Multiple equilibria in economic systems and stochastic dynamics

or: prices as conventions in agent-based models of growing economies

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Satellite meeting: Social Complexity of Informal Value Exchange
Outline

Background

SCIVE

Ideas in progress

References
Economics and Climate Change

- Standard: Theory of general equilibrium
- supply = demand; several equilibria possible; static view
- models compute a unique equilibrium
Economics and Climate Change

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- Climate policy context: intertemporal optimization models
- one welfare function optimized, value of a sequence of situations society finds itself in is summarized in a global utility function
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▶ deviation from optimal path has a cost
▶ climate problem = problem of distributing mitigation costs
▶ e.g. COP 15, Copenhagen 2009, deadlock situation
Alternative approach

- switch focus: consider emission reduction goals as focal point
- emissions as an externality, internalization yields benefits

Foley [2007]: The economic fundamentals of global warming
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- leaving the one equilibrium or BAU path, theoretical issues arise
- theory of general equilibrium does not say anything about choice of equilibria or out-of-equilibrium behaviour of the economy
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- theory of general equilibrium does not say anything about choice of equilibria or out-of-equilibrium behaviour of the economy
- agent-based economic models
  aims: investigate system behaviour and generate more complete theory
Economic ABM

- Aspects of the economy, such as financial markets
- Economy as a whole, e.g. EURACE model

Gintis [2007]: The dynamics of general equilibrium

Agent-based dynamics to replace Walrasian auctioneer; agents have private prices, limited information about other agents, imitate and mutate strategies

Gintis observes convergence to equilibrium prices in simulations

Theory? Simple mathematical description of what happens in the model?

Bilancini and Petri [2008] caution: capital used in production is 'land', equilibrium notion becomes irrelevant when using capital
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- Lagom models based on Gintis’ model, add heterogeneous capital goods, economic growth
- sector structure, several regions, labour productivity grows with investment, financial system determines interest rate etc.

"proof of concept": large-scale agent-based macro-model with capital accumulation

Simulations suggest that agent-based dynamics can drive the economic system to a stochastically stable state with equilibrium features [Mandel et al., 2010]

Again, theory seems out of reach right now
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Social Complexity of Informal Value Exchange

- social phenomena that involve value-exchange
- social processes and mechanisms other than those usually considered by economists
  social norms, reputation, trust, group membership, expectations
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- work in progress in the spirit of the Dahlem Conference “New Approaches to Economics after the Financial Crisis” (Berlin August, 2010)

- central idea: insights from the social sciences, a variety of models, and judgement needed for “better” economics, in particular concerning policy making
Value

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  make more abstract ideas comparable, reduce to 1 dimension
- aggregate indicators of value considered, GDP etc.
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- Reduction to 1 dimension desirable
Stochastic dynamics

- investigate economic dynamics using simple stochastic models

\[ dX_t = f(X_t) \, dt + \sqrt{\varepsilon} \, dB_t \]

random perturbations allow transitions between different meta-stable states

dynamics: long stays around one meta-stable state and quick switches to another

conventions, e.g., Young [1993]: repeated \( n \)-person game, finitely many strategies, best reply and mutation

Mandel and Botta [2009]: exchange economy

Ormerod et al. [2009]: cluster analysis of US, British and German data (1871-2009) identify different regimes in inflation/unemployment space major shifts between regimes and small fluctuations within
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- “next-best try” towards some understanding, replacing welfare function optimization
- stochastic dynamic model as a simpler pre-step towards agent-based model that could represent the observed dynamics
- get an idea of which details might be the important ones from the micro level that influence the macro level
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- Wyart and Bouchaud [2007]: Self-referential behaviour, overreaction and conventions in financial markets
- Chartist agents use (alleged) correlation between some information (index) and stock price to predict stock price; their behaviour impacts the price
- Noise arises from other agents trading randomly
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- Impact function: price change as function of what agents do; estimation procedure used by chartist agents combined into an Itô-Langevin equation, with double-well potential function
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- Impact function: price change as function of what agents do estimation procedure used by chartist agents combined into an Itô-Langevin equation, with double-well potential function
- Stable conventions appear for correlations of price change and index change (positive/negative) quick switches from one to the other
Goals

- climate policy context: get out of deadlock situation
- identify concrete win-win options for emission reduction and labor market/economic growth (e.g. energy-efficiency improvements to buildings)
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- not completely scrapping general equilibrium theory: transitions between different equilibria
- potential function model
- very basic Lagom model, i.e. agent-based but tractable
References

http://european-climate-forum.net

Thank You!