

**Sociology 952: Causal Mediation Analysis**  
**University of Wisconsin-Madison**  
**Spring 2020**

[Last Updated: January 20, 2020]

**Course location:** 6310 Social Science Building

**Meeting time:** Wed 2:30pm-5:00pm

**Website:** <https://canvas.wisc.edu/courses/186561>

**Instructor:** Prof. Felix Elwert, Ph.D.

**Office Hours:** Tue & Wed 9:30-10:30 am (<https://felix-elwert.youcanbook.me>)

**Office Location:** 4426 Sewell Social Science Bldg.

**Email:** [elwert@wisc.edu](mailto:elwert@wisc.edu)

**Instructional Mode:** Face-to-face

**Credits:** 3 (2 hours of class and 6-10 hours of work out of class per week)

**Course Designations:** Graduate

**Prerequisites:** Soc 362 or equivalent, or consent of instructor.

**Course Description**

Causal mediation analysis investigates *how* and *why* a cause affects the outcome. Whereas causal inference for total causal effects establishes the existence, sign, and magnitude of causal effects, causal mediation analysis tries to *explain* through which processes or mechanisms the causal effect comes about. Causal mediation analysis has many uses: understanding how the world works, building theory, designing and refining policies.

Causal mediation analysis is a fairly recent discipline, though building on ancient foundations. Social scientists have pursued mediation questions for decades (see the well-known paper by in the *American Sociological Review* by Duane Alwin and Wisconsin's own Robert Hauser). Mediation analysis was incorporated into the now-dominant potential outcomes framework of causal inference with Robins and Greenland's widely ignored 1992 paper in *Epidemiology* and finally gathered steam with Pearl's influential 2001 paper.

Causal mediation analysis remains a frontier of methodological development. Fortunately, it is now mature enough to have generated a first, excellent, textbook.

There's no denying that causal mediation analysis is hard. 'Hard' in the sense of placing high demands on identification. The assumptions needed to justify inference about causal mediation estimands are considerably more restrictive than the assumptions required for inference about total causal effects. Indeed, it can be shown that randomization alone does not justify inference about certain important causal mediation estimands. Let that sink in: randomized-controlled experiments are not enough.

These difficulties, of course, also make causal mediation analysis exciting. This course will survey the landscape of modern causal mediation analysis, largely by following Tyler VanderWeele's—again—excellent textbook, coupled with a number of more recent papers.

The course will focus on (a) a detailed understanding of mediation estimands, (b) an appreciation of the challenges of mediation analysis, and (c) a thorough, albeit largely qualitative, understanding of identification results. The course will not go deeply into estimation, although estimation will, of course, feature. In this, this course focuses more on methodology than on statistics.

Because much of causal mediation analysis has been developed with medical applications in mind, this course will necessarily give much room for medical and epidemiological applications. Nonetheless, we will continuously discuss possible applications in the social sciences and also read new sociological research that avails itself to causal mediation analysis.

### **Class structure**

Class meetings will be split between lectures and seminar discussions. In some meetings, lecture will predominate, in others, we will work through key passages or results from the readings together. This requires that you have carefully read all readings prior to coming to class. I will often call on students to explain passages from the readings in order to probe and improve understanding. Everybody gets a turn, and there's no shame in getting things wrong the first time around. The material is, after all, demanding.

### **Learning Outcomes**

By the end of the semester, students will have gained a broad understanding of state-of-the-art methods of causal mediation analysis.

### **Goals**

Although we will read material close to the research frontier, we will emphasize concepts and intuition over proofs. While we will often inspect clever mathematical moves—and appreciate that most notation is there for a reason—, this course is fundamentally geared toward applied researchers who want to consume and understand—but not develop—the modern literature on causal mediation analysis. There will be no software component to the course.

### **Prerequisites**

This course is geared at graduate students from all disciplines with a serious interest in causality and causal mediation analysis. The minimal requirement for this seminar is a solid background in GLM, basic familiarity with survival analysis and instrumental variables estimation, and some prior exposure to the potential outcomes framework of causal inference—all at about the level of Angrist and Pischke's *Mostly Harmless Econometrics*. Sociology 362 will do. Neither linear algebra nor calculus is required beyond the basics, though neither will hurt.

### **Enrollment**

This course is limited to regularly enrolled students. Auditors must demonstrate a compelling need and meet the same requirements as regularly enrolled students (exception: no term paper).

## Requirements

*Readings:* It is essential that you commit to carefully completing all required readings prior to class. There's a lot of readings. Start early. When reading assigned chapters, it is understood that students will also consult the corresponding technical appendix.

*Abstracts:* Every week, students will submit a half-page (single-spaced) abstract of the required readings. The abstract should summarize the main insights from the readings, share ideas and observations, and *pose questions*. Seriously: do ask questions, especially about things you didn't understand. Your questions are extremely helpful for preparing the lecture. Please proof your abstracts for content, style, spelling, and grammar. Abstracts are to be sent as email attachments in .docx format (so that I can comment efficiently) to [elwert@wisc.edu](mailto:elwert@wisc.edu) by Monday night. Write "Soc 952 Abstract, Week X" in the subject line—else I might miss it. I will read your abstracts every week, but I won't comment every week.

*Attendance:* This is a graduate seminar, and hence you should attend every meeting. Please send me a note in advance if you cannot make a meeting. Excessive absences will cut into your participation grade.

*Paper:* Students will write a term paper on a topic involving causal mediation analysis. The topic could be methodological (i.e. developing or exploring a statistical result), conceptual (i.e., developing a detailed research proposal for a future empirical study), or empirical (i.e. data analysis using methods in the course). Regardless, the paper must engage causal mediation analysis involving a topic covered in or after Chapter 3 of the textbook (i.e. demonstrate sustained engagement with the material presented in the semester). The paper should not exceed 15 double-spaced pages, 12-point font, one-inch margin, including everything. I will stop reading after 15 pages. Papers are due on May 6 (no extensions), .docx preferred.

There is no final exam during exam period.

## Grading

15% participation, 15% abstracts, 70% final assignment.

## Academic Integrity

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to [studentconduct.wiscweb.wisc.edu/academic-integrity/](http://studentconduct.wiscweb.wisc.edu/academic-integrity/).

## Accommodations for Students with Disabilities

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with

disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform me of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. I will work either directly with you or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. <http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php>

### **Diversity and Inclusion**

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. <https://diversity.wisc.edu/>

### **Parenting**

If you are a parent, you are invited to bring your baby or child to class if you find yourself in a rare childcare crisis and would miss a lecture or section meeting otherwise. Make sure to bring food, drink, and something to keep your child entertained quietly. Position yourself near the door so you can step out with your child if need be.

## Course Outline

*Subject to change. Please monitor course announcements.*

Readings are posted on the course website.

EIC: *Explanation in Causal Inference* (VanderWeele)

All readings are required.

January	22	L1: Review of Causal Inference & Directed Acyclic Graphs <ul style="list-style-type: none"> <li>• Elwert 2013. Graphical Causal Models.</li> <li>• ECI Ch 1</li> </ul>
	29	L2: Mediation Estimands <ul style="list-style-type: none"> <li>• Nguyen, Schmid, and Stuart. 2019. “Clarifying causal mediation analysis for the applied researcher: Defining effects based on what we want to learn.” <i>arXiv</i>:1904.08515.</li> </ul>
February	5	L3: Regression-based Approaches <ul style="list-style-type: none"> <li>• ECI Ch 2</li> <li>• MacKinnon, Lockwood, Hoffman, West, and Sheets. 2015. “A Comparison of Methods to Test Mediation and Other Intervening Variable Effects.” <i>Psychological Methods</i> 7(1):83–104.</li> </ul>
	12	L4: Regression-based Approaches (cont’d.)
	19	L5: Experimental Designs. <ul style="list-style-type: none"> <li>• Imai, Tingley, Yamamoto. 2013. “Experimental designs for identifying causal mechanisms.” <i>Journal of the Royal Statistical Society</i> 176(1):5-51.</li> </ul>
	26	L6: Unmeasured-Mediator Outcome Confounding <ul style="list-style-type: none"> <li>• Kim and Elwert. 2020. Difference-in-Difference Mediation (DiDiM) Analysis with Unmeasured Mediator-Outcome Confounding. Working paper.</li> <li>•</li> </ul>
March	4	L7: Sensitivity Analysis <ul style="list-style-type: none"> <li>• EIC Ch 3</li> </ul>
	11	L8: Multiple Mediators <ul style="list-style-type: none"> <li>• EIC Ch 5</li> <li>• VanderWeele and Vansteelandt. 2013. “Mediation Analysis with Multiple Mediators.” <i>Epidemiological Methods</i> 2(1):95-115.</li> </ul>
	18	<i>Spring Break (no class)</i>

- 25 L9: Time-varying Exposures and Mediators
- EIC: Ch 6
  - Zhou and Wodtke 2018. “A Regression with Residuals Method for Estimating Controlled Direct Effects.” *Political Analysis* (27):360–369.
  - Wodtke and Zhou. Forthcoming. “Effect Decomposition in the Presence of Treatment-induced Confounding: A Regression-with-residuals Approach.” *Epidemiology*.
- April 1 L10: Selected topics
- EIC Chs. 4 & 7 (except 7.4)
  - *Paper proposals due (email Word document or editable pdf).*
- 8 L11: Mediation and Gap-Closing Estimands
- EIC. Ch 7.4
  - Jackson & VanderWeele 2018. “Decomposition analysis to identify intervention targets for reducing disparities.” *Epidemiology* 29(6):825–835.
  - Lundberg 2019. “Gap-closing estimators to study categorical inequality that persists under a local intervention to equalize a treatment.” *Working Paper*.
- 15 L12: Other Topics (including Mendelian Randomization)
- EIC: Ch 8
- 22 L13: Interaction Analysis
- EIC: Ch 9
- 29 L14: A Unification of Mediation and Interaction
- EIC: Ch 14
  - Wodtke, Yildirim, Harding, Elwert. 2020. “Are Neighborhood Effects Explained by Differences in School Quality.” *Working paper*.
- May 6 *Final paper due (no extensions)*