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Optimal partnership in a repeated prisoner's dilemma

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Abstract

This paper studies informational partnerships in a repeated prisoner's dilemma with random matching. Assuming that players observe the play within but not across partnerships, we find the surprising result that the relation between the observability of actions and the sustainability of cooperation is non-monotonic. Increasing partnerships beyond a certain optimal size hardens cooperation although it improves observability.

Keywords: Prisoner's dilemma; Random matching; Observability; Cooperation

JEL classification: C70; C73

1. Introduction

The sustainability of cooperation in a two-player repeated prisoner's dilemma is a well established fact. Fudenberg and Maskin (1986) were the first to prove a Folk Theorem for the case of perfectly observable actions. The extension of this result to the case of imperfectly observable actions has attracted considerable attention in recent years (e.g. Piccione (2002) and references therein). If the prisoner's dilemma is played in a population of uniformly randomly matched players further informational imperfections might exist. Kandori (1992) has considered two extreme cases of observability. For a fully informed population in which every player observes the identity and actions of

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all other players Kandori proves a Folk Theorem. Kandori also shows that cooperation can be sustained in a fully uninformed population in which players only observe the actions of their stage game opponents and the players' identities are unobserved. This paper extends Kandori's analysis to the intermediate case of partially informed populations in order to study the relationship between the sustainability of cooperation and the amount of available information in more detail. We assume that the population is partitioned into partnerships and that there is perfect observability within but not across partnerships. Surprisingly, it turns out that more information does not necessarily imply that cooperation is easier to sustain. Increasing partnerships beyond a certain optimal size hardens cooperation although it improves observability.

So far the literature has found that additional information facilitates cooperation. Okuno-Fujiwara and Postlewaite (1995) for example assume that players possess observable labels like reputation or membership. They find that the introduction of this additional information improves cooperation. In a more applied setting Greif (1993) shows how the introduction of trade coalitions with specific information transmission mechanisms facilitated cooperation between 11th-century traders and their oversea agents. The present paper is the first to find a non-monotonistic relation between the amount of available information and the sustainability of cooperation.

Other papers have shown that cooperation in a population of players can be sustainable by departing from the assumption of uniform random matching. Harrington (1995) assumes that some players meet more frequently than others and Matsushima (1990) and Ghosh and Ray (1996) consider models in which opponents are chosen endogenously. Although these papers have explained the sustainability of cooperation they have failed to consider its dependence on the amount of available information.

The remainder is organized as follows. Section 2 presents the basic prisoner's dilemma framework and introduces partnerships as a particular form of informational structure. Section 3 shows how cooperation can be sustained in such a partially informed population. Section 4 discusses the dependence of the sustainability of cooperation on the partnership-size and Section 5 concludes.

2. The model

Consider an even number $N \geq 4$ of perfectly rational players. Time is discrete and periods are indexed by $t=0, \ldots, \infty$. In each period players get uniformly randomly matched to play a two-player prisoner's dilemma. After the prisoner's dilemmas have been played in period t and payoffs have been realized the pairs of players separate and random matching determines the new pairs for period $t+1$. Players discount future utility by a homogeneous discount factor $\delta \in (0, 1)$. The one-period payoffs of the prisoner's dilemma are defined in Fig. 1. They are normalized by setting the efficient payoff equal to 1 and the Nash payoff equal to zero. Payoffs are therefore completely characterized by two parameters; the gain from defecting, $G>0$ and the loss from being defected, $L>0$. We suppose that the population is

	C	D
C	1,1	$-L$,1+G
D	1+G,$-L$	0,0

Fig. 1. Payoff matrix of the normalized prisoner's dilemma.