Causal Inference and Machine Learning

Section I:

Introduction to Panel Data Models and Non-parametric Estimation

Data Science for Decision Making Master

Barcelona School of Economics

LAURA MAYORAL
Institute for Economic Analysis and BSE

Winter 2025

1. DESCRIPTION

The course "Causal Inference and Machine Learning" consists of two sections. This syllabus describes the first section.

This 10-hour graduate course explores two key deviations from the standard regression framework. First, it addresses the challenge of omitted variable bias and introduces panel data methods as a solution, leveraging repeated observations to control for unobserved heterogeneity. Second, it considers cases where the functional form of the model is unknown or incorrectly specified, motivating the use of nonparametric and semiparametric estimation techniques. Through lectures and practical examples, students will gain foundational skills in handling these advanced econometric challenges.

2. INSTRUCTORS AND WEBSITE OF THE COURSE

Main Instructor: Laura Mayoral, mayoralaura@gmail.com

Teaching Assistant: Margherita Philipp, margherita.philipp@bse.eu

Website of the course:

http://mayoral.iae-csic.org/econometrics2025/econometrics_2025.htm

3. Course outline

(1) Omitted variable bias. Overview of classical panel data methods.
(2) Recent developments in Difference in Differences approaches.
(3) Advanced topics: dynamic panel data models, nonlinear models, models for time varying omitted variables. . . (time permitting).
(4) The problem of incorrect specification. A quick introduction to nonparametric and semi-parametric estimation.

4. Textbooks

Main references:

- Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). MIT Press.
- Cameron, A. Colin and and Pravin K. Trivedi, *Microeconometrics: Methods and Applications*, Cambridge University Press, New York May 2005
- Cameron, A. Colin, and Pravin K. Trivedi. *Microeconometrics Using Stata*. Revised Edition. Stata Press, 2010.
- Angrist, J. D., Pischke, J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Other useful resources:

Additional references will be provided in the website of the course as the course evolves.

5. Organization of the course

- *Classes*: Teaching consists of 5 lectures (2 hours each) and 2/3 seminars (1 hour each). Participation in class and seminars is highly encouraged.
- *Course Materials*: All the materials of the course will be posted in this website: `http://mayoral.iae-csic.org/econometrics2025/econometrics_2025.htm` as well as in Classroom. Please check it regularly for updates.
- *Assignments*: There will be 3 problem sets. Contents and submission dates and rules will be provided soon. Late submissions are graded with zero points.

6. Office hours

By appointment.

- For questions about the main lectures, please send an email to arrange a day/time to: mayoralaura@gmail.com.
- For questions about the seminars, please send an email to arrange a day/time to: margherita.philipp@bse.eu.

7. GRADING

- Final examination (70%)
- Problem sets (30%)