

March 1-12, 2021 | 2:00pm-7:00pm EST

Modern Difference in Difference Designs

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Course Description

Difference in Difference designs are one of the most versatile and powerful tools for observational causal inference in use today. In the last few years, we have seen a veritable explosion of work on DiD methods that has made it very difficult to keep track of rapidly changing standards. This ten-day workshop will begin with the basic DiD design using two-way fixed effects and build up to the state-of-the-art applications. We will then move into advanced extensions like matching, synthetic control, asymmetric/staggered treatments, dynamic treatments, interference, and heterogeneous treatment effects. We will work through DiD designs with practical examples, assumptions, diagnostics, and code in R and Stata (when available).

This workshop is appropriate for anyone considering using observational causal inference tools and makes no assumption of pre-existing training beyond basic regression.

Course Materials

You will find all of the course materials in Dropbox at the [Course Dropbox Files Link](#). I suggest you bookmark it and check it each day as I will be updating it throughout the course. I will be adding material all weekend once I've rechecked everything.

Slack

The primary means of asynchronous communication for the class will be a dedicated slack channel. This will allow everyone to post questions regardless of if they are on the live zoom call. We STRONGLY encourage you to post questions to this channel and to answer questions if you believe you can.

You can download Slack [here](#) for free and join the course slack channel [At This Link](#).

Zoom

All class sessions will be conducted over zoom. The zoom links will be provided in Slack, by email, and in a file in Dropbox for ease of access by Sunday at noon EST

I plan to record the class sessions and post them to a private YouTube channel once edited. I'll provide the link to this in Slack.

Readings

A working reading list has been included on this draft of the syllabus to indicate what will be covered in class to varying degrees of depth. The reading list is designed to give you additional material when you leave. We will be going through specific papers and their applications each day and you do not have to have read them ahead of time (though it is helpful).

Software

Applications will be made available in Stata and R. However, not all of the tools covered are available in both software packages. Many are also currently beta versions and will be somewhat limited.

You can find copies of Stata 16 SE, R 4.04, and RStudio in the [Course Dropbox Files](#) in the Software subfolder. This version of Stata is a limited time license and will expire after the course.

You will also find some code to run in both Stata and R (please use RStudio to open the file). It's in the Code>Day 0 Folder in the R [Course Dropbox Files](#). It *should* install all the necessary packages for the workshop. Be warned that the current build of R (4.04) is a little twitchy and gave me some headaches reinstalling packages for my test runs. Those problems

seem to be restricted to Mac OS Big Sur but don't be shocked if something weird happens. That's why we have the first lab dedicated to troubleshooting the software.

Schedule

Each day will follow the same three block format. Most days this will include 1) a broad overview of a problem & the associated literature 2) an in-depth look at a particularly important paper that you need to understand well and 3) how to implement these methods in software.

References associated with each block are listed below their time slot. You do not have to have read these articles before their lecture.

We will have two 30 minute breaks at 3:15 & 5:00 each day.

Monday: Introduction to DiD

2:00-3:15 Basic Difference in Difference

Wing, C., et al. (2018). "Designing Difference in Difference Studies: Best Practices for Public Health Policy Research." *Annual Review of Public Health* 39: 453-469.

Kahn-Lang, A., & Lang, K. (2019). The promise and pitfalls of differences-in-differences: Reflections on 16 and pregnant and other applications. *Journal of Business & Economic Statistics*, 1-14.

3:45-5:00 Making Sense of the DiD Literature

Almost all work in the extended universe of DiD and DiD-like methods are concerned with one or more of the following questions:

- 1) Are treatment & control groups comparable?
- 2) How are the treatments structured?
- 3) Is there heterogeneity in treatment effects?
- 4) Are there issues of spillover, interference, or non-compliance?

5:30-7:00 DiD in R & Stata

We will be working to make sure that people have access to both R and Stata and can the appropriate packages in either. If you are familiar with both programs (and both work on your machine) then you may decide to skip this lab and work through the material yourself.

Prior to the lab please have the programs installed on your machine. You can find them in the Software folder in the [Course Dropbox Files](#)

Tuesday: Parallel Trends Assumptions

The parallel trends assumption is fundamentally concerned with treatment & control group comparability. The use of the negative outcome control allows us to go from mean exchangeability to trend exchangeability assumptions.

2:00-3:15 A Macroscopic View of Parallel Trends

Sofer, T., Richardson, D. B., Colicino, E., Schwartz, J., & Tchetgen, E. J. T. (2016). On Negative Outcome Control of Unobserved Confounding as a Generalization of Difference-in-Differences. *Statistical science*, 31(3), 348-361.

Keele, L. J., Small, D. S., Hsu, J. Y., & Fogarty, C. B. (2019). Patterns of Effects and Sensitivity Analysis for Differences-in-Differences.

Rambachan, A. & Roth, J., (2019). An honest approach to parallel trends. Working Paper.

Bilinski, A., & Hatfield, L. A. (2018). Nothing to see here? Non-inferiority approaches to parallel trends and other model assumptions. arXiv preprint

Mora Villarrubia, R., & Reggio, I. (2012). Treatment effect identification using alternative parallel assumptions. Universidad Carlos III de Madrid. Departamento de Economía.

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

Egami, N., & Yamauchi, S. (2019). How to improve the difference-in-differences design with multiple pre-treatment periods. Working Paper

Leavitt, T. (2020). Beyond Parallel Trends: Improvements on Estimation and Inference in the Difference-in-Differences Design. Working paper.

Roth, J. (2018). Should we adjust for the test for pre-trends in difference-in-difference designs?. Working Paper

3:45-5:00 An In-Depth Look at Rambachan & Roth (2019)

5:30-7:00 Testing for Parallel Trends with R & Stata

We will be going through a number of packages but will primarily focus on `fect` (R Stata), `didq` (Stata), and `HonestDiD` (R)

Wednesday: Treatment Structures & Effect Heterogeneity

We will cover two difficult and understudied problems in the DiD literature today: complex treatment structures and effect heterogeneity.

We will be going over them initially at a somewhat general level and we will focus in on specific implications (variation in treatment timing, unmodeled heterogeneity) next week. The first problem occurs when treatment structures don't follow a simple on/off pattern that is consistent across treated groups. Here, we will look at fuzzy or continuous treatments and treatments that are similar but not identical due to variation in implementation or legislation. The second problem occurs when variations on the ATE or ATT do not adequately describe the treatment effects because those effects vary in important ways across the treated group. The most common example of this occurs with differential timing of adoption or implementation which we will cover in detail next week.

2:00-3:15 A Macroscopic View of Effect Heterogeneity

de Chaisemartin, C., & d'Haultfoeuille, X. (2019). Two-way fixed effects estimators with heterogeneous treatment effects (No. w25904). National Bureau of Economic Research.

Goodman-Bacon, A., 2018. Difference-in-differences with variation in treatment timing (No. w25018). National Bureau of Economic Research.

Bonhomme, S., & Sauder, U. (2011). Recovering distributions in difference-in-differences models: A comparison of selective and comprehensive schooling. *Review of Economics and Statistics*, 93(2), 479-494.

Rhodes, W. (2010). Heterogeneous treatment effects: what does a regression estimate? *Eval Rev*, 34(4), 334-361.

Gibbons, C. E., Suárez Serrato, J. C., & Urbancic, M. B. (2019). Broken or Fixed Effects? *Journal of Econometric Methods*, 8(1).

Glynn and Ichino, 2019 "Generalized nonlinear difference-in-difference-in-differences," V-Dem Working Paper

3:45-5:00 A Macroscopic View of Treatment Structures

De Chaisemartin, C., & d'Haultfoeuille, X. (2018). Fuzzy differences-in-differences. *The Review of Economic Studies*, 85(2), 999-1028.

Yamauchi, S. (2020). Difference-in-Differences for Ordinal Outcomes: Application to the Effect of Mass Shootings on Attitudes toward Gun Control. Working Paper

5:30-7:00

We will be working through the basics of applications for fuzzy DiD and the quantile treatment effects options in both Stata and R. If we have time we will also discuss how to model treatment effects for ordinal outcomes and the Goodman-Bacon Decomposition.

Thursday: Interference, Spillover, & Noncompliance

2:00-3:15 A Macroscopic View of Interference

Bowers, J., Fredrickson, M. M., & Panagopoulos, C. (2013). Reasoning about interference between units: A general framework. *Political Analysis*, 21(1), 97-124.

Delgado, M. S., & Florax, R. J. (2015). Difference-in-differences techniques for spatial data: Local autocorrelation and spatial interaction. *Economics Letters*, 137, 123-126.

De Castris, M., & Pellegrini, G. (2015). Neighborhood effects on the propensity score matching (No. 0515).

Aronow, P. M., Eckles, D., Samii, C., & Zonszein, S. (2021). Spillover effects in experimental data. arXiv preprint arXiv:2001.05444.

Ogburn, E. L., & VanderWeele, T. J. (2014). Causal diagrams for interference. *Statistical science*, 29(4), 559-578.

Berg, T., & Streitz, D. (2019). Handling Spillover Effects in Empirical Research. Available at SSRN 3377457.

Clarke, D. (2017). Estimating Difference-in-Differences in the Presence of Spillovers.

Egami, N. (2021) Spillover Effects in the Presence of Unobserved Networks. *Political Analysis*

Harris, R.; Moffat, J. Kravtsova, V. (2011) In search of 'W'. *Spatial Economic Analysis*

3:45-5:00 In-Depth Look at Bowers (2013), Aronow (2021), & Harris (2011)

5:30-7:00 Spatial and Network weights in Stata & R.

We will look at the interference package in R and work through what exactly a latent variable weights matrix looks like and does.

Friday: Project Consultations

No formal lectures today.

Participants will schedule individual meetings with the instructors to discuss their research. Students with similar research agendas may be grouped together to facilitate collaboration.

You will be asked to fill out a brief questionnaire about your research by Thursday morning to allow us to prepare for the meeting.

Monday: Propensity Score Theory & Application in DiD

2:00-3:15 A Macroscopic View of Propensity Score Theory in DiD

Stuart, E. A., Huskamp, H. A., Duckworth, K., Simmons, J., Song, Z., Chernew, M., & Barry, C. L. (2014). Using propensity scores in difference-in-differences models to estimate the effects of a policy change. *Health Services Outcomes Research Methodology*, 14(4), 166-182.

Daw, J. R. and L. A. Hatfield (2018). Matching in Difference-in-Differences: between a Rock and a Hard Place, Health Research & Educational Trust.

Lindner, S. and K. J. McConnell (2019). "Difference-in-differences and matching on outcomes: a tale of two unobservables." *Health Services and Outcomes Research Methodology* 19(2-3): 127-144.

Daw, J. R. and L. A. Hatfield (2018). "Matching and Regression to the Mean in Difference-in-Differences Analysis." *Health Serv Res* 53(6): 4138-4156.

Sant'Anna, P. H., & Zhao, J. B. (2020). Doubly robust difference-in-differences estimators. Forthcoming at the *Journal of Econometrics*

Ben-Michael, E., Feller, A. and Rothstein, J., (2018). The augmented synthetic control method.

3:45-5:00 In-Depth Look at Stuart et al (2014) / Ben-Michael, Feller, & Rothstein (2018)

5:30-7:00 Building IP Weights and Matching with DiD.

MatchIt, WeightIt, and augsynth in R as well as the standard IPW suite in Stata

Tuesday: Differential Timing

2:00-3:15 A Macroscopic View of Staggered Adoption Problems

Goodman-Bacon, A., 2018. Difference-in-differences with variation in treatment timing (No. w25018). National Bureau of Economic Research.

Abraham, S., & Sun, L. (2018). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects.

Callaway, B. and P. H. Sant'Anna (2019). "Difference-in-differences with multiple time periods."

Ben-Michael, E., Feller, A., & Rothstein, J. (2019). Synthetic controls and weighted event studies with staggered adoption.

Athey, S., & Imbens, G. W. (2018). Design-based analysis in difference-in-differences settings with staggered adoption.

de Chaisemartin, C., & D'Haultfoeuille, X. (2020). Difference-in-Differences Estimators of Intertemporal Treatment Effects. arXiv preprint arXiv:2007.04267.

3:45-5:00 An In-Depth Look at Goodman-Bacon (2018) and Callaway & Sant'Anna (2019)

5:30-7:00 The `bacon` and `did` packages

Wednesday: Generalized Counterfactual Estimators

2:00-3:15 Building a Theory of Counterfactual Estimators

Liu, L., Wang, Y., & Xu, Y. (2020). A practical guide to counterfactual estimators for causal inference with time-series cross-sectional data.

Ferman, B., Pinto, C. (2019). Synthetic controls with imperfect pre-treatment fit. Working Paper

Ben-Michael, E., Feller, A. and Rothstein, J., 2018. The augmented synthetic control method.

Doudchenko, N., & Imbens, G. W. (2016). Balancing, regression, difference-in-differences and synthetic control methods: A synthesis.

Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W., & Wager, S. (2019). Synthetic difference in differences (No. w25532). National Bureau of Economic Research. par

Kropko, J., & Kubinec, R. (2018). Why the two-way fixed effects model is difficult to interpret, and what to do about it.

3:45-5:00 An In-Depth Look at Liu, Wang, and Xu (2020)

5:30-7:00 Using the FECT package in Stata & R

Thursday: Techniques for Unobserved Heterogeneity & Endogeneity

Today's discussion is on advances in generalized latent variable modeling techniques as ways to account for types of endogeneity. This includes some of the methods that we discussed yesterday.

2:00-3:15 Latent Variable Models in Generalized Counterfactual Estimation

Liu, L., Wang, Y., & Xu, Y. (2020). A practical guide to counterfactual estimators for causal inference with time-series cross-sectional data.

Gobillon, L., & Magnac, T. (2016). Regional policy evaluation: Interactive fixed effects and synthetic controls. *Review of Economics and Statistics*, 98(3), 535-551.

Xu, Y., 2017. Generalized synthetic control method: Causal inference with interactive fixed effects models. *Political Analysis*, 25(1), pp.57-76.

Athey, S., Bayati, M., Doudchenko, N., Imbens, G., & Khosravi, K. (2018). Matrix completion methods for causal panel data models.

Stewart (2014) Latent factor regressions for the social sciences. Unpublished

3:45-5:00 An In-Depth Look at Stewart (2014)

5:30-7:00 The `gsynth` package in R . More on fact. Some additional treatments of latent variable IPW if there is time

Friday: Review

We will set up a review day based on what people would like more time on. It will be somewhat flexible since the class is so small.