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Individual evolutionary learning, other-regarding preferences, and the voluntary contributions mechanism ☆

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ABSTRACT

The data from experiments with the Voluntary Contributions Mechanism suggest five stylized facts, including the restart effect. To date, no theory has explained all of these facts simultaneously. We merge our Individual Evolutionary Learning model with a variation of heterogeneous other-regarding preferences and a distribution of types to provide a new theory that does. In addition, our theory answers some open questions concerning the data on partners–strangers experiments. One interesting feature of the theory is that being a conditional cooperator is not a type but arises endogenously as a behavior. The data generated by our model are quantitatively similar to data from a variety of experiments, and experimenters, and are insensitive to moderate variations in the parameters of the model. That is, we have a robust explanation for most behavior in VCM experiments.

1. Introduction

The voluntary contributions mechanism (VCM) is often used to decide how much of a public good to produce and how to fund it. Beginning with the pioneering work of Marwell and Ames (1979), Isaac et al. (1985) and Kim and Walker (1984), there have been an amazing range of experiments involving the VCM in linear public goods environments. In this paper we focus on the experiments that involve repeated play. Five well-known[1] stylized facts from many experiments are:

1. Average contributions begin at around 50% of the total endowment and then decline with repetition, but not necessarily to zero.
2. There is considerable variation in individual contributions in each repetition. Some give everything. Some give nothing. The individual contributions also show no consistent monotonic pattern over time. Some increase, some decrease, and some have a zig-zag pattern.
3. Increases in the marginal value of the public good relative to the private good lead to an increase in the average rate of contribution. This is particularly true in later repetitions and for small groups.
4. Increases in the size of the group lead to an increase in the average rate of contribution. This is particularly true in later repetitions and for small values of the marginal value of the public good relative to the private good.
5. There is a restart effect; that is, if after 10 periods the subjects are told the game is restarting, then contributions in period 11 increase over those in period 10.

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[1] See Ledyard (1995), Holt and Laury (2008), and Chaudhuri (2011).

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It has not been too hard to come up with a reasonably sensible theory that explains one or two of the qualitative features of these stylized facts, although most of the effort has been spent on explaining just the first. It has been hard to come up with a theory that explains all five facts. It has been even harder to match the quantitative findings of the various experiments and experimenters. Standard game theory provides no help in understanding these facts. In linear experiments, contributing zero is the dominant strategy in a one-shot game. Solving backwards, one finds that zero contribution is also the equilibrium in games with multiple rounds. If one believes that all subjects care only about their own payoff, then one cannot explain positive contributions in VCM experiments, except perhaps as serious mistakes. There have been many suggested modifications to the standard theory in an attempt to explain the experimental data. Holt and Laury (2008) do an excellent job of summarizing much of the earlier literature.

More recently, there is a developing consensus that the levels of contributions seen in VCM experiments are due to conditional cooperation on the part of some players. As Chaudhuri (2011, p.56) summarizes in his excellent survey article: "…many participants in linear public goods games are conditional cooperators whose contributions to the public good are positively correlated either with their *ex ante* beliefs about the contributions to be made by their peer or to the actual contributions made by the same." But this still leaves open the question as to the theoretical basis for this behavior. There have been two basic dimensions in which the literature has carried out the search for a good theory. The first dimension involves the characteristics of the agents, their preferences and attitudes. The second involves the behavior of the agents, how they play a game.

Characteristics. While it is a bit of a simplification, two main approaches have been taken in defining the characteristic of an agent: other-regarding preferences and reciprocity. The idea behind the other-regarding preference approach is simple. The experimenter controls the payoff to each subject, but subjects also care about the distribution of the experimental payoffs. Each subject has a utility function that depends on others' payoffs and that is not controlled by the experimenter. Those taking the other-regarding preference approach[2] include Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Charness and Rabin (2002), and Cox et al. (2007, 2008)).

The reciprocity approach also comes in several flavors. It is sometimes assumed that there are agents who are hard wired as conditional cooperators; that is, these agents will behave as conditional cooperators no matter what. It is in their nature. See, e.g., Ambrus and Pathak (2011). At other times it is assumed that agents have a taste for reciprocity behavior; that is, they get direct utility from cooperating with a cooperator or direct disutility from cooperating with a non-cooperator. In these theories, they cooperate because they like to. See, e.g., Charness and Rabin (2002). Those taking the reciprocity approach include Rabin (1993), Dufwenberg and Kirchsteiger (2004), Wendel and Oppenheimer (2007), and Ambrus and Pathak(2011). Charness and Rabin (2002) mixes both other-regarding preferences and reciprocity.

Behavior. The second dimension considers the dynamics of the repeated game problem and how this affects the observed behavior of the agents. Again it is a bit of a simplification but the literature seems also to have split into two approaches here: strategic or learning. In the strategic approach, agents are assumed to follow some game theoretic equilibrium behavior when they play the repeated VCM game. This requires agents to have a serious base of common knowledge, that subjects rarely have, about the rationality and behavior of others as well as about the parameters of the games. As early example of this for prisoner dilemma games is found in Kreps et al. (1982) who introduce the possibility of an altruist, one who always cooperates in prisoner dilemma games.[3] Under an assumption of common knowledge of Bayesian beliefs, reputation can then induce selfish types to cooperate, i.e. to mimic the altruist, for some number of periods.

Those taking this approach with other-regarding preferences include Anderson et al. (1998), Fehr and Schmidt (1999), and Andreoni and Samulerson (2006). Those taking this approach with reciprocity include Ambrus and Pathak (2011).

In the learning approach, it is usually assumed that subjects are reacting to past choices of others in some kind of best response way. This requires no common knowledge among the agents. Those taking this approach with reciprocity include Wendel and Oppenheimer (2007). Those taking this approach[4] with other-regarding preferences include Anderson et al. (2004), Cooper and Stockman (2002), and Janssen and Ahn (2006).

1.1. Our approach

We take a very standard and simple approach to modeling. We merge other-regarding preferences and learning. We provide a common functional form for the utility received by each subject from the outcome of an experiment. Combined with their initial endowments and the rules of a VCM experiment, this will define a game. We also provide a theory about how subjects will play such games.[5] We do not assume they are fully strategic, but instead they learn how to play. Whether they learn to behave selfishly, altruistically or as conditional cooperators arises endogenously as a result of the combination of the parameters of the game and their preferences.

Characteristic. In our model, agents have other-regarding preferences (ORP) over outcomes. They neither know nor care about the intentions or preferences of others. Each subject's utility depends on their own payoff, the average payoff to the group, and the amount by which their payoff is less than the average payoff to the group. These three pieces reflect, respectively, a personal preference, a social preference, and a preference for fairness to self. Since the experiments are for relatively small stakes, we further assume as a local approximation that each subject's utility function is linear in its variables. To complete the utility formulation, we assume that an agent's two utility parameters, their marginal utility for altruism and their marginal disutility for envy, are independently and identically drawn from a probability distribution. That is, although there is a common functional form for the utilities, there is heterogeneity among agents in the parameters of that function.

All three pieces of the payoff are important and necessary to explain the contributions in linear public good experiments. Without the fairness component, in the stage game equilibrium contributions will be either to give nothing or to give everything. While both of these behaviors are observed in experiments, this would imply there are no conditional cooperators leaving contributions between all or nothing to be explained by confusion. Without the social component, equilibrium contributions in the stage game would be zero for everyone, which is clearly inconsistent with the evidence. As we will see, with all three pieces we can explain the existence of three

[2] We further discuss these papers below in Section 2.2.2.

[3] It is possible to compare prisoner dilemmas with voluntary contribution mechanisms by thinking of the strategy in a prisoner dilemma as the probability of cooperating and comparing that to the strategy in a VCM which is the percent of endowment contributed.

[4] We further discuss these papers below in Section 2.3.1.

[5] It is important to emphasize that we are not describing how subjects *should* play the games. Instead we want our theory to tell us how they behaved in the experiments they were in and how they would change their behavior if we changed the parameters of the experiments.