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Do people contribute more to intra-temporal or inter-temporal public goods?

Gilles Grolleau [a], Angela Sutan [b], Radu Vranceanu [c,*]

[a] LAMETA, UMR 1135, and LESSAC, 2 place Viala, 34060 Montpellier, France
[b] LESSAC, ESC Dijon, and LAMETA, 29 rue Sambin, BP 50608, 21006 Dijon, France
[c] ESSEC Business School, and THEMA, 3 Av. Bernard Hirsch, PB 50105, 95021 Cergy, France

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ABSTRACT

We introduce a dynamic public goods game, where an individual's investment in the public good at a given round provides benefits to other individuals in the next round, and the individual himself benefits from investments in the public good made by his current group members in the previous round. Subjects turn out to be more generous in this inter-temporal context than in a standard public goods experiment where contributions and transfers are exchanged at the same period. Furthermore, when known, benefits from the past investment are positively related to the individual's current investment in the public good.

1. Introduction

Experimental economics has so far developed around a relatively small number of general purpose games, and a larger set of ad-hoc games with a more specific use. Among the fundamental games, the *public good contribution game* or simply the *public goods* (PG) game introduced in the 70s (see Bohm, 1972; Smith, 1979, 1980; Marwell and Ames, 1979) has emerged as the dominant model for analyzing the evolution of cooperation within groups of unrelated, anonymous individuals. The impressive success of the PG game is backed by its ability to parallel real life situations where people would be better-off if they collaborate, but they individually prefer to free ride, such as the common pool resource problem, the management of production externalities, the supply of public goods and services such as infrastructures (e.g., roads, bridges, or parks) or national defense.[1]

In a typical public goods experiment, individuals are assigned to a group and are asked to sacrifice some direct individual utility by contributing to the public good. Individual contributions increase the utility of all other members of the group but cannot offset the sacrifice agreed to by the individual. Parameters are chosen such as when all group members contribute one unit of wealth to the PG, the individual's benefit, reflecting the sum of individual contributions, outweighs his sacrifice. The Nash-equilibrium of this game, as implemented by selfish, self-regarding agents, consists in all players making no

* Corresponding author.
E-mail addresses: grolleau@supagro.inra.fr (G. Grolleau), angelasutan@escdijon.eu (A. Sutan), vranceanu@essec.fr (R. Vranceanu).

[1] What makes the difference between a private and a public good is *nonrivalry* – several consumers can consume the good simultaneously, and *nonexcludability* – one cannot exclude from consumption an individual who does not pay the price.

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contribution to the PG (Davis and Holt, 1993).[2] Yet the utility of all group members would be the highest if they can coordinate their actions and make the highest contribution.[3]

One-shot public goods games were followed by analyses of finite horizon Repeated Public Goods (RPG) games, where individuals are asked to play the same game for several rounds. Like in the one-period setting, in the standard RPG experiment contributions are provided by, and benefits go to the same group members who play the game within the active round. Thus the decision sequence repeats itself identically from one round to another. In a finite horizon game with selfish self-regarding agents, free-riding at all rounds is also the sub-game perfect equilibrium, since nothing can enforce cooperation at the last round.[4] Note that in repeated games, decisions taken at the current round do not carry any material effect on the endowment or the marginal effect of contributing at latter periods, what makes their context "intra-temporal". By contrast, in Dynamic Public Goods (DPG) games current decisions carry their effects on future endowments or utilities of other people, in a context that can be referred to as "inter-temporal". The main contribution of this paper lies in introducing a specific DPG and analyzing the behavior of the participants in this framework. But before moving to our experiment, it is worth presenting the main and robust results inferred from a sizeable body of literature on PG games, most often dominated by the linear version of the repeated public goods game.

Surveys of the experimental literature on the PG game by Davis and Holt (1993), Ledyard (1995), Holt (2006), Chaudhuri (2011) acknowledge that when asked to play a standard linear RPG game, participants would contribute on average between 40% and 60% of their endowment in the first round, with wide variations between individuals, ranging from nothing, to 100% of their endowment. Zelmer (2003) performed a meta-analysis of 349 PG experiments and found support that the "marginal per capita return, communication, constant group composition over the session ("partners"), positive framing, and the use of children as subjects had a positive and significant effect on the average level of contribution to the public good." (p. 299). Several studies point out that contributions tend to increase in larger groups (Isaac and Walker, 1988; Isaac et al., 1994; Carpenter, 2007). Other analyses emphasize that enhanced anonymity is associated with lower voluntary contributions in PG games (Andreoni and Petrie, 2004; Alpizar et al., 2008; Hugh-Jones and Reinstein, 2011).

Many studies aim to explain why people do not follow the prediction of the theoretical model with rational, selfish agents by contributing nothing. Among the wide range of tested reasons, one can mention commitment (Bordignon, 1990), altruism (Smith et al., 1995; Andreoni, 1989, 1990) and reciprocity (Sudgen, 1984). Croson (2007) performed a set of experiments to distinguish between these competing theories by testing their comparative statics predictions in a linear RPG setting and show that reciprocity theories dominate both theories of commitment and of altruism. Cooperation increases when introducing a social approval mechanism (Rege and Telle, 2004) or when the group had the opportunity to develop a social identity (Lankau et al., 2012). A relatively recent literature points out that a majority of individuals behave as "conditional cooperators", i.e. they tend to cooperate as long as the others cooperate, and reverse their behavior in the opposite case; thus they anchor their contribution to their beliefs about the contributions to be made by the other members of the group (inter alia, Keser and Van Winden, 2000; Fischbacher et al., 2001; Croson et al., 2005; Fischbacher and Gächter, 2010).

Another key finding, when the PG game is repeated several times with a clearly identified finite horizon, contributions start high, then tend to decline over time with an end-game effect where contributions get close to the zero amount predicted by the Nash equilibrium. Several scholars aim at understanding why contributions decline over the rounds. While it is beyond the purpose of our short paper to present all the relevant explanations, we can mention the "frustrated attempts at kindness" as indicated by Andreoni (1995) or initial confusion about the stakes and the game (Andreoni, 1995; Houser and Kurzban, 2002). In a more skeptical paper about the strengths of the experimental method, Levitt and List (2007) argue that subjects come to the lab with a cooperative view about the world, learn that that in the lab many subjects behave in a non-cooperative way, and then adapt their own behavior accordingly. Taking stock on an experiment building on the conditional cooperation theory, Fischbacher and Gächter (2010) argue that "the decline of cooperation can be driven by the fact that most people have a preference to contribute less than the others, rather than by their changing beliefs of others' contribution over time".

Andreoni (1988) has introduced an important methodological development in the analysis of RPG games. He asked participants to play a standard linear RPG game under two distinct treatments. In the "Partner" treatment, the composition of the group did not change for the ten rounds of the experiment. In the "Stranger" treatment, groups were rematched after each round among the total population participating to the experimental session. As mentioned by Andreoni (1988), in the second situation, the participants' ability to play strategically is much reduced, thus one would expect to observe lower contributions. Yet in his experiment contributions in the Stranger context were significantly higher than in the Partner design. If a study by Palfrey and Prisbrey (1996) corroborated this result, other studies find the opposite one (Croson, 1996; Keser and Van Winden,

[2] See Camerer and Fehr (2006) for a definition of the concept of "self-regarding" agent.

[3] Most experiments use the *linear* PG game and its voluntary contribution mechanism (VCE). A group of N anonymous players having an individual endowment W are asked to make a voluntary contribution x to a common pool of money, with $x \in [0, W]$. Each gets back a constant percentage m of the total contribution. The non-trivial situation corresponds to $m \in [(1/N);1]$. In this case, a player does not gain enough to individually contribute one unit to the public good ($m < 1$), thus the Nash equilibrium is $x=0$ for all group members. If all contribute W, each will get mNW, which is obviously more than W as obtained at the Nash equilibrium.

[4] In an infinitely repeated game, cooperation can be enforced by threats of not contributing to the public good in the future.