Chapter 3
Playing with Ambiguity:
An Agent Based Model of Vague Beliefs in Games

Konstantinos Georgalos
University of York, UK

ABSTRACT

This chapter discusses the way that three distinct fields, decision theory, game theory and computer science, can be successfully combined in order to optimally design economic experiments. Using an example of cooperative game theory (the Stag-Hunt game), the chapter presents how the introduction of ambiguous beliefs and attitudes towards ambiguity in the analysis can affect the predicted equilibrium. Based on agent-based simulation methods, the author is able to tackle similar theoretical problems and thus to design experiments in such a way that they will produce useful, unbiased and reliable data.

INTRODUCTION

In this chapter, our aim is to explore how Agent-Based Simulation techniques can act as a complement to a relatively new field of the experimental economics literature, that of preferences towards ambiguity. As experimental techniques in economics constitute an indispensable part of the applied and empirical research, with scholarly research getting published in the top journals of the profession, it is of paramount significance for the implemented experimental protocols to be carefully designed so as to provide by minimizing the number of possible flaws. Moreover, advances in the field of decision theory, combined with the numerous available datasets of experimental observations, pose a huge challenge to the 'rational' agent paradigm[1]. As a result, empirics have rendered the use of more realistic modelling of human behaviour as well as the interdisciplinary research to be more than necessary. Due to this, several new scientific fields have emerged such as the field of 'Behavioral' economics (where elements from psychology and biology are coalesced with the economic theory) or the field of neuroeconomics (where advances of neuroscience are applied) to name but a few. In addition to the latter, crucial improvements have been made to the literature of decision making under ambiguity, or stating it in a different way, improvements on how to model agents' behaviour in situations where they lack useful information. This

DOI: 10.4018/978-1-5225-2594-3.ch003

fact can be explained by the increased frequency of research papers published that either focus on similar theoretical issues or on the application of theory to real life. Consequently, every single field in economics now takes advantage of these advances augmenting the ability to explain data and behaviour in a more realistic way (e.g. macroeconomics, game theory, environmental economics). Similar applications can be found in the present volume by Trindade, Magessi, and Antunes (2014) and Arciero et al. (2014).

In this chapter, we show how three distinct fields can be brought together enabling us to design and conduct more effective experiments that will generate useful and unbiased data. Our aim is to use advances of the literature of decision making under ambiguity that centres on individual choice, in order to predict behaviour in strategic interaction environments. The commonest way to model interaction in economics is game theory. There are several other different ways to model social interaction such as using the public choice approach (for a similar approach, see Lucas and Payne (2014) and Trigo (2014) or principal- agent models to name but a few. Incorporating the theoretical advances into the game theoretical models enables us, on the one hand, to solve puzzles that the standard assumption of the rational choice produces and, on the other, to obtain better predictions of how agents will react in similar interactions. The next step, after having derived the theoretical predictions, is to test this theory in the lab. The role of agent-based simulation becomes apparent at the step before entering the lab. Thus, what we provide is an intuition of how decision theory, game theory and computer science can be combined for the optimum design of economic experiments. As this chapter is addressed to readers of multifarious scientific backgrounds, careful consideration has been taken as regards the fact that they may not be familiar with the tools and methods that are employed in economic analysis to model individual behaviour. Henceforth, effort has been made to keep mathematics and definitions to the lowest formal level possible. A mathematical as well as a technical appendix with the code for the simulation is attached at the end of this chapter.

Agent-Based Simulation in Economics

As was described in the introduction, we focus on the use of agent based modelling in order to design and implement economic experiments. Before proceeding to this, it is instructive to outline other cases as well in which agent-based modelling can be useful in economic research. It is well-known that economics is a science heavily based on mathematics, making it one of the most essential tasks when conducting research. The range of applications is enormous. Starting from complex optimization programs that need to be solved, testing theoretical models or writing estimation routines to simulate evolutionary systems, agent-based modelling can be proved to be the optimal way to do so. Tesfatsion (2006) provides a nice definition of Agent Based Computational Economics (ACE) as the “computational study of economic processes modelled as dynamic systems of interacting agents.”

In economics, there are various reasons where simulation techniques can be exploited for research. Van Dinther (2008) discusses one of the major benefits in agent based modelling, namely that of controlling all the parameters of interest in order to adapt them to the specific problem under investigation. This offers to the researcher a unique flexibility in the modelling process that allows comparative statics analysis but also is a powerful prediction and testing tool.

Why should one use agent-based models in economics? Starting with the most simple, the main reason to program the behaviour of agents is to tackle complex mathematical problems that the theoretical model under consideration demands. When the mathematics allows, closed form expressions that represent the optimal decisions that a decision maker takes can be derived. In a similar case, agent-based models are useful for conducting comparative statics exercises and seeing how the results change when some of the