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# A behavioral study of "noise" in coordination games ☆

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**Abstract**

'Noise' in this study, in the sense of evolutionary game theory, refers to deviations from prevailing behavioral rules. Analyzing data from a laboratory experiment on coordination in networks, we tested 'what kind of noise' is supported by behavioral evidence. This empirical analysis complements a growing theoretical literature on 'how noise matters' for equilibrium selection. We find that the vast majority of decisions (96%) constitute myopic best responses, but deviations continue to occur with probabilities that are sensitive to their costs, that is, less frequent when implying larger payoff losses relative to the myopic best response. In addition, deviation rates vary with patterns of realized payoffs that are related to trial-and-error behavior. While there is little evidence that deviations are clustered in time or space, there is evidence of individual heterogeneity.



*JEL classification:* C73; C91; C92

*Keywords:* Behavioral game theory; Discrete choice; Evolution; Learning; Logit response; Stochastic stability; Trial-and-error

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## 1. Introduction

Individuals occasionally deviate from their prevailing behavioral rules because of, for instance, mistakes, misperceptions, inertia, or trial-and-error experiments. Evolutionary game theory demonstrates that the exact nature of such individual-level deviations can crucially influence equilibrium selection (Kandori et al., 1993; Young, 1993, 1998, 2011a; Kandori and Rob, 1995; Blume, 2003; Montaneri and Saberi, 2010; Sandholm, 2010; Newton, 2012a; Bergin and Lipman, 1996). In this paper, we therefore tested competing assumptions regarding the nature of deviations, analyzing data from a laboratory experiment on coordination games played in fixed networks. Using classical discrete-choice estimation techniques (McFadden, 1974), we tested, in particular, the assumptions that deviations ($i$) occur with a constant probability (Kandori et al., 1993; Young, 1993), ($ii$) depend on the costs of deviating (Blume, 1993), and ($iii$) vary with payoff patterns related to trial-and-error behavior (Young, 2009; Pradelski and Young, 2012).

To study deviations, it is fundamental to justify the behavioral model relative to which a decision is considered a deviation. Most evolutionary game theory models focus on variants on myopic best-response (MBR) behavior, which assumes that agents maximize their individual payoffs in the current period by best-responding to others' actions as previously sampled. The concept of myopic best response dates back to the Nash equilibrium (Nash, 1950b; Young, 2011b) but the section on myopic best-response dynamics from Nash's PhD thesis (Nash, 1950a) was unfortunately omitted in its published version (Nash, 1951). Based on our experimental data, statistical tests revealed that MBR (confined to a minimal memory length of one) accurately describes 96% of subjects' decisions, leading us to define deviations as the remaining decisions. It is noteworthy that best-response models with longer memories and also simple models of reinforcement learning (Bush and Mosteller, 1955; Suppes and Atkinson, 1959; Harley, 1981; Cross, 1983; Roth and Erev, 1995; Erev and Roth, 1998) make virtually identical predictions in our experiment. Hence, while we cannot be certain as to which precise underlying decision rule the subjects applied, we can be certain that decisions identified as deviations indeed deviated from the decision rule, whichever was applied by the subject.

Alternative terminologies for deviations from an underlying rule are "noise", "errors", "trembles", "experiments" or "mistakes" (Kandori et al., 1993; Young, 1993). We shall prefer the terminology of "deviation", a more neutral word with regard to causality. There is a related but separate literature on noise in static situations of stochastic choice under risk (for example, Wilcox, 2008; Butler et al., 2012). These contributions study the effects of random perturbations of utility functions, rather than deviations from dynamic strategy protocols. Related static notions are the trembling-hand perfect (Selten, 1975), quantal response (McKelvey and Palfrey, 1995, 1998) and proper (Myerson, 1978) equilibrium concepts, which are static analogues of various dynamics. Our paper complements this line of research with the study of evolutionary dynamics.

## 2. Competing deviation assumptions

We tested three competing deviation assumptions as used in theoretical models. First, we tested the assumption that deviations occur with constant probability. That is, agents play, for instance, MBR most of the time but occasionally deviate with some constant rate (Kandori et al.,