

PHD146: Applied Environmental Economics and Policy Evaluation

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PhD in Science and Management of Climate Change

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Office hours: by appointment

Lectures: Aula Delta 2B/D (Edificio Delta, via Torino)

21.05.26 - 27.05.26

Course Overview

This course provides PhD students with a rigorous and applied introduction to modern causal inference methods for policy evaluation, with applications drawn from environmental and climate economics. Starting from the canonical difference-in-differences (DiD) framework, the course covers the challenges posed by staggered treatment adoption and heterogeneous treatment effects, and introduces three families of robust DiD estimators: Callaway & Sant'Anna, Sun & Abraham, and De Chaisemartin & D'Haultfoeuille. Students will also learn the local projection DiD approach for estimating dynamic treatment effects, the synthetic control method (SCM), and synthetic DiD, which combines ideas from both SCM and DiD. The course concludes with regression discontinuity design (RDD), covering both sharp and fuzzy variants. Throughout, methods are illustrated with environmental policy applications — including the US Clean Air Act, the EU Emissions Trading System, and carbon pricing schemes — and accompanied by hands-on R tutorials.

Topics

This is the list of topics covered in the course:

1. Difference-in-Differences (DiD): A Recap
2. Robust Difference-in-Differences Methodologies
 - The TWFE problem: Goodman-Bacon (2021) decomposition and negative weights
 - Callaway and Sant’Anna (2021): group-time ATTs and the doubly robust approach
 - Sun and Abraham (2021): interaction-weighted estimator
 - De Chaisemartin and D’Haultfoeuille (2020, 2024): the DID_M estimator, dynamic effects, and continuous treatment
3. Local Projection Difference-in-Differences (LP-DiD)
4. Synthetic Control Method (SCM)
5. Synthetic Difference-in-Differences (SDiD)
6. Regression Discontinuity Design (RDD)

Weekly Schedule

Lecture	Date	Hour	Activity	Topic
1	21.05.26	14:00-17:15	Lectures & Tutorials	1-2
2	25.05.26	09:30-12:30	Lectures & Tutorials	3-4
3	27.05.26	14:00-15:30	Lectures & Tutorials	5-6

Class Structures

Lectures

Each session begins with lectures introducing the methodological framework, its key assumptions, and its formal specification. Environmental and climate policy applications are used throughout to illustrate each method in practice. Applications discussed include the

US Clean Air Act, the EU Emissions Trading System, US Renewable Portfolio Standards, carbon taxes, California's cap-and-trade program, NAAQS nonattainment designations, and energy efficiency subsidies.

Tutorials

Lectures are complemented by hands-on coding tutorials in R. Students will learn to implement each method using the relevant packages: `did` (Callaway & Sant'Anna), `fixest` (Sun & Abraham via `sunab()`), `DIDmultiplegtDYN` (De Chaisemartin & D'Haultfoeuille), `lpdid` (LP-DiD), `tidysynth` (SCM), `synthdid` (SDiD), and `rdrobust` (RDD). Companion R scripts will be provided for each lecture.

Course Materials

Lecture Notes

Lecture notes and scripts will be made available on Moodle.

Bibliography

Surveys and textbooks:

- Angrist, J.D. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics*. Princeton University Press. — Ch. 5 (DiD), Ch. 6 (RDD).
- Lee, D.S. and Lemieux, T. (2010). Regression Discontinuity Designs in Economics. *Journal of Economic Literature*, 48(2), 281–355.
- Imbens, G.W. and Lemieux, T. (2008). Regression Discontinuity Designs: A Guide to Practice. *Journal of Econometrics*, 142(2), 615–635.
- Abadie, A. (2021). Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. *Journal of Economic Literature*, 59(2), 391–425.

Methodological references:

- Goodman-Bacon, A. (2021). Difference-in-Differences with Variation in Treatment Timing. *Journal of Econometrics*, 225(2), 254–277.

- Callaway, B. and Sant'Anna, P.H.C. (2021). Difference-in-Differences with Multiple Time Periods. *Journal of Econometrics*, 225(2), 200–230.
- Sun, L. and Abraham, S. (2021). Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects. *Journal of Econometrics*, 225(2), 175–199.
- De Chaisemartin, C. and D'Haultfoeuille, X. (2020). Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects. *American Economic Review*, 110(9), 2964–2996.
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- Ben-Michael, E., Feller, A. and Rothstein, J. (2021). The Augmented Synthetic Control Method. *Journal of the American Statistical Association*, 116(536), 1789–1803.
- Arkhangelsky, D., Athey, S., Hirshberg, D.A., Imbens, G.W. and Peel, S. (2021). Synthetic Difference-in-Differences. *American Economic Review*, 111(12), 4088–4118.
- Calonico, S., Cattaneo, M.D. and Titiunik, R. (2014). Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs. *Econometrica*, 82(6), 2295–2326.
- Roth, J. (2022). Pretest with Caution: Event-Study Estimates after Testing for Parallel Trends. *American Economic Review: Insights*, 4(3), 305–322.

Applications:

- Greenstone, M. (2004). Did the Clean Air Act Cause the Remarkable Decline in Sulfur Dioxide Concentrations? *Journal of Environmental Economics and Management*, 47(3), 585–611.

- Petrick, S. and Wagner, U. (2014). The Impact of Carbon Trading on Industry: Evidence from German Manufacturing Firms. Working Paper.
- Dechezleprêtre, A., Nachtigall, D. and Venmans, F. (2023). The Joint Impact of the European Union Emissions Trading System on Carbon Emissions and Economic Performance. *Journal of Environmental Economics and Management*, 118, 102758.
- Chay, K.Y. and Greenstone, M. (2005). Does Air Quality Matter? Evidence from the Housing Market. *Journal of Political Economy*, 113(2), 376–424.
- Isen, A., Rossin-Slater, M. and Walker, W.R. (2017). Every Breath You Take — Every Dollar You’ll Make: The Long-Term Consequences of the Clean Air Act of 1970. *Journal of Political Economy*, 125(3), 848–902.
- Ito, K. (2014). Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing. *American Economic Review*, 104(2), 537–563.