ELSEVIER

Journal of Economic Behavior & Organization
Vol. 32 (1997) 483–503

JOURNAL OF
Economic Behavior
& Organization

Adaptive behavior and coordination failure

John B. Van Huyck*, Joseph P. Cook, Raymond C. Battalio

Department of Economics, Texas A&M University, College Station TX 77843-4228, USA

Received 31 July 1995; received in revised form 12 March 1996

Abstract

We use the experimental method to study people's adaptive behavior in a generic game with multiple Pareto ranked equilibria. The experiment was designed to discover if behavior diverged at the separatrix predicted by the fictitious play dynamic. The equilibrium selected was sensitive to small differences in initial conditions as predicted. The experiment provides some striking examples of coordination failure growing from small historical accidents.

JEL classification: c720; c920

Keywords: Adaptive learning; Coordination failure; Fictitious play; Path dependence; Predictive success

1. Introduction

The power of the equilibrium method derives from the ability to abstract from the dynamic process that produces mutually consistent behavior and to abstract from the historical accident that initiated the process. This ability depends on an appeal to the long run: a time when adaptive behavior will have converged to a unique stable equilibrium (see Lucas, 1987). In this paper, we consider two related problems with this traditional defense of the equilibrium method: non-convergence and non-uniqueness.[1]

First, models of adaptive behavior do not guarantee convergence to Nash equilibria in general. For example, Cournot's (1960) myopic best response dynamic and Brown's (1951) fictitious play dynamic can lead to cycles or chaos. Hence, an open question is whether we should expect strategic behavior to converge to an outcome that satisfies a mutual consistency condition, like Nash equilibrium, or to an outcome that does not, like rationalizability.

* Corresponding author.

[1] See Kreps (1990) for discussion, examples, and references.

PII S0167-2681(97)00007-3

Second, multiple equilibria undermine the usefulness of an analysis that abstracts from historical accident and dynamic process. Multiple equilibria arise in many economic contexts. For example, multiple Pareto ranked equilibria arise in both macroeconomic models with production, search, or trading externalities and microeconomic models of monopolistic competition, technology adoption and diffusion, and manufacturing with non-convexities. These superficially dissimilar market and non-market models share the common property that a decision maker's best 'level of effort' depends positively upon other decision makers' 'level of effort.' This property is called strategic complementarity in the coordination failure literature.[2]

While it is tempting to assume that behavior will converge to an efficient equilibrium in situations with multiple Pareto ranked equilibria, doing so ignores the role of historical accident and dynamic process in producing mutually consistent behavior. Models of adaptive behavior often predict barriers that separate the space of outcomes into regions in which behavior does, and regions in which behavior does not converge to an efficient equilibrium. The selected equilibrium is path-dependent, that is, the equilibrium predicted to emerge depends on the historical accident of the initial condition, rather than on deductive concepts of efficiency.

The experiment reported in this paper was designed to discover if the predicted separation is observed. Our search was conducted in a generic game with strategic complementarities. While a deductive analysis predicts multiple Pareto ranked equilibria, the observed behavior was systematic. We did observe the separation predicted by the fictitious play dynamic. Moreover, the equilibrium selected was sensitive to small differences in initial conditions as predicted. The experiment provides some striking examples of coordination failure growing from small historical accidents.

Finally, the paper introduces a measure of the origin of mutually consistent behavior. Our measure searches the space of ϵ-equilibria to find the $\epsilon(t)^*$ that maximizes Selten's (1991) measure of predictive success. Our measure reveals that, while initially naive subjects behave more like decision theorists than game theorists, their behavior becomes mutually consistent in the sense that $\epsilon(t)^*$ decreases with time. While adaptive behavior leads to mutually consistent behavior, the mutually consistent behavior that emerges is path-dependent.

2. Analytical framework

To focus the analysis, consider the following generic version of a game with strategic complementarities and positive spillovers. Let $e^1 \ldots e^n$ denote the actions taken by n players where n is an odd number greater than one. Let e denote this action combination. An abstract market process is a mapping from the action space into a real number, the market outcome M.

The market outcome could represent market thickness, industry production, average market price, aggregate demand, or aggregate supply. In the coordination failure literature, the mean of the players' actions is a common example of an abstract market

[2] See Cooper and John (1988) and Milgrom and Roberts (1991) for examples and references.