Empirical Validation Issues for Agent-Based Computational Economics

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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?