The Theory/Model Section of a Computational Research Paper

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Good quote

"Aspiring programmers: be aware that programming is hard and unnatural. A human programming is like a dog playing a piano. If you are finding it hard, that is normal. Successful programmers look for their niche and keep plugging away at that keyboard."
(Peter Shirley, @Peter_shirley, 3/29/18)

Rubric for proposal presentations

- 5 minutes, 10 slides, 30 sec per slide
- Use PowerPoint, LaTeX/beamer, or some other PDF slide software
- LaTeX Beamer slides template available in repository
- Proposal presentation rubric

Previous proposal presentations

Blast from the past

Go through previous proposals

Blundell (2017), Structural model def and properties

"Structural models aim to identify three distinct, but related objects:"

- structural "deep" parameters
- underlying mechanisms
- policy counterfactuals

$$\boldsymbol{f}(\boldsymbol{x}, \boldsymbol{z}|\theta) = \mathbf{0}$$

Earlier Def: Structural Model

Model in which the equations derived from individual optimization or firm optimization (behavioral equations).

- Includes linear models and linear approximations
- Most often nonlinear, dynamic

Theory 1: Formal Model

A set of cause and effect mathematical relationships between variables used to explain, predict, and understand phenomena.

- Exogenous variables: inputs to the model, taken as given, from outside the model
- Endogenous variables: output of the model, dependent exog. vars.
- Has both qualitative and quantitative implications

$$\boldsymbol{f}(\boldsymbol{x}, \boldsymbol{z}|\theta) = \mathbf{0}$$

Model

Theory 2: Informal Model

Narrative qualitative descriptions of relationships between variables, sometimes backed by experimental or anecdotal evidence.

- Often competing informal models are cited to show different possible relationships among variables
- Provides interpretability of results
- Lacks quantitative implications

Data generating process (DGP)

Def: Data generating process (DGP)

- Def. 1: A complete description of the mechanism that causes some observed phenomenon with all its dependencies (too complex)
- Def. 2: A simplified model version of the process that causes some observed phenomenon with its key dependencies.
  - This DGP or model must be specified in such a way that it could be used to simulate data.
  - This is a formal model, described earlier

Reduced Form model

Def: Reduced Form Model

Models in which equations are either not derived from behavioral equations or are only implicitly a linear approximation of some other model.

- Most often static
- There can be gray area or overlap between these two definitions
- Includes machine learning
- Often (but not always) atheoretical

Theory vs. Empirical Strategy

- Theory
  - Statement of model (either formal or informal)
  - Provides interpretability of empirical results
  - Provides testable hypotheses
  - Assumes direction of causality
- Empirical strategy
  - What you do with your model and the data
  - Sometimes empirical strategy implicitly assumed to be the model
    - e.g., reduced form model with no connection to theory

Pure Theory Papers

- Pure theory papers
  - Not what we are doing in this class
  - I love pure theory
  - Theory is the laboratory, rather than data
  - Mathematical analysis can determine results
  - Computational simulation can determine results

Model Section

- Equations plus intuition
- Give the story of what your model is doing and what are the main interactions. This spells it out for the reader
- What are the main pieces of your model?
- Why did you choose to model some parts of the real world and neglect others?
    - This has to do with your research question
- How do the parts of your model match up with the data?

Model Section

- If much of model is standard, you can summarize
  - I am big advocate of technical appendices
  - List all your equations and derivations somewhere
  - You might find an error in the previous work
  - You might find an assumption that could be improved by a different assumption
- Some models require you to spend a lot of time on solution method

Types of models

- Experiment
- Survey
- Reduced form
- Structural, formal theory
- Machine learning
- Natural language processing
- Network analysis

Keller, et al (JET, 2019)

- Keller, Godfrey, Vladimír Novák, and Tim Willems, "A note on optimal experimentation under risk aversion," *Journal of Economic Theory*, 179, pp. 476-487 (January 2019).
  - Perfect abstract
  - Pure theory
  - Empirical predictions and cautions
  - Theory section is short but has all equations and intuition
  - All the proofs are in the appendices

De Nardi and Fella (RED, 2017)

- De Nardi, Mariacristina and Giulio Fella, "Saving and Wealth Inequality," *Review of Economic Dynamics*, 26, pp. 280-300 (Oct. 2017).
  - Facts section is like a lit review of data results
  - Short general model overview
  - Each section afterward tests the effect of different parts of the model on inequality

Model Section Examples

- DeBacker, Evans, Phillips, "Integrating Microsimulation Models of Tax Policy into a DSGE Macroeconomic Model," *Public Finance Review*, 47:2, pp. 207-275 (Mar. 2019)
  - What is question: How do rich tax functions perform in analysis of canonical tax reform?
  - Demographics
  - Heterogeneous ability
  - Overlapping households
  - Taxes
  - How fits with data

Model Section Examples

- Li, Narajabad, Temzelides, "Robust Dynamic Energy Use and Climate Change" *Quantitative Economics*, 7, pp. 821-857 (2016)
  - What is question: What is optimal carbon tax when policy makers have model uncertainty?
  - Household optimization
  - Production: intermediate goods and final goods
  - Aggregate resource constraint
  - Model uncertainty
  - Appendices
  - Given their question, did they have enough model uncertainty? Did they put the model uncertainty in the right place?