

Fall 2015 | Thu., 2-4pm | Classroom: CGIS K354

Gov 2002: Causal Inference

Matthew Blackwell

Office: CGIS K305

Office Hours: just drop by

mblackwell@gov.harvard.edu

<http://www.mattblackwell.org>

TF: Stephen Pettigrew

Office: TBA

Office Hours: TBA

pettigrew@fas.harvard.edu

General Information

This course will cover a growing field in political science and the social sciences more generally: causal inference. That is, we will primarily be concerned with how and when we can make causal claims from empirical research. This is a difficult task and, in general, there are no formulas or computer programs that can give your research a causal interpretation. We always require assumptions. This course will focus on providing you the analytic and quantitative framework to assess and implement these assumptions. Perhaps at the most basic level, this course will sharpen your senses toward the issues of causal reasoning in the social sciences.

The structure of the class will mix lectures, discussions, and computer work. You'll learn these technique by actually implementing them. Having said this, this will not be a computing class. After this class you should understand and be able to apply the standard set of causal inference tools in the social sciences. These include randomized experiments, matching, weighting, fixed effects, differences-in-differences, instrumental variables, regression discontinuity designs, marginal structural models, and sensitivity analyses.

Qualified undergraduates or students from other departments are welcome to take this course.

Who should and should not take this class?

Students in the class should plan to work hard at understanding some difficult material. You'll need to have some proficiency with R. You should have taken GOV 2000 and GOV 2001 or the equivalent. Of course there are always exceptions to this, so feel free to chat with me about your background to see if the fit is right.

Course Details

Reading

There are readings for each topic and they mostly cover the theory of the method along with some applications. Obviously, read the required readings and any others that pique your curiosity. In addition, though, engage with the readings: take notes, write down your impressions or confusions, talk with your classmates. All of your classes should be pushing your research forward and you will be more creative the more you actively read.

Homeworks

Methods are tools and it isn't very instructive to read a lot about hammers or watch someone else wield a hammer. You need to get your hands on a hammer or two. Thus, in this course, you will have homeworks on a (roughly) biweekly basis. They will be a mix of analytic problems, computer simulations, and data analysis. These homeworks should be typed and well-formatted. We will grade on a (+, ✓, -) basis. I encourage you to work in groups on the homework, but you always need to write your own solutions *including your computer code*. Also, it is hugely beneficial to attempt the problems sets on your own before working in groups.

Student Project

In lieu of a final exam, this course requires students to write a short empirical paper on a research topic of their choice. This paper should apply at least some of the methods in the course to an empirical problem. It should be 5-15 pages and focus on the research design, data, methodology, results, and analysis. Literature reviews or background material should be omitted or included in an appendix. Co-authored projects are strongly encouraged: working with collaborators will be the cornerstone of your career from now on. It's crucial to get to know this process sooner rather than later. Of course, with a co-authored project, we will have higher expectations on the paper and presentation. (Note that if you want to use this paper for your second-year paper, you should think about co-authorship carefully.)

Here is a brief timetable for the projects:

- **October 30th:** Email me and Stephen a short (half-page) description of your proposed project. You should meet with me and Stephen in office hours to discuss your project, especially if you are interested in applying methods that we cover later in the course (which are great!).
- **November 19th:** Email me and Stephen a 2-3 page description of your progress, including tables, figures, preliminary results, and analysis.
- **December 10th:** Extra class meeting where each student will give a short, 5-10 minute presentation on their project with a brief summary of the data, methods, and results.
- **December 11th:** Email me and Stephen your final version of the project.

Books

The following texts are **required** for this course:

- Angrist, Joshua D. and Jörn-Steffen Pischke. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.
- Hernán, Miguel A. and James M. Robins. 2012. *Causal Inference*. Forthcoming, Cambridge University Press. (Note that this book is still being written and you can find draft PDFs on the linked page above.)

Optional Books

- *The following books are optional but may prove useful for additional coverage of some of the course topics.*
- *Reference Book for Panel Methods*
 - Wooldridge, Jeffrey M. 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.
- *Causal Inference*
 - Imbens, Guido W., and Donald B. Rubin. 2010. *Causal Inference for Statistics, Social, and Biomedical Sciences*. Cambridge University Press.
 - Morgan, Stephen L, and Christopher Winship. 2007. *Counterfactuals and Causal Inference*. Cambridge University Press.

- Rosenbaum, Paul R. 2009. Design of Observational Studies. Springer Series in Statistics.
 - Rosenbaum, Paul R. 2002. Observational Studies. Springer-Verlag. 2nd edition.
 - Pearl, Judea. 2000. Causality: Models, Reasoning, and Inference New York: Cambridge University Press.
 - Manski, Charles F. 1995. Identification Problems in the Social Sciences. Cambridge: Harvard University Press.
- *Matching*
 - Rubin, Donald. 2006. Matched Sampling for Causal Effects. Cambridge University Press.

Computing

We'll use R in this class, which you can download for free at <http://www.r-project.org>. R is open source and available on all major platforms (including Solaris, so no excuses). You can find a virtually endless set of resources for R on the internet, including this [Getting Started With R](#) page. You may also be interested in using [RStudio](#), an editor and development environment for R. If you are completely new to R, you should complete this online short course, [Try R](#).

Grading

- biweekly homework assignments (50% of final grade)
- student project (40% of final grade)
- participation and presentation (10% of final grade).

Preliminary Schedule

The following is a preliminary schedule of course topics. We may adjust the schedule due to time or interest. Required readings are marked with a (★). Note that there is no class on March 14th due to Spring break.

§1 Introduction

- Overview, Course Requirements, Course Outline

§2 Review of Statistical Concepts Useful for Causal Inference

- Random Variables, Measures of Location and Dispersion
- Inference and Properties of Estimators
- Conditional mean function

§3 The Potential Outcome Model

- Counterfactual Responses and the Fundamental Identification Problem
- Graphical Causal Models
- Estimands and Assignment Mechanisms

Readings

- Hernán and Robins, Chapter 1, 6. (★)
- Angrist and Pischke: Chapter 1. (★)
- Holland, P. W. 1986. *Statistics and Causal Inference*. Journal of the American Statistical Association, Vol. 81, No. 396: 945-960. (★)
- Sekhon, J.S. 2004. *Quality Meets Quantity: Case Studies, Conditional Probability and Counterfactuals*. Perspectives on Politics, Vol. 2: 281-293.

§4 Randomized Experiments

- Identification of Causal Effects under Randomization
- Implementation, Estimation, Diagnostics, Blocking
- Effect Modification

Readings: Theory of Experiments

- Angrist and Pischke: Chapter 2. (★)
- Hernán and Robins, Chapter 2.1-2.3, 4.1-4.3. (★)
- Imbens and Rubin, Chapter 4.

Readings: Application of Experiments

- Olken, Benjamin. 2007. **Monitoring corruption : Evidence from a field experiment in Indonesia**. *Journal of Political Economy*. 2007, vol. 115, No 2: 200-249. (★)
- Gerber, A., Green, D., Larimer, C. 2008. **Social Pressure and Voter Turnout: Evidence from a Largescale Field Experiment**. *American Political Science Review*. Vol. 102, No. 1: 1-48. (★)
- Wantchekon, Leonard. 2003. **Clientelism and Voting Behavior: Evidence from a Field Experiment in Benin** *World Politics*. Volume 55, Number 3, April: 399-422. (★)
- Chattopadhyay, R. and Duflo, E. 2004. **Women as Policy Makers: Evidence from a Randomized Policy Experiment in India**. *Econometrica*, Vol. 72, No. 5: 1409–1443.
- Mutz, Diana C. and Byron Reeves. 2005. **The New Video Malaise: Effects of Televised Incivility on Political Trust**. *American Political Science Review* 99 (February): 1-15.
- Gartner, Scott. 2008. **The Multiple Effects of Casualties on Public Support for War: An Experimental Approach**. *American Political Science Review* 102(1): 95-106.

Readings: Application of Natural Experiments

- Della Vigna, Stefano, and Ethan Kaplan. 2007. **The Fox News Effect: Media Bias and Voting**. *Quarterly Journal of Economics* 122(3): 1187-1234.
- Hyde, Susan D. 2007. **The Observer Effect in International Politics: Evidence from a Natural Experiment**. *World Politics* 60(1): 37-63. (★)
- Ferraz, Claudio, and Federico Finan. 2008. **Exposing Corrupt Politicians: The Effects of Brazil's Publicly Released Audits on Electoral Outcomes**. *Quarterly Journal of Economics* 123(2): 703-45.
- Ho, Daniel E., and Kosuke Imai. 2008. **Estimating Causal Effects of Ballot Order from a Randomized Natural Experiment: The California Alphabet Lottery, 1978-2002**. *Public Opinion Quarterly* 72(2): 216-40.

Readings: Experiments Review Articles

- Palfrey, Thomas. 2009. **Laboratory Experiments in Political Economy**. *Annual Review of Political Science* 12: 379-88.

- Druckman, James N., Donald P. Green, James H. Kuklinski, and Arthur Lupia. 2006. **The Growth and Development of Experimental Research in Political Science**. *American Political Science Review* 100(4): 627-35.
- de Rooij, Eline A., Donald P. Green, and Alan S. Gerber. 2009. **“Field Experiments on Political Behavior and Collective Action.”** *Annual Review of Political Science* 12: 389-95. (★)
- Humphreys, Macartan, and Jeremy Weinstein. 2009. **Field Experiments and the Political Economy of Development**. *Annual Review of Political Science* 12: 367-78.
- Harrison, Glenn and John A. List. 2004. **Field Experiments**. *Journal of Economic Literature*, XLII: 1013-1059.
- List, John A., and Steven Levitt. 2006. **What Do Laboratory Experiments Tell Us About the Real World?** University of Chicago and NBER.
- Gaines, Brian J., and James H. Kuklinski. 2007. **The Logic of the Survey Experiment Reexamined**. *Political Analysis* 15: 1-20.

Readings: Useful Methodological Guides for Experiments

- Duflo, Esther, Abhijit Banerjee, Rachel Glennerster, and Michael Kremer. 2006. **Using Randomization in Development Economics: A Toolkit**. *Handbook of Development Economics*.
- Howard S. Bloom. 2006. **The Core Analytics of Randomized Experiments for Social Research**. MDRC Working Papers on Research Methodology.
- Bruhn, Miriam and David McKenzie. 2008. **In Pursuit of Balance**. The World Bank Policy Research Working Paper 4752.
- Gary King, et.al. 2007. **A “Politically Robust” Experimental Design for Public Policy Evaluation, with Application to the Mexican Universal Health Insurance Program**. *Journal of Policy Analysis and Management* 26, 3, 479–506.
- Harvard University Committee on the Use of Human Subjects
<http://cuhs.harvard.edu>

§5 Randomization Inference

- Fisher's approach to inference, permutation tests, Lady Tasting Tea.
- Sharp null of no effect, randomization distribution

Readings: Fisher's randomization inference

- Bower, Jake and Panagopoulos, Costas. 2011. **Fisher's randomization mode of inference, then and now.** (★)
- Rosenbaum, Paul R. 2002. **Covariance Adjustment in Randomized Experiments and Observational Studies (with discussion).** *Statistical Science*, Vol. 17(3): 286–327. (★)
- Imbens and Rubin, Chapter 5.
- Rosenbaum, Paul R. 2002. *Observational Studies*. Springer-Verlag. 2nd edition. Chapter 2.

§6 Causal Effects under Selection on Observables

Selection on Observables

- Identification under Selection on Observables, Back-door criterion
- Subclassification

Readings

- Hernán and Robins, Chapter 7. (★)
- Rubin, Donald B. 2008. **For Objective Causal Inference, Design Trumps Analysis.** *Annals of Applied Statistics* 2(3): 808-840.(★)
- Rosenbaum, Paul R. 2002. *Observational Studies*. Springer-Verlag. 2nd edition. Chapter 3.
- Rosenbaum, P. R. 2005. **Heterogeneity and Causality: Unit Heterogeneity and Design Sensitivity in Observational Studies.** *The American Statistician*, Vol. 59: 147-152.
- Acemoglu, D. 2005. **Constitutions, Politics, and Economics: A Review Essay on Persson and Tabellini's The Economic Effects of Constitutions.** *Journal of Economic Literature* Vol. XLIII: 1025-1048. (★)

- Cochran, W. G. 1968. *The Effectiveness of Adjustment by Subclassification in Re-moving Bias in Observational Studies*, *Biometrics*, vol. 24: 295-313.
- Pearl, Judea. 1995. Causal diagrams for empirical research. *Biometrika*.

Matching Methods

- Covariate Matching, Balance Checks, Properties of Matching Estimators

Readings: Matching Theory

- Stuart. 2010. *Matching methods for causal inference: A review and a look forward*. *Statistical Science*. Vol. 25, No. 1: 1-21 (★)
- Morgan and Harding. 2006. *Matching Estimators of Causal Effects: Prospects and Pitfalls in Theory and Practice*.
- Sekhon, Jasjeet S. 2009. *Opiates for the Matches: Matching Methods for Causal Inference*. *Annual Review of Political Science* 12: 487-508.(★)
- Ho et. al. 2007. *Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference*. *Political Analysis*, Vol. 15: 199-236.
- Rubin. 2006. Chapters 3 to 5.
- Rosenbaum, P. R., 1995. *Observational Studies*. New York: Springer-Verlag. Chapter 3.
- Abadie, A. and G. W. Imbens. 2006. *Large Sample Properties of Matching Estimators for Average Treatment Effects*, *Econometrica*, vol. 74, 235-267.
- Abadie, A. and G. W. Imbens. 2011. *Bias Corrected Matching Estimators for Average Treatment Effects*, *Journal of the American Statistical Association*, Vol. 29, No. 1, . (PDF) .

Readings: Matching Applications

- Jason Lyall. 2010. *Are Co-Ethnics More Effective Counter-Insurgents? Evidence from the Second Chechen War*. *American Political Science Review*, 104:1 (February 2010), 1-20.
- Gordon, S. and Huber, S. 2007. *The Effect of Electoral Competitiveness on Incumbent Behavior*. *Quarterly Journal of Political Science*, vol. 2: 107-138.

- Sekhon, J. 2004. *The 2004 Florida Optical Voting Machine Controversy: A Causal Analysis Using Matching*. Manuscript. UC Berkeley.
- Gilligan, M. and Sergenti, J. 2008. *Do UN Interventions Cause Peace? Using Matching to Improve Causal Inference*. Quarterly Journal of Political Science, vol. 3: 89–122.
- Simmons, B. and Hopkins, D. 2005. *The Constraining Power of International Treaties: Theory and Methods*. American Political Science Review 99(4): 623-631.

Propensity Score Methods

- Identification, Propensity Score Estimation, Matching on the Propensity Score, Weighting on the Propensity Score, Reweighting methods

Readings: Propensity Score Methods Theory

- Morgan and Winship: Chapter 3.
- Rubin, D. 2006. Chapters 10, 11 and 14 (all with Paul R. Rosenbaum).
- Imbens, G. 2004. *Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review*. Review of Economics and Statistics 86 (1): 4–29. (★)

Readings: Propensity Score Methods Applications

- Rubin, D. 2001. *Using Propensity Scores to Help Design Observational Studies: Application to the Tobacco Litigation*. Health Services and Outcomes Research Methodology. Volume 2, Numbers 3-4: 169-188. (★)
- Blattman, C. and Annan, J. 2010. *The Consequences of Child Soldiering*. The Review of Economics and Statistics, Vol. 92, No. 4. (★)

Regression

- Non-parametric Regression, Identification with Regression

Readings

- Angrist and Pischke: Chapter 3. (★)
- Morgan and Winship: Chapter 5. (★)
- Chapter in Winship and Morgan on Matching vs Regression.

- Härdle, W and Linton, O. 1994. **Applied Nonparametric Methods**, in R. F. Engle and D. L. McFadden eds. Handbook of Econometrics, vol. 4. New York: Elsevier Science.
- White, H. 1980. **Using Least Squares to Approximate Unknown Regression Functions**. International Economic Review, vol. 21: 149-170.

Conclusion: Selection on Observables

- Can Non-Experimental Method Recover Causal Effects?

Readings: Comparison of Experimental and Non-experimental Methods

- Dehejia, R. H. and Wahba, S. 1999. **Causal Effects in Non-Experimental Studies: Re- Evaluating the Evaluation of Training Programs**, Journal of the American Statistical Association, vol. 94: 1053-1062.(*)
- Heckman, J. J., H. Ichimura and P. E. Todd (1997), **Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme**, Review of Economic Studies, vol. 64, 605-654.
- Shadish, W. M. Clark, H., and Steiner, P. 2008. **Can Nonrandomized Experiments Yield Accurate Answers? A Randomized Experiment Comparing Random and Nonrandom Assignments**. Journal of the American Statistical Association, Vol. 103, No. 484: 1334-1344. (*)
- Arceneaux, Kevin, Alan S. Gerber, and Donald P. Green. 2006. **Comparing Experimental and Matching Methods using a Large-Scale Voter Mobilization Experiment**. Political Analysis 14: 1-36.
- John Concato, Nirav Shah, and Ralph Horwitz. 2000. **Randomized, Controlled Trials, Observational Studies, and the Hierarchy of Research Designs**. New England Journal of Medicine 342(25): 1887-92.
- Benson, Kjell and Arthur J. Hartz. 2000. **A Comparison of Observational Studies and Randomized, Controlled Trials**. New England Journal of Medicine 342(25): 1878-86.

§7 Causal Effects under Selection on Time-Invariant Characteristics

Panel Data Methods

- Fixed Effects and Random Effects Estimation

Readings: Panel Methods Theory

- Angrist and Pischke: Chapter 5.1 (★)
- Angrist and Pischke: Chapter 8 (★)
- Michael E. Sobel. 2012. “Does Marriage Boost Men’s Wages?: Identification of Treatment Effects in Fixed Effects Regression Models for Panel Data.” *Journal of the American Statistical Association* 107, no. 498 (June): 521–529 (★)
- Imai, Kosuke, and In Song Kim. 2012. *On the Use of Linear Fixed Effects Regression Models for Causal Inference*. Working paper. (★)

Readings: Panel Methods Applications

- Ladd, Jonathan McDonald, and Gabriel S. Lenz. 2009. *Exploiting a Rare Communication Shift to Document the Persuasive Power of the News Media*. *American Journal of Political Science* 53(2): 394-410. (★)
- Cox, Gary W., and William Terry. 2008. *Legislative Productivity in the 93d-105th Congresses*. *Legislative Studies Quarterly* 33(4): 603-16.
- Berrebi, C. and Klor, E. 2008. *Are Voters Sensitive to Terrorism? Direct Evidence from the Israeli Electorate*. *American Political Science Review* (2008), 102:279-301.

Difference-in-Differences Estimators

- Identification, Estimation, Falsification tests

Readings: DID Theory

- Angrist and Pischke: Chapter 5.2-5.4 (★)
- Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. *How Much Should We Trust Differences-in-Differences Estimates?* *Quarterly Journal of Economics* 119(1): 249-75.
- Abadie, Alberto. 2005. *Semiparametric Difference-in-Differences Estimators*. *The Review of Economic Studies* 72(1): 1–19.

Readings: DID Applications

- Lyall, Jason. 2009. *Does Indiscriminate Violence Incite Insurgent Attacks? Evidence from Chechnya*. *Journal of Conflict Resolution* 53(3): 331-62.(★)

- Card, D. (1990), *The Impact of the Mariel Boatlift on the Miami Labor Market*, *Industrial and Labor Relations Review*, vol. 44, 245-257.
- Card, D. and A. B. Krueger (1994), *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, *American Economic Review*, vol. 84, 772-793. (★)

§8 Causal Effects under Selection on Time-variant Characteristics

Instrumental Variables

- Identification: Using Exogenous Variation in Treatment Intake Given by Instruments
- Imperfect Compliance in Randomized Studies
- Wald Estimator, Local Average Treatment Effects, 2SLS

Readings: Instrument Variable Theory

- Angrist and Pischke: Chapter 4 (★)
- Morgan and Winship: Chapter 7
- Angrist, Joshua D., and Alan B. Krueger. 2001. *Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments*.
- Angrist, Imbens, and Rubin 1996. *Identification of Causal Effects Using Instrumental Variables*. *Journal of Economic Perspectives* 15(4): 69-85.
- Abadie, Alberto 2003. *Semiparametric instrumental variable estimation of treatment response models*. *Journal of Econometrics* 113 (2003) 231-263.

Readings: Instrument Variable Critique

- Deaton, Angus. 2010. *Instruments, Randomization, and Learning About Development*. *Journal of Economic Literature* 48(2): 424-55. (★)
- Hernan, Miguel A., and James M. Robins. 2006. *Instruments for Causal Inference: An Epidemiologist's Dream?* *Epidemiology* 17(4): 360-72.
- Guido Imbens. 2010. *Better LATE Than Nothing: Some Comments on Deaton (2009) and Heckman and Urzua (2009)*. *Journal of Economic Literature*, Vol. 48, No. 2: 399-423. (★)

Readings: Instrument Variable Applications

- Kern and Hainmueller **Opium for the Masses: How Foreign Free Media Can Stabilize Authoritarian Regimes**. Political Analysis (2009). (★)
- Angrist and Krueger. 2001 **Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments**
- Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. **The Colonial Origins of Comparative Development: An Empirical Investigation**. American Economic Review 91(5): 1369-1401.(★)
- Clingingsmith, David, Asim Ijaz Khwaja, and Michael Kremer. 2009. **Estimating the Impact of the Hajj: Religion and Tolerance in Islam's Global Gathering**. Quarterly Journal of Economics 124(3): 1133-1170.
- Stromberg, David. 2004. **Radio's Impact on Public Spending**. Quarterly Journal of Economics 119(1): 189-221.
- Angrist, Joshua D. 1990. **Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records**. American Economic Review 80(3): 313-36.

The Regression Discontinuity Design

- Sharp and Fuzzy Designs, Identification, Estimation, Falsification Checks

Readings: RDD Theory

- Imbens, Guido W., and Thomas Lemieux. 2008. **Regression Discontinuity Designs: A Guide to Practice**. Journal of Econometrics 142: 615-35. (Part of special issue on RDD, all of which is of interest.) (★)
- Angrist and Pischke: Chapter 6 (★)
- Hahn, J., P. Todd and W. van der Klaauw (2001), **Identification and Estimation of Treatment Effects with a Regression Discontinuity Design**, Econometrica, vol. 69: 201-209.

Readings: RDD Applications

- Ferraz, C., and F. Finan. 2008. **Motivating Politicians: The Impacts of Monetary Incentives on Quality and Performance**. Mimeo. 2009 NBER Working paper w14906.

- Lee, David S. 2008. **Randomized Experiments from Non-random Selection in U.S. House Elections**. *Journal of Econometrics*. Volume 142, Issue 2, Pages 675-697. (★)
- Eggers, A. and Hainmueller, J. 2009. **MPs for Sale? Estimating Returns to Office in Post-War British Politics**. *American Political Science Review*. Vol. 103, No. 4 November 2009.
- Butler, Daniel M., and Matthew J. Butler. 2006. **Splitting the Difference? Causal Inference and Theories of Split-Party Delegations**. *Political Analysis* 14(4): 439-55.
- Hainmueller, Jens, and Holger Lutz Kern. 2008. **Incumbency as a Source of Spillover Effects in Mixed Electoral Systems: Evidence from a Regression-Discontinuity Design**. *Electoral Studies* 27: 213-27.
- Caughey, Devin and Shekon, Jas. 2010. **Regression-Discontinuity Designs and Popular Elections: Implications of Pro-Incumbent Bias in Close U.S. House Races**.

§9 Causal Mediation

- Interactions
- Direct, Indirect Effects, Mechanisms/Mediation

Readings

- Hernán and Robins, Chapter 5.1-5.3. (★)
- Imai, Kosuke, Luke Keele, Dustin Tingley, and Teppei Yamamoto. 2011. **Unpacking the Black Box of Causality: Learning About Causal Mechanisms From Experimental and Observational Studies**. *American Political Science Review* 105(04): 765-89. (★)
- Vansteelandt, Sijn, and Tyler J VanderWeele. 2009. **Conceptual Issues Concerning Mediation, Interventions and Composition**. *Statistics and Its Interface*: 1-12.

§10 Causal Inference with Time-varying Treatments

- Time-varying confounders, sequential ignorability, marginal structural models.

Readings

- Matthew Blackwell, *A Framework for Dynamic Causal Inference in Political Science*, American Journal of Political Science. (★)
- Robins, James M. 1999. “Association, Causation, and Marginal Structural Models.” *Synthese* 121(1/2): 151–79.
- Robins, James M., Miguel A Hernán, and Babette Brumback. 2000. “Marginal Structural Models and Causal Inference in Epidemiology.” *Epidemiology* 11(5): 550–60.

§11 Odds, Ends, and Practicals

Sensitivity Analysis

- Nonparametric Bounds
- Formal sensitivity tests

Readings

- Guido W. Imbens. 2003. *Sensitivity to Exogeneity Assumptions in Program Evaluation*. The American Economic Review 93(2): 126–32. (★)
- Morgan and Winship: Chapter 6 (★)
- Rosenbaum, Paul R. 2002. *Observational Studies*. Springer-Verlag. 2nd edition. Chapter 4.
- Manski, C. 1995. *Identification Problems in the Social Sciences*. Cambridge: Harvard University Press. Chapter 2.
- Joseph Altonji, Todd E. Elder, and Christopher Taber. 2005. *Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools*. Journal of Political Economy Vol. 113: 151-184.
- Paul Rosenbaum and Donald Rubin. 1983. *Assessing Sensitivity to an Unobserved Binary Covariate in an Observational Study with Binary Outcome*. Journal of the Royal Statistical Society. Series B (Methodological) 45(2): 212-18.

Synthetic Control Methods

Readings

- Abadie, Diamond, and Hainmueller. 2010. **Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program**. Journal of the American Statistical Association. (★)
- Abadie, Alberto and Javier Gardeazabal. 2003. **The Economic Costs of Conflict: a Case-Control Study for the Basque Country**. American Economic Review 92 (1).

Quantile Regression

Readings

- Angrist and Pischke: Chapter 7 (★)
- Roger Koenker, Kevin F. Hallock, **Quantile Regression**, Journal of Economic Perspectives, Vol. 15, No. 4 (Fall 2001), pp. 143–156

Distributional Effects in Difference-in-Differences

Readings

- Athey, S. and Imbens, G. **Identification and Inference in Nonlinear Difference-in-Differences Models**. Econometrica, 74 (2), March 2006, pp. 431–497.