Chapter XIV
Agent-Based Computational Economics

Charlotte Bruun
Aalborg University, Denmark

ABSTRACT

This chapter argues that the economic system is best perceived as a complex adaptive system, and as such, the traditional analytical methods of economics are not optimal for its study. Agent-based computational economics (ACE) studies the economic system from the bottom up and recognizes interaction between autonomous agents as the central mechanism in generating the self-organizing features of economic systems. Besides a discussion of this new economic methodology, a short how-to introduction is given, and the problem of constraining economics as a science within the ACE approach is raised. It is argued that ACE should be perceived as a new methodological approach to the study of economic systems rather than a new approach to economics, and that the use of ACE should be anchored in existing economic theory.

INTRODUCTION

Terming a specific approach to economics agent-based may appear paradoxical. Isn't human behavior the foundation of economics—and shouldn't all economic theory be based on agents behavior in some sense? This, at least, is what conventional economic theory has been claiming since the 1970s. In this introduction we shall argue that agent-based computational economics (ACE) allows agents, and especially their interaction, a more pivotal role than does conventional microeconomics or microfounded theory. There is a difference between microeconomics and agent-based economics: in the latter you are not satisfied with understanding exactly how a single agent acts in economic markets; you are primarily interested in the system view that arises when you observe the interaction between a number of agents. From observing an isolated agent, it is impossible to foresee what happens when a multitude of agents interact; it cannot be deduced. This adds importance to the computational part. In agent-based economics the computer is not merely used as a giant calculator finding analytical or numerical solutions, but it is used as a central part in a new methodological approach to economics.

THE ECONOMY AS A COMPLEX ADAPTIVE SYSTEM

The economy may be described as a complex adaptive system—that is, a system where complexity arises because of the way a large number of agents interact. Complexity thus stems from the fact that the economy is a large composite system. What we observe as the economy is the result of millions of agents interacting. We know the output of this system as growth rates, inflation rates, unemployment rates, and so forth, but how do we get from the description of our agents to these aggregate magnitudes, and can we say anything about the aggregate magnitudes in their own right?

As other sciences dealing with large composite systems, economics has developed a tradition of dealing with two levels: the microlevel and the macrolevel. Microeconomics takes as its starting point the behavior of individual agents, whereas macroeconomics theorizes about relations between aggregate magnitudes. The problem is that unless one is willing to make very restrictive assumptions, it has proven to be impossible to unite the two levels. This has resulted in assumptions of homogeneity and constructions as the representative agent—a construction that among others has been heavily criticized by Kirman (1992).

The apparent impossibility of uniting micro and macro is particularly crucial in economics since we have developed a tradition of demanding microfoundation of macroeconomics. In reality this means a dismissal of macroeconomics altogether, and an ignorance of the fact that important characteristics of the system may arise in the interaction part. If Keynes' conception of effective demand (Keynes, 1936) is something that arises in the interaction, then the possible lack of aggregate demand is dismissed from the outset since it cannot be microfounded.

Complexity science now offers a way out of this situation. Rather than starting with either a single isolated agent or aggregate magnitudes, complexity science suggests focusing on the interaction between agents. Recognizing that what turns large composite systems into systems and not just collections is the interaction between the parts, it seems apparent to start with the interaction.

Traditional microeconomic models also have interaction, it could be claimed, but this is really pseudo-interaction since here an agent either interacts with the aggregate whole or all are simultaneously interacting with all others (Rosser, 1999). That is, we really do not have interaction taking place in time and space. In general equilibrium models, the pseudo-interaction is obtained by having a controller signal out a price vector to agents, and collecting information on demand and supply given this price vector. Being able to handle heterogeneity, time, and space, the sort of interaction suggested by complexity science comes much closer to the kinds of interaction that is actually taking place in economic systems.

As a consequence of allowing economic agents to actually interact, we must expect our system to display a less predictable behavior—that is, we must expect very complex dynamics. In their introduction to the first Santa Fe workshop on "The Economy as an Evolving Complex System," Arthur, Durlauf, and Lane (1997) characterize complex dynamic systems