



Econometrics III: Advanced Econometrics and Machine Learning (only PhD) (formerly, Topics in Applied Econometrics)

Course instructor

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Office hours: by arrangement

Lecture: March 21-25, 2022 (9am to 4pm); Z534/Z536

Prerequisites: Econometrics I and II (TUM) or equivalently solid introductory courses in econometrics. Preferably some basic knowledge of R and Python. Participants should bring their own laptop with R and/or Python installed. The target audience are PhD students.

Grading: Successful participation; details below (4SWS / 6 ECTS points)

Course outline:

The course covers a selection of state-of-the-art methods in econometrics and machine learning. It aims to provide students with a sound understanding of the methods discussed, such that they are able to do research using modern econometric techniques, as well as critically assess existing studies.

In particular, the course will cover the following topics:

- Regression Shrinkage Methods (Ridge, Lasso, Elastic Net)
- Adaptive Lasso Regression
- Classifier-Lasso Regression
- Double Machine Learning

1st part of the week:

In the morning sessions, we will discuss the econometric methods and/or machine learning techniques (including some applications to illustrate them). Students will then apply these methods and will replicate recent research papers in the afternoon sessions.

2nd part of the week:

The second part of the week will be a reading course in which we will discuss selected papers. I will assign a (replication) project to each student at the organizational meeting, which (s)he will present. All participants are expected to read the papers before the meetings. The presentation (roughly 30 minutes) together with a short report that summarizes the assigned paper (roughly 5 pages w/o figures, tables and references) will be relevant for the grading. There will be an organizational meeting roughly four weeks before the lectures start (via Zoom).

Recommended textbooks:

Hansen Bruce. *Econometrics*, online textbook
available at <http://www.ssc.wisc.edu/~bhansen/econometrics>

Hastie Trevor, Tibshirani Robert and Friedman Jerome. *The Elements of Statistical Learning*, Springer, available at <https://web.stanford.edu/~hastie/Papers/ESLII.pdf>

Goodfellow Ian, Bengio Yoshua and Courville Aaron. *Deep Learning*, MIT Press, available at <https://www.deeplearningbook.org>

Papers you definitely should read:

- Bach *et al.* (2022): DoubleML - An Object-Oriented Implementation of Double Machine Learning in Python, *Journal of Machine Learning Research* 23(53), 1-6.
- Su, Shi and Phillips (2016): Identifying Latent Structures in Panel Data, *Econometrica*, 84(6), 2215–2264.
- Tibshirani (1996): Regression Shrinkage and Selection via the Lasso. *Journal of the Royal Statistical Society: Series B (Methodological)* 58(1), 267–288.
- Zou (2006): The Adaptive Lasso and Its Oracle Properties, *Journal of the American Statistical Association* 101(476), 1418-1429.

Papers you could read if you have plenty of time:

- Angrist and Frandsen (2020): Machine Labor, NBER Working Paper 26584.
- Athey and Imbens (2019): Machine Learning Methods Economists Should Know About, *Annual Review of Economics*, 11, 685–725.
- Chernozhukov *et al.* (2018): Double/debiased Machine Learning for Treatment and Structural Parameters, *Econometrics Journal*, 21, C1–C68.
- Giannone, Lenza and Primiceri (2021): Economic Predictions with Big Data: The Illusion of Sparsity, *Econometrica*, 89(5), 2409–2437.
- Mullainathan and Spiess (2017): Machine Learning: An Applied Econometric Approach, *Journal of Economic Perspectives*, 31(2), 87–106.
- Varian (2014): Big Data: New Tricks for Econometrics, *Journal of Economic Perspectives*, 28(2), 3–28.
- Wüthrich and Zhu (2021): Omitted Variable Bias of Lasso-based Inference Methods: A Finite Sample Analysis, *Review of Economics and Statistics*, forthcoming.

Timetable:

	Monday	Tuesday	Wednesday	Thursday	Friday
9-11	Lecture 1 (Recap)	Project Work	Project Work	Project Work	Project Work
11-13	Lecture 2	Lecture 2	Project Work	Presentations	Presentations
13-14	Lunch break				
14-16	Lecture 2	Lecture 3	Project Work	Presentations	Presentations

In lecture 1 I will briefly recap the basics in OLS, 2SLS and GMM. If you have already heard about these methods, feel free to arrive on Monday 11am.

Project Work: In this slot you are supposed to work on your application. I will be available for individual questions and discussions in my office or via Zoom.