HUMBOLDT-UNIVERSITÄT ZU BERLIN

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Advanced Econometrics / Econometrics II

Summer Term 2023

This course deals with advanced estimation techniques in modern econometrics. In the first part we review some elements of classical and Bayesian statistical theory, concentrating on special problems relevant to the study of econometrics: post-selection inference, multiple testing, and uniform asymptotics. Then we study extremum estimation problems (especially, GMM) with special attention to asymptotic theory and the weak instruments problem. The second part covers non- and semi-parametric topics including the bootstrap, density estimation, and non- and semi-parametric regression. The fundamental aim in this part is to understand the curse of dimensionality and the bias-variance trade-off in flexible model classes. The third part covers the concept of econometric identification, and a framework to write down causal estimands (treatment effects). We also discuss a number of techniques for estimation of treatment effects. A deep knowledge of the techniques conveyed in this course is extremely useful since these techniques form the basis of specific applications of econometrics to macroeconomics, industrial organization, development economics, as well as financial economics. At the end of the course we will be able to critically evaluate the methods used in contemporary applied econometric research projects.

Requirements: Participation in the course "Econometric Methods" or a course with similar learning outcomes.

Ver.: 19.03.23

Course Outline

0. Review of Linear Regression and OLS

0.1. Stochastic Regressors and the Conditional Expectation Function
0.2. Best Linear Projections
0.3. Instrumental Variables, 2SLS

1. Statistical Theory and Asymptotics

1.1. Decision Theory
1.2. Hypothesis Testing and Set Estimation
    1.2.1. Optimality Criteria, Neyman–Pearson Theory
    1.2.2. P-values and Confidence Intervals
    1.2.3. Testing Multiple Hypothesis, Post-Selection Inference
1.3. Classical Asymptotic Theory (Revision)
    1.3.1. Convergence Concepts
    1.3.2. Stochastic Processes
    1.3.3. Useful LLNs and CLTs
1.4. Uniform Asymptotics and Empirical Processes
    1.4.1. Uniform LLN
    1.4.2. Functional CLT
    1.4.3. Concepts in Empirical Processes
    1.4.4. Basic Tail and Concentration Bounds

2. Extremum Estimation (GMM)

2.1. Moment Estimation
    2.1.1. Motivation
    2.1.2. Moment Functions
    2.1.3. The Method of Moments Estimator
    2.1.4. Special Cases
    2.1.5. The Principle of GMM

2.2. Asymptotic Properties
    2.2.1. Extremum Estimators
    2.2.2. Consistency of Extremum Estimators
    2.2.3. Asymptotic Normality of Extremum Estimators

2.3. GMM Estimation
    2.3.1. Optimal Choice of the Weighting Matrix
    2.3.2. Optimal Conditional Moment Estimation
    2.3.3. Hypothesis Testing
    2.3.4. Applications

2.4. Weak Instruments

3. The Bootstrap

3.1. The Bootstrap
3.1.1. Motivation, the Bootstrap as an Algorithm
3.1.2. Bootstrap Consistency
3.1.3. Variations on the Bootstrap

3.2. Bootstrap for Time Series

4. Identification
4.1. Meanings of Identification in Econometrics
4.1.1. Point Identification
4.1.2. Set Identification
4.1.3. Examples

4.2. Structural vs Causal Modelling
4.2.1. The Potential Outcomes Framework
4.2.2. Structural Models
4.2.3. Structural vs Causal Modelling?

4.3. Causal Estimands (Treatment Effects)
4.3.1. A Compendium of Causal Estimands
4.3.2. Overview: IV, Diff-in-Diff, RDD, Matching

5. Non- and Semi-parametrics

5.1. Density Estimation
5.1.1. Histogram
5.1.2. Kernel Density Estimator
5.1.3. Kernel and Bandwidth Choice
5.1.4. Boundary Effects and Curse of Dimensionality

5.2. Regression Estimation
5.2.1. Kernel-Based Conditional Mean Estimation
5.2.2. Other Methods: Splines, Series Estimators
5.2.3. Intro to Endogeneity and Ill-Posed Inverse Problems

5.3. Semi-Parametric Estimation
5.3.1. Partially Linear Model
5.3.2. Single Index Model

Literature

The following readings will help you contextualize the material, with additional explanations, etc. The course draws on these sources but deviates from them, most notably in notation. It is helpful if you familiarize yourself with these background readings before the corresponding lecture.

Background Readings

- **Chapter 0:** Angrist, J., Pischke, J.S. (2009): *Mostly Harmless Econometrics,* Princeton University Press, Section 3.1. / Florens, J., Marimoutou, V., Peguin-Feissolle, A. (2007): *Econometric Modeling and Inference,* Cambridge University Press, Chapter 7.
- **Chapter 1:** Robert, C. (2007): *The Bayesian Choice*, Springer, Chp 2.; Schervish, M. (1995): *Theory of Statistics*, Springer, selected theorems; Romano, J.P., Shaikh, A.M, and Wolf, Michael (2010): Hypothesis Testing in Econometrics, *Annual Review of Economics* 2(1), pp. 75–104; Davidson J. (2021): *Stochastic Limit Theory*, 2nd ed, Oxford University Press, Chp 22.
- **Chapter 2:**
  - **General reference:** Hayashi, F. (2000): *Econometrics,* Princeton University Press, Chapters 3 and 7.
  - **Topic 2.4:** Andrews, I., Stock, J.H., Sun, L. (2019): Weak Instruments in Instrumental Variables Regression: Theory and Practice, *Annual Review of Economics* 11(1), 727–753.
- **Chapter 3:** Horowitz, J. (2019): Bootstrap Methods in Econometrics, *Annual Review of Economics* 11(1), 193–224.
- **Chapter 4:** Lewbel, A. (2019): The Identification Zoo: Meanings of Identification in Econometrics, *Journal of Economic Literature* 57(4), 835–903, Sections 3, 5, 8; Matzkin, R. (2007): Nonparametric Identification, in Heckman, J.J, and Leamer, E.E. (eds): *Handbook of Econometrics*, vol 6. Part B Chp 73, pp. 5307–5368; Selected contemporary papers.
- **Chapter 5:** Racine, J.S. (2019): *An Introduction to the Advanced Theory and Practice of Nonparametric Econometrics*, Cambridge University Press, Chapters 2, 6, 7, 8.

Additional Readings

We will discuss various journal articles (applications and for further context) during the course. I will give you precise references beforehand.

A collection of books on econometrics can be found here: https://www.econometricsbooks.com/

You may find the following resources especially helpful:
1. Bruce Hansen's lecture notes on econometrics: https://www.ssc.wisc.edu/~bhansen/econometrics/
2. Wooldridge, J.M. (2010): *Econometric Analysis of Cross Section and Panel Data*, 2nd ed, Princeton University Press.
3. Van der Vaart, A. (2006): *Asymptotic Statistics*, Cambridge University Press.

If you are thinking about doing research in econometrics please reach out and I'll be happy to discuss further reading recommendations.