The objective of this course is to teach two of the three steps it takes to write a successful quantitative economics paper. Broadly speaking, a quantitative project involves three distinct steps. First, one needs to specify an economic model, which requires choosing appropriate functional forms for various components (utility and production functions, various cost functions, stochastic processes for shocks, etc.). This step requires a thorough understanding of the trade-offs involved in each choice. Second, most dynamic models with heterogeneity used in research today do not have analytical solutions, which makes computational tools indispensable. Therefore, the second requirement is the mastery of a state-of-art toolbox of computational methods. Third, once a (numerical) solution is obtained, one needs to calibrate (or estimate) the model---that is, assign values to the key model parameters in a sensible fashion. This latter step is crucial. This semester’s course will focus on steps 1 and 3 and will alternate with a related course (to be taught next year) that focuses on step 2 (computation).

This course is intended to be a primer on these methods, not a comprehensive treatment of all the useful methods (not even close!). It intends, however, to provide a solid foundation that you can build upon and improve your skills to write a masterfully executed thesis and job market paper.

Course Requirements

Although not required, familiarity with Stata, SAS, and Matlab will be expected. If you are not familiar with any of these though, be prepared to work harder than others to catch up, especially in the first half of the course. A solid understanding of first year macro and micro is required too.

To get credit for this course you will need to complete all the homework assignments that will be distributed each week. You will submit all assignments electronically. I will describe how to do this in class.

Contact information

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Textbooks and Reading Materials

The lectures will mainly draw on my notes that I intend to make self-contained. Although I will not follow any textbook closely, some of the books listed below contain detailed and authoritative treatments of the subjects we will study in this course.
Some useful books:

- *Simulation-Based Econometric Methods*, by Christian Gourieroux and Alain Monfort, Oxford University Press.

Fortran 90 Books:

If you don’t know Fortran, a good book that starts from the basics is:


A shorter but solid reference book:

- *Fortran 90/95 Explained*, by Michael Metcalf and John Reid, Second Edition, Oxford University Press. (Both Metcalf and Reid played leading roles in the development of the Fortran 90 standard, so they surely know what they are talking about.)

TENTATIVE SCHEDULE

1. **Week 1: Introduction**

2. **Weeks 1 & 2: Model Specification and Choice of Functional Forms**

   - Utility Functions: Preferences over Consumption; Preferences over Consumption and Leisure, More Exotic Preferences (Habit formation, external habit, GHH preferences, Epstein-Zin preferences, First order risk aversion, etc.)
   - Production Functions: Dixit-Stigliz, Capital-Skill Complementarity, exotic functions.
   - Functional Forms for Balanced Growth; King et al. (2002)’s Conditions.
   - Dynamic Problems with Homothetic Solutions
   - Stochastic Processes for income, productivity, health, etc.
   - Transaction costs, fixed costs, etc.

3. **Week 3: Basic Issues in Calibration**

   - Three Key Parameters in Macro: Risk aversion, EIS, Frisch elasticity.
   - External vs. Internal Consistency
   - Time Aggregation and Preference Parameters
   - What Dataset to Use?

4. **Weeks 4 & 5: Basic Issues in Empirical Analysis**

   - A big headache: Endogeneity
• Measurement Error:
  o Measurement error in the right hand side variable; in the left hand side variable.
  o Is measurement error classical? (Brown, Bound, and Mathiowetz)
  o Identification with measurement error (Blundell, et al 2008), correction for correlation, Heathcote et al (2010).
  o Lack of identification without functional form assumptions in GMM

• Instrumental Variables

• Caution: Small sample issues.

• Analyzing Panel Data:
  o Time, Cohort, and Age effects: A cautionary note.
  o Fixed effects, random effects: what do they mean?

• The Kalman Filter: As a device to solve sophisticated Bayesian learning problems; as an estimation tool (to derive likelihoods easily).
  (Read: Jim Hamilton’s book Chapters 12, 13).

**Suggested Readings:**


5. **Week 6: Generalized Method of Moments**
   • Large Sample Properties; Small Sample Properties
   • Advantages of GMM; Disadvantages
   • How to Generate Moment Conditions?
6. **Week 6 and 7: Simulation-Based Estimation**
   - Method of Simulated Moments (MSM)
   - Basic Algorithm
   - Calibr-estimation: The Mechanics
   - Estimation via Indirect Inference: The Quadratic “Wald” Objective; The “Likelihood” Objective
   - Guvenen and Smith (2013) Model: Dynamic Programming Problem; Identification; Implementation

7. **Week 7: What Can We Learn From A Structural Model?**
   - Policy Experiments
   - Counterfactuals, Decompositions
   - Impulse Response Functions
   - Welfare analysis with heterogeneous agents

8. **Optional: Global Optimization**
   - Outline of the Algorithm
   - Quasi-Random Numbers
   - A Simple Global Optimization Algorithm
   - Termination Criterion
   - Refinements: Clustering and Pre-testing
   - Narrowing Down the Search Area
   - Parallelizing the Algorithm
   - A Practical Guide

9. **Optional: Methodology**
   - Friedman’s methodology
   - Calibration vs Estimation
   - Establishing Causality
   - Instrumental Variables Approach


