Empirical Validation Issues for Agent-Based Computational Economics

Leigh Tesfatsion

Professor Emerita of Economics
Courtesy Research Professor of ECpE
Iowa State University
Ames, Iowa 50011-1070
https://www2.econ.iastate.edu/tesfatsi/
tesfatsi@iastate.edu
Outline

➢ Redux: Three strands of ACE Research
➢ For which strand(s) is empirical validation appropriate?
➢ Does one approach work for all?
➢ Summary of arguments and open issues
➢ Other important issues arising for the empirical validation of ACE models

Empirical Validation Resource Site: https://www2.econ.iastate.edu/tesfatsi/EmpValid.htm
Three Strands of ACE Research

- Qualitative Insight/Theory Generation
  (e.g. coordination in decentralized markets, ...)

- Empirical Understanding
  (e.g. possible reasons for empirical regularities, ...)

- Normative Understanding
  (e.g. institutional design, ...)
ACE and Qualitative Analysis

Illustrative Issue: What are the performance capabilities of decentralized markets? *(Adam Smith, F. Hayek, ...)*

ACE Approach:

- *Construct an agent-based world* that qualitatively captures key aspects of decentralized market economies (firms, consumers, limited information, ...)

- *Introduce traders with endowments, needs, wants,*.... Let the world evolve. Observe the degree of coordination that results.

*Examples:* Decentralized exchange economies without a Walrasian Auctioneer, *Zero-Intelligence (ZI)* agent double-auction markets,...
ACE and Empirical Regularities

Key Issue: Is there a causal explanation for persistently observed empirical regularities?

ACE Approach:

- Construct an agent-based world capturing salient aspects of the empirical situation.
- Investigate whether the empirical regularities can be reliably generated as outcomes in this world.

Example: ACE financial market research seeking explanation of several “stylized facts” in combination

https://www2.econ.iastate.edu/tesfatsi/afinance.htm
ACE and Institutional Design

Key Issue: Does an institutional design ensure **efficient, fair, and orderly social outcomes over time** despite possible attempts by participants to “game” the design for their own personal advantage?

ACE Approach:

- **Construct an agent-based world** capturing salient aspects of the institutional design.

- **Introduce agents with endowments, needs, goals, beliefs, etc.** Let the world evolve. Observe and evaluate resulting social outcomes.

Examples: Design of matching mechanisms, unemployment benefit programs, electricity markets
Key Distinctions in Approaches to the Empirical Validation of ACE Models

https://www2.econ.iastate.edu/tesfatsi/EmpValid.htm

- **Input validation**: Are the exogenous inputs for the model empirically meaningful and appropriate for the purpose at hand (e.g., initially specified state conditions, functional forms, random shock realizations, data-based parameter estimates, and/or parameter values imported from other studies)?

- **Process Validation**: How well do the physical, biological, institutional, and social processes represented within the model reflect real-world aspects important for the purpose at hand? Are these modeled processes consistent with essential scaffolding constraints (e.g., physical laws, stock-flow relations, and accounting identities)?

- **Descriptive output validation**: How well are model-generated outputs able to capture the salient features of the sample data used for model identification? (*in-sample fitting*)

- **Predictive output validation**: How well are model-generated outputs able to forecast distributions, or distribution moments, for sample data withheld from model identification or for new data subsequently acquired? (*out-of-sample forecasting*)
Input Validation via Iterative Participatory Modeling (IPM)

◆ Stakeholders and researchers from multiple disciplines jointly engage in a continual learning process that consists of repeated looping through four stages of analysis:

- Field work and data collection;
- Scenario discussion/role-playing games;
- Agent-based model development;
- Intensive computational experiments.

Note: See Barreteau et al. (JASSS, 6-1,2003)
Other Issues Related to the Empirical Validation of ACE Models

- How can researchers provide summary reports of model findings to other researchers and to intended model users (e.g. policy makers) in a manner that is accurate, compelling, and clear?

For Example: How to achieve both clarity and accuracy?

It might be necessary to report distributions for outcomes rather than simple point predictions for outcomes.

And/or it might be necessary to report how network interaction patterns vary systematically in response to policy changes.
Other Issues...Continued

- How can researchers ensure the *robustness* of their model findings?

  **For Example: How to avoid spurious effects?** How to ensure that model findings arise from the modeled attributes of a real-world system under study rather than from spurious aspects of the software/hardware platform used to implement this model?

- How can researchers ensure the *accumulation over time* of important empirically-supported findings?