

# 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 (see [template](#))
- State research question
- Cite some literature from which you will draw and to which you will contribute
  - Where do you fit?
  - How are you different?
- How will you model your research question? What is your model?
- What methods will you use to answer your research question?
- What do you think the answer will be (don't have results yet)?

## Blundell (2017), Structural model def and properties

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

- structural “deep” parameters
- underlying mechanisms
- policy counterfactuals

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

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## 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

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# 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

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- 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

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- 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 (2017)
  - 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 (*QE*, 2016) “Robust dynamic energy use and climate change”
  - 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?