



Short Communication

Greed and fear in multiperson social dilemmas



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ABSTRACT

We consider greed and fear in social dilemmas, represented by multiplayer games with two strategies, cooperation and defection. The dilemmas are defined by relevant axioms. The N-person Prisoner's Dilemma, Public Goods, Tragedy of the Commons, Volunteer's Dilemma, and Assurance Game, are included in the considered axiomatization. For two-player interactions the scheme leads to three types of social dilemmas, the PD (and the Weak PD), the Chicken and the Stag Hunt game. We define greed and fear for multiplayer social dilemmas, and observe that all the dilemmas have greed or fear build in.

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1. Introduction

Social dilemmas have attracted a great deal of interest of scholars in various branches of science, cf. e.g., [1,2], and references cited therein. They describe situations in which the optimal strategy for each individual player leads to a suboptimal collective outcome: acting in one's self-interest is tempting to every individual involved, even though all individuals would benefit from acting in the group interest.

Game theory provides a formal scheme for analysis of the social dilemmas. The corresponding models are referred to as social dilemma games. The most studied situations involved two-player interactions, with three basic types of social dilemmas: the PD, the Chicken and the Stag Hunt games. They are characterized by different types of social tension, referred to as greed and fear, two distinct motives underlying noncooperative choice behavior of the players. Greed corresponds to situation in which players prefer unilateral defection to mutual cooperation, fear to that in which players prefer mutual defection to unilateral cooperation [3]. Greed brings the gains for exploiting cooperative partners, whereas fear leads to the cost of cooperating with exploitative partners. In particular, in the PD game the players face two incentives: the expected gain for those who exploit cooperative partners (greed) and the expected loss for cooperators, who are exploited by partners (fear). In the Chicken game only greed is present, whereas in the Stag Hunt game only fear is present.

The relative impact of fear and greed on cooperation in social dilemmas has been studied by many scholars, see for example [4–9]. Recently greed and fear were studied in social dilemmas on networks [10].

In this note we consider a generalization of the notions of greed and fear for the multiplayer social dilemmas, defined by a set of axioms. In the next section we consider axiomatization of the dilemmas, which leads to three types of social dilemmas for the two-player games. In Section 3 we define greed and fear for the multiplayer dilemmas, and conclude that the proposed generalization leads to the existence of both greed and fear in the N-PD, Public Goods and the Tragedy of the Commons, greed only in the Volunteer's Dilemma, and fear only in the Assurance Game. Finally we briefly discuss the two-player case.

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2. Multiplayer social dilemmas

We consider general N-person strategic games $\langle \aleph, \{C, D\}, P_C, P_D \rangle$, where \aleph is the set of $N \geq 2$ identical players who can choose strategy C: cooperate for the collective best interest, or D: defect to pursue its own self-interest, and receive strategy dependent payoffs: $P_C(n)$ for an individual who plays strategy C, and $P_D(n)$ for that who plays strategy D, where $n \in \{0, 1, \dots, N\}$ is the number of players who use strategy C. The payoff matrix reads

	C...C	C...CD	...	CD...D	D...D	(1)
C	$P_C(N)$	$P_C(N-1)$...	$P_C(2)$	$P_C(1)$	
D	$P_D(N-1)$	$P_D(N-2)$...	$P_D(1)$	$P_D(0)$	

where e.g., C...CD stands for the set of $N - 2$ C-players and one D-player.

Definition 1. Multiplayer social dilemma game is the strategic game which satisfies

Axiom 1. N C-players are better off than N D-players:

$$P_C(N) > P_D(0), \quad n = 1, \dots, N - 1. \tag{2}$$

Axiom 2. The payoffs are nondecreasing functions of the number of cooperators:

$$P_C(n) \leq P_C(n + 1), \quad n = 1, \dots, N - 1. \tag{3}$$

$$P_D(n) \leq P_D(n + 1), \quad n = 0, \dots, N - 2. \tag{4}$$

Axiom 3. Strategy C does not dominate strategy D:

$$\sim (\forall n = 1, \dots, N \quad P_C(n) \geq P_D(n - 1)). \tag{5}$$

Otherwise, the players could be tempted to choose C, i.e. there would be no “dilemma”. We can rewrite (5) in the form:

$$\exists n \in \{1, \dots, N\} : P_C(n) < P_D(n - 1).$$

By straightforward calculations we check that the popular multiplayer social dilemmas, such as (cf. Appendix for the definitions) the N-PD, the Public Goods, the Tragedy of the Commons, the Volunteer’s Dilemma, and the Assurance Game satisfy the above axioms [11].

We remind that for the two-player symmetric games with the payoff matrix

	C	D
C	R	S
D	T	P

the PD is defined by $T > R > P > S$, and the Weak PD by $T > R > P = S$ [12]. The Stag Hunt is assumed to satisfy $R > T \geq P > S$. Let us call the Anticoordination Dilemma a two-player game which satisfies $T > R \geq S > P$. In particular, the Chicken, the Snowdrift, and the two-player Volunteer’s Dilemma game (cf. Appendix A, game IV for $N=2$) are Anticoordination Dilemmas. We prove

Lemma 1. For $T \neq R$ the only two-player social dilemmas are the PD, the Weak PD, the Anticoordination Dilemma, and the Stag Hunt game.

Proof. For $N=2$ Axioms 1,2,3 read: $R > P, R \geq S, T \geq P$, and $(T > R \text{ or } P > S)$. For $T > R$ and $P > S$ we obtain the PD, for $T > R$ and $P = S$ the Weak PD, for $T > R$ and $P < S$ the Anticoordination Dilemma. Finally, for $T < R$ and $P > S$ we obtain the Stag Hunt game. \square

3. Greed and fear in multiplayer social dilemma games

Definition 2. Greed is present in a multiplayer social dilemma if in the group of N C-players a C-player would be better off exploiting all other C-players by changing to D:

$$P_C(N) < P_D(N - 1). \tag{6}$$

Fear is present in a multiplayer social dilemma if in a mixed group of N players defection is a safer choice:

$$\exists n \in \{1, 2, \dots, N - 1\} : P_D(n - 1) > P_C(n). \tag{7}$$

We have

Corollary 1. Greed or fear (or both) are present in each multiplayer social dilemma.

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