduce the Claim Game that modifies the Public Good game by allowing for appropriating the contributions of others before the public good is produced. The impact of such possible takings on public good production is dramatic. No public good is produced, not even in the initial stages of interaction. We link our findings to the relevance of common pool games for modeling environmental problems, and stress the need to experimentally test environmental institutions within harsher social dilemmas than the standard Public Good game.

1. Introduction

Environmental degradation and natural resource depletion are social dilemmas. All agents involved are better off if they cooperate in protecting the natural environment, but if all others do so, an individual agent is even better off by not contributing. Standard game theory, assuming that agents only care about their own private welfare, yields a straightforward prediction – efficiency in environmental and natural resource conservation situations will be equal to the Selfish Nash equilibrium level, and no cooperation will be observed.

By their very nature, the number of agents involved in environmental and resource problems is typically (much) larger than two, and multi-player experimental games have been developed that may speak to the relevance of the behavioral economics literature for environmental and resource problems (for an overview, see Sturm and Weimann, 2006). Two of these have received most attention (albeit not to the same extent): the Voluntary Contribution Mechanism (the VCM game, also known as the Public

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Good game), and the Common Pool Resource (CPR) game. In their canonical form, both games are finitely repeated, multi-period multi-person social dilemma games.

The VCM game represents the case of a pure public good. Agents can invest in their provision, no agent can be excluded from enjoying the benefits the public good provides, and agents neither have the option nor the incentive to destroy the public good. Benefits are a linear function of the subjects' contribution, and hence aggregate payoffs are maximized if each subject invests her entire endowment in the public good. However, the own-payoff maximizing strategy in this game is to pocket one's endowment independent of the amount contributed by the other members of the group. Contributing zero to the public good is thus a dominant strategy if (i) all subjects only care about their own private payoffs, and (ii) this is common knowledge. In contrast, subjects are observed to typically invest, on average, between 40% and 60% of their endowment in the first period of the interaction (Ledyard, 1995; Chaudhuri, 2010). Contributions decline over time, but only become (approximately) zero in the very last period–even if the game lasts as long as 50 periods (Gächter et al., 2008).[1] Also, cooperation in this game is not just due to the fact that it is typically played with just four subjects in a group; cooperation is not markedly lower if groups consist of 40 or 100 subjects (Isaac et al., 1994; Diedrich et al., 2014) – if anything, it tends to be higher.

These outcomes are, however, markedly different from those observed in the CPR game, the second (and much less studied) multi-person social dilemma paradigm (Ostrom et al., 1992). In this experimental paradigm, subjects can extract from a common pool, and the benefits of doing so are a decreasing function of the extraction levels chosen – by the subject herself, but also by the other subjects. The CPR is thus a non-linear Public Bad game, and cooperation typically dissipates very quickly over the interaction. Aggregate extraction typically starts roughly in between the socially optimal and the selfish Nash equilibrium levels, and then converges to the latter in just two or three periods – independent of the number of periods the interaction lasts (Sturm and Weimann, 2006; Ostrom et al., 1992; Vyrastekova and Van Soest, 2008; Stoop et al., 2013).

This difference in outcomes between the two experimental paradigms is intriguing, and it is not straightforward to identify the underlying causes of why cooperation is observed in the one experimental paradigm, and not in the other. Indeed, the two games differ in many respects – contributions versus takings, payoffs that are linear versus concave functions of the decision variable, groups of 4 subjects versus groups of 5, or a dominant strategy versus a negatively-sloped own-payoff maximizing best response function. Finally, the social optimum and the Selfish best-response function are easy to identify in the VCM game, but they are less obvious (because of the non-linearity) in the CPR game (cf. Saunders, 2014; Cason and Gangadharan, 2015).

This paper's key conjecture is that the difference in the observed patterns of cooperation in the VCM game and the CPR game is caused by the nature of the strategic interaction. This strategic interaction is an important factor delineating the circumstances under which cooperation can or cannot be sustained. More specifically, we conjecture that the lack of cooperation in the CPR game is due to the fact that some can undo the good works of other, whereas in the VCM game the worst a freerider can do is to not contribute to the public good. We test this conjecture by constructing a game that is mathematically identical to the VCM game in all respects but one. In this new game, subjects can either invest in or take from the public fund, and the size of the remaining contributions in the public fund – if any – are used to subsequently produce the public good.

Referring to the modified paradigm as the Claim game, the key difference between that game and the VCM game is that the strategy space is larger in the Claim game.[2] Full contribution is still the social optimum, and subjects are substantially better off if they all contribute than if they do not. No public good is created in the game's Selfish Nash equilibria, as is the case in the VCM game. That means that in principle play in the Claim game can replicate play in the VCM game, yet we find that providing subjects the option to undo the good works of others has dramatic consequences for cooperation rates – average contributions are non-positive in all periods of the interaction, including the very first one.

This result of complete freeriding sets our paper apart from other papers that try to identify which of the VCM game's characteristics give rise to the relatively high levels of cooperation. Giving subjects the option to undo the good works of others implies that the private and social returns to investing in the public good are uncertain. They may be high if all other group members refrain from taking, but they may be zero if one's investments are offset by the actions of others. By itself, uncertain returns to investing in the public good reduce average contributions, but only weakly so – overall, group contributions remain significantly different from zero (Dickinson, 1998; Burger and Kolstad, 2009). Also, allowing subjects to undo the good works of others introduces the option of taking as opposed to investing. Andreoni (1995) and Khadjavi and Lange (2015) analyze whether reframing the Public Good game as a Public Bad game affects cooperation, and find that cooperation is (weakly) smaller in the Public Bad game, but still significantly different from zero.[3] So by themselves, certain returns versus uncertain ones, or a frame of giving or a frame of taking, do not destroy cooperation.

The insights obtained in this paper are important for four reasons. First, our Claim game may capture some real-world situations where the benefits of the public good, if it is created, are non-excludable and where there is non-rivalry in

[1] When the marginal per capita return (MPCR) from the public good is sufficiently high, contributions in the last period may still be greater than zero. For example, Isaac and Walker (1988) report that average contributions are 26% of the maximum when the MPCR is 0.75.

[2] Changing the strategy space in the VCM game necessarily implies that there are other differences too. For example, keeping all other parameters constant, a larger strategy space implies that the payoff space is larger too. We do, however, control for some important differences (in the socially optimal payoffs and in the incentives to freeride) by implementing different parameterizations of the Claim game.

[3] In a standard Public Goods game, subjects are asked how much to invest in a public account, which is currently empty. In the Public Bad game, subjects are informed of the existence of a non-empty public account, and are asked how much they wish to take from it. The difference between the two is thus the initial allocation (a full private account, or a full public account), and hence differences in outcomes are thus due to pure framing effects.