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Minimax play by teams

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ABSTRACT

We analyze the behavior of two-person teams and individuals who repeatedly play the game with a unique mixed strategy equilibrium in the laboratory. When teams play O'Neill's 4×4 game against another team, the choice frequencies are consistent with equilibrium of the game at the decision-maker level. In contrast, individuals against another individual play far from equilibrium, as previous experiments have found. The hide-and-seek game experiment reveals that teams' behavior is less heterogeneous than individuals. When teams play O'Neill's game against individuals, teams win at above the equilibrium rate in one treatment, but not in the other.

1. Introduction

In many real-life situations, decisions are made by groups or teams of two or more individuals, such as families, boards of directors, legislatures and committees. Similarly, political decisions, monetary policy decisions, and some business decisions are often made by teams. There are many economic and strategic situations where an individual's decisions are made based on expertise of others, for instance, lawyers or consultants. These are also considered to be a team's decision making. This paper reports the results of an experiment in which common-purpose freely-discussing minimum-size (two-person) teams and individuals repeatedly play two-person zero-sum games with a unique mixed strategy equilibrium.

In much of economic theory, game theory, and most experimental investigations of these theories, there is no distinction between decisions by teams and those by individuals. Only recently has the importance of whether the decision maker is a team or an individual drawn attention. All studies in the past have used the framework of experimental economics with a variety of decision tasks and games, such as the dictator game in Cason and Mui (1997), the ultimatum game in Bornstein and Yaniv (1998), the investment game in Cox (2002), the centipede game in Bornstein et al. (2004), the monetary policy in Blinder and Morgan (2005), the limit pricing game in Cooper and Kagel (2005), the beauty contest game in Kocher and Sutter (2005), and the common value auction in Cox and Hayne (2006). In general, teams do as well or somewhat better (more in line with equilibrium prediction) than individuals in experimental economics with the possible exceptions of Cason and Mui (1997) and Cox and Hayne (2006).[1] Psychological experiments have shown that teams generally perform better than individuals on intellective tasks that have a correct action (or actions) and ex-post evaluation criteria for quality of performance (see, for example, Davis, 1992, and Kerr et al., 1996, for a survey of general decision tasks).

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[1] In Cason and Mui (1997), team choices tended to be dominated by the more other-regarding member. In Cox and Hayne (2006), one treatment revealed that teams tend to be less rational than individuals in the sense that their bids fell prey to the winner's curse. Cooper and Kagel (2005) provided a detailed review.

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In order to behave in line with equilibrium prediction, players are required to express certain specific abilities depending on the game played. For example, in a beauty contest game, players are required to apply greater depth of reasoning. In a dictator game or an ultimatum game, there is a conflict between self-interest and fairness. This indicates that even though we could find a difference in consistency with the theory between teams and individuals in one game, that result might not be applicable to other games.

In games with a unique mixed strategy equilibrium, players are required to choose their actions using i.i.d. draws from a certain stationary multinomial distribution over actions in order to behave in line with equilibrium prediction. In the psychological literature, it has been shown that human beings are not good at i.i.d. draws from a stationary distribution (see, for example, Wagenaar, 1972, and Bar-Hillel and Wagenaar, 1991, for surveys of subjective randomization in psychology). Human-produced sequences have too few symmetries and long runs, too many alternations among events, and too much balancing of event frequencies over relatively short regions (Lopes and Oden, 1987). Our experiment can provide new evidence of the difference in ability between teams and individuals in such an environment.

Previous laboratory experiments on games with a unique mixed strategy equilibrium found behavior inconsistent with the minimax theory, especially at the player level (O'Neill, 1987; Brown and Rosenthal, 1990; Rapoport and Boebel, 1992; Rapoport and Budescu, 1992; Mookherjee and Sopher, 1994; Binmore et al., 2001; Shachat, 2002; Rosenthal et al., 2003). Main findings in this literature include the following: (1) the aggregated data from the experiment was close to some of the implications of the minimax solution; (2) there is substantially more variation in choice frequencies across subjects than the theory predicts; and (3) there exists a significant amount of serial correlation in the players' choices across time.

First, we conduct an experiment in which subjects play O'Neill's (1987) game repeatedly. There are two types of treatments in this experiment: in the individual treatment, individuals interact with individuals, while in the team treatment, teams of two subjects interact with other teams in situations in which each subject is allowed to discuss freely with his or her teammate. The research hypothesis in this experiment is that teams behave more in accordance with the equilibrium prediction than individuals. In the team treatment, the choice frequencies at the decision-maker level are consistently close to the prediction of the minimax theory, while in the individual treatment they are further from the prediction. The consistency with the theory at the decision-maker level is a clear distinction from the previously found evidence. Other findings include the following: (1) the aggregated data in both team and individual treatments are close to the implications of the minimax solution, though some statistical tests reject the minimax hypothesis; and (2) the subjects' choices are serially correlated in both treatments.

We can interpret teams' consistency of choice frequencies at the decision-maker level with equilibrium prediction in at least two ways. One possibility is that a team's decision making has some positive synergies through communication with the teammate that makes teams more consistent with the equilibrium prediction. Another possibility is that putting individuals into teams moderates the heterogeneity of the individual choices, leading a team's choice to be closer to the equilibrium frequencies. In order to investigate which hypothesis is supported, we conduct the hide-and-seek game experiment developed in Rosenthal et al. (2003). Rosenthal et al. (2003) found that subjects adopting the evader role play the *Left* action with substantially more than its equilibrium frequency. If a team's decision making generates a positive effect, teams will behave more in accordance with equilibrium than individuals in this experiment. If a team's behaviors are the result of moderating the heterogeneity of individual frequencies, we should observe the lower variance in teams' behavior, and the aggregated choice frequencies are still far from the equilibrium prediction. The experiment supports the latter hypothesis.

We also conduct O'Neill's game experiment in which teams interact with individuals. In one treatment (denoted the team *A* vs. individual *B* treatment), teams adopt the player *A* role against individuals adopting the player *B* role. In the other treatment (denoted the individual *A* vs. team *B* treatment), teams and individuals play the opposite roles. This experiment examines whether teams win more often than individuals. The results are mixed and inconclusive. In the team *A* vs. individual *B* treatment, teams win significantly at above the equilibrium rate. In the individual *A* vs. team *B* treatment, teams win at the rate which is not statistically different from the equilibrium rate. It is hard to see why teams outplay individuals in one treatment, but not in the other.

The paper is organized as follows. Section 2 describes our experimental design, which allows us to analyze the behaviors of teams and individuals. Section 3 provides the results of O'Neill's experiment where teams interact with teams and individuals interact with individuals. Section 4 reports the results of the hide-and-seek game experiment where teams interact with teams and individuals interact with individuals. Section 5 reports the results of O'Neill's experiment where teams interact with individuals. Section 6 concludes.

2. Experimental design

Our experiment has two types of decision makers: teams and individuals. Each team consists of two subjects. Assignment of subjects to a team was random. Participants were seated with their teammate at one computer terminal, were allowed to discuss face-to-face, and were required to reach a single decision in each round. They were requested to speak softly and were strictly forbidden to speak to members of other teams. The minimum distance from the next team (computer terminal) was about three meters. Individuals were isolated from each other and were not allowed to communicate. We implement two different zero-sum games: O'Neill's game and the hide-and-seek game.