Topic in structural econometrics

by Fedor Iskhakov

Intensive course at the University of Oslo, January 2026

Schedule

- 5 days of teaching, January 12-16
- Each day 10:15 to 17:00 with breaks
- Approximately 2 hours of theory + 3 hours of practical work

Prerequisites and materials

- Knowledge of basic econometric techniques
- Some familiarity with Python programming
- Laptop with installed software:
    - Text editor (VS Code recommended)
    - Python (Anaconda distro recommended)
    - Git version control with GUI (Fork, VS Code built-in, GitHub Desktop, etc)
- Some familiarity with the above software (see lecture 2 in my CompEcon course)

Web lecture notes

All materials for the course will be made available at uio.iskh.me (updated continuously)

Syllabus

1. Static random utility models

Theory:

- Overview of structural econometric approach
- Generalized extreme value distribution and max stability
- Random utility models with GEV idiosyncratic random terms
- Choice probability (logit, nested logit)
- Logsum functions
- Smoothing of kinks

Practice:

- Working environment setup: editors, version control
- Coding up flexible random utility model
- Numerical issues in computing logit probabilities and logsums
- How parameters affect choice probabilities
- Scale parameter
- Understanding identification by *playing with the model*
- Simulations from the model

- Dashboards

Reading materials:

- M. Keane, “Structural vs. atheoretic approaches to econometrics,” Journal of Econometrics, vol. 156, no. 1, pp. 3–20, 2010.
- J. Rust, “The Limits of Inference with Theory: A Review of Wolpin (2013),” Journal of Economic Literature, vol. 52, no. 3, pp. 820–850, Sept. 2014
- Train, K. (2009). *Discrete Choice Methods with Simulation*. Cambridge University Press. (up to and including Chapter 4)

2. Maximum likelihood estimation

Theory:

- Maximum likelihood estimation principles
- Properties of MLE estimators
- Numerical optimization methods for MLE
- Newton-Raphson method, quasi-Newton methods
- BFGS and BHHH

Practice:

- Numerical algorithms (evaluations of polynomials, binary search, bisections, Newton-Raphson method)
- Recursion (towers of Hanoi)
- Implementing MLE for static RUMs
- Using python optimization libraries for MLE
- Estimagic/Optimagic package

Reading materials:

- Train, K. (2009). *Discrete Choice Methods with Simulation*. Cambridge University Press. (Chapters 3.7, 9)

3. Dynamic programming

Theory:

- Dynamic discrete choice
- Bellman principle of optimality
- Infinite and finite horizon problems
- Bellman equation
- Solution methods for dynamic programming
- Value function iteration (successive approximations)
- Howard policy iterations
- Newton-Kantorovich iterations
- Convergence rates of different methods

Practice:

- Coding up an inventory problem
- Implementing value function iterations
- Implementing Howard policy iterations
- Implementing Newton-Kantorovich iterations

Reading materials:

- J. Rust, “Chapter 14 Numerical dynamic programming in economics,” in Handbook of Computational Economics, vol. 1, Elsevier, 1996, pp. 619–729. doi: 10.1016/S1574-0021(96)01016-7
- CompEcon lectures/labs 27

4. Rust engine replacement model

Theory:

- Rust model in deterministic formulation
- Removing statistical degeneracy by adding EV shocks
- Expressing Bellman equations in expected value form
- Maximum likelihood NFXP method

Practice:

- Coding up Rust model
- Implementing NFXP estimation

Reading materials:

- Rust, J. (1987). "Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher." *Econometrica*, 55(5), 999-1033.
- CompEcon lectures/labs 28, 44, 46

5. CCP based estimation

Theory:

- Inversion theorem
- CCPs and form of utility function
- Finite dependence
- Linear regression in CCP estimation
- Quasi-likelihood estimation
- Swapping NFXP: NPL estimator

Practice:

- Computing CCPs from Rust model
- Estimating Rust model using CCPs
- Linear regression in CCP estimation
- Quasi-likelihood estimation
- Implementation of NPL estimator

Reading materials:

- Hotz, V. J., & Miller, R. A. (1993). "Conditional choice probabilities and the estimation of dynamic models." *The Review of Economic Studies*, 60(3), 497-529.
- P. Arcidiacono and R. A. Miller, “Conditional Choice Probability Estimation of Dynamic Discrete Choice Models With Unobserved Heterogeneity,” Econometrica, vol. 79, no. 6, pp. 1823–1867, 2011