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An experimental study of costly coordination

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Abstract

This paper reports data for coordination game experiments with random matching. The experimental design is based on changes in an effort-cost parameter, which do not alter the set of Nash equilibria nor do they alter the predictions of adjustment theories based on imitation or best response dynamics. As expected, however, increasing the effort cost lowers effort levels. Maximization of a stochastic potential function, a concept that generalizes risk dominance to continuous games, predicts this reduction in efforts. An error parameter estimated from initial two-person, minimum-effort games is used to predict behavior in other three-person coordination games.

JEL classification: C72; C92

Keywords: Coordination games; Stochastic potential; Logit equilibrium; Out-of-sample prediction

1. Introduction

After the prisoner's dilemma, the coordination game is perhaps the most widely discussed paradigm in game theory. Interest in coordination games stems from the presence of multiple Nash equilibria that can be Pareto ranked, which raises the possibility of "getting stuck" in an outcome that is undesirable for all players. For this reason, this

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class of games is of interest to macroeconomists (Bryant, 1983; Cooper and John, 1988; Romer, 1996). Since (generically) all equilibria are strict, standard refinements leave the set of Nash equilibria unchanged, which has prompted game theorists to search for new selection criteria. An array of alternative theories of behavior in coordination games have been put forward, both static and dynamic.[1]

Some theorists argue that coordination game experiments are useless for game theory because the Nash equilibrium and its refinements have no predictive power in this case and, as a consequence, "anything goes." We feel that the opposite is true: the unexpected empirical regularities observed in coordination experiments (such as the ones reported in this paper) can guide further theoretical work. For instance, previous experiments have shown that coordination problems cannot be ruled out by an assumption that agents somehow find the Pareto-dominant equilibrium. Indeed, some of the most widely cited results from laboratory experiments provide cases where subjects end up at the Nash equilibrium that is *worst* for all concerned (Van Huyck et al., 1990; Cooper et al., 1992; and the survey of Ochs, 1995). Since much of the theoretical work was motivated by the need to explain coordination failures in the laboratory, it is now time to return to the laboratory and carry out experiments designed explicitly to evaluate some of these theories.

This paper reports the results of several new coordination experiments. The first game to be considered is one in which pairs of subjects choose an effort level, and the resulting payoff is the *minimum* of the efforts minus the cost of one's own effort. This payoff structure can arise from a joint production process in which the group output is proportional to the minimum of the individual inputs, as is the case with perfect complementarity. The different treatments are based on a change in the common cost per unit of effort. As long as this cost is less than one, the best response to any set of others' efforts is just the minimum of those efforts, so (non-critical) changes in the cost of effort will not alter the set of Nash equilibria in pure strategies, nor will they change the predictions of any dynamic theory that is based on adjustment toward the best response to efforts observed in the previous period. Changes in the cost of effort do affect the relative costs of "errors" in overshooting or undershooting the minimum of other's efforts, so theories like risk dominance and maximum stochastic potential (discussed below) that take into account the costs of errors will be sensitive to the effort cost parameter.

The qualitative predictions that follow from maximizing the stochastic potential are supported by this first experiment. The data are used to estimate the "noise" parameter of the model, which is then used for out-of-sample prediction in six new sessions with three-person games. These sessions include both minimum-effort and median-effort coordination games.

The paper is organized as follows: the theoretical motivation for the experimental design is discussed in more detail in Section 2, and laboratory results for two- and three-person

[1] Static approaches include Pareto dominance (Harsanyi and Selten, 1988), risk dominance (Harsanyi, 1995; Carlsson and van Damme, 1993), and "noisy" equilibrium models (Anderson et al., 2001; Carlsson and Ganslandt, 1998). Dynamic models of coordination behavior can be roughly divided into evolutionary models (Kandori et al., 1993; Young, 1993; Crawford, 1991; Anderson et al., 2004), adaptive learning models (Crawford, 1995; Van Huyck et al., 1997), and "noisy" learning models (Battalio et al., 2001; Camerer and Ho, 1999).