DS925: Causal Inference for Management Research

Course Syllabus Fall 2022
Class Meets: Fridays 1:00-4:00 PM, Questrom School of Business, Room 667

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Objectives

This course will teach you to apply methods for estimating causal relationships using non-experimental data, and in the process, how to address issues of endogeneity and identification that commonly arise in applied empirical research. We will discuss how to establish what relationships exist in the data, maintained assumptions that are sufficient to place a causal interpretation on those relationships, and strategies for communicating empirical methods and results. We will also discuss the importance of careful theoretical thinking, and a detailed knowledge of relevant institutions for this type of empirical research, particularly as applied to management topics.

This course has three main goals. The first is to develop a clear understanding of the conceptual difficulties associated with establishing causality in empirical research. In particular, I hope to clarify the nature of the identification problem and illustrate several types of "endogeneity" that often arise in applied empirical research. A good grasp of these concepts will lead to improved research design and a sharper understanding of the relative strengths and weaknesses of various statistical methods. The second goal is to introduce a set of empirical methods for making causal inferences using observational data. I will emphasize the importance of understanding the maintained assumptions behind each method and highlight practical problems that often arise in applications. The third goal is to help students learn to communicate the essential details of their empirical strategy in a concise and compelling manner.

Preparation and Prerequisites

This course is designed to complement a graduate sequence in econometrics, but it should be accessible to students with basic knowledge of probability and statistics. We will emphasize intuition and application over proof. However, the readings and class discussion will cover technical material. Most problem sets and in-class examples will be taught using the Stata statistical software package, and students will find that a working knowledge of Stata is quite valuable for following the class discussion. I have also started translating the course materials into R, and will accept assignments that are completed using that open source alternative as well.

Auditing

You are welcome to audit this class as long as you show up prepared to contribute to class discussion. I will only grade your assignments (including comments on the final paper) if you enrol for credit.

Assignments & Grading

Grades will be based on class participation (10%), five problem sets (65%), and a final project (25%).

Class participation (10%): Read the materials, come to class (on time), and participate in the discussion. I will strive to create opportunities for everyone to contribute. Asking a good question is often more valuable than having the best answer.

Problem Sets (65% total): The first problem set is actually a short programming and writing exercise, worth 5% of the total grade. The next four problem sets (each worth 15% of the grade) are empirical exercises that allow you to practice the methods we learn in class within a fairly controlled environment. The data will be relatively clean, and the tasks should be clearly described (so feel free to ask questions if they are not). Students may work on these assignments in teams, but should write up their final submissions individually.

Final Project (25%): For this project, you can choose between replicating and extending a published paper, or submitting an original research design. Each option is described below.

Replication: Choose an existing empirical paper to replicate, and discuss/critique the robustness of the results using concepts from class. Several journals (e.g. Management Science, American Economic Review, American Economic Journals, Journal of Applied Econometrics, Journal of Business Economics and Statistics) and various researchers post data from published papers. While there is no page limit, my guess is that the reports will contain 1-4 pages of text, 2-5 tables and/or figures, and a Stata ".log" output file. One to three tables would likely replicate results from the existing paper and one or two more would present results that are not shown in the paper. If you can communicate the core ideas in less space, no problem. If you need more space, that's fine too. The key is to show that you could reproduce the main results and that you tried some additional specifications (informed by what we do in class) to check robustness. *Please confirm with me that your chosen paper is appropriate before starting to gather data*.

Research Design: This 4 to 6 page document will describe how you plan to implement an empirical study. Your research design should read like the "Data and Methods" section of a high-quality empirical paper. I expect to see a description of your data, a specification for the regressions you will perform, and (most importantly) discussion and justification of the assumptions that your reader must maintain in order to believe that your analysis constitutes an answer to the proposed research question. For this option, I strongly recommend that you choose a question you are actually working on. Preferably, you have the data in hand. However, an acceptable alternative is to choose a research question that leads to a regression specification (or set of hypotheses) developed as part of a previous class assignment. In either case, you should submit a 1 or 2 page summary of the theory / hypotheses along with your research design, for a total of 5 to 8 pages.

Readings

Each class will have several assigned readings. There are three types of reading:

1) Conceptual readings deal with tools and methods for causal inference. Some conceptual readings are academic papers, and others are chapters from Mostly Harmless Econometrics: An Empiricist's Companion, by Joshua Angrist and Steve Pischke. This is an excellent handbook for applied empirical research, and I highly recommend that you purchase a copy. Since MHE is not a complete reference, you

may also wish to get a copy of William Greene's Econometric Analysis, Jeffrey Wooldridge's Econometric Analysis of Cross Section and Panel Data, or Cameron and Trivedi's Microeconometrics.

*** Another useful text is Scott Cunningham's "Causal Inference: The Mixtape." In fact, it seems likely that this book has greater overlap with the course material, and presents it in a more accessible manner (especially through use of simulation in Stata and R). In future years, this may become the course text. I encourage you to buy it, and use it as an alternative reference for topics you find challenging.

2) Applied Readings are research papers that use the tools and methods we learn in class. For each Applied Reading, you should arrive ready to answer to the following questions: What is the research question? What is the unit of observation? What are the sources of variation? What are the key estimating equation(s)? What are the results and interpretation? In some cases, you will have access to the underlying data used in an Applied Reading, and I strongly encourage you to play around with it.

3) Optional readings provide additional detail on topics related to those covered in class.

Calendar

	Room	**Date**	**Topic**	**Assignments Due**
1	667	Sep 9	Identification & Inference	
			No Class on September 16	
2	667	Sep 23	Types of Endogeneity	Problem Set 0
3	667	Sep 30	Selection on Observables	
4	667	Oct 7	Matching	
5	667	Oct 14	Instrumental Variables	Problem Set 1
6	667	Oct 21	Exclusion Restrictions	
7	667	Oct 28	MTEs and RDD	Problem Set 2
8	667	Nov 4	RDD and Bunching	
9	667	Nov 11	Panel Data and Fixed Effects	Problem Set 3
10	667	Nov 18	Difference-in-Differences	
			No Class on November 26	
11	667	Nov 2	Event Studies	Problem Set 4
12	667	Dec 9	Non-linear Models	
13	667	Dec 16	Structure and Transparency	Final Project

Detailed Reading List

KEY: C = Required conceptual reading; A = Required application reading; O=optional reading.

Session 1: Identification & Inference

C: Mostly Harmless Econometrics, Chapters 1, 2 & 8.

C: Gelman, A. (2011), "Causality and Statistical Learning." *American Journal of Sociology*, 117(3):955-966.

C: A. Lewbel (2019), "The Identification Zoo: Meanings of Identification in Econometrics" Journal of Economic Literature, 57(4): 835-903.

C: Manski, C. (1995), Identification Problems in the Social Sciences, Introduction and Chapter 1.

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation" NBER Working Paper 14251. Pages 1 to 12.

C: Romer, D. (2020) "In Praise of Confidence Intervals" *AEA Papers and Proceedings*, 110:55-60.

C: Abadie, A., S. Athey, G. Imbens and J. Wooldridge (2017) "When Should you Adjust Standard Errors for Clustering?" NBER Working Paper 24003

C: MacKinnon, J. (2006) "Bootstrap Methods in Econometrics" Queen's Economics Department Working Paper, No. 1028. [Sections 1, 4 and 5 only]

O: Abadie, A., S. Athey, G. Imbens and J. Wooldridge (2020) "Sampling-Based Versus Design-Based Uncertainty in Regression Analysis" Econometrica, 88(1):265-296.

Session 2: Types of Endogeneity

Part 1: Classic Identification Problems

C: Radio Lab Episode on Diagnosis (listen to story on SIDS, starting at 47:39 through 57:45) https://radiolab.org/episodes/91662-diagnosis

C: Bellmare, M. (2016) "There is more than one source of endogeneity" Blog post, http://marcfbellemare.com/wordpress/11579

Selection: Manski, C. (1999), Identification Problems in the Social Sciences, Chapter 2.

Simultaneity: Manski, C. (1999), Identification Problems in the Social Sciences, Chapter 6.

Co-linearity: Goldberger, A. (1991) "Multicollinearity," Ch. 23 in A Course in Econometrics, Harvard University Press.

Heterogeneity vs. State-dependence: Heckman, J. (1981), "Heterogeneity and State Dependence" in Studies in Labor Markets, S. Rosen (ed.) University of Chicago Press. (*through Section 3.1*)

The Reflection Problem: Manski, C. (1999), <u>Identification Problems in the Social Sciences</u>, Chapter 7.

O: Rysman, M. (2019) "The reflection problem in network effect estimation." *Journal of Economics and Management Strategy*, (28)1: 153-158.

Part 2: Field Experiments

A: Bertrand, M. and S. Mullainathan (2004), "Are Emily and Greg More Employable than Lakisha and Jamal?: A Field Experiment on Labor Market Discrimination." *American Economic Review*, 94(4): 991-1013.

C: Gelman, A (2010) "Experimental Reasoning in Social Science," Chapter 7 in <u>Field Experiments and Their Critics</u>, ed. D. Teele, Yale University Press.

O: Bloom, N., B. Eifert, A. Mahajan, D. McKenzie and J. Roberts (2013), "Does Management Matter?: Evidence From India." *Quarterly Journal of Economics*, 128(1): 1-51.

O: Duflo, E., Glennerster and Kremer (2006) "Using Randomization in Development Economics Research: A Toolkit" NBER Technical Working Paper No. 333.

Session 3: Selection on Observables

C: Mostly Harmless Econometrics, Sections 3.1 and 3.2

C: Imbens, G. (2020) "Potential Outcome and Directed Acyclic Graph Approaches to Causality: Relevance for Empirical Practice in Economics." Working Paper.

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation." NBER Working Paper 14251. <u>Pages 19 to 31</u>.

A: LaLonde, R. (1986), "Evaluating the econometric evaluations of training programs with experimental data." *American Economic Review*, 76, 604-620.

A: Kruger, A. (1993), "How Computers Have Changed the Wage Structure: Evidence from Micro Data." *Quarterly Journal of Economics*, 108, 33-60.

A: DiNardo, J, and Pischke J. (1997), "The Returns to Computer Use Revisited: Have Pencils changed the Wage Structure Too?" *Quarterly Journal of Economics*, 112, 291-303.

O: Oster, E. (2019) "Unobservable selection and coefficient stability: theory and evidence." *Journal of Business and Economic Statistics*, 37(2): 187-204.

Session 4: Matching

C: Mostly Harmless Econometrics, Section 3.3

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation" NBER Working Paper 14251. Section 5 to 6.2. <u>Pages 31 to 47</u>.

C: Iacus, S., G. King, and G. Porro (2012) "Causal Inference Without Balance Checking: Coarsened Exact Matching." *Political Analysis*, 20(1):1-24.

C: Urminsky, O., C. Hansen and V. Chernozhukov (2016) "Using Double-Lasso Regression for Principled Variable Selection" Available at SSRN: https://ssrn.com/abstract=2733374

A: Jaffe, A., M. Trajtenberg and R. Henderson (1993), "Geographic Knowledge Spillovers as Evidenced by Patent Citations." *Quarterly Journal of Economics*, 108(3):577-98.

A: Thompson, P., and M. Fox-Kean (2005): "Patent citations and the geography of knowledge spillovers: a reassessment." *American Economic Review*, 95(1): 450-460.

Session 5: Instrumental Variables

C: Mostly Harmless Econometrics, Sections 4.1 through 4.3.

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation." NBER Working Paper 14251. <u>Pages 53 to 58</u>.

C: Bellemare (2015) Blog Post: "You Keep Using That Instrumental Variable; I Do Not Think It Does What You Think It Does," http://marcfbellemare.com/wordpress/10900.

C: Murray, Michael (2006). "Avoiding Invalid Instruments and Coping with Weak Instruments." *Journal of Economic Perspectives*, 20(4): 111-132.

A: Acemoglu, D., S. Johnson and J. Robinson (2001) "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review*, 5, 1369-1401.

A: Albouy, D. (2012) "The Colonial Origins of Comparative Development: An Empirical Investigation: Comment." *American Economic Review*, 102(6): 3059-3076.

O: Conley, T., C. Hansen, and P. Rossi (2012) "Plausibly Exogenous" *Review of Economics and Statistics*, 94(1): 260-272.

Session 6: Exclusion Restrictions

C: Mostly Harmless Econometrics, Sections 4.3 through 4.6.

C: Goldsmith-Pinkham, P., I. Sorkin and A. Swift (2020) "Bartik Instruments: What, When, Why and How" *American Economic Review*, 110(8):2586-2624.

C: Wooldridge, J. (2015). "Control Function Methods in Applied Econometrics." *Journal of Human Resources*, 50(2): 420-445.

C: Young, A. (2017) "Consistency Without Inference: Instrumental Variables in Practical Application." *Working Paper*.

C/A: Sarsons (2015) "Rainfall and Conflict: A Cautionary Tale." *Journal of Development Economics, 115: 62-72.*

A: Williams, H. and Sampat, B. (2019) "How do Patents Affect Follow-on Innovation? Evidence from the Human Genome." *American Economic Review*, 109(1): 203-236.

A: Righi, C. and T. Simcoe (2019) "Patent Examiner Specialization." *Research Policy*, 48(1): 137-148.

Session 7: Marginal Treatment Effects & Regression Discontinuity

C: Heckman, J., S. Urzua and E. Vytlacil (2006) "Understanding Instrumental Variables in Models with Essential Heterogeneity." *Review of Economics and Statistics*, 88(3): 389-432.

A: Carneiro, Heckman and Vytlacil (2011) "Estimating Marginal Returns to Education." *American Economic Review*, 101(6): 2754-2781.

C: Cornelissen, T., C. Dustmann, A. Raute and U. Schonberg (2016) "From LATE to MTE: Alternative Methods for the Evaluation of Policy Interventions." IZA Discussion Paper No. 10056.2

C: Mostly Harmless Econometrics, Chapter 6.

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation." NBER Working Paper 14251. Pages 58 to 64.

C: Gelman and Imbens (2014) "Why High Order Polynomials Should Not Be Used in Regression Discontinuity Designs." NBER Working Paper 20405.

Session 8: RDD and Bunching

A: Luca, M. (2016) "Reviews, Reputation and Revenue: The Case of Yelp.com" Harvard Business School Working Paper 12-016.

A: Dechezlepretre, A., E. Einio, R. Martin, K. Nguyen and J. Van Reenen (2016). "Do Tax Incentives for Research Increase Firm Innovation? An RD Design for R&D" NBER Working Paper 22405.

C: Kleven, H. (2016) "Bunching." *Annual Review of Economics*, 8: 435-464.

A: Diamond, R. and P. Persson (2017) "The Long-Term Consequences of Teacher Discretion in Grading of High-Stakes Tests" *Stanford University Working Paper*.

O: Imbens, G. and T. Lemieux (2007) "Regression Discontinuity Designs: A Guide to Practice." NBER Technical Working Paper No. 337.

O: Lee, D., and T. Lemieux (2010). "Regression Discontinuity Designs in Economics." *Journal of Economic Literature*, 48(2): 281–355.

Session 9: Panel Data and Fixed Effects

C: Mostly Harmless Econometrics, Chapter 5.

C/A: Griliches, Z. and J. Mairesse (1995) "Production Functions: The Search for Identification." NBER Working Paper 5067.

C: Fixed Effects Infatuation: http://greedgreengrains.blogspot.com/2013/11/fixed-effects-infatuation.html

C: Imbens, G. and Wooldridge, J (2008) "Recent Developments in the Econometrics of Program Evaluation" NBER Working Paper 14251. Pages 64 to 71.

C/A: Heckman, J. And J. Smith (1999) "The pre-programme earnings dip and the determinants of participation in a social programme: Implications for simple programme evaluation strategies." *Economic Journal*, 109(457), 313-348.

O: Abowd, J., F. Kramarz and D. Margolis (1999). "High Wage Workers and High Wage Firms." *Econometrica*, 67(2): 251-333.

O: Imbens, G. and J. Wooldridge Lecture (2007) "Linear Panel Data Models" Notes from Lecture 2 at the NBER Summer Institute

Session 10: Difference-in-Differences

A: Card, D. and A. Krueger (1994) "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania" American Economic Review, 84(4): 772-793.

A: Agrawal, A., and A. Goldfarb (2008). "Restructuring Research: Communication Costs and the Democratization of University Innovation." *American Economic Review*, 98(4): 1578–90.

C: Goodman-Bacon, A. (2019) "Difference-in-Differences with Variation in Treatment Timing." *Working Paper*.

C: Chaisemartin and D'Haultfoeuille (2018). "Fuzzy Difference-in-Differences" *The Review of Economic Studies*, 85(2): 999–1028.

A: X. Li and T. Simcoe. (2021) "Competing or Complementary Labels? Estimating Spillovers in Chinese Green Building Certification." *Strategic Management Journal*, forthcoming.

C: Donald, S. and K. Lang (2007), "Inference with Difference in Differences and Other Panel Data" *Review of Economics and Statistics*, 2, 221-233.

Session 11: Event Studies

A: Azoulay, P., J. Graff-Zivin and J. Wang (2010). "Superstar Extinction." *The Quarterly Journal of Economics, 125 (2): 549-589.*

A: Basker, E. and T. Simcoe (2019) "Upstream, Downstream: Diffusion and Impacts of the Universal Product Code." *Journal of Political Economy,* forthcoming.

C: Callaway, B. and P. Sant'Anna (2019) "Difference-in-Differences with Multiple Time Periods" *Working Paper*.

C: K. Borusuyak, X. Jaravel and J. Spiess (2021) "Revisiting Event Study Designs: Robust and Efficient Estimation" *Working Paper*.

C: Chaisemartin and D'Haultfoeuille (2020). "Two-Way Fixed Effects Estimators With Heterogeneous Treatment Effects" *American Economic Review*,110(9): 2964-2996.

C/O: Roth, Jonathan. 2022. "Pretest with Caution: Event-Study Estimates after Testing for Parallel Trends." American Economic Review: Insights, 4 (3): 305-22.

C/A: Alberto Abadie, Alexis Diamond and Jens Hainmueller (2010) "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program." *Journal of the American Statistical Association*, 105, 490-505.

A/O: Andersson, Julius J. 2019. "Carbon Taxes and CO2 Emissions: Sweden as a Case Study." American Economic Journal: Economic Policy, 11 (4): 1-30.

Session 12: Non-linear Models

C: Angrist, J. (1999) "Estimation of Limited Dependent Variable Models with Dummy Endogenous Regressors: Simple Strategies for Empirical Practice." *Journal of Business and Economic Statistics*, 19(1), 2-16.

Logit, Probit and LPM

http://davegiles.blogspot.co.uk/2012/06/another-gripe-about-linear-probability.html
http://davegiles.blogspot.co.uk/2012/06/yet-another-reason-for-avoiding-linear.html
http://www.mostlyharmlesseconometrics.com/2012/07/probit-better-than-lpm/

Beck, N. (2015) "Estimating grouped data models with a binary dependent variable and fixed effects: What are the issues?" Working Paper.

Non-linear interactions

Ai, Chunrong, and Edward C. Norton. 2003. "Interaction Terms in Logit and Probit." *Economics Letters,* 80, 123-129.

Puhani, P. (2008) "The Treatment Effect, the Cross Difference, and the Interaction Term in Nonlinear "Difference-in-Differences" Models." IZA Discussion Paper # 3478.

Count Data

Mullahy, J. (1997), "Instrumental-Variable Estimation of Count Data Models: Applications to Models of Cigarette Smoking Behaviour," *Review of Economics and Statistics*, 11, 586-593.

Santos Silva, J. M. C. and Silvana Tenreyro. 2006. "The Log of Gravity." *Review of Economics and Statistics*, 88(4): 641-658.

O: Wooldridge, J. (1999) "Distribution free estimation of some non-linear panel data models" *Journal of Econometrics*, 77-97.

Duration Data

Jenkins, S. (1995) "Easy estimation methods for discrete-time duration models." *Oxford Bulletin of Economics and Statistics* 57 (1), 129–137.

Freedman, D. (2008) "Survival Analysis: A Primer." The American Statistician, 62(2): 110-119.

Session 13: Conclusions

C: King, A., B. Goldfarb and T. Simcoe (2020) "Learning from Testimony on Quantitative Research in Management." Academy of Management Review, *in press*.

A: Durlauf. S., Navarro, S. and D. Rivers (2016) "Model uncertainty and the effect of shall-issue right-to-carry laws on crime," *European Economic Review*, 81: 32-67.

C/A: Bakari, Hong, Krainer and Nekipelov (2013) "Estimating Static Models of Strategic Interactions" Journal of Business and Economic Statistics.

C: Andrews, Gentzkow and Shapiro (2020) "Transparency in Structural Research", Journal of Business and Economic Statistics.

C: Athey, S. and G. Imbens (2017) "The State of Applied Econometrics: Causality and Policy Evaluation." *Journal of Economic Perspectives*, 31(2):3-32.

O: Heckman, J. (2000), "Causal Parameters and Policy Analysis in Economics: A Twentieth Century Retrospective." *Quarterly Journal of Economics*, 115, 45-97. Sections I, II.2. II.3 and III.3