

12-2016

## Review of Agent-Based Computational Economics: How the Idea Originated and Where It Is Going

Leigh Tesfatsion

*Iowa State University*, [tesfatsi@iastate.edu](mailto:tesfatsi@iastate.edu)

Follow this and additional works at: [https://lib.dr.iastate.edu/econ\\_las\\_pubs](https://lib.dr.iastate.edu/econ_las_pubs)



Part of the [Economics Commons](#), and the [Software Engineering Commons](#)

The complete bibliographic information for this item can be found at [https://lib.dr.iastate.edu/econ\\_las\\_pubs/678](https://lib.dr.iastate.edu/econ_las_pubs/678). For information on how to cite this item, please visit <http://lib.dr.iastate.edu/howtocite.html>.

---

This Book Review is brought to you for free and open access by the Economics at Iowa State University Digital Repository. It has been accepted for inclusion in Economics Publications by an authorized administrator of Iowa State University Digital Repository. For more information, please contact [digirep@iastate.edu](mailto:digirep@iastate.edu).

---

## Review of Agent-Based Computational Economics: How the Idea Originated and Where It Is Going

### Abstract

Agent-based computational economics (ACE) is the computational modeling of economic processes (including whole economies) as openended dynamic systems of interacting agents (Tesfatsion 2016a). In this book, author Shu-Heng Chen—an important pioneering contributor to the development of ACE—undertakes a detailed exposition of the ACE modeling approach that focuses on two fundamental questions. First, what is ACE? Second, to what extent is ACE useful, or even necessary, for understanding economic processes?

### Disciplines

Economics | Software Engineering

### Comments

This is a review of an article published as Review of Agent-Based Computational Economics: How the Idea Originated and Where It Is Going, by Shu-Heng Chen, Routledge: New York, in: *Journal of Economic Literature* 54(4), 2016, 1394-1395. doi: [10.1257/jel.54.4.1390](https://doi.org/10.1257/jel.54.4.1390). Posted with permission.

this point. The issue, however, is really that silence on such matters is not part of game theory per se. It is a choice, and the question is: how is that choice made and are we happy with it? My suspicion is that the choice is not consciously made most of the time; and it is mainly overlooked because economics has become divorced (with the aid of some cod-methodologies) from politics. Whatever the reason, Amadae is right to suggest that teaching game theory is not neutral in its effects.

Amadae has some suggestions about what should be done. In the last chapter on Pax Americana, she offers, among others, Abraham Maslow on the hierarchy of human needs and the importance of the participatory dimension of democracy. She also returns to a frequent theme that she is right to remind us about. Economists, following Lionel Robbins's famous encapsulation, do too often think of economic/social interactions as only involving choices over how to use scarce resources. As a result, individual choices use up resources in different degrees. But we know that many social resources like friendship are not like that. When we engage social capital of this kind in what we do, it usually does not get depleted. It grows.

SHAUN HARGREAVES HEAP  
*King's College London*

*Agent-Based Computational Economics: How the Idea Originated and Where It Is Going.* By Shu-Heng Chen. Routledge Advances in Experimental and Computable Economics, vol. 8. London and New York: Taylor and Francis, Routledge, 2016. Pp. xx, 507. ISBN 978-0-415-61488-7, cloth; 978-1-315-73442-2, e-book.  
*JEL 2016-1145*

*Agent-based computational economics* (ACE) is the computational modeling of economic processes (including whole economies) as open-ended dynamic systems of interacting agents (Tsfatsion 2016a). In this book, author Shu-Heng Chen—an important pioneering contributor to the development of ACE—undertakes a detailed exposition of the ACE modeling approach that focuses on two fundamental questions. First, what is ACE? Second, to what extent is ACE useful, or even necessary, for understanding economic processes?

Previous introductory ACE writings (Tsfatsion 2016b) have typically been tailored for general readers interested in obtaining a basic understanding of the methodology. In contrast, Chen's book is a meticulous scholarly study that should be of particular interest to economists with a good analytical background, a broad acquaintance with economic research, a strong interest in empirically grounded economic modeling, and a willingness to consider alternative viewpoints with an open mind.

Part 1 of the book begins (chapter 1) with a broad outline of intended topic coverage. Chapter 2 reviews the historical development of a “new discipline across the social sciences,” referred to as *computational social science* (CSS), and discusses the role of agent-based modeling within CSS. Part 2 (chapters 3–6) attributes the origins of ACE to four distinct sources: market analysis; cellular automata research; game and tournament studies; and experimental economics. The discussion of each source is accompanied by examples, thought-provoking discussion, and references for further study.

The design of decision-making ACE agents is addressed in part 3, with a stress on empirical grounding. Chapter 7 surveys research exploring how data obtained from human-subject experiments might be used to calibrate the decision rules of computational agents. Seminal “zero-intelligence agent” research exploring the relative impact of intelligence versus institutional structure in double auction experiments is reviewed in chapters 8–9.

Part 4 considers the ability of ACE agents with learning capabilities to adapt their behaviors to changing environments. Chapter 10 reviews work incorporating reinforcement learning algorithms. Chapter 11 considers “fuzzy” learning algorithms based on closeness (similarity) metrics rather than on probability metrics. Artificial neural network (ANN) learning algorithms are reviewed in chapter 12; ANN learning with multiple hidden layers is an important form of “deep learning” currently being explored as a way to extract information from Big Data. Evolutionary learning algorithms (in particular genetic programming) permitting continual exploration and assessment of new ideas are discussed in chapter 13.

Agent-based financial-market research is highlighted in part 5. The connections between ACE and evolutionary economics are clarified in chapters 14–15, using illustrative financial market studies. Chapter 16 considers ACE financial research in relation to financial “stylized facts” in order to clarify and discuss empirical validation issues.

Part 6 (chapters 17–21) returns to the connection between ACE and experimental economics, discussing and illustrating the ability of ACE agents to display intelligence, cognitive ability, and personality. Part 7 (chapter 22) and part 8 (chapter 23) provide abbreviated discussions of two fundamentally important issues for ACE modelers: the formation and evolution of agent interaction networks; and the modeling of innovation, with a stress on the “modularity” modeling approach pioneered by Chen and his collaborators. An epilogue (chapter 24) concludes.

The only major criticism I have of Chen’s book is that the key question he raises in part 1, “what is ACE,” is not answered in a concise, straightforward manner. Various real-world features that ACE models can incorporate are identified. However, while interesting and helpful, this does not permit a clear understanding of the principles underlying ACE modeling that distinguish it from other modeling methodologies.

Below are seven basic ACE modeling principles (Tesfatsion 2016a) that reflect the fundamental goal of many agent-based modelers: namely, to study real-world dynamic systems as historical processes unfolding through time, driven solely by their own internal dynamics.

- *Agent Definition*: An *agent* is a software entity within a computationally constructed world capable of acting over time on the basis of its own *state*, i.e., its own internal data, attributes, and methods.
- *Agent Scope*: Agents can represent individuals, social groupings, institutions, biological entities, and/or physical entities.
- *Agent Local Constructivity*: The decision-making process undertaken by a decision-making agent at any given time must be entirely expressible as a function of the agent’s state at that time.

- *Agent Autonomy*: Coordination of agent interactions over time cannot be externally imposed by means of free-floating cross-sectional or intertemporal restrictions, that is, by means of modeler-imposed restrictions that are not embodied within agent states.
- *System Constructivity*: The state of the modeled system at any given time consists of the collection of agent states at that time.
- *System Historicity*: Given initial agent states, all subsequent outcomes in the modeled system are determined solely by agent interactions.
- *Modeler as Culture-Dish Experimenter*: The role of the modeler is limited to the setting of initial agent states and to the non-perturbational observation of model outcomes.

Together, these principles embody the idea that ACE models are computational laboratories permitting users to explore how changes in initial conditions affect outcomes in modeled economic systems over time. This exploration process is analogous to biological experimentation with cultures in petri dishes. A user sets initial conditions for the modeled system in accordance with some purpose at hand. The “cover” is then closed, and the modeled system thereafter runs forward through time as a virtual world whose dynamics are entirely determined by the interactions of its constituent agents.

A careful exposition of these ACE modeling principles in part 1 of his book would have helped Chen to buttress his claim that ACE modeling provides a useful *complement* to currently prevalent economic modeling approaches. The latter approaches typically involve the external imposition of equilibrium conditions as *a priori* restrictions on agent interactions, which hinders the study of real-world economic processes as open-ended dynamic processes displaying continual endogenous change.

#### REFERENCES

- Tesfatsion, Leigh. 2016a. “Agent-Based Computational Economics Website: Homepage.” <http://www2.econ.iastate.edu/tesfatsi/ace.htm>.
- Tesfatsion, Leigh. 2016b. “Agent-Based Computational Economics: Introductory Materials.” <http://www2.econ.iastate.edu/tesfatsi/aintro.htm>.

LEIGH TEFATSION  
Iowa State University