Agent-Based Economic Models and Econometrics

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Abstract

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1 Introduction

Recently, we evidence increasing conversations between agent-based economics (ABE) and econometrics.\(^1\) In this paper, we shall review the relation between the two. While the link can be bi-directional, as we shall see in this survey, most work developed so far focused more on the direction (influence) from econometrics to ABE. This series of work certainly, to some extent, provides the econometric foundation of ABE. However, what is equally important and interesting is the other direction: ABE can also provide stimulating thoughts to econometrics. In this reverse direction, we may pursue for an agent-based foundation of econometrics, or a microfoundation of macroeconometrics.

This survey article is, therefore, divided into three parts which correspond to a three-stage development of the literature. The first two stages, namely, the econometric influence to ABE, examine the econometric practice in ABE modeling. The first stage, entitled with “presenting ABE with econometrics,” is to use econometrics to analyze the data generated from the ABE models, and see whether they are able to display a number of frequently observed empirical features, i.e., to replicate or grow “stylized facts.” At this stage, the efforts are made to fine-tune the ABE model by matching the statistical properties of the real data with those of the artificial data to a qualitative precision. For example,

\(^{1}\)In fact, this trend is generally shared in other social sciences to which agent-based approach is applied (Janssen and Ostrom, 2006).
if the real data exhibits the feature of volatility clustering, can a specific ABE model with a proper design generate the data sharing the same feature? Further distinction among various designs which may also generate the feature is not further pursued in this stage, but is addressed in the second stage.

The concept of “optimizing” ABE models with real data characterizes the development of the next stage, which is entitled with “building ABE with econometrics.” In this stage, econometrics is used directly or indirectly, top-down or bottom-up, to estimate or calibrate ABE models. The attempt is to make ABE models can replicate the stylized facts, or even forecast the future, to a degree of quantitative precision.

The last part of the paper presents the above link in a reverse direction, i.e., looking at the influence of ABE to econometrics. In this third stage, entitled with “emerging econometrics with ABE,” econometrics is still applied to the artificial data generated by ABE; however, instead of replicating the macroscopic structure, we examine whether macroscopic structure defined by the econometric results from the artificial data can be, in a sense, consistent with the micro-structure. This bring us to the elusive quest of a representative agent and the associated economic conditions for consistency in aggregation, an issue well discussed in both economic theory and econometrics (Kirman, 1992; Hartely, 1997; Casella, Thoron, and Trannoy, 2007).

Our survey mainly focuses on the concepts and the associated key questions appearing in each stage. For the first-stage development, the question to address is, given a set of stylized facts, what are the necessary elements to make an ABE model be able to replicate those stylized features. By and large, we inquire how much we can attribute the causes of the stylized facts to heterogeneity, bounded rationality (learning) and social network (interaction), the three pillars of ABE. The question naturally leads us to categorize ABE models by their intensities on each of the three key elements, which is to be distinguished from the usual but less informative dichotomy, namely, the analytical ABE vs. the computational ABE.

The same style of analysis is carried over to the addressing of the second-stage development. At this stage, we ask what makes an ABE model econometrically tractable. Alternatively put, what are the necessary restrictions or assumptions needed to be imposed before an ABE model can be estimated? However, we will soon realize that the answer would not be independent of the estimation method involved. This leads us to distinguish three main estimation methods: the direct one, the indirect one, and the bottom-up one. As a result, ABE models can also be categorized by the appropriate estimation method which makes them econometrically tractable.

Questions addressed in the third stage are very different from the first two. It is not about the empirical relevance or empirical validation of the built ABE models, but using the ABE models as a tool to address the aggregation problem or the analogy principle, which has been extensively discussed in the literature (Blinder, 1983; Barker and Pesaran, 1990; Forni and Lippi, 1997; Gallegati, Palestrini, Delli Gatti, Scalas, 2006). In light of the Debreu-Mantel-Sonnenschein theorem, there is no ground to expect macro behavior to be in any way similar or analogous to the behavior of individual agents. ABE models can help us see how dissimilar the two can have, if the aggregation is made from the ABE models.

With the description above, the rest of the chapter is organized as follows. The three-stage development of literature are given in Section 2 (Presenting ABE with Econometrics), Section 3 (Building ABE with Econometrics), and Section 4 (Emerging Econometrics).
with ABE). Concluding remarks are given in Section 5.
References


