

# Statistical Panel Models: Recent Developments in Difference-in-Differences and Fixed-Effects

Winter Semester 2023/2024, FU Berlin

Room: Ihnestr.22/UG 5 Seminarraum (Ihnestr. 22)<sup>1</sup>

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## **Course description:**

This course provides a gentle introduction to difference-in-differences (DiD) analysis, including various extensions and recent developments. DiD is a straightforward research design that involves comparing the same units over time, along with a suitable control group, to estimate causal effects. It is widely used in fields such as economics, policy evaluation, marketing, political sciences and social sciences to uncover causal relationships. In recent years, researchers have critiqued previous methods of estimating DiD effects and increased our conceptual understanding of DiD analysis. This course aims to introduce the fundamentals of DiD, its basic assumptions, and its recent extensions. It will establish the connection between the DiD research design and fixed-effects estimation. In addition to understanding major concepts, we will engage in hands-on data exercises. By the end of this course, students will have a solid understanding of DiD that allows them to critically evaluate existing research that uses this method. Furthermore, it provides students with a set of techniques to conduct their own DiD analysis.

**Course assignment:** A term paper (appr. 3000 words), either

- featuring your own Differences-in-Differences (DiD) analysis, ideally centered around an original research question. Alternatively, you may opt for a research question provided by the instructor.
- or, if you feel like lacking confidence in utilizing Stata or R, you might alternatively discuss the limitations of an existing DiD or panel fixed-effects study from your research field instead of doing your own analysis. The term paper could then take the form of a critical review and discussion of the chosen study

**Form of active participation:** short presentations of own project in every session, exercises with Stata and R, (group) discussions during the seminar

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<sup>1</sup> [https://www.lvplanung.fu-berlin.de/Evt\\_Pages/brn\\_RessourcenKalender.aspx?idressource=7983&MP=EvtFrame&Theme=EventoDisplay1024x768LektionVon=getdate](https://www.lvplanung.fu-berlin.de/Evt_Pages/brn_RessourcenKalender.aspx?idressource=7983&MP=EvtFrame&Theme=EventoDisplay1024x768LektionVon=getdate)

## **General course objectives:**

- **This course is not about making you a statistician, but about giving you confidence in evaluating a research design that you will very likely encounter in your career, whether you will become a social scientist, a data scientist in the private sector, or a policy evaluator at an NGO or government institution.**
- Gaining intuition for when panel data are beneficial for identifying causal effects and the ability to identify cases where difference-and-difference methodology is applicable
- Understanding fixed-effects and differences-in-differences analysis and their most important assumptions theoretically
- Equipping students with a basic knowledge of the estimation techniques that are necessary to conduct a differences-in-differences analysis

## **Timeline:**

The course will take place every two to three weeks. In the time between the sessions, I would like to ask you to do small tasks that will ultimately prepare you for writing your final term paper. There is also some reading to do between the sessions. There will be at least one hour of breaks during seminar days (but likely more).

1. **Th, 19.10.2023, 10:15-15:15: Introduction and intuition behind differences-in-differences**
  - a. Content: This seminar day provides you with the basic intuition behind differences-in-differences. We discuss why panel data are so appealing for questions of cause-and-effect. Furthermore, we discuss the data requirements of a solid difference-in-differences analysis. The practical objective is for you to generate potential research questions independently by the next session in three weeks. Key points include:
    - What are the basic elements of a differences-in-difference analysis?
    - What makes differences-and-differences and fixed-effects so appealing to researchers and policy evaluators
    - Understanding typical data structures suitable for DiD analysis.
    - Recognizing the importance of selecting and preparing data for a 'quasi-experiment.'
    - Quick refresher to causal inference and the issue of confounding/selection into treatment.
    - Exploring potential data sources applicable to your individual projects.
2. **Th, 09.11.2023, 10:15-15:15: More on differences-in-differences in simple scenarios**
  - a. Prepare the following exercise for this session: **Formulate a potential research question suitable for a differences-in-differences analysis that is of interest to you.** Ideally, the question should be addressable using available data. When searching for data sources, take into consideration the

typical structure of a natural experiment that we learned in the last session. You might work on the chosen research question over the next weeks, and you can incorporate your findings into the final term paper. In the event that you do not find suitable data sources, you should search for research articles that employ the differences-in-differences method for similar research questions or think of an ideal design to study your research question in a DiD setting.

- b. Literature to read for this session:
  - (Freedman, 1991), pages 293 to 299. The whole text is worth reading, but this part nicely introduces the case study that the next text discusses (Snow and cholera)
  - (Caniglia and Murray, 2020)
- c. Content: We build upon the previous session, clarifying some important concepts:
  - Clarifying some terms
  - We will discuss your research questions in a guided group discussion
  - What is fixed-effects regression?
  - Learning about the so-called parallel trend assumption (PTA) and which processes invalidate the PTA
  - Use counterfactual reasoning to understand what we want to know from the data
  - How to prepare data for DiD analyses?
  - Estimating DiD effects with regression
  - What to do when the PTA assumption does not hold?

### 3. **Th, 30.11.2023, 10:15-15:15: Estimands, Identification, Estimation and DiD with continuous treatments**

- a. Prepare the following exercise for this session: Start more actively working on your research question. Depending on the stage and direction of your project, this includes either preparation of data, searching for data, or actively searching and choosing a research article that uses fixed-effects or Differences-in-Differences that you can use in your final term paper.
- b. Literature: (Callaway, Goodman-Bacon and Sant'Anna, 2021)  
This text is rather technical, try to get the main points without understanding all the mathematics.  
Here is also a summary: <https://bcallaway11.github.io/posts/five-minute-did-continuous-treatment>
- c. Content:
  - Estimands: Quantity of interest
  - Identification: Theoretical assumptions that need to be met
  - Estimation: The calculation you use to arrive at your estimand
  - Relate the upper three points to DiD with continuous treatments

### 4. **Th, 14.12.2023, 10:15-15:15: Estimation with covariates**

- a. Prepare the following exercise for this session: Finish the data preparation based on comments and suggestions you received in the previous session; or: finish formulating the main critiques of the paper you chose to discuss.
  - b. Literature:
    - Covariates in DiD: (Zeldow and Hatfield, 2021)
    - (Auspurg, Brüderl and Wöhler, 2019)
  - c. Contents:
    - DiD with additional control for covariates
    - How to run a DiD analysis with staggered treatments
- 5. Th, 18.01.2024, 10:15-15:15: staggered treatments**
- a. Prepare the following exercise for this session: Given the programs we know by now, estimate your DiD analysis with your own data. Also reflect upon potential problems in your data, analysis or even your research question itself. Or: what are the problems in the data, analysis or even the research question itself in the paper you chose to review.
  - b. Literature: (Roth *et al.*, 2023) pages 1-15
  - c. Additional literature for the interested:
    - Staggered designs estimation: (Callaway and Sant'Anna, 2021)
    - On bias in TWFE: (Goodman-Bacon, 2021)
- 6. Th, 08.02.2024, 10:15-15:15: Wrap up session**
- a. Prepare the following exercise for this session: prepare a small presentation of about 5 minutes with your main results, and potential issues that you found during data analysis. Or: present your critique of an already existing paper.
  - b. TBD

### **References (preliminary):**

Auspurg, K., Brüderl, J. and Wöhler, T. (2019) 'Does Immigration Reduce the Support for Welfare Spending? A Cautionary Tale on Spatial Panel Data Analysis', *American Sociological Review*, 84(4), pp. 754–763. Available at: <https://doi.org/10.1177/0003122419856347>.

Callaway, B., Goodman-Bacon, A. and Sant'Anna, P.H.C. (2021) 'Difference-in-Differences with a Continuous Treatment'. Available at: <https://doi.org/10.48550/ARXIV.2107.02637>.

Callaway, B. and Sant'Anna, P.H.C. (2021) 'Difference-in-Differences with multiple time periods', *Journal of Econometrics*, 225(2), pp. 200–230. Available at: <https://doi.org/10.1016/j.jeconom.2020.12.001>.

Caniglia, E.C. and Murray, E.J. (2020) 'Difference-in-Difference in the Time of Cholera: a Gentle Introduction for Epidemiologists', *Current Epidemiology Reports*, 7(4), pp. 203–211. Available at: <https://doi.org/10.1007/s40471-020-00245-2>.

Freedman, D.A. (1991) 'Statistical Models and Shoe Leather', *Sociological Methodology*, 21, p. 291. Available at: <https://doi.org/10.2307/270939>.

Goodman-Bacon, A. (2021) 'Difference-in-differences with variation in treatment timing', *Journal of Econometrics*, 225(2), pp. 254–277. Available at: <https://doi.org/10.1016/j.jeconom.2021.03.014>.

Roth, J. *et al.* (2023) 'What's trending in difference-in-differences? A synthesis of the recent econometrics literature', *Journal of Econometrics*, p. S0304407623001318. Available at: <https://doi.org/10.1016/j.jeconom.2023.03.008>.

Zeldow, B. and Hatfield, L.A. (2021) 'Confounding and regression adjustment in DIFFERENCE-IN-DIFFERENCES studies', *Health Services Research*, 56(5), pp. 932–941. Available at: <https://doi.org/10.1111/1475-6773.13666>.