

GESIS Spring Seminar 2024

Syllabus for course: “Recent Developments in Difference-in-Differences Estimation”

Lecturer:	Dr. Scott Cunningham	Teaching Assistant:	Kyle Butts
Affiliation:	Baylor University	Affiliation:	University of Colorado Boulder
Email:	scunning@gmail.com	Email:	Kyle.Butts@colorado.edu
Website:	www.scunning.com	Website:	https://www.kylebutts.com/

Date: 04 - 08 March 2024

Time: Mo-Fr: 10:00-17:00

Venue: Onsite at GESIS Cologne

About the Lecturers

Scott Cunningham is a professor of economics at Baylor University in Waco Texas. He has published in economics outlets such as *The Review of Economic Studies*, *Journal of Urban Economics*, *Journal of Human Resources*, *Journal of Public Economics*, *Journal of Development Economics* and more. He is the author of [Causal Inference: the Mixtape](#) published by Yale University Press in 2021 and co-editor of [The Handbook on the Economics of Prostitution](#) (with Manisha Shah) published by Oxford University Press in 2016. His research focus covers a range of applied topics in health and labor, including sex work, abortion, drug policy, corrections and mental healthcare. He has taught dozens of in-person and online workshops on causal inference and difference-in-differences to universities and firms across the world including eBay, Twitch, Facebook, HP, University of Oxford, London School of Economics, University of Pennsylvania and countless others.

Kyle Butts is a PhD Candidate at the University of Colorado Boulder. He works on questions of urban economics and applied econometrics including work on difference-in-differences with spatial spillovers. His work has been published in the *Journal of Urban Economics*, the *Journal of Urban Economics Insights*, and more. His most recent work focuses on treatment effect estimation accounting for certain kinds of parallel trends failures. He has contributed to open source statistical software that has been downloaded tens of thousands of times.

Selected Publications

Chin, Yoo-Mi, and Scott Cunningham. "Revisiting the effect of warrantless domestic violence arrest laws on intimate partner homicides." *Journal of Public Economics* 179 (2019): 104072.

Cunningham, Scott, and Manisha Shah. "Decriminalizing indoor prostitution: Implications for sexual violence and public health." *The Review of Economic Studies* 85.3 (2018): 1683-1715.

Cunningham, Scott, et al. "Adverse Impacts of Mental Health Needs Assessment on Jail Outcomes: Evidence from Transition Age Youth and Adults." *Journal of Human Resources* (2023).

Butts, Kyle. "JUE Insight: Difference-in-differences with geocoded microdata." *Journal of Urban Economics* 133 (2023): 103493. <https://www.sciencedirect.com/science/article/pii/S0094119022000705>

Butts, Kyle and Gardner, John. "did2s: Two-Stage Difference-in-Differences", *The R Journal*, 2022. <https://journal.r-project.org/articles/RJ-2022-048/>

Course Description

When researchers are not able to field randomized experiments to study the causal effects of large social programs due to their size, associated costs, feasibility, and ethical constraints, they often rely on natural experiments such as law changes or natural disasters. The most popular research design for estimating the causal effects using longitudinal data is the difference-in-differences design. The method is extremely popular in the empirical social sciences. For instance, around 25% of all papers at the NBER working paper series using difference-in-differences.

But, while difference-in-differences is relatively straightforward, unbiasedness in the parameter estimates depends on the setup of the quasi-experiment and the methodology used. For instance, when there are more than one dates when units are treated, then traditional panel methods are no longer guaranteed to be unbiased, even under parallel trends. Our understanding of these issues has evolved considerably over the last several years, both in terms of econometric theory and software implementation. This workshop will review this emerging work covering both the intuition behind the statistical models and the technical details of the models themselves using lectures, discussion and group exercises using R and/or Stata.

The last day we will review the synthetic control estimator which will be presented as an option for when the conditions that make difference-in-differences not ideal are more suitable for this method.

Keywords

Causal inference; difference-in-differences; synthetic control

Course Prerequisites

- Econometrics preferred, another causal inference course preferred, exposure to potential outcomes model, but we will be focused on beginner to advanced, so if not it's not a problem.

Target Group

You will find the course useful if:

- They work on policy analysis in either public policy or private policy (e.g., industry), or they are academics who work on problems needing estimates of causal inference.
- They are students wishing to learn these methods for a thesis or dissertation.

Course and Learning Objectives

By the end of the course you will:

- Be able to apply the methods covered in class in their own research using software such as R or Stata.

Organizational Structure of the Course

Days will be spent mixing lecture, discussion, and labs exercises. We have 15 min breaks on the hour, 1 hour break for lunch, and then continue with the same rhythm until end of day.

Software and Hardware Requirements

Course participants will need to bring a laptop with R/RStudio and Stata installed. The latest versions of R and RStudio are available for free at <https://cran.r-project.org/> and <https://www.rstudio.com/>. Participants may receive a Stata short term license provided by GESIS for the duration of the course if needed.

Participants will need to be able to download files from the internet (free Wifi is provided by GESIS) and will need to have the rights to install R packages or Stata Ados on their laptops during the course.

Recommended Literature to Look at in Advance

Please read Cunningham’s Mixtape by Yale Press (available for free at <https://mixtape.scunning.com> , where you may use the TOC on the left to navigate through the book's chapters), as well as the draft on difference-in-differences by Baker, Callaway, Goodman-Bacon and Sant’Anna (under review; not yet available). You may also find the discussions of difference-in-differences and synthetic control at Scott’s Substack (<https://causalinf.substack.com>) helpful.

Day-to-day Schedule and Literature

Day	Topic(s)
1	<p>Basics of diff-in-diff</p> <p>Scott’s Substack writings on diff-in-diff (causalinf.substack.com)</p> <ul style="list-style-type: none"> ▪ Introduction to difference-in-differences (history) ▪ “Four averages and three differences” – the difference-in-differences equation ▪ Potential outcomes review, the average treatment effect on the treated group, and parallel trends ▪ OLS specification and inference ▪ Marshalling evidence for difference-in-differences <ul style="list-style-type: none"> ○ Bite ○ Falsifications ○ Event studies ○ Main Results ○ Mechanisms ▪ Coding exercises <p><i>Literature:</i> Cunningham (2021), Gruber (1995), Miller, Johnson and Wherry (2021), Bertrand, Duflo and Mullainathan (2004)</p>
2	<p>Violations of parallel trends</p> <ul style="list-style-type: none"> ▪ Violations of parallel trends: Repeated cross sections and compositional change ▪ Violations of parallel trends: Triple differences ▪ Violations of parallel trends: Incorporating covariates <ul style="list-style-type: none"> ○ Heckman, Ichimura and Todd (1997) ○ Abadie (2005) ○ Sant’Anna and Zhao (2020) ○ Twoway fixed effects with time varying controls ▪ Lalonde coding exercise <p><i>Literature:</i> Hong (2013), Lalonde (1986), Sant’Anna and Zhao (2020), Abadie (2005), Heckman, Ichimura and Todd (1997)</p>
3	<p>Twoway fixed effects with and without heterogenous treatment effects</p> <p>Panel fixed effects and strict exogeneity (Cunningham 2021)</p> <ul style="list-style-type: none"> ○ Cheng and Hoekstra (2013): “Castle Doctrine” paper ▪ Bacon decomposition (Goodman-Bacon 2021) ▪ Coding exercise

	<i>Literature:</i> Goodman-Bacon (2021), Callaway and Sant'Anna (2021), Cunningham (2021), Cheng and Hoekstra (2013)
4	<p>Event studies and staggered, Imputation</p> <p>Decomposition event study leads and lags under staggered adoption (Sun and Abraham 2021)</p> <ul style="list-style-type: none"> ▪ Imputation estimators <ul style="list-style-type: none"> ○ Borusyak, et al. (2021) ○ Wooldridge (2022) ○ Gardner, et al. (2021) ▪ Coding exercise ▪ Stacking if time
	<i>Literature:</i> Sun and Abraham (2021), Borusyak, et al (2021), Wooldridge (2021), Gardner et al. (2022)
5	<p>Synthetic control</p> <p><i>Literature:</i> Abadie, Diamond and Hainmueller (2010, 2015)</p> <ul style="list-style-type: none"> ▪ Ben-Michael, et al. (2021) ▪ Athey, et al. (2021) ▪ Arkhangelsky, et al. (2021)

Additional Recommended Literature

When the date gets closer, Scott Cunningham will be distributing two survey articles: one on diff-in-diff by himself and a few others, and one on synthetic control by Abadie.

References

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Heckman, J. J., Ichimura, H., & Todd, P. E. (1997). "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme" *The Review of Economic Studies*, 64(4), 605–654.
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Sant'Anna, Pedro HC, and Jun Zhao. (2020). "Doubly robust difference-in-differences estimators." *Journal of Econometrics* 219.1: 101-122. <https://www.sciencedirect.com/science/article/pii/S0304407620301901>

Sun, Liyang, and Sarah Abraham. (2021) "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects." *Journal of Econometrics* 225.2: 175-199.

Wooldridge, Jeffrey M. (2021). "Two-Way Fixed Effects, the Two-Way Mundlak Regression, and Difference-in-Differences Estimators": Available at <http://dx.doi.org/10.2139/ssrn.3906345>