Modelling 101

By Simon Board

Models in Economics

▸ Economists think and communicate via mathematical models

   ▸ Assumptions are explicit

   ▸ Clear derivation of conclusions

   ▸ Can bring models to data

▸ Problems

   ▸ We don't see what we can't formalize

   ▸ Searching for keys under the lamp post

   ▸ Assumptions often unrealistic

"I have no sympathy for those people who criticize the unrealistic simplifications of model-builders, and imagine that they achieve greater sophistication by avoiding stating their assumption clearly"

Paul Krugman

Models in Economics

"All models are wrong, some are useful"

George Box

"For me, the biggest thrill in theory is the moment when your model tells you something that should have been obvious all along, something that you can immediately relate to what you know about the world, and yet which you didn't really appreciate."

Paul Krugman

Economists as Story Tellers

"The author of a tale seeks to impart a lesson about life to his readers. He does this by creating a story that hovers between fantasy and reality. It is possible to dismiss any tale on the grounds that it is unrealistic, or that it is too simplistic. […] We will take the tale's message with us when we return from the world of fantasy to the real world, and apply it judiciously when we encounter situations similar to those portrayed in the tale."

<div align="right">Ariel Rubinstein</div>

Economists as Engineers

"The role of theory, in any policy application, is to show how people behave in various circumstances, and to identify the tradeoffs involved in altering those circumstances. What the theorists found to be the most useful in designing the auction and advising the bidders was not complicated models that try to capture a lot of reality at the cost of relying on special functional forms. Such theorizing fails to develop intuition, as it confounds the effects of the functional forms with the essential elements of the model. A focused model that isolates a particular effect and assumes few or no special functional forms is more helpful in building understanding."

McAfee and McMillan

Economists as Scientists

"I have spent my entire professional life as an economist attempting to respect the high standards and the rigorous protocols of hard science in my research […] I seek non-tautological, rigorously justified models derived from theory and verified on rigorously justified data. Measurement and theory together are the hallmarks of good science. No serious scientist pretends to "let the data speak for themselves," nor would they impose models on data that wouldn't support them."

James Heckman

Value of Model (Theory)

1. Paper asks a new question
   - E.g. Becker's model of marriage market
2. Paper posits a new model
   - E.g. Akerlof's lemons.
3. Model speaks to application
   - E.g. School choice and matching.
4. Model identifies a new economic force
   - E.g. Spence's model of signaling.
5. Model develops new empirical predictions
   - E.g. Gravity model of trade.
6. Technical contribution, solving a long-standing problem.

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Value of Model (Empirical)

1. ## Provide a logical framework to organize thoughts

   ▸ Illustrate a particular mechanism that may generate data

2. ## Generate testable predictions

   ▸ Typically qualitative, e.g. "wages decrease with monitoring"

3. ## Provide interpretation of data

   ▸ E.g. The drift of consumption reflects the agent's discount rate

4. ## Estimate structural model

   ▸ Use model to as skeleton to discipline data

5. ## Produce counterfactuals

   ▸ Not extrapolation, but analysis of hypothetical policy changes

How to Write Models

Where do you Find Ideas?

▸ Literature

    ▸ Existing models are lacking

▸ Puzzle

    ▸ There is an unexplained phenomenon

▸ Policy

    ▸ Firms or Government need to choose plan of action

▸ Data

    ▸ We wish to understand DGP

▸ "The tricky part is to get a good idea. The way you do this is to come up with lots and lots of ideas and throw out all the ones that aren't good."   Hal Varian

Building Models

▶ **Be conventional when you can**

- ▶ Occam's razor: The simplest explanation is preferable
- ▶ Econ version: The most conventional explanation is preferable
- ▶ Readers want to understand which assumptions drive results

▶ **Be daring where you must**

- ▶ If conventional models don't work, change them.
- ▶ Krugman: "We are always making silly assumptions; it's just that some of them have been made so often that they come to seem natural. […] The injunction to dare to be silly is not a license to be undisciplined."

▶ **What is "silly" in one area is "convention" in another**

- ▶ E.g. monopolistic competition in IO vs trade
- ▶ This does make "interdisciplinary" work tricky

The Two Broad Approaches

▶ Artist approach

- ▶ You want model to understand a set of facts
- ▶ E.g. "Higher wages can induce people work harder"
- ▶ Adjust the theory to explain the facts

▶ Scientist approach

- ▶ You want to investigate a canonical model
- ▶ E.g. "Firms and workers cooperate play repeated game"
- ▶ Don't have a strong view on results

▶ Few economists live solely in one camp

The Elements of the Model

▶ **All economics models have the same ingredients**

   ▶ Agents

   ▶ Actions

   ▶ Information

   ▶ Payoffs

   ▶ Solution concept

▶ **This basic structure suggests a plan of attack:**

   ▶ Who are the people making the choices?

   ▶ What are the constraints they face?

   ▶ How do they interact?

   ▶ What adjusts if the choices aren't mutually consistent?

KISS ("Keep It Simple, Stupid")

▸ Start with examples

  ▸ Build zoo of examples

  ▸ First examples should be trivial

  ▸ Understand what properties they share

▸ You are ready to build model

  ▸ Express your ideas in the simplest possible model

  ▸ Isolate the essence of your argument

  ▸ Easy to communicate to others

"Everything should be as simple as possible… but no simpler"

Albert Einstein

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Generalizing Your Model

▸ Aim of generalization

  ▸ May help you see structure (e.g. no functional forms)

  ▸ Show result is robust

  ▸ Incorporate important institutional detail

  ▸ Wish to fit institutional data

▸ The degree of generality depends on the point of the model

  ▸ Applied theory vs Structural model

▸ Questions

  ▸ What is the ratio of assumptions to results?

  ▸ Are some parameters included "for realism"?

  ▸ Are the parameters identified?

Working on Your Model

‣ Build a workbook consisting of

  ‣ Motivation

  ‣ Questions

  ‣ Conjectures

  ‣ Examples

  ‣ Results

‣ The project will evolve, e.g. by reframing the question

  ‣ A new question can change how you think about the topic

  ‣ A complex model can be simplified by reframing the question

Understand your Model

- If there are multiple modelling choices, try them all
  - Which is most tractable?
  - Which can make insights most transparent?
  - Which is more general?
- What are key sensitivities to your result?
  - Which assumptions are important for the result?
  - Which are for tractability?
- What is the intuition for the result?
  - Can you express the result in English?
  - Can you draw the main forces graphically?
  - Can you explain it to a non-expert?

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Communicating Models

▶ We use models to communicate with other economists

  ▶ Model should be fully specified

  ▶ Analysis should clear

  ▶ Results should be precise

  ▶ Intuition should be honed

  ▶ Contribution to the literature should be explained

▶ This is a topic for another day. Fortunately, I wrote up some notes to help:
http://www.econ.ucla.edu/sboard/teaching/WritingEconomicTheory.pdf

Common Mistakes by Students

- Waiting for genius to strike
  - Writing theory is 5% inspiration, 95% craft
- Not writing enough
  - Modelling is a craft that one perfects with practice
- Reading too early
  - You don't want to think like everyone else
- Reading too little
  - You need to know key techniques and understand contribution
- Abandoning ideas too quickly
  - You should study model variants and ask different questions
- Abandoning ideas too slowly
  - Some projects will not pay off

Common Mistakes by Students, cont.

- Getting discouraged by negative comments
  - Advisors cannot always see what you see
- Being too stubborn
  - Advisors' views are representative of referees
- Getting lost in the details
  - Forgetting original motivation and why question is interesting
- Forgetting comments
  - Write down all ideas, whether yours or your advisors
- Not prioritizing best material
  - The reader doesn't need to see every model variant

Examples of My Projects

- **"Bidding into the Red"**, *Journal of Finance*, 2007
  - Heard story about bankrupt vendors on radio
  - Learning about auction theory at the time
  - This application gave me a new perspective on literature

- **"Reputation for Quality,"** *Econometrica*, 2013
  - Standard model of reputation had strange equilibrium
  - Tried to figure out what was going wrong in those models
  - After you build new model, innovation seems trivial

- **"Discrimination in Hiring,"** Working paper, 2023
  - Had data set that seemed to suggest source of discrimination
  - Built canonical models to generate hypotheses
  - Use model to pin down empirical specification and tests