

# Theory development through agent-based modelling

## Lessons from economics

Dr. Claudius Gräbner<sup>1,2</sup>

<sup>1</sup>Johannes Kepler University Linz  
Institute for the Comprehensive Analysis of the Economy

<sup>2</sup>ZOE. Institute for Future-Fit Economies

🐦 ClaudiusGrabner

[www.claudius-graebner.com](http://www.claudius-graebner.com)

June 14 2018

# Outline

## Purpose of the presentation

- What can we learn from (mainstream) economics when it comes to theory construction?
  - Positive practices to follow, negative practices to avoid

## Outline:

- 1 Basic terminology
- 2 The situation in economics
- 3 The lessons from economics
- 4 My conclusions for theory development using ABM

## 1 Basic terminology

2 The situation in economics

3 The lessons from economics

4 My conclusions for theory development using ABM

# Terminology I

## Concept

Mental representations (or 'ideas') and basic building blocks of thinking, e.g. 'shirt', 'love', 'GDP', 'money', ...

- ▶ Concept  $\neq$  symbolic representation of a concept
- ▶ Concepts as such located on the *meaning structure*
- ▶ For transfer among individuals, a symbolic representation needed (*surface structure*)
- ▶ Communication of concepts requires shared meanings as well as shared symbolic framework

# Terminology II

## Theory

A set of concepts, a set of propositions about relations among these concepts, and logical justifications of these propositions (including a clarification of scope).

- ▶ Theories also have a meaning and a surface structure
- ▶ Theory development is a social endeavor: requires communication
- ▶ Both *mental* and *surface* level must align

# Terminology III

## Model

Epistemic artifacts, usually used to represent a target system.

- ▶ Ontology of models highly disputed area of philosophy
- ▶ Best understood *functionally*
  - ▶ Representations of targets, used to facilitate cognitive processes such as understanding
- ▶ *How* models represents requires explicit epistemological framework (e.g. the DEKI account, see Frigg and Nguyen, 2016; Gräbner, 2018a)
- ▶ ABM are a particular **type** of model with particular *representational capacities* (Weisberg, 2013)

## Main question

What can we learn from (mainstream) economics when it comes to theory construction?

- 1 Basic terminology
- 2 **The situation in (mainstream) economics**
- 3 The lessons from (mainstream) economics
- 4 My conclusions for theory development using ABM

# On the situation in economics I

- Economics is divided, with a strong 'mainstream' and smaller 'heterodoxies'
- In the 'mainstream', ABM increasingly present but still a rather peripheral method
  - ▶ Situation a bit different outside the 'mainstream'

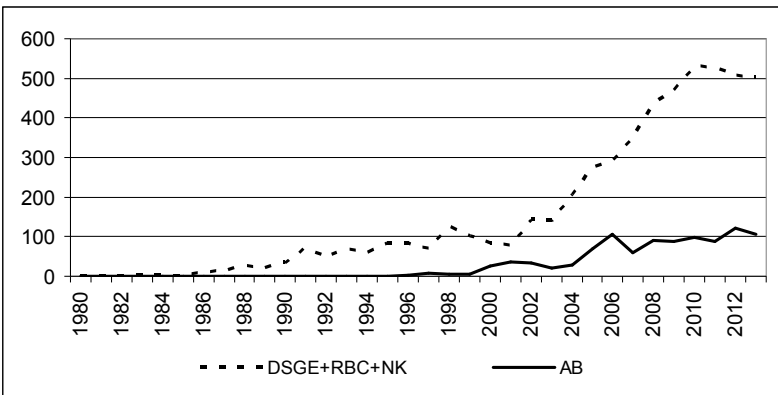


Figure: Source: Richiardi (2015), data from Econlit (2015).



## On the situation in economics II

‘Economics’ mainly defined ‘in terms of the economic method’

**Picture  
removed**

“economics is a **way of doing social science, using particular tools**. In this interpretation the discipline is associated with an apparatus of formal modeling and statistical analysis rather than particular hypotheses or theories about the economy.” (Rodrik, 2015, p. 7)

“There is a standing presumption in economics that, if an empirical statement is **deduced from standard assumptions** such as expected utility maximization and market-clearing, then that statement is reliable ” (Sugden, 2000, pp. 16-17)

**Picture  
removed**

- The 'economic model' is characterized by...
  - Utility maximizing individuals
  - Systemic equilibrium
- Strong preference for analytical models over simulations (e.g. Lehtinen and Kuorikoski, 2007)
- This has important implications for communication within economics

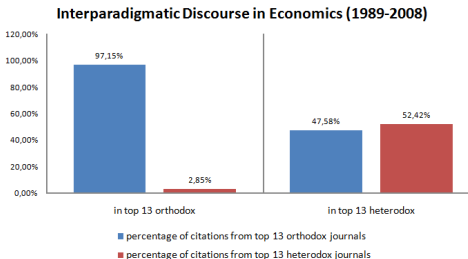


Figure: Source: Aistleitner, Kapeller, and Steinerberger (2017), data from *Thomson Scientific*.

- Citation patterns show strong segregation in 'research programs'
  - Intense communication within mainstream, but absent communication with non-mainstream
- Hypothesis: Theoretical 'lock-in' in economics (e.g. Gräbner, 2018b)

- 1 Basic terminology
- 2 The situation in (mainstream) economics
- 3 **The lessons from (mainstream) economics**
- 4 My conclusions for theory development using ABM

# Lessons from (mainstream) economics

## Positive aspects

- Almost universally shared mapping between *meaning* and *surface* structure of theories
- Successful application of the TAPAS practice
- Close integration of theoretical and empirical work
  - ▶ Yet no fallibilism a la Popper

## Negative aspects

- Alternative methods & inconsistent theories not considered
  - ▶ Theoretical 'lock-in' with 'blind spots'
- Lack of self-reflection and excessive reliance on 'standard' approaches
- Extreme concentration on 'Top five' journals and their theoretical approaches

- 
- ▶ Communication on the applied level works well
  - ▶ Theory development of dominant approaches works - superficially - very efficiently
  - ▶ There is an alarming lack of diversity
  - ▶ Many parts of the 'theory space' are neglected

# Best practice outside the 'mainstream'

Already works *somehow well* in some non-mainstream areas of economics

Journal of Economic Dynamics & Control 69 (2016) 375–408



ELSEVIER

Contents lists available at [ScienceDirect](#)

## Journal of Economic Dynamics & Control

journal homepage: [www.elsevier.com/locate/jedc](http://www.elsevier.com/locate/jedc)



## Agent based-stock flow consistent macroeconomics: Towards a benchmark model



Alessandro Caiani<sup>a,\*</sup>, Antoine Godin<sup>b</sup>, Eugenio Caverzasi<sup>a</sup>, Mauro Gallegati<sup>a</sup>,  
Stephen Kinsella<sup>c</sup>, Joseph E. Stiglitz<sup>d</sup>

- ▶ Follow very much Volker Grimm's practice
- ▶ Theoretical core provided by an evolutionary approach to economics

# Three lessons

## First lesson

- Aligning the meaning and surface structures of researchers working on the same theories is essential
  - ▶ Shared standard, common meta-theoretical convictions,
  - ▶ Using both simple & complex formal models, and aligning them with each other, helps

## Second lesson

- A certain theoretical and methodological diversity is important (for general assessment see Page, 2007)
  - ▶ Otherwise, theoretical lock-ins and blind spots will occur
  - ▶ Diversity must be actively protected against tendencies of monopolization
  - ▶ ABM alone cannot contribute to good theory development
    - ▶ Triangulation with other methods mandatory

## Third lesson

- There is an inherent trade off between ...
  - ... successful communication and well aligned meaning and surface structures and...
  - ... a sane openness to theoretical and methodological innovations
- ▶ Good theory development requires an answer to this tension

- 1 Basic terminology
- 2 The situation in (mainstream) economics
- 3 The lessons from (mainstream) economics
- 4 **My conclusions for theory development using ABM**

# Short-run conclusions

- There are both short-run and medium-run conclusions that I draw from my experience in economics

## Short-run conclusions

- Other social theories must not be neglected: much valuable knowledge has been already accumulated
  - ▶ This applies to both 'mainstream' as well as 'heterodox' approaches
  - ▶ Citation statistics often not good to identify 'useful' theories
- Transform and extend existing theories & models in an agent-based framework is fruitful and important for ABM in several respects (see e.g. Gräbner et al., 2017)
  - ▶ Allows exploitation of existing theory
  - ▶ Allows aligning ABM to other methods and approaches
  - ▶ Might also increase acceptance of ABM



## Medium-run conclusions

- ▶ Measures must be taken to level successful communication with theoretical diversity

### To ensure communication

- Embed models into explicit epistemological frameworks (Gräbner, 2018a, JASSS)
  - ▶ Consider PoS, e.g. debate on multiple-model hypothesis (Aydinonat, 2018)
  - ▶ Debates on pluralism in economics (e.g. Gräbner, 2018b)

### To ensure diversity

- Sane mixture between theoretical and empirical ABM
  - ▶ Theoretical ABM extend the computational menu of “causal mechanism schemes” (Ylikoski and Aydinonat, 2014)
  - ▶ Use Empirical ABM to synthesize these causal mechanism schemes and explore their empirical validity
- Ensure the representation of diverse “schools of thought” and alternative methodologies in publication outlays
- Organize interdisciplinary symposia where the contributions of these schools and methods are related to each other to ensure sane communication among them
  - ▶ Examples include thematic special issues, e.g. on ‘Different perspectives on the sources for inequality’

# Summary

- Economics can teach us a lot - in the positive as well as in the negative
- Good theory development requires good communication among researchers...
- ...as well as a well-aligned diversity of theoretical and methods
- My more concrete suggestions have been:
  - 1 Take existing theories, *express and extend* them via ABM
  - 2 Embed this work into explicit meta-theoretical frameworks
  - 3 Align & appreciate stylized, theoretical, complex, and empirical ABM
  - 4 Actively embrace interdisciplinary and pluralist discourse

# References I

- Matthias Aistleitner, Jakob Kapeller, and Stefan Steinerberger. "Citation Patterns in Economics and Beyond: Assessing the Peculiarities of Economics from Two Scientometric Perspectives". In: **ICAE Working Paper** 60 (2017).
- N Emrah Aydinonat. "The diversity of models as a means to better explanations in economics". In: **Journal of Economic Methodology** (2018).
- Roman Frigg and James Nguyen. "The Fiction View of Models Reloaded". In: **The Monist** 99.3 (Oct. 2016), pp. 225–242.
- Claudius Gräbner et al. "Getting the Best of Both Worlds? Developing Complementary Equation-Based and Agent-Based Models". In: **Computational Economics** (2017).
- Claudius Gräbner. "How to Relate Models to Reality? An Epistemological Framework for the Validation and Verification of Computational Models". In: **Journal of Artificial Societies and Simulation** 21.3 (2018).
- Claudius Gräbner. "The Complexity of Economies and Pluralism in Economics". In: **Journal of Contextual Economics** (2018).
- Aki Lehtinen and Jaakko Kuorikoski. "Computing the Perfect Model: Why Do Economists Shun Simulation?" In: **Philosophy of Science** 74.3 (July 2007), pp. 304–329.
- Scott E Page. **The Difference**. How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies. Princeton, IL: Princeton University Press, 2007.
- Matteo Richiardi. "The future of agent-based modelling". In: **Economics Papers Nuffield College Oxford** (2015).
- Dani Rodrik. **Economics Rules**. Oxford, UK: Oxford University Press, 2015.
- Robert Sugden. "Credible worlds: the status of theoretical models in economics". In: **Journal of Economic Methodology** 7.1 (2000), pp. 1–31.
- Michael Weisberg. **Simulation and Similarity**. New York, NY: Oxford University Press, 2013.
- Petri Ylikoski and N Emrah Aydinonat. "Understanding with theoretical models". In: **Journal of Economic Methodology** 21.1 (2014), pp. 19–36.