Structural Econometrics

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Learning objectives:

The goal of this course is to bridge the gap between formal training in econometrics and theory and their practical applications. We will cover numerical methods for analyzing economic model predictions and estimating technology and preference parameters, often referred to as ”structural” econometrics. These methods are particularly relevant for students interested in applied economic research, including empirical industrial organization, urban and trade economics, labor and demographic economics, and business economics (e.g., marketing and personnel economics).

In the first week, we will provide a brief introduction to quantitative analysis and structural estimation techniques in applied economics. We will also explore recent studies that integrate randomized controlled trials or other reduced-form methods with structural modeling across various economic subfields.

Then, we will discuss generic static and dynamic models. The focus will be on formulating the model, solving it computationally, calibrating or estimating its parameters using data, and conducting counterfactual analysis.

In the final two weeks, students will present their research proposals.

Learning Outcomes:

At the end of this course, students are expected to be able to apply computational methods to solve and estimate models in industrial organization, urban, trade, international, macroeconomics, labor economics, and public finance.

Topic and Schedule:

(**Generic Model Types in Bold**, Numerical Method in Blue, Estimation Method in Red

1. Brief Discussion on Quantitative Analysis and Structural Estimation in Applied Economics -1 week
   (a) Urban, trade, IO applications
2. **Static Discrete Choice Models (Logit)** (2 weeks)
   (a) Logit Model (with closed-form)
      - Coding a Logit Model
      - Simulating observations: Structural zeros versus sampling zeros
      - The three extreme value distributions (Gumbel, Fréchet, Weibull)

(b) An application to spatial models
  - Trade: Eaton and Kortum (2002);
    - Applications: Location Choice: Allen and Arkolakis (2014); Commuting: Ahlfeldt, Redding, Sturm, Wolf (2015)
  - Numerical solution: Iteration and Contraction mapping (Alvarez and Lucas, 2007)

(c) Estimation
  - Estimations based on reduced forms (Gravity Equation, Caliendo and Parro (2015), Eaton and Kortum (2002))
  - Bias in the approach in Eaton and Kortum (2002) and its correction by the simulation methods (Simonovska and Waugh, 2014)

3. **Static Discrete Choice Models (Breaking IIA Assumptions)** -2 weeks

(a) Demand for differentiated products (without closed form)
  - Model: Berry(1994), BLP(1995/2004)
  - Numerical integration: Simulations methods, Quadrature, Bayesian and MCMC

(b) Identification and Estimation
  - Identification and Instruments: Gandhi and Houde (2019)
  - Estimation Method: MLE and GMM
  - Implementation: Nevo(2000), Conlon and Gortmaker (2019)

(c) Continuous Choice Models or Mixed Choice Models(optional)
  - Almost ideal demand system (Deaton and Muellbauer, 1980), discrete and continuous demand (Hanemann, 1984; Cardon and Hendel, 2001)

4. **Single Agent Dynamic Discrete Choice** (Computation and Calibration)-2 weeks

(a) Solving dynamic models(I):
  - Value function iteration

(b) Hat-Algebra Techniques to Solve Counterfactuals:
  - Static: Exact Hat-Algebra (Dekle, Eaton, Kortum, 2007)
  - Dynamic: Dynamic Hat-Algebra (Caliendo, Dvorkin, Parro, 2019)

(c) Estimation (based on reduced forms)
  - Artuç, Chaudhuri, McLaren (2010); Artuç and McLaren (2015)

(d) Calibration and Estimation
  - Estimation of mobility costs (and amenity): Minimum distance estimator following Artuc, Lederman, Porto (2015)
  - Trade costs (Head and Ries, 2001); Migration costs (Tombe and Zhu, 2019)
  - Productivity and amenity: Static (Ahlfeldt, Redding, Sturm, Wolf, 2015)) and Dynamic (Giannone, Paixão, Miyauchi, Pang, Suzuki, mimeo)

5. **Single Agent Dynamic Discrete Choice** (Estimation)-1 weeks

(a) Solving dynamic models(II): Policy Function Iteration, Conditional Choice Probability

(b) Estimation: Nested Fixed-Point MLE Rust (1987), Two-step Estimators: Hotz and Miller (1993), Pseudo-likelihood estimators Aguirregabiria and Mira (2002)

(c) Curse of dimensionality: Rust (1997), Keane and Wolpin (1994), Keane and Wolpin (1997)

6. **Strategic Models of Industry Dynamics** -1 week
   (a) Introduction to strategic models: Seim (2007)
   (b) Markov games: Pakes and McGuire (1994), Besanko and Doraszelski (2004)
   (c) Solution methods: Doraszelski and Pakes (2007), Ifrach and Weintraub (2017)
   (d) Oblivious equilibrium: Weintraub, Benkard, and van Roy (2008), Weintraub, Benkard, and van Roy (2010)
7. Presentations (1-2 weeks)

Grading:

1. 4 coding assignments(40%)-2 about solving models and 2 about estimating models:
   (a) PS1: Solve a GE model and simulate samples
   (b) PS2: Numerical integration exercises
   (c) PS3: Solve a dynamic discrete choice model and estimation: Spatial application
   (d) PS4: Nested-fixed point estimation: Dynamic discrete choice model
2. Class presentation (20%): A 30-minute presentation on your research proposal at the end of the course.
3. Research proposal (40%): Each student must submit a research proposal within two weeks after the course ends. The proposal should clearly state the research question, review relevant literature, identify potential data sources, outline the structural model, describe the estimation method, and present the counterfactual simulation design. Ideally, the proposal should also include robust empirical evidence to motivate the project.

General readings and textbooks

1. Computational methods: Miranda and Fackler (2002), Judd (1999)
2. Simulation methods: Train (2009)
3. Estimation of dynamic models: Adda and Cooper (2003)
4. Handbook chapters: Rust (1994), Keane, Todd, and Wolpin (2011)

Software

This course covers numerical methods for estimating and solving various economic models. You will be required to write your own code, unlike statistical software such as Stata, which provides built-in estimation commands. While we primarily use MATLAB, we recommend non-commercial or open-source alternatives like Python, R, or Julia, especially if you are new to programming.

Prerequisites for students

1. Probability, Statistics, Calculus & Matrix algebra
2. Econometrics (Finish the PhD sequences)