Quantal Response Statistical Equilibrium: A New Class of Maximum Entropy Distributions [†]

Ellis Scharfenaker

Department of Economics, University of Utah, Salt Lake City, UT, USA

[†] Presented at the Entropy 2021: The Scientific Tool of the 21st Century, 5–7 May 2021; Available online: https://sciforum.net/conference/Entropy2021/.

The principle of maximum entropy has been applied fruitfully to many economic and social situations. One limitation of such applications, however, is the tendency neglect of the joint determination of social outcomes and the actions that shape them in the formal modeling despite the fact that both dimensions of the problem are typically articulated in the theoretical exposition. The fact that closed-form marginal distributions are good model candidates for many economic variables in statistical equilibrium based on fit has the unfortunate consequence of leading to economic rationalization based on mathematical necessity of the constraints. From the Principle of Maximum Entropy perspective the use of closed-form distributions is premature. While there may be good reasons to rely on such distributions for modeling statistical equilibrium in some situations, in general this limits inference to an arbitrary subset of models.

This research explores an alternative approach to modeling economic outcomes based on the Principle of Maximum Entropy called the quantal response statistical equilibrium (QRSE) model of social interactions. The QRSE model provides a behavioral foundation for the formation of aggregate economic outcomes in social systems characterized by negative feedbacks. It can approximate a wide range of commonly encountered theoretical distributions that have been identified as economic statistical equilibrium and displays qualitatively similar behavior to the Subbotin and Asymmetric Subbotin distributions that range from the Laplace to the Normal distribution in the limit. Asymmetry in the frequency distributions of economic outcomes arises from the unfulfilled expectations of entropy-constrained decision makers and asymmetric impacts of actions. The logic of the model is demonstrated in an application to US stock market data, firm profit rate data, and the distribution of income from a classical perspective.