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Cooperation and turn taking in finitely-repeated prisoners' dilemmas: An experimental analysis ☆

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ABSTRACT

In the standard prisoners' dilemma (SPD) cooperation is efficient. In the repeated, modified prisoners' dilemma (MPD) turn taking is efficient. It might be expected that the cooperative preferences exhibited by some agents, which gives rise to cooperation in the finitely repeated SPD, also give rise to turn taking in the finitely repeated MPD. We consider this question theoretically and experimentally. We find experimentally that 50% of participant pairs undertake turn-taking in the finitely repeated MPD. Turn taking continues to the final round for 37.5% of participant pairs, indicating that at least 18% of participant pairs exhibit cooperative preferences. Further, the prevalence of turn taking in the MPD is less than cooperation in the SPD, a finding that is consistent with theoretical predictions.

1. Introduction

Turn taking can be viewed as a form of cooperative behaviour which is observed in many social interactions. The strategic environment facing individuals in many of these interactions could be modelled as a repeated modified prisoners' dilemma (MPD): a MPD game differs from the standard prisoners' dilemma (SPD) game in that it is efficient for one player to 'compete' and the other player to 'cooperate'. Given the importance of prisoner dilemma games in explaining economic behaviour, it is similarly important to understand how people actually play repeated MPD games and, specifically, whether and how turn taking occurs in the finitely repeated version of this game.

In this paper, we present the results of an experiment in which participants play a finitely repeated MPD. To provide a benchmark for these experimental findings we also conduct a finitely repeated SPD. The cooperation observed in finitely repeated SPD has been attributed to the presence of cooperative agents in the population (Kreps et al., 1982). Cooperative agents are a behavioural type that places a high value on achieving efficient outcomes. It might be expected that the cooperative preferences exhibited by some agents, which gives rise to cooperation in the finitely repeated SPD, also give rise to

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turn taking in the finitely repeated MPD. To assess this question, we develop a series of conjectures based on the hypothesis that the population of participants who undertake our experiment consist of two different agent types: self-seeking and cooperative agents.

The formal difference between MPD and SPD games is illustrated in Table 1. These games are prisoner dilemmas if $Y < Z$, $Z < \alpha X$ and $Y > (1-\alpha)X$. These prisoner dilemma conditions ensure that while (T, T) is the unique equilibrium dominant strategy, it is not efficient. In SPD games $X < 2Z$, and the efficient outcome arises when both players play S. However, in MPD games in which $X > 2Z$, the efficient outcome in a one shot game is one in which one player plays T and the other S. In the repeated game, efficiency can be achieved by turn taking. Turn taking occurs when players synchronise and alternate the rounds in which they play T and S.

In both the finitely repeated SPD games and the finitely repeated MPD games there is a unique dominant strategy (and thus Nash) equilibrium (in monetary payoffs) where the outcome in each round is (T, T). The finitely repeated SPD game has been extensively studied experimentally, notably by Andreoni and Miller (1993) and Cooper, DeJong, Forsyth, and Ross (1996), and cooperation in early rounds (i.e. both participants playing S) is commonly observed. In a seminal paper Kreps et al. (1983) showed that such cooperation in finitely repeated SPD can arise when there is a number (possibly very small) of cooperative types, that is, agents which gain utility from acting cooperatively.

To date, there has been limited study of finitely repeated MPD games relative to the extensive literature on finitely repeated SPD games. As it generates efficiency, and is seen as relatively equitable, turn taking could be expected to be seen by cooperative types as the natural way to undertake cooperation in repeated MPD games. Turn taking in MPD games would then arise for the same reason as cooperation in SPD games: the presence of participants with cooperative preferences in the population in addition to those with self-seeking preferences. As with Kreps, Milgrom, Roberts, and Wilson (1982) the presence of cooperative types (where a participant type is private information) can induce self-seeking types to undertake turn taking in finitely repeated MPD games.

Given these considerations, we conducted a laboratory based experiment to determine the presence and prevalence of turn taking in finitely repeated MPD games. We also conducted an experiment of a related repeated SPD game to use as a benchmark for our study of MPD games. This allows us to compare the occurrence of cooperation in finitely repeated SPD games with the occurrence of turn taking in finitely MPD games. We compare the experimental outcomes of a finitely repeated MPD games with those of a finitely repeated SPD games, both with and without cheap talk. Cheap talk has been observed to promote a large increases in cooperative behaviour by participants in experimental settings. (Balliet, 2010; Meier, 2007). If, as we conjecture, turn taking is a manifestation of cooperative behaviour, we expect that cheap talk will increase the rate of turn taking. Conducting the experiments under both communication conditions provides a test of this conjecture.

We find that some participants in our experiment do indeed exhibit behaviour that is consistent with them having cooperative preferences, while others exhibit behaviour consistent with self-seeking preferences. Notably, we find turn taking occurring in MPD games, with some participants maintaining turn taking through into the final round (which a selfish player would not do). Cheap talk enhances the occurrence of both cooperation in the SPD games and turn taking in the MPD games. We also find that the incidence of turn taking in the MPD games is less than the incidence of cooperation in the SPD games. We attribute this finding to the requirement that turn taking in MPD games requires coordination amongst the partners, and this coordination will sometimes reveal the type of self-seeking players.

In an infinitely repeated SPD dilemma, cooperation can be maintained using the folk theorem (Friedman, 1971). Lau and Mui (2012) suggested that a turn taking equilibrium may exist in infinitely repeated MPD games in addition to infinitely repeated common resource games. Lau and Mui (2008) showed turn taking is an equilibrium with desirable attributes in the infinitely repeated allocation game. Folk theorems, however, cannot explain observed cooperation in the finitely repeated SPD games or turn taking in MPD games, suggesting that pro-social preferences are important drivers of this conduct.

Nowak and Sigmund (1994) and Neill (2003) have shown that turn taking can be an evolutionary outcome in finitely repeated MPD games. However, the application of such an evolutionary equilibrium to human subjects is questionable. In particular, because evolutionary processes are backward looking they do not create any final round effects in a finitely repeated game. We expect human subjects to be forward looking (to at least some extent) and thus generate final round effects. Indeed, this is what we observed in our experiments.

Bhaskar (2000) showed that an efficient symmetric Nash equilibrium in allocation games occurs when players randomise their strategy until coordination occurs, then engage in turn taking until the game terminates. Kuzmics, Palfrey, and Rogers (2014) provided a theoretical analysis of rational play in finitely repeated allocation games (coordination games with competition over payoffs). They showed that a focal point equilibrium in these games will be both efficient and simple, and that

Table 1
The stage game.

	S	T
S	Z, Z	$(1-\alpha)X, \alpha X$
T	$\alpha X, (1-\alpha)X$	Y, Y

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