Outline of the

Applied Economics and Econometrics sequence at the EUI

Academic year: 2021-22

This version: October 25, 2021

Courses and instructors

Core 1A: Pre-course on Probability and Statistics **Block I**
Cristina Lafuente Martinez (Cristina.Lafuente@eui.eu)

Core 1B: Regression Analysis **Block I**
Andrea Ichino (andrea.ichino@eui.eu)

Core 2: Econometric Models for Micro Data **Blhttps://www.overleaf.com/project/60a9e7f33de49 II**
Sule Alan (sule.alan@eui.eu) and Thomas Crossley (thomas.crossley@eui.eu)

Core 3: Dynamics: Time Series and Simulation Based Estimators **Block III**
Russell Cooper (russellcoop@gmail.com) and Jesus Bueren (jesus.bueren@eui.eu)

Optional 1 The Econometrics of Causality **Block I**
Fabrizia Mealli (fabrizia.mealli@unifi.it)

Optional 2: Field Experiments **Block III**
Sule Alan (sule.alan@eui.eu)

Optional 3: Topics in Microeconometrics **Block III**
Alessandro Tarozzi (alessandro.tarozzi@gmail.com)

Optional 4: Economic Measurement **Block II**
Sule Alan (sule.alan@eui.eu) and Thomas Crossley (thomas.crossley@eui.eu)

Optional 5: Topics in Macroeconometrics **Block III**
Barbara Rossi (barbara.rossi@upf.edu)

Optional 6: Development Economics and Global Health **Block IV**
Alessandro Tarozzi (alessandro.tarozzi@upf.edu)

Optional 7: The Econometrics of Real Data **Block IV**
Thomas Crossley (thomas.crossley@eui.eu)

Optional 8: Machine Learning for Economists **Block I**
Sergio Pastorello (U.Bologna)

Optional 9: Modern Difference-in-Differences **Block I**
Mirjam Reutter (mirjam.reutter@eui.eu)

Core 1A: Probability and Statistics

Cristina Lafuente Martinez (Cristina.Lafuente@eui.eu)

The main goal of this course is to review core concepts in probability theory and univariate and bivariate statistics. The pre-course will cover the building blocks of probability theory, moving to the study of random variables and their distributions (with a focus on the most important distributions for economists), basics of bivariate distributions, large sample theory and finish with an introduction to markov processes. All lectures will contain intuitive examples of basic concepts and practice problems.

There will be seven lectures and three exercise classes in this part.

Topics

Topic 1

Introduction. Set theory. Basic probability theory. Probability axioms. Joint, marginal and conditional probabilities.

Blitzstein and Hwang, chapters 1 and 2

Topic 2

Discrete random variables. Probability mass and cumulative distribution functions. Continuous Random Variables. Probability density functions. Important distributions: Normal, Poisson, Exponential.

Blitzstein and Hwang, chapters 3 and 5

Topic 3

Expected values. Moments and moment generating functions. Transformations of random variables.

Blitzstein and Hwang, chapters 4, 6 and 8

Topic 4

Multivariate random variables. Joint and marginal distributions. Conditional distributions and independence of random variables. Covariance and correlation. The distribution of order statistics. Bivariate and multivariate normal densities. Conditional normal densities. Bivariate transformations of random variables. Law of Iterated Expectations.

Blitzstein and Hwang, chapters 7 and 9

Topic 5

Large sample theory. Laws of large numbers. Central limit theorems. Markov Chains.

Blitzstein and Hwang, chapter 10 and 11

Exercise classes

There will be 3 exercise classes, one after topic 3, one after topic 5 and a final one covering problems from all topics.

Teaching material

- Joseph K. Blitzstein and Jessica Hwang. *Introduction to probability.* Chapman and Hall/CRC, Second Edition, 2019.
- Lecture notes by the instructor, which will highlight the parts of the textbook that would be relevant for the course.

Other reference books:

- George Casella and Roger L. Berger. *Statistical Inference.* Thomson, Second Edition, 2002.
- Richard J. Larsen and Morris L. Marx. *An introduction to mathematical statistics and its applications.* Prentice Hall, Fifth Edition, 2012.

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Core 1B: Regression Analysis

Andrea Ichino (andrea.ichino@eui.eu)

The main goal of this Core course is to give an introduction to the basic tools that an econometrician needs: the most popular estimation methods; inference and hypothesis testing; asymptotics; simple and multiple regression; instrumental variables.

In addition to the lectures there will be six exercise classes. Examples and applications will be used to illustrate the theoretical content of the course.

Topics

Topic 1

Introduction: what is econometrics about; the tool-box of econometrics; the econometrics sequence at the EUI; Content of this course.
Estimation: Estimators and estimates; the Method of maximum Likelihood; the Method of Moments.

Larsen and Marx, chapter 5. Casella and Berger, chapter 7 . Lecture notes.

Topic 2

Estimation: Finite sample properties of estimators; Unbiasedness, Efficiency,, Sufficiency, Minimum variance estimators; The Cramer-Rao Lower Bound, Invariance.

Larsen and Marx, chapter 5. Casella and Berger, chapter 7 and chapter 5. Lecture notes.

Topic 3

Estimation: Asymptotic properties of estimators; Asymptotic Unbiasedness, Asymptotic Efficiency, Consistency; Asymptotic Normality
Basic asymptotics: concepts of convergence; Law of Large Numbers; Central Limit theorem; Continuous Mapping Theorem, Slutzky Theorem and Delta Method.

Larsen and Marx, chapter 5. Casella and Berger, chapter 7 and chapter 5. Lecture notes.

Topic 4

Simple regression: The Conditional Expectation Function; The Population Regression Function; The Sample Regression Function; OLS, Method of Moments and Maximum Likelihood estimation of a regression; Algebraic and geometric properties of the OLS-MM estimators.

Angrist and Pischke chapter 1, 2 and 3. Wooldridge part 1. Lecture notes.

Topic 5

Simple regression: Goodness of fit and the R-Squared; Statistical Properties of the OLS-MM estimator; The Gauss-Markov Theorem'.

Angrist and Pischke chapter 1, 2 and 3. Wooldridge part 1. Lecture notes.

Topic 6

Simple regression: Causality and Regression.

Angrist and Pischke chapter 1, 2 and 3. Lecture notes.

Topic 7

Multiple regression: The Conditional Independence Assumption; Interpretation of the partial Multiple Regression Coefficient; Multiple Regression in matrix notation; Omitted variable bias and inclusion of irrelevant regressors.

Angrist and Pischke chapter 1, 2 and 3. Wooldridge part 1. Lecture notes.

Topic 8

Multiple regression: The Gauss-Markov Theorem and Multiple Regression; "Partialling out" and the interpretation of coefficients; Good and bad habits concerning control variables;

Angrist and Pischke chapter 1, 2 and 3. Wooldridge part 1. Lecture notes.

Topic 9

Inference and Hypothesis testing: what is a statistical test and how it is constructed; The decision rule; Type I and type II errors; Power of a test.

Larsen and Marx, chapters 6 and 9. Casella and Berger, chapter 8. Lecture notes.

Topic 10

Inference and Hypothesis testing: finite sample and asymptotic tests in the context of a regression model.

Larsen and Marx, chapters 6 and 9. Casella and Berger, chapter 8. Lecture notes

Topic 11

Instrumental Variable estimation: The traditional interpretation and the Angrist-Imbens-Rubin interpretation of IV; Average Treatment Effect; Average Treatment Effect for the Treated; Local Average Treatment Effect.

Woolridge (2009); Angrist and Pischke (2013). Lecture notes

Exercise classes: TBD

There will be 6 exercise classes.

Teaching material

- Richard J. Larsen and Morris L. Marx. *An introduction to mathematical statistics and its applications.* Prentice Hall, Fifth Edition, 2012.
- George Casella and Roger L. Berger. *Statistical Inference.* Thomson, Second Edition, 2002.
- Jeffrey Wooldridge, *Introductory Econometrics. A Modern Appproach.* South Western Cengage Learning, 2009
- Joshua Angrist and Jorn-Steffen Pischke. *Mostly Harmless Econometrics. An Empiricist's Companion.* Princeton University Press, 2013.
- Lecture notes by the instructor.

Final exam and Grading

There will be two separate class room exams for Core 1A and Core 1B, but a single final grade based on:

- 20% of the Core 1A grade;
- 80% of the Core 1B grade;

The professors of each Core course will communicate in class the weights of the problems sets and of the final exam for the respective parts.

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Core 2: Econometrics Models for Micro Data

Sule Alan (sule.alan@eui.eu)
and
Thomas Crossley (thomas.crossley@eui.eu)

The course is intended to introduce students to some standard methods specifically designed for the analysis of microeconomic data. The first half of the course covers methods for limited dependent variables, censoring, truncation and duration data, mostly by maximum likelihood. The 2nd half of the course covers methods for panel data (with a focus on linear models).

Topic 1

Overview and Introduction Content of this course. Review of maximum likelihood methods.

Cameron and Trivedi, 5

Topic 2

Binary Response models: Probit and Logit.

Cameron and Trivedi, 14

Topic 3

Multinomial and Ordered Response: Ordered probit models, Multinomial logit models; Independence of irrelevant alternatives.

Cameron and Trivedi, 15

Topic 4

Corners, Censoring, Truncation: Censoring, Tobit, Selection models.

Cameron and Trivedi, 16

Topic 5

Introduction to Duration Analysis:

Cameron and Trivedi, 17, 18

Topic 6

Basic Linear Panel Data Models: Pooled, fixed effects, random effects. Fixed effects versus first differencing. Hausman Test. Differenes in Differences.

Cameron and Trivedi, 21

Topic 7

Further topics in Linear Panel Data Models :IV and GMM approaches to linear panel data models. Hausman Taylor. The Chamberlain approach and minimum distance.

Cameron and Trivedi, 22

Topic 8

Binary Response Models for Panel Data:(Time allowing.)

Exercise classes

There will be 6 problem sets, 6 exercise classes and 1 review class before the exam.

Teaching material

- (main text) Cameron and Trivedi, *Microeconometrics: Methods and Applications*, Cambridge University Press, 2005
- (supplement) Joshua Angrist and Jorn-Steffen Pischke. *Mostly Harmless Econometrics. An Empiricist's Companion.* Princeton University Press, 2013.
- (alternative) Jeffrey Wooldridge, *Introductory Econometrics. A Modern Approach.* South Western Cengage Learning, 2009
- Lecture notes by the instructors.

Final exam and Grading

- 6 problem sets will count for 30% of the final grade;
- A final exam will count for 70% of the final grade.

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Core 3: Dynamics: Time Series and Simulation Based Estimators

Russell Cooper (russellcoop@gmail.com)
Jesus Bueren (jesus.bueren@eui.eu)

The first part of the course introduces students to the analysis and modelling of time series processes, including stationary and non-stationary stochastic processes, and estimation in multivariate time series. The second part focuses on estimation and inference using generalized method of moments and simulation based estimators.

Topic 1

Basic Time Series concepts: Recap on difference equations, Stationarity, Ergodicity, ARMA processes.

Hamilton (Chapters 1, 3), Lecture notes.

Topic 2 Maximum Likelihood Estimation

Estimation of ARMA models using MLE. Statistical Inference. Likelihood Ratio test. Model selection criteria.

Hamilton (Chapter 5), Lecture notes.

Topic 3 *Multivariate VAR Models*: Stationarity, Conditional likelihood and OLS estimation, Granger Causality, Impulse responses, error bands, recursive VARs.

Hamilton (Chapter 11), Lecture notes.

Topic 4 *State-Space Representation and the Kalman Filter*: . Representation, a recursive algorithm. *Hamilton (Chapter 13), Lecture notes.*

Topic 5 (4 h)

Generalized Method of Moments: Estimation and Inference

- Adda and Cooper, Chpt. 4
- Hansen, L. and K. Singleton, "Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models," *Econometrica*, 50 (1982), 1269-86.
- J. Wooldridge,(2010) *Econometric Analysis of Cross Section and Panel Data*, MIT Press, Chpt. 8

Topic 6 (7 h)

Simulated Method of Moments: Estimation and Inference

- Adda and Cooper, Chpts. 5-8.
- Adda, J. and R. Cooper, "Balladurette and Juppette: A Discrete Approach," *Journal of Political Economy*, August, 2000.
- Cooper, R. and G. Zhu, "Household finance over the life-cycle: What does education contribute?" *Review of Economic Dynamics*, 20 (2016), 63-89.
- Cooper, R. and J. Haltiwanger, "On the Nature of Capital Adjustment Costs," *Review of Economic Studies*, 73 (2006), 611-33.
- Gourieroux, C. and A. Monfort,(1996) *Simulation Based Econometric Methods*, Oxford University Press.
- Smith, A. "Estimating Nonlinear Time-Series Models using Simulated Vector Autoregressions," *Journal of Applied Econometrics*, 8 (1993), S63-84.

Exercise classes

There will be 6-8 exercise classes

Teaching material

- Adda, J. and R. Cooper, *Dynamic Economics: Quantitative Methods and Applications*, MIT Press.
- Hamilton, J. H. (1994), *Time Series Analysis*, Princeton University Press
- Harvey, A,C. (1993), *Time Series Models*, Harvester-Wheatsheaf
- J. Wooldridge,(2010) *Econometric Analysis of Cross Section and Panel Data*, MIT Press,
- Lecture notes by the instructor.

Final exam and Grading

There will be problems set to be graded by TAs in classes (20%) and a final exam (80%).

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Optional 1: The econometrics of causality

Fabrizia Mealli (fabrizia.mealli@unifi.it)

This course will feature 10 2-hour lectures.

1. Introduction to Causality and Causal Inference (1 lecture)
    - Setting up the problem: the potential outcome framework
    - The role of the assignment mechanism
    - Design and analysis of randomized experiments
    - Estimands and modes of inference: Fisher exact tests; Neyman frequentist perspective; Regression analysis; Bayesian model-based imputation
    - Examples
2. Introduction to observational studies under unconfoundedness (2-3 lectures)
    - The role of the propensity score
    - Designing observational studies: matching, weighting, trimming
    - Analysis of observational studies: stratification, weighting estimators, matching estimators, methods based on the outcome models and regression.
    - Methods combined: bias corrected estimators, doubly robust estimators
    - Sensitivity analysis
    - Enhancing causal inference with machine learning in high dimensional settings and heterogeneous effects
3. Instrumental variables (2 lectures)
    - IV and RCT with noncompliance - revisited
    - Bayesian IV analysis: relaxing some of the assumptions
    - Point, partial, weak identification of causal effects
    - The role of covariates
    - IV and beyond: principal stratification and mediation analysis
4. Regression discontinuity designs (2 lectures)
    - The identification strategy: continuity vs local randomization
    - Sharp RDD
    - Fuzzy RDD and the local LATE interpretation of RDD
    - Graphical analysis, assessing identification assumptions
    - Bandwidth selection
    - Multiple thresholds, multiple forcing variables
    - Examples
5. Difference in difference, synthetic controls and beyond (1-2 lecture)
    - DID and extensions
    - Lagged dependent variables

- Synthetic controls and permutation inference
- Some recent developments

6. Causal Inference with interference (1-2 lectures)
    - Cluster/partial interference in randomized studies
    - Design, detect, assess interference
    - Cluster/partial interference in observational settings
    - General network interference in experimental and observational settings

Exercise classes

Two practical sessions on Bayesian (Causal) Inference

Teaching material

- Articles in journals
- Lecture notes by the instructor.

Final exam and Grading

There will be final class room exam (referee report) and two take-home assignments (simulation and real data exercises).

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Optional 2: Field Experiments: Research Design and Impact Evaluation using RCTs

Sule Alan (sule.alan@eui.eu)

Topic 1

Introduction to Impact Evaluation: Thinking about a major policy problem, designing an experiment to evaluate a program that aims to solve this problem, and evaluating the program in a causal manner to guide policy.

Lecture notes.

Topic 2

Theory of Change and Data: Establishing theory of change and underlying mechanisms in evaluation designs.

Lecture notes.

Topic 3

Randomization in Practice: Random assignment of program participation, cluster designs, phase-in designs, balance checks, research ethics in program participation.

Lecture notes.

Topic 4

Indicators and Measurement: Determining outcomes of interests: Real outcomes, behavioural (incentivized) outcomes, lab-in the field, survey outcomes.

Lecture notes.

Topic 5

Sampling: Determining optimal sample size, power calculations, study registration, pre-analysis plan (PAP). *Lecture notes.*

Topic 6

Threats and analysis: Dealing with missing data, non-compliance, demand effects, and attrition.

Topic 7

Evaluation: ATEs, ITTs LATEs, inference, small sample permutation, mechanism search, mediation analysis.

Lecture notes.

Topic 8

An evaluation from A to Z: Student presentations of the outline of the take home project, receiving feedback.

Teaching material

Course materials will be lecture notes, lecture slides (provided by S. Alan), and assigned journal articles.

Evaluation

Course work will be 20 percent outline presentation 80 percent take home project. The project will be a case study where students are expected to replicate a well-known RCT from design stage to dissemination of the results. There will be no exercise classes.

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Optional 3: Topics in Microeconometrics

Alessandro Tarozzi (alessandro.tarozzi@gmail.com)

A 20-hour topics course in applied micro-econometrics, with a particular emphasis on problems likely to be encountered in applied micro work, and techniques for dealing with those.

1. **Non-standard standard errors and inference** (10 hours): Adjusting standard errors with non-*i.i.d.* data in cross-sectional and panel data; the bootstrap; small-sample inference; randomization inference; inference with multiple hypothesis and family-wise error rates. Moulton (REStat 1990), Bertrand, Duflo and Mullainathan (QJE 2004), Cameron and Miller (JHR 2015), Holm (1979), Clarke, Romano and Wolf (2020).
2. **Introduction to non-parametric and semi-parametric methods**. Non-parametric estimation of densities and regressions. (4 hours): Bandwdiths and Kernels; Nadaraya-Watson and locally weighted regressions; partially linear models.
3. **Quantile Regression**. (2 hours)
4. **Bounding causal estimates when exogeneity does not hold**. Altonji et al (JPE 2005), Oster (JBES 2017), Pei, Pischke and Schwandt (JBES 2019), De Luca, Magnus and Peracchi (JBES 2019) (4 hours)

Exercise classes

No exercise class

Teaching material

- Selected journal articles and additional reading assigned with each lecture.
- Lecture notes provided by the instructor.

Evaluation

There will be 2-3 problem sets and a take home exam.

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Optional 4: Economic Measurement

Sule Alan (sule.alan@eui.eu)
and Thomas Crossley (thomas.crossley@eui.eu)

A first course in Economic Measurement, covering both "micro" and "macro" topics. 20 hours.

Topic 1

Introduction to National Accounting: Output, income and expenditure GDP; Intermediate consumption and value added. Supply-use balancing. Sectoral accounts. National and sectoral balance sheets.

Lequiller and Blades (2014), chapters 1, 4-8, and 10; Lecture notes and additional assigned readings.

Topic 2

Price-Volume Decomposition: Price and quantity Indices. Axiomatic and economic approaches. The CPI in practice. Multilateral price indices and international comparisons.

Lequiller and Blades (2014), chapters 2 and 3; Lecture notes and additional assigned readings.

Topic 3

The Labour Market: Labour market states and labour market flows.

Lecture notes and assigned readings.

Topic 4

Investment, Capital and Productivity: Measuring investment. Estimation of the capital stock. Productivity measurement.

Lecture notes and assigned readings.

Topic 5

Poverty and Inequality: Household income, consumption and wealth. Poverty lines and measures. Inequality measures.

Lecture notes and assigned readings.

Topic 6

Item Response Theory: Construction and of tests and scales.

Lecture notes and assigned readings.

Topic 7

Measuring Economic Preferences: Preferences over Risk and Time Preferences. Incentivized measures and survey measures.

Topic 8

Measuring Social Preferences:

Lecture notes and assigned readings.

Exercise classes

No exercise class

Teaching material

- Lequiller, F. and D. Blades, (2014). Understanding National Accounts, 2nd Ed. OECD. (available here: http://www.oecd.org/std/UNA-2014.pdf)
- Selected journal articles and additional reading assigned with each lecture.
- Lecture notes provided by the instructors.

Evaluation

- Paper presentation (50%)
- Take home exam (50%)

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Optional 5: Topics in Macroeconometrics

Barbara Rossi (barbara.rossi@upf.edu)

A course in Macroeconometrics. 20 hours.

The course will offer an overview of the econometric techniques used in the empirical analysis of monetary and fiscal policy as well as their empirical results.

The course has three specific objectives. The first is to equip students with the tools they need for empirical research on monetary and fiscal policy. The second objective is to lay out the econometric theory used in estimating the effects of economic policies, with an emphasis on recent developments. The third objective is to analyze selected recent empirical works.

1. Overview of econometric techniques to estimate the effects of economic policies
2. Selected works on monetary policy: identification, estimation and empirical results
3. Selected works on fiscal policy: identification, estimation and empirical results

Exercise classes

No exercise classes.

Teaching material

- Journal articles and other assigned readings.

Evaluation

The evaluation will be based on an in-class presentation and a written exam. Back to Overview

Optional 6: Development Economics and Global Health

Alessandro Tarozzi (alessandro.tarozzi@gmail.com)

20 hours. The course will cover a number of topics in Development micro-economics, with a focus on Global Health and Gender in low and middle-income countries (LMICs).

1. From health to wealth and vice-versa. Causal links between health inputs and shocks and human capital, in the short and long-run. The importance of early-life health investments.
2. The importance of demand factors in explaining poor health in LMICs: liquidity constraints, information, trust, present-bias.
3. The importance of supply factors in explaining poor health in LMICs: doctors' competence and effort, workers' selection, drug quality.
4. Gender in LMICs. 'Missing women', preference for sons and sex-selective abortion, female labor force participation, intra-household allocation of resources.
5. Fertility: Demand and supply factors, the role of contraceptives, information, old-age support, gendered preferences for large families.

Exercise classes

No exercise classes.

Teaching material

- Journal articles and other assigned readings.
- Lecture notes from the instructor.

Evaluation

The evaluation will be based on problem sets, a referee report for a recent unpublished paper and an in-class presentation.

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Optional 7: The Econometrics of Real Data

Tom Crossley (thomas.crossley@eui.eu)

A 20 hour course on problems that arise in micro data, and tools to deal with those problem.

Topic 1

Introduction: Sources of Economic Data. Surveys and versus administrative and other "naturally occurring" data sources. Integrated data. Overview of data problems. Total error framework.

Lecture notes and assigned readings.

Topic 2

Survey Data: How surveys are designed and conducted. Particular features of survey data. Design weights. Strata and PSU. Consequences for analysis. Population (or design-based) inferences versus model-based inferences.

Lecture notes and assigned readings.

Topic 3

Missing Data: How missing data arises: unit non- response, item non-response, attrition. Consequences for Analysis. Solutions: weighting; GMM; Single and multiple imputation; partial identification approaches (bounds).

Lecture notes and assigned readings.

Topic 4

Measurement Error: The ubiquity of measurement error. Classical measurement error, Berkson errors, non-classical measurement error, mis-classification. Measurement error in dependent and independent variables. Proxy variables. Consequences for analysis and solutions.

Lecture notes and assigned readings.

Topic 5

Data Combination: Issues arising when combining data from mulitiple sources (survey or admin) and solutions.

Lecture notes and assigned readings.

Topic 6

Data Management and Reproducible Workflow: A practical topic. Securing, organizing and documenting your data and ensuring your work is reproducible.

Lecture notes and assigned readings.

Exercise classes

No exercise classes.

Teaching material

- Journal articles and other assigned readings.
- Lecture notes from the instructor.

Evaluation

There will be graded data assignments worth 50 % and a final project worth 50 %.

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Optional 8: Machine Learning for Economists

Sergio Pastorello (U.Bologna)

A 20 hour course in Machine Learning tools for economists. At the end of the course the student will have a good understanding of the main tools used in machine learning. In particular, he/she: - understands and knows how to apply key aspects of machine and statistical learning, such as out-of-sample cross-validation, regularization and scalability - is familiar with the concepts of supervised learning, regression and classification - understands and can apply the main learning tools such as lasso and ridge regression, regression trees, boosting, bagging and random forests, support vector machines and neural nets. - The course will put special emphasis on empirical applications using the R software.

Topic 1

Introduction and Overview of Statistical Learning: Types of learning algorithms, regression vs. classification, the bias-variance trade-off

Topic 2

Linear Regression as Prediction Tool: Introduction to R

Topic 3

Binary and Multinomial Classification: Logistic Regression, Linear Discriminant Analysis, Naïve Bayes and K-Nearest Neighbours.

Topic 4

Resampling Methods: Cross-Validation and the Bootstrap

Topic 5

Model Selection and Regularization: Subset selection methods, Regularization methods (Ridge Regression, the LASSO, etc.), Dimension reduction methods (Partial Least Squares and Principal Components Regression)

Topic 6

Tree-based Methods: Classification and Regression trees, Bagging, Random Forests, Boosting and Bayesian Additive Regression Trees

Topic 7

Support Vector Machines and Neural Networks: Separating Hyperplanes as a classification tool, nonlinear decision boundaries, the kernel trick and the Support Vector Machine; Support Vector Regression

Topic 8

Deep Learning: Single and Multilayer Neural Networks, Convolutional and Recurrent Neural Networks, fitting methods (Backpropagation, Regularization and SGD, etc.)

Topic 9

Multiple Testing: the Family-Wise Error Rate, the False Discovery Rate, Resampling approaches

Exercise classes

No exercise class.

Teaching material

- James, Witten, Hastie and Tibshirani, *An Introduction to Statistical Learning, 2nd edition*, Springer 2021 (the first edition can be downloaded from https://www.statlearning.com/).

  Hastie, Tibshirani and Friedman, *The elements of Statistical Learning*, Springer 2009 (the 2017 12th printing can be downloaded from https://web.stanford.edu/ hastie/ElemStatLearn/)

- Lecture slides and R scripts by the instructor.

Evaluation

Problem sets (30%) and a final project (70%).

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Optional 9: Modern Difference-in-Differences

Mirjam Reutter (mirjam.reutter@eui.eu)

Course description

Difference-in-Differences approaches are one of the most popular and powerful tools for causal inference in use today. In the last years, there was an explosion of work on DiD methods that has made it very difficult to keep track of rapidly changing standards. This course will begin with the basic DiD design using two-way fixed effects and discuss state-of-the-art applications. It will cover extensions like staggered treatment adoption, heterogeneous treatment effects, interference, and matching. We will work through assumptions, diagnostics, practical examples and code in R and Stata (if available). Moreover, students will present and discuss extensions of the classical DiD design with practical examples from recent papers.

Syllabus

1. Review of the Basic DiD and Issues in Modern DiD
2. Parallel Trends + presentations
3. Propensity Score + presentations
4. Staggered Treatment Adoption + presentations
5. Interference and Spillovers + presentations

Course Work (10 hours mini course)

- Participation in the paper and presentation discussions (20%)
- Presentation of a research paper (80%)

Literature (to be updated)

Basic DiD:

- Joshua Angrist and Jörn-Steffen Pischke (2013). *Mostly Harmless Econometrics. An Empiricist's Companion.* Princeton University Press, 2013.
- David Card and Alan Krueger (1994). Minimum Wages and Employment: A Case Study of the Fast Food Industry in New Jersey and Pennsylvania. *American Economic Review*, 84(4), 772-793.
- Jörn-Steffen Pischke (2007). The Impact of Length of the School Year on Student Performance and Earnings: Evidence from the German Short School Years. *Economic Journal*, 117(523), 1216-1242.

Parallel Trends:

- Freyaldenhoven, S., Hansen, C., & Shapiro, J. M. (2019). Pre-event trends in the panel event-study design. American Economic Review, 109(9), 3307-38.

- Rambachan, A., & Roth, J. (2019). An honest approach to parallel trends. Unpublished manuscript, Harvard University.[99].
- Roth, J. (2018). Should we adjust for the test for pre-trends in difference-in-difference designs?. arXiv preprint arXiv:1804.01208.
- Leavitt, T. (2020). Beyond Parallel Trends: Improvements on Estimation and Inference in the Difference-in-Differences Design. Working paper.

Propensity Score:

- Abadie, A. (2005). Semiparametric difference-in-differences estimators. The Review of Economic Studies, 72(1), 1-19.
- Houngbedji, K. (2016). Abadie's semiparametric difference-in-differences estimator. The Stata Journal, 16(2), 482-490.
- Sant'Anna, P. H., & Zhao, J. (2020). Doubly robust difference-in-differences estimators. Journal of Econometrics, 219(1), 101-122.

Staggered Treatment Adoption:

- Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. Journal of Econometrics.
- Goodman-Bacon, A., & Marcus, J. (2020). Using difference-in-differences to identify causal effects of COVID-19 policies.
- Sun, L., & Abraham, S. (2020). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. Journal of Econometrics.
- Callaway, B., & Sant'Anna, P. H. (2020). Difference-in-differences with multiple time periods. Journal of Econometrics.
- Athey, S., & Imbens, G. W. (2021). Design-based analysis in difference-in-differences settings with staggered adoption. Journal of Econometrics..
- de Chaisemartin, C., & D'Haultfoeuille, X. (2020). Difference-in-Differences Estimators of Intertemporal Treatment Effects. Available at SSRN 3731856.

Interference and Spillover:

- Delgado, M. S., & Florax, R. J. (2015). Difference-in-differences techniques for spatial data: Local autocorrelation and spatial interaction. Economics Letters, 137, 123-126.
- Clarke, D. (2017). Estimating difference-in-differences in the presence of spillovers.

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