ECON 2148 Topics in Econometrics

Course Outline

Class Meetings

Lectures: Monday, Wednesday 9am - 10.15am, Classroom: TBD

Instructor

Davide Viviano
Email: dviviano fas.harvard.edu
Office Hour: TBD

Grader and teaching assistant

TBD

Course outline

This course covers advanced topics in econometrics with a particular focus on topics in causal inference for applications in economics. The course is designed for students interested in pursuing research in applied and theoretical econometrics, as well as for students with a solid background in econometrics or statistics interested in learning recent advances in causal inference for applied economic research. The first part presents topics in causal inference, starting from selection on observables, non-compliance, and then focusing on experimental design, and inference in experiments. The second part covers most advanced topics for semi-parametric estimation, heterogeneous treatment effects and policy learning, instrumental variables, panel data models, spillover effects. The class concludes with an overview of recent research in econometrics on the design of scientific communication. Readings for each topic will include theoretical papers in econometrics and papers in applied economic research that provide empirical examples of the method.

Course information

Lectures will be on Monday and Wednesday 9am - 1015am. Office hours will be held every week for 1.30h (time TBD). Grading will be based on 6 problem sets, a final research essay, and a final presentation. Final grade will assign weight 40% to the problem sets

(equally weighted after removing the problem set with the lowest grade), 15% for in-class participation (based on attendance only), 45% for the final essay.

Problem sets

There will be 6 problem sets in total due every other Monday and submitted through Canvas. I will only accept on-time problem sets. For each problem set, there will be one or two graded problems and one or more ungraded problems. You will only required to submit the graded problems, while the ungraded problems are optional. Problem sets will involve theoretical calculations, computer exercises, and/or referee reports of a paper discussed in class. I recommend using R as a statistical software for the numerical exercises, but other software is possible. You are welcome to collaborate on the problem sets, but you should write up and submit your own solution. Identical solutions will not receive credits. Please list your collaborators on the problem sets.

In-class participation

15% of the final grade will be based on in-class participation. The in-class participation grading will be based on attendance only. Students are encouraged to read papers assigned before each class, although this does not affect the in-class grading.

Final essay

Students must write and submit a final essay, whose evaluation accounts for 45% of the final grade. Students can write the essay in collaboration with at most another student. Two students can submit together a collaborative essay. Students must discuss the topic and structure of the essay for approval by the instructor during office hours any time before the submission deadline. Students can discuss progress on their essays any time during office hours.

The essay should be between seven and twenty-five pages long (double-spaced). It must present an analysis of an estimation or inference procedure presented in a paper on a reading list provided during the first week of the class. It is possible to study a method not in the reading list subject to the approval of the instructor.

The essay may either (or both) focus on studying an econometric method from a theoretical perspective or a study of a method's properties and applicability for applied economic research.

The essay must contain a short introduction that motivates the method for applied economic research, a section discussing the setup, a section discussing the methodology and presenting the main theoretical analysis, and a section presenting the numerical properties of the procedure and an empirical application using some existing data.

The theoretical analysis must include the main theoretical argument of the original paper and does not need to contain all theoretical results in the original paper. (For

instance, students more interested in the applicability of methods in applied research may only report the main identification result or proof of consistency.) Each formal statement reported in the essay must have a proof in an appendix.

Students are encouraged to present novel numerical studies and an empirical application different from the one in the original paper.

The paper will be graded based on correctness, quality of the writing, and novelty of the theoretical, numerical, and empirical analysis. Depending on the number of enrolled students (TBD), students will also be asked to present the essay during the final week of class. If I include the presentation as part of the grading, the presentation will count towards 20% of the grade of the essay (approximately 10% of the total grade).

The essay will be submitted via Canvas during the week of the exam (exact date TBD).

Prerequisites

Students must have take the first year graduate sequence in econometrics (ECON2120 and ECON 2140) or equivalent with the permission of the instructor. Multivariable calculus, linear algebra, concepts in probability theory and asymptotic statistics will be needed extensively.

Readings

The slides and the paper readings assigned during the class will cover the topics in the class. I will also be using (or assign reading from) subsections of books, review papers or handbook chapters, that I will specify at the end of each slide.

Students interested in learning more about the topics, can refer to the following books (the books are not mandatory):

- Imbens, Guido W., and Donald B. Rubin. Causal inference in statistics, social, and biomedical sciences. Cambridge University Press, 2015. (I will be using some of the chapters of this book to introduce concepts during the first couple of weeks of the course).

- Hernán MA, Robins JM (2020). Causal Inference: What If. Boca Raton: Chapman & Hall/CRC. (I will be using some of the chapters of this book to introduce some of the concepts discussed during the first couple of weeks of the course).

- Gerber, Alan S., and Donald P. Green. "Field experiments: Design, analysis, and interpretation." (2012). (I will be using some of the chapters of this book to introduce concepts for the analysis and design of experiments).

- Wainwright, Martin J. High-dimensional statistics: A non-asymptotic viewpoint. Vol. 48. Cambridge university press, 2019. (I will be using some sections of this

book when discussing policy learning and non-asymptotic theory. The book is a useful reference if you are interested in doing research in econometrics.)

- Romano, Joseph P., and E. L. Lehmann. "Testing statistical hypotheses." (2005). (This book is mostly for your reference, I will not use much of the content of this book, except when discussing hypothesis testing and multiple hypothesis testing. The book is a useful reference if you are interested in doing research in econometrics.)

For writing the final essay, students are strongly encouraged to read

- Varanya Chaubey: The Little Book of Research Writing

The book introduces students to research writing.

Code of conduct

All course activities, including class meetings and homework assignments are subject to Harvard's academic integrity policies as detailed at https://gsas.harvard.edu/codes-conduct/academic-integrity. Please be on time and make sure that your cell phone is turned off during class time. Laptops may be used in class.

Accommodations for students with disabilities

The Department of Economics values an inclusive environment. If you need an accommodation for your studies, please make sure you have contact University Disability Services (website https://accessibility.harvard.edu; email disability- services@harvard.edu) so I can be in a position to properly help you.

Tentative plan of the course

- Review of potential outcomes and structural equation models
  - Potential outcomes, ATE, SUTVA, selection on observables, propensity score, matching, balancing
  - Non-compliance, LATE, MTE
  - do-calculus, backdoor, frontdoor criterion, negative controls, mediation analysis
- Design of experiments and inference in experiments
  - Power and regression adjustments in experiments
  - Stratification, matched pair designs, encouragement designs, mean-squared error optimal designs, factorial designs
  - Design and model based uncertainty

  - Randomization inference and permutation tests
  - Multiple hypothesis testing
  - Inference with cluster and spatial dependence

- Topics on estimation of causal effects in quasi-experiments
  - Augmented inverse probability weights estimators, high-dimensional estimators for causal effects, double machine learning
  - Heterogeneous effects, shrinkage and empirical Bayes

- Policy learning and adaptive experiments
  - Theory of and applications for statistical treatment choice
  - Adaptive experiments and bandits

- Advances in instrumental variables
  - Bartik instruments, shift-share designs, recentered instruments, instruments for structural models, instruments in high dimensions

- Advances in panel data methods for causal inference
  - Difference-in-Differences with multiple time periods
  - Event studies and synthetic controls, matrix completion methods
  - Group fixed effects and clustering with panel data
  - Dynamic treatments, marginal structural models, G-estimation

- Spillovers, network data, and general equilibrium effects
  - Causal effects and identification with network data
  - Network formation models and inference with network dependence
  - Seeding, policy learning and welfare analysis with spillover effects
  - Experimental designs with spillovers

- Decisions, incentives and mechanisms in econometrics
  - Theory of experiments, robustness and external validity
  - Communicating scientific discoveries in applied economic research
  - p-hacking, publication bias and meta-analysis
  - Design of statistical tests when agents are strategic