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On the persistence of strategic sophistication

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Abstract

We examine whether the "Level-*k*" model of strategic behavior generates reliable cross-game predictions at the individual level. We find no correlation in subjects' estimated levels of reasoning across two families of games. Furthermore, estimating a higher level for Ann than Bob in one family of games does not predict their ranking in the other. Direct tests of strategic reasoning generally do not predict estimated levels. Within families of games, we find that levels are fairly consistent within one family, but not the other. Our results suggest that the use of Level-*k* reasoning varies by game, making prediction difficult.

JEL classification: C72; C91; D03

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1. Introduction

Following a considerable literature demonstrating deviations from Nash equilibrium play (see, for example, Camerer, 2003), behavioral research has sought to model the processes determining individual play and aggregate behavior in experimental games. One widely-used approach for modeling behavioral deviations from Nash equilibrium in one-shot games involves

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the use of heterogeneous types, based on varying levels of strategic sophistication (Nagel, 1993; Stahl and Wilson, 1994; Costa-Gomes et al., 2001; Camerer et al., 2004).[1] In this framework—often referred to as *Level-k* or *Cognitive Hierarchy*—players' strategic sophistication is represented by the number of iterations of best response they perform in selecting an action.

In the simplest version of these models, Level-0 types randomize uniformly over all actions and, for all $k > 0$, the Level-k type plays a best response to the actions of Level-$(k-1)$. Thus, the model suggests that a subject's level is a measure of her strategic sophistication—or, more precisely, her belief about her opponents' strategic sophistication. The application of such models to data from one-shot play in experiments has yielded several instances in which the model accurately describes the aggregate distributions of action choices. We provide a review of this literature in the next section.

The value of the Level-k framework as a *post hoc* descriptive model of the aggregate distribution of actions in laboratory games has been widely documented. There is also evidence that the overall distribution of levels may posses some stability across games (e.g., Camerer et al., 2004), meaning that one might be able to predict the distribution of actions in a novel game based on the distributions in other games.

However, an open question remains regarding whether Level-k types correspond to some meaningful individual characteristic that one might label as "strategic sophistication." That is, does a particular individual's estimated level correspond to a persistent trait that can be used to predict play across games? If levels are indicative of strategic sophistication, and if strategic sophistication is an invariant characteristic of a person, then there should exist reliable cross-game patterns in players' observed levels. Estimated levels in one game could then be used to predict players' behavior in novel games. Moreover, estimates of a player's level could be improved by using direct psychometric measures that correlate with strategic sophistication.

On the other hand, if players' levels appear to be randomly determined from game to game, then one of two negative conclusions must be reached: Either iterative best response is not an accurate description of players' reasoning, or the model is accurate but players' levels vary from game to game in a manner that is difficult to predict. In either case, knowledge of a player's level in one game provides neither information about their play in another game, nor a useful measure of that person's strategic sophistication in general.[2]

In this paper we test for persistence of individuals' strategic sophistication across games. We begin by identifying several plausible, testable restrictions on cross-game behavior in the Level-k framework. For example, the most stringent testable restriction is that players' levels are constant across all games. A weaker restriction requires only that players' relative levels be invariant, so that a ranking of players based on their levels remains constant across games, even if their absolute levels do not.

We then conduct a laboratory experiment in which subjects play several games drawn from two distinct families of games. The first family of games consists of four novel matrix games

[1] An alternative approach involves modeling deviations from Nash equilibrium as noise (or unobservable utility shocks) in players' best response. For an example, see the Quantal Response Equilibrium model proposed by McKelvey and Palfrey (1995). Rogers et al. (2009) bridge the Quantal Response approach with the Level-k approach studied here. Other directions in behavioral game theory include the study of dynamics following initial play (see Crawford, 1995; Erev and Roth, 1998; Camerer and Ho, 1998, for example).

[2] We do not suggest that levels must be constant across games for the model to have predictive power. Camerer et al. (2004) and Chong et al. (2005), for example, suggest that levels *will* change in certain situations. Predictive power simply requires that situational changes be predictable.