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Quantal-response equilibrium models of the ultimatum bargaining game

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Abstract

This paper investigates the implications of quantal response equilibrium (QRE) models [McKelvey and Palfrey, 1995, Games Econ. Behav. 10, 6–38; 1998, Exper. Econ. 1, 9–41] in the ultimatum bargaining game. It is shown that, in a normal-form QRE (NQRE), each bargainer's decision depends critically on the anticipated behavior of the other, and there is a NQRE in which the proposer makes any offer between zero and equal split as a strict best response. The application of NQRE to the experimental data [Slonim and Roth, 1998, Econometrica 66, 569–596] suggests that the history dependence observed in the experiment is a result of the strategic interactions between bargainers.

JEL classification: C79; C92

Keywords: Quantal response equilibrium; Ultimatum bargaining game; Backward induction

1. Introduction

The ultimatum bargaining game could not be simpler. One player, called the proposer, makes an all-or-nothing offer, which the other, the responder, can either accept or reject. If the offer is accepted, the pie is shared according to the proposal. If it is rejected, both get nothing. In any sequential equilibrium, the proposer offers 0 to the responder (or, in the discrete case, the proposer offers either 0 or the minimum positive proposal) and the responder

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accepts. This prediction is, however, chronically violated in experiments. Most offers are concentrated between 30% and 50%, and smaller positive offers were often rejected (see Roth, 1995, Chapter 4).

The reasons for these violations have been a source of controversy for more than a decade. Some studies have sought to explain the experimental results for ultimatum games by assuming that subjects' preferences depend not only on their own monetary payoffs but also on others' payoffs in various ways, so called "social utilities," as in the general models proposed by Rabin (1993), Fehr and Schmidt (1999), and Bolton and Ockenfels (2000), and the econometric models of subjects' behavior in ultimatum experiments of Costa-Gomes and Zauner (2001). Other analyses have sought to explain the results without social utility, assuming expected monetary payoff maximization, but studying adaptive learning dynamics (Prasnikar and Roth, 1992), reinforcement learning model (Roth and Erev, 1995), evolutionary dynamics (Gale et al., 1995), or "limited cognition" (Johnson et al., 2002).

This paper takes a different approach, assuming expected monetary payoff maximization as in the papers just mentioned, but using McKelvey and Palfrey's (1995) notion of quantal response equilibrium (QRE) as a static model of boundedly rational strategic behavior. Extending results of McKelvey and Palfrey (1995, 1996, 1998), the present analysis gives a complete characterization of extensive- and normal-form versions of QRE in the ultimatum bargaining game and shows that QRE models have the potential to explain important features of subjects' behavior in Slonim and Roth's (1998) experiment and other ultimatum experiments.

In a QRE, players do not always choose best responses to their beliefs. Instead, their strategy choices are noisy, and strategies with higher expected payoffs are chosen with higher probabilities, with players taking the noise in each other's strategies rationally into account in equilibrium. In applications of QRE, the noise in players' strategy choices follows a specific distribution, which allows the degree of noisiness to be represented by as few as one parameter. The distribution most often used is the logit, and a QRE with a logit response function is called a *logit equilibrium*.

McKelvey and Palfrey's original notion of QRE is a normal-form concept, and McKelvey and Palfrey (1995), Anderson et al. (1998, 2001), and others have shown that the normal-form QRE (NQRE) is surprisingly successful in describing the quantitative as well as qualitative patters of deviation from equilibrium observed in a variety of normal-form game experiments. However, the NQRE gives identical predictions for extensive- and normal-form representations of a given game even though experimental subjects' choice behavior is systematically different in normal- and extensive-form representations of many games, including ultimatum bargaining games (Schotter et al., 1994; Cooper and van Huyck, 2002).

In response to these difficulties, McKelvey and Palfrey (1998) extended their notion of NQRE to extensive-form games, proposing a notion they called *agent QRE* (AQRE). An AQRE is defined like a NQRE, but for the agent normal-form of an extensive-form game, in which different information sets of a given player are assumed to be played independently by different agents, but all of a given player's agents share the same payoff function. Because each agent's noise is assumed to be independent, for any game with a non-trivial