The evolution of beliefs and strategic behavior

Document status and date:
Published: 01/01/2015

DOI:
10.26481/dis.20150603do

Document Version:
Publisher's PDF, also known as Version of record

SUMMARY

This dissertation theoretically studies how evolutionary game theory and observational learning can be used to model three aspects of economic and social interactions: repeated interactions, experimentation and communication. All these three aspects influence individual beliefs and behavior and in turn social welfare. Unlike classical game theory, learning and evolutionary game theory relaxes the assumptions of perfect rationality and foresight making it suitable for modeling such interaction environments. The organization of the dissertation is into two themes. The first part focuses on the aspects of repeated interactions and experimentation when agents behave strategically, and the second part focuses on evolution of individual beliefs under repeated interactions and communication.

Chapter 2 analyzes aggregate outcomes of stochastic evolutionary processes, that is repeated strategic interactions with experimentation. It develops computational methods for identifying the most likely outcomes in such interactions. In this regard, we define *epsilon stability* as the appropriate solution concept. That is, epsilon stable states (hence strategies) are the most likely outcomes in the long-run given the level of experimentation. We use this concept to show that if probabilities of mistakes depend on payoff losses associated with the transition, then risk-dominant strategies are the most likely to be played in the long-run. Risk-dominant strategies however need not be epsilon stable in general.

Chapter 3 studies learning and evolutionary processes under limited information. That is players are assumed to observe the behavior of only a select few from the population. These select few are each player's social or ego-network. The Chapter particularly focuses on large decentralized societies, whereby we define *asymptotic global stability* as an appropriate solution concept. A state and hence strategy is said to be asymptotically globally stable if it is uniquely stable in the long-run at the limit of the population size. Unlike the case of global interactions, limited information ensures that asymptotic global stability is robust to the model of experimentation. We identify *global* and *path-wise contagion* as key factors that are compatible with asymptotic global stability. These two factors depend on the relative payoff gains and network structure. The implications are that for any given payoff structure and hence relative payoff gains, it is possible to design a network such that a unique strategy is asymptotically globally stable. Similarly, for a given network structure

and set of strategies, one can determine the relative payoff gains that lead to a given strategy to be globally stable.

Chapter 4 studies rates of convergence of stochastic evolutionary processes. The main result is that the speed of evolution is influenced by three main factors: the payoff gains, the topology of the interactions among agents and the level of noise. For a given level of noise, there is no clear-cut linear relationship between convergence rates and payoff gains and topology of interactions. The key factor is whether or not long-run epsilon stable strategies are *globally contagious*. Global contagion leads to shorter convergence time to the epsilon stable states but longer convergence times to stationarity. When global contagion is feasible, the expected waiting time from any other subset of states to the long-run stable set is shorter for highly than sparsely connected networks. The reverse is true for convergence time. Networks for which global contagion is infeasible lead to shorter convergence time.

Chapter 5 studies the evolution of individual beliefs through repeated interactions and word-of-mouth communication. Three main factors are modeled as relevant in determining the structure of beliefs over time: historical factors—*prior beliefs*, the learning mechanism (the manner in which individuals incorporate new information into their beliefs)—-*rational or bounded-rational learning*, and the topology of communication structure governing information exchange. Heterogeneity in public beliefs resulting from such interactions is more likely when individuals are rational than when they are not. This could result from heterogeneity in historical factors, topology of interaction structure or both. We also examine conditions under which the resulting public beliefs correctly aggregate decentralized private information. Under rational learning, the only relevant factors for correct aggregation is knowledge of the network topology (and not the network topology) and boundedness of private beliefs. The network topology however plays a significant role for correct aggregation under bounded-rational learning