Confronting Agent-Based Models with Data: Methodological Issues and Open Problems

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Summary. This paper addresses the problem of finding the appropriate method for conducting empirical validation in AB models. We identify a first set of issues that are common to both AB and neoclassical modellers and a second set of issues which are specific to AB modellers. Then, we critically appraise the extent to which alternative approaches deal with these issues. In particular, we examine three important approaches to validation that have been developed in AB economics: indirect calibration, the Werker-Brenner approach, and the history-friendly approach. Finally, we discuss a set of open questions within empirical validation.

18.1 Introduction

Agent-based (AB) researchers in economics have enjoyed significant success over the last twenty years. The models that have been developed indicate the viability and vitality of an alternative to mainstream neoclassical economics. Indeed, deep philosophical differences exist between neoclassical and AB modellers regarding the world faced by real-world agents and, hence, the type of models that it is useful for economists to construct. AB modellers reject the aprioristic commitment of new classical models to individual hyper-rationality, continuous equilibrium, and representative agents. Everything in the neoclassical world can, in principle, be known and understood. It is often assumed that the entire set of objects in the world (e.g. techniques of production, or products) is known at the outset. The opposite is the case in the AB world. Here the set is unknown, and agents must engage in an open-ended search for new objects. Associated with this distinction are important differences with regards to the types of innovative learning and adaptation that are considered, definitions of bounded rationality, the treatment of heterogeneity amongst individual agents and the interaction between these individuals,
and whether the economic system is characterized as being in equilibrium or far from equilibrium. Mainstream economists have often recognized the significance of the AB Weltanschauung, and have reacted by extending their own modelling framework to incorporate (certain) aspects of heterogeneity, bounded rationality, learning, increasing returns, and technological change. Another sign of the vitality of the AB community has been the development of its own specialist international journals and annual conferences, and the diffusion of its ideas to other areas such as management science, political science and to policy circles.

Nevertheless, there is a perceived lack of robustness in AB modelling, due to the problematic relationship between AB models and empirical data. There is a lack of standard techniques not only for constructing and analyzing AB models, but also to conduct empirical validation. Key areas of debate include: is a ‘realist’ methodology appropriate? Why should empirical validation be the primary basis for accepting or rejecting a model? Do other tests of model validation exist than the reproduction of stylised facts? If we do proceed down the path of empirical validation, then how should one relate and calibrate the construction of parameters, initial conditions, and stochastic variability in AB models to the existing empirical data? Which classes of empirically observed objects do we actually want to replicate? How dependable are the micro and macro stylised facts to be replicated? To what extent can we truly consider output traces to be stylised facts or, alternatively, counterfactuals? What are the consequences, for the explanatory power of a model, if the stylised facts are actually ‘unconditional objects’ that only indicate properties of stationary distributions and, hence, do not provide information on the dynamics of the stochastic processes that generated them?

The aim of this paper is to provide a critical overview of how AB modellers have been tackling the issue of empirical validation. A strongly heterogeneous set of approaches can be found in the AB literature. An important (and novel) contribution of the paper is a taxonomy that maps the different dimensions of the empirical validation approaches found in AB models. In the next section we shall draw attention to some crucial issues of empirical validation, faced by both AB and neoclassical modellers.

18.2 Core Issues of Empirical Validation

Any model isolates some features of an actual phenomenon. It is usually assumed, in economics as in any other science, that some causal mechanism (deterministic or non-deterministic) has produced the data. We call this causal mechanism “real-world data generating process” (rwDGP). A model approximates portions of the rwDGP by means of a “model data generating process” (mDGP). The mDGP must be simpler than the rwDGP and generates a set of simulated outputs. The extent to which the mDGP is a good representation of the rwDGP is evaluated by comparing the simulated outputs of the