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Coordination with endogenous groups

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ABSTRACT

The endogenous choice of groups can have an important effect on coordination behavior, but it is an underexplored area of research. In this study, I examine how endogenous group choice affects coordination in a laboratory setting using the minimum-effort game. Most studies on coordination use randomly assigned groups, with some showing that successful coordination can be achieved if the subjects have some social interaction. This study shows that an alternative strategy to improving coordination behavior and equilibrium play is to allow subjects some choice over their group membership.

1. Introduction

Groups are both pervasive and diverse. It has been reported that 80% of firms use groups to complete projects (Lazear and Shaw, 2007). Diversity within groups can have a positive effect on group production (e.g. Hamilton et al., 2003, with ability heterogeneity), but it can also lead to problems with coordination. If the output of group work depends on the effort of all group members, it is important to understand and promote the circumstances under which everyone chooses to give more effort.

One approach adopted by some firms is to allow employees to make decisions regarding the working environment, such as when they work, where they work from, and what they work on. Another possibility is to allow workers to choose who they work with. Rather than using the simple method of random assignment to groups, the firm could ask workers to choose their own work groups. This could have the benefit of increasing trust among group members, increasing the attachment individuals have towards the group, and increasing the sense of responsibility that group members have towards the group's outcome. In this sense, it is worth exploring whether allowing people to choose their own groups can lead to an increase in effort by group members, and therefore lead to an increase in the output of group work.

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This paper explores, in a laboratory setting, whether endogenous groups, i.e. groups formed by subjects themselves, can improve group coordination. In experimental settings, group coordination is frequently studied using the minimum-effort game (Van Huyck et al., 1990). In that game, every player in a group chooses a (costly) level of effort, and each player's payoff is determined by the minimum effort chosen. This is a game with multiple Nash equilibria which occur when every player chooses the same level of effort. These Nash equilibria are also Pareto-ranked, in that everyone receives a higher payoff if everyone chooses higher effort. Due to the cost of providing more effort, uncertainty about other players' actions can lead to worse equilibria.

It is interesting to consider how groups choose from among these multiple equilibria in practice. Van Huyck et al. (1990) and Knez and Camerer (1994) show that there are cases where groups will generally converge to the highest-effort equilibrium after repeated play, and other cases where they will converge to the lowest-effort equilibrium. These different cases depend on the number of subjects playing the game, as well as the cost to providing more effort. Monderer and Shapley (1996), in theoretical work, show that the minimum effort game is a member of a larger class of games called *potential games*. These games all exhibit a *potential function*, which, when maximized, gives a prediction for the equilibrium that will be chosen by players. For the minimum effort game, the equilibrium that maximizes its potential function is determined by the number of subjects and the cost of providing more effort, in the same way that the previous experiments had demonstrated. If the cost or the number of players is low enough, then players are expected to converge to the Pareto-efficient equilibrium where everyone exerts the maximum possible effort. If both are too high, then players are predicted to converge to the worst equilibrium where everyone gives as little effort as possible.

In the cases where subjects are expected to choose the low-effort equilibrium, several experimental studies have been able to increase subject effort. The methods used vary, including establishing a precedent of efficiency (Knez and Camerer, 2000; Weber, 2006; Brandts and Cooper, 2006), intergroup competition (Bornstein et al., 2002; Riechmann and Weimann, 2008), communication (Brandts and Cooper, 2007; Blume and Ortmann, 2007; Chaudhuri et al., 2009), common identity (Engelmann and Normann, 2010), and ingroup matching (Chen and Chen, 2011). One method that has not been explored is that of allowing subjects to choose their own groups.

In this paper, I study the effect of endogenous groups on equilibrium selection in the minimum-effort game. The experiment uses a 2×2 between-subjects design, with varying group formation procedure and game information. In the first dimension, I vary whether subjects are placed into groups randomly ("Exogenous" treatment) every few periods, or whether they have some choice in their group membership ("Endogenous" treatment). In the second dimension, I vary whether the subjects are only shown the results of their own minimum-effort game ("Own-Group Feedback" treatment) or the results of all of the minimum-effort games in the session ("All-Groups Feedback" treatment). This second dimension allows me to examine whether subjects change their behavior when they have information about other groups. I find that subjects in the Endogenous treatment give significantly more effort and are able to coordinate to Nash equilibria better than those in the Exogenous treatment. I also find that the subjects in the All-Groups Feedback and Own-Group Feedback treatments choose approximately the same level of effort and achieve about the same level of coordination to Nash equilibria.

Much of the work exploring the effectiveness of endogenous groups uses the voluntary contribution mechanism (VCM), a standard game in studying cooperation. Results from these studies show the importance of sorting in successful cooperation. This sorting might also be important in minimum-effort game, since subjects are better off if they choose similar effort. Ehrhart and Keser (1999) show that subjects, when given the opportunity, sort themselves by contribution level, with high-contributing subjects "fleeing" from free riders and free riders chasing high contributors from group to group. Gürerk et al. (2014) allow subjects to join either a group that will play the standard VCM, or a group that will play the VCM with post-play punishment of low-contributing subjects. They find that allowing subjects to choose which group to join attracts subjects to the punishment group who will contribute high amounts and harshly punish those who defect.

This study contributes to both the literature on the minimum-effort game as well as the literature on the effectiveness of endogenous groups. It also provides some insight into how the method of group formation can have an impact on the effectiveness of groups.

2. Economic environment

In this study, subjects play the minimum-effort game repeatedly. In between rounds of the minimum-effort game, some subjects will be given the opportunity to change their groups.

The minimum-effort game (or weakest-link game) is a game with multiple Pareto-ranked Nash equilibria. Each round, all subjects choose an effort level from an allowed set of values. Subject i's payoff function is:

$$\pi_i(e_1, \ldots, e_n) = a \cdot \min\{e_1, \ldots, e_n\} - c \cdot e_i + b, \tag{1}$$

where n is the number of subjects playing the minimum-effort game in a group; a, c, and b are real, nonnegative constants; and $e_i \in [\underline{e}, \bar{e}]$ is the effort provided by subject i. A Nash equilibrium occurs when all players provide the same level of effort ($e_1 = e_2 = \cdots = e_n$), and any Nash equilibrium where all players choose a higher level of effort is a Pareto improvement over a Nash equilibrium where all players choose a lower level of effort. Thus, the case where all players choose the highest effort level ($e_i = \bar{e} \ \ \forall i$) is Pareto efficient, and the case where they all choose the lowest effort ($e_i = \underline{e} \ \ \forall i$) is the worst equilibrium.

In a laboratory experiment, Van Huyck et al. (1990) show that when subjects play this game repeatedly in large groups (n = 14–16) with costly effort, they eventually converge to the worst equilibrium. They also show that eliminating the cost to