

# ***Econometrics, Harmless and Otherwise***

**Alberto Abadie  
MIT and NBER**

**Joshua Angrist  
MIT and NBER**

**Chris Walters  
UC Berkeley**

**ASSA January 2017**

*We discuss econometric techniques for program and policy evaluation, covering new developments and old favorites. Methods are illustrated with applications. The focus is on conceptual and research design issues rather than programming. Topics include randomized trials, matching, instrumental variables, differences-in-differences, synthetic controls, regression discontinuity designs, structural models for policy evaluation, and Bayesian and machine learning methods. The course consists of nine 80 minutes sessions, two on the first day, five on the second, two on the third.*

**Lecture 1: Causality, Potential Outcomes, and the Estimation of Treatment Effects in Randomized Studies (Abadie)**

Causality, counterfactuals and potential outcomes  
Randomized experiments, Fisher's exact test  
Threats to internal and external validity in randomized experiments

**Lecture 2: Making Regression Make Sense (Angrist)**

Causal control  
3 reasons to love  
The long and short of regression anatomy  
Omitted Variables Bias  
Hey, where d'ya go to school?

**Lectures 3: Instrumental Variables Part I (Angrist)**

IV and omitted variables bias: estimating a long regression without controls  
Two-stage least squares (2SLS); 2SLS lingo and mistakes  
The Wald estimator, grouped data, and two-sample IV  
The bias of 2SLS

**Lecture 4: Instrumental Variables Part II (Angrist)**

*Heterogeneous Potential Outcomes*

Local average treatment effects; understanding *compliers*  
IV in randomized trials

*Additional Topics*

Average causal response in models with variable treatment intensity  
External validity  
All my children

**Lecture 5: Matching and the Propensity Score (Abadie)**

Selection on observables  
Matching, subclassification, and propensity score methods  
Comparison of estimators using the National Supported Work Demonstration data  
What to match on: a brief introduction to Directed Acyclic Graphs (DAGs)

**Lecture 6: Differences-in-Differences and Synthetic Controls (Abadie)**

Motivation: difference-in-differences estimation in comparative case studies  
Estimation and inference with synthetic controls  
Empirical examples

**Lecture 7: Regression Discontinuity Designs (Walters)**

*Theory*

Sharp RD identification  
RD diagnostics  
RD estimation: global and local  
Fuzzy RD  
Regression kink designs

*Applications*

The incumbency advantage  
Sheepskin effects: signaling vs. human capital

**Lecture 8: Selection Models and Policy Evaluation (Walters)**

*Theory*

Selection model basics  
Control function estimation  
Connections to IV: LATE equivalence and extrapolation  
Marginal treatment effects and policy evaluation

*Application*

Head Start counterfactuals

**Lecture 9: Bayesian and Machine Learning Methods (Walters)**

*Theory*

Empirical Bayes shrinkage  
Bayes vs. empirical Bayes  
Machine learning techniques

*Applications*

Teacher and school evaluation  
Social spillovers at the movies

READINGS

Texts: J.D. Angrist and J.S. Pischke, *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton University Press, 2009.  
J.D. Angrist and J.S. Pischke, *Mastering 'Metrics: The Path from Cause to Effect*, Princeton University Press, 2014.

Many of the readings are from *MHE* and *MM*. Published journal articles should be available in JSTOR. Working papers are available from online sources.

CAUSALITY, POTENTIAL OUTCOMES, AND THE ESTIMATION OF TREATMENT EFFECTS IN  
RANDOMIZED STUDIES

*MM* Chapter 1; *MHE* Chapter 2

Duflo, E., R. Glennerster and M. Kremer (2008), "Using Randomization in Development Economics Research: A Toolkit," in T.P. Schultz and J.A. Strauss eds. *Handbook of Development Economics*, vol. 4. Elsevier Science.

Imbens, G.W. and J.M. Wooldridge (2009) "Recent Developments in the Econometrics of Program Evaluation," *Journal of Economic Literature*, vol. 47(1), 5-86.

Imbens, G.W. and D.B. Rubin (2015), *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge University Press. Chapters 1-10

Krueger, A. (1999), "Experimental Estimates of Education Production Functions," *Quarterly Journal of Economics*, vol. 114, 497-532.

MAKING REGRESSION MAKE SENSE

*MM* Chapter 2; *MHE* Chapters 1-2 and 3.1-3.2.

S.B. Dale and A.B. Krueger, "Estimating the Payoff to Attending a More Selective College: An Application of Selection on Observables and Unobservables," *The Quarterly Journal of Economics* 117, November 2002, 1491-152

MATCHING AND THE PROPENSITY SCORE

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 Business and Economic Statistics*, vol. 29, 1-11.

Abadie, A. and G.W. Imbens (2012), "A Martingale Representation for Matching Estimators," *Journal of the American Statistical Association*, vol. 107, 833-843.

Abadie, A. and G.W. Imbens (2016), "Matching on the Estimated Propensity Score," *Econometrica*, vol. 84, 781-807.

- Dehejia, R.H. and S. Wahba (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.
- Hernán, M. and J. Robins (2012), *Causal Inference*. Available online at: <http://www.hsph.harvard.edu/miguel-hernan/causal-inference-book/>
- Hirano, K., G.W. Imbens, and G. Ridder (2003), "Efficient Estimation of Average Treatment Effects Using the Estimated Propensity Score," *Econometrica*, vol. 71, 1161-1189.
- Imbens, G.W. (2004), "Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review," *Review of Economics and Statistics*, vol. 86(1), 4-29.
- Imbens, G.W. and D.B. Rubin (2015), *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge University Press. Chapters 12-18.
- Newey, W.K. (1994), "The Asymptotic Variance of Semiparametric Estimators," *Econometrica*, vol. 62, 1349-1382.
- Newey, W.K. and D.L. McFadden (1994), "Large Sample Estimation and Hypothesis Testing." In: Engle, R.F., McFadden, D.L. (Eds.), *Handbook of Econometrics*, vol. IV. Amsterdam: Elsevier Science.
- Pearl, J. (2009), *Causality* (second edition). Cambridge University Press.
- Rosenbaum, P.R., and D. B. Rubin (1983), "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika*, vol. 70, 41-55.
- Rubin, D.B. (1977), "Assignment to Treatment Group on the Basis of a Covariate," *Journal of Educational Statistics*, vol. 2, 1-26.

## INSTRUMENTAL VARIABLES I

(Part 1:2SLS with constant effects; the Wald estimator, grouped data, two-sample IV)

MM Chapter 3, MHE Section 4.1

- J. Angrist and A. Krueger, "Instrumental Variables and the Search for Identification," *Journal of Economic Perspectives*, Fall 2001.
- J. Angrist, "Grouped Data Estimation and Testing in Simple Labor Supply Models," *Journal of Econometrics*, February/March 1991.
- J. Angrist, "Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records," *American Economic Review*, June 1990.
- Inoue, Atsushi and G.Solon, "Two-Sample Instrumental Variables Estimators," *The Review of Economics and Statistics*, August 2010.

2SLS Mistakes: MHE, Section 4.6.1.

*The Bias of 2SLS*

MHE Section 4.6.4

- J. Angrist, G. Imbens, and A. Krueger, "Jackknife Instrumental Variables Estimation," *Journal of Applied Econometrics* 14(1), 57-67.
- Flores-Lagunes, Alfonso, "Finite-Sample Evidence on IV Estimators with Weak Instruments," *Journal of Applied Econometrics* 22, 2007, 677-694.

## INSTRUMENTAL VARIABLES (II)

*Heterogeneous Potential Outcomes*

MM Chapter 3, MHE Section 4.4

G. Imbens and J. Angrist, "Identification and Estimation of Local Average Treatment Effects," *Econometrica*, March 1994.J. Angrist, G. Imbens, and D. Rubin, "Identification of Causal Effects Using Instrumental Variables," with comments and rejoinder, *JASA*, 1996.J. Angrist and A. Krueger, "Does Compulsory Schooling Attendance Affect Schooling and Earnings?," *Quarterly Journal of Economics* 106, November 1991, 979-1014.J. Angrist, "Instrumental Variables in Experimental Criminological Research: What, Why, and How," *Journal of Experimental Criminological Research* 2, 2005, 1-22.*Models with Variable and Continuous Treatment Intensity*

MHE Section 4.5.3

J. Angrist and G. Imbens, "Two-Stage Least Squares Estimation of Average Causal Effects in Models with Variable Treatment Intensity," *JASA*, June 1995.J. Angrist, K. Graddy, and G. Imbens, "The Interpretation of instrumental Variables Estimations in Simultaneous Equations Models with an Application to the Demand for Fish," *Rev. Ec. Studies* 67 (2000), 499-527.*External Validity*J. Angrist, V. Lavy, and Analia Schlosser, "Multiple Experiments for the Causal Link Between the Quantity and Quality of Children," *The Journal of Labor Economics*, October 2010.J. Angrist and I. Fernandez-Val, "Extrapo-LATEing: External Validity and Overidentification in the LATE Framework," in *Advances in Econometrics Theory and Applications*, Tenth World Congress, Volume III, 2013.

## DIFFERENCES-IN-DIFFERENCES AND SYNTHETIC CONTROLS

MM Chapter 5, MHE Chapter 5

Abadie, A. (2005), "Semiparametric Difference-in-Differences Estimators," *Review of Economic Studies*, vol. 72, 1-19.Abadie, A., A. Diamond and J. Hainmueller (2010), "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program," *Journal of the American Statistical Association*, vol. 105, 493-505.Abadie, A. and J. Gardeazabal (2003), "The Economic Costs of Conflict: A Case Study of the Basque Country," *American Economic Review*, vol. 93(1), 113-132.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.

- Duflo, E. (2001), "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment," *American Economic Review*, vol. 91, 795-813.
- Gruber, J. (1994), "The Incidence of Mandated Maternity Benefits," *American Economic Review*, vol. 84(3), 622-641.

## REGRESSION DISCONTINUITY DESIGNS

MM Chapter 4, MHE Chapter 6

- Card, D., Lee, D., Pei, Z., and Weber, A. (2015). "Inference on causal effects in a generalized regression kink design." *Econometrica* 83(6).
- Calonico, S., Cattaneo, M., and Titiunik, R. (2014). "Robust nonparametric confidence intervals for regression-discontinuity designs." *Econometrica* 82(6).
- Clark, D., and Martorell, P. (2014). "The signaling value of a high school diploma." *Journal of Political Economy* 122(2).
- Imbens, G., and Lemieux, T. (2008). "Regression discontinuity designs: a guide to practice." *Journal of Econometrics* 142(2).
- Imbens, G., and Kalyanaraman, K. (2012). "Optimal bandwidth choice for the regression discontinuity estimator." *Review of Economic Studies* 79(3).
- Lee, D. (2008). "Randomized experiments from non-random selection in U.S. House elections." *Journal of Econometrics* 142.
- Lee, D., and Lemieux, T. (2010). "Regression discontinuity designs in economics." *Journal of Economic Literature* 48(2).
- McCrary, J. (2008). "Manipulation of the running variable in the regression discontinuity design: a density test." *Journal of Econometrics* 142(2).
- Thistlethwaite, D., and Campbell, D. (1960). "Regression-discontinuity analysis: an alternative to the ex post facto experiment." *Journal of Educational Psychology* 51(6).
- Urquiola, M., and Verhoogen, E. (2009). "Class-size caps, sorting, and the regression discontinuity design." *American Economic Review* 99(1).

## SELECTION MODELS AND POLICY EVALUATION

- Brinch, C., Mogstad, M., and Wiswall, M. (forthcoming). "Beyond LATE with a discrete instrument." *Journal of Political Economy*.
- Carneiro, P., Heckman, J., and Vytlacil, E. (2010). "Evaluating marginal policy changes and the average effect of treatment for individuals at the margin." *Econometrica* 78(1).
- Heckman, J. (1979). "Sample selection bias as a specification error." *Econometrica* 47(1).
- Heckman, J., Urzua, S., and Vytlacil, E. (2006). "Understanding instrumental variables in models with essential heterogeneity." *Review of Economics and Statistics* 88(3).
- Heckman, J., and Vytlacil, E. (1999). "Local instrumental variables and latent variable models for identifying and bounding treatment effects." *Proceedings of the National Academy of Sciences* 96(8).
- Heckman, J., and Vytlacil, E. (2005). "Structural equations, treatment effects, and econometric policy evaluation." *Econometrica* 73(3).

- Kline, P., and Walters, C. (2016). "Evaluating public programs with close substitutes: the case of Head Start." *Quarterly Journal of Economics* 131(4).
- Olsen, R. (1980). "A least squares correction for selectivity bias." *Econometrica* 48(7).
- Vytlacil, E. (2002). "Independence, monotonicity and latent index models: an equivalence result." *Econometrica* 70(1).

#### BAYESIAN AND MACHINE LEARNING METHODS

- Abadie, A., and Kasy, M. (2016). "The risk of machine learning." Working paper.
- Angrist, J., Hull, P., Pathak, P., and Walters, C. (forthcoming). "Leveraging lotteries for school value-added: testing and estimation." *Quarterly Journal of Economics*.
- Belloni, A., Chen, D., Chernozhukov, V., and Hansen, C. (2012). "Sparse models and methods for optimal instruments with an application to eminent domain." *Econometrica* 80(6).
- Belloni, A., Chernozhukov, V., and Wang, L. (2011). "Square-root LASSO: pivotal recovery of sparse signals via conic programming." *Biometrika* 98(4).
- Chetty, R., Friedman, J., and Rockoff, J. (2014). "Measuring the impacts of teachers II: teacher value-added and outcomes in adulthood." *American Economic Review* 104(9).
- Chetty, R., and Hendren, N. (2016). "Impacts of neighborhoods on intergenerational mobility II: county-level estimates." Working paper.
- Gilchrist, D., and Sands, E. (2016). "Something to talk about: social spillovers in movie consumption." *Journal of Political Economy* 124(5).
- Morris, C. (1983). "Parametric empirical Bayes inference: theory and applications." *Journal of the American Statistical Association* 78(381).
- Robbins, H. (1964). "An empirical Bayes approach to statistical decision problems." *Annals of Mathematical Statistics* 35(1).
- Varian, H. (2014). "Big data: new tricks for econometrics." *Journal of Economic Perspectives* 28(2).