Course unit English denominatio n	Causal Inference in Social Science Observational Studies
Teacher in charge (if defined)	• Bruno Arpino • Marco Tosi
Teaching Hours	12
Number of ECTS credits allocated	2
Course period	06/2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence, apart from exceptional absences that must be justified in advance) ☐ No
Course unit contents	In several disciplines, research is often motivated by questions that imply a causal link between phenomena. Although the gold standard for establishing causality is represented by randomized experiments, they are not always possible because of ethical or practical reasons and the estimation of causal effects often has to rely on observational studies. The validity of inference will then strictly depend on the plausibility of the assumptions underlying the employed statistical techniques. This course will cover some of the most popular techniques for estimating causal effects with observational data: propensity score matching, instrumental variable regression, fixed effects models, and difference-in-differences methods. Special emphasis will be placed during the course on discussing the plausibility of the identifying assumptions, the data requirements and other practical and theoretical challenges for the implementation of each method. This short course will offer theoretical and applied perspectives on the covered topics. Examples will be drawn from social sciences, public health and policy evaluation. The implementation of the covered techniques in the R software will be illustrated. Day 1 (3 hours) • Introduction and course overview - Potential Outcome framework - Directed Acyclic Graphs: A graphical tool to visually represent causal models - Randomized experiments versus observational studies - Overview of statistical methods corresponding to different sets of assumptions • Quick review of regression methods: pros and cons • Propensity score matching (and similar methods) Day 2 (3 hours)

	• Sensitivity analyses to address unmeasured confounding • Instrumental Variable Regression Day 3 (3 hours) • Panel data models with individual fixed effects • Difference-in-Differences models Day 4 (3 hours) • Summary and key take home messages • Directions on recent developments in causal inference - Causal Inference vs Predictive Modeling - Causal Inference and Machine Learning
Learning goals	The goal is to provide the fundamental tools to navigate in a growing field of methodological and empirical research, while also providing solid understanding on several specific methods.
Teaching methods	• Lectures • Laboratories
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☐ No Students from other PhD courses may be admitted subject to CV evaluation and until the maximum number of students has been reached
Prerequisites (not mandatory)	Regression analysis and the R software.
Examination methods (in applicable)	None
Suggested readings	• Course material available from the instructors • Becker, S.O. (2016). Using instrumental variables to establish causality. IZA World of Labor. • Brüderl, J., & Ludwig, V. (2015). Fixed-effects panel regression. The Sage handbook of Regression Analysis and Causal Inference, 327-357. • Dominici, F., Bargagli-Stoffi, F.J., & Mealli, F. (2021). From controlled to undisciplined data: Estimating causal effects in the era of data science using a potential outcome framework. Harvard Data Science Review, 3(3), 1–34. • Holland, P. (1986). Statistics and Causal Inference, with discussion and rejoinder. Journal of the American Statistical Association, 81, 945-970. • Imbens, G.W. & Rubin, D.B. (2015). Causal inference for statistics, social, and biomedical sciences: An introduction. Cambridge University Press. • Reiter, J. P. (2000). Using statistics to determine causal relationships. The American Mathematical Monthly, 107, 24-32.

- Shahidur R. Khandker, Gayatri B. Koolwal and Hussain A. Samad (2010) Handbook on Impact Evaluation. Quantitative Methods and Practices, The World Bank, Washington D.C. Freely available on-line at: http://documents.worldbank.org/curated/en/650951468335456749/pdf/520990PUB0EPI1101Official0Use0Only1.pdf
- Zhao, Q., & Hastie, T. (2021). Causal interpretations of black-box models. Journal of Business & Economic Statistics, 39(1), 272-281.

Additional information