

EMPIRICAL STRATEGIES

NAKE Workshop
December 2004

Maastricht University
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This short-course covers econometric ideas and empirical modeling strategies that I have found to be especially useful for applied work. The main theoretical ideas are illustrated with examples. This introductory handout includes a problem set to test your understanding.

OUTLINE

I. Agnostic regression – a great place to start!

- Regression as Best Linear Predictor (BLP) for the Conditional Expectation Function (CEF)
- Quick review of large sample theory for OLS estimates
- Inference problems

II. Causal regression (our main occupation); regression vs. matching

- Linking a regression model with a causal model
- The experimentalist view of non-experimental research
- Matching to estimate the effect of treatment on the treated
- Theoretical comparison of regression and matching
- The Angrist (1998) study of the effects of voluntary military service

III. Estimating the effect of training programs (the mother of econometric evaluation problems)

- Why training programs are hard to evaluate; Ashenfelter (1978)
- The Ashenfelter and Card (1985) training evaluation
- The credibility of non-experimental training evaluations; Lalonde (1986)
- Use of the propensity score in evaluation research
- The Dehejia and Wahba (1999) propensity-score study
- Smith and Todd vs. Dehejia

IV. Instrumental variables (exploiting “nature’s stream of experiments”)

A. Constant-effects models

- IV and omitted variables bias: estimating a “long regression” without the controls
- Review of large-sample theory for IV
- The Wald estimator and grouped data
- Two-sample IV and related methods
- The Angrist (1990) study of the effects of Vietnam-era military service

B. Instrumental variables with heterogeneous potential outcomes

- Local average treatment effects; internal vs. external validity
- The *compliers* concept; identification of effects on the treated
- Models with variable treatment intensity; examples
- The Angrist and Krueger (1991) schooling study

V. Statistical problems and special topics

- A. Bias in two-stage least squares; solutions
- B. Clustering and the Moulton problem
- C. IV for limited dependent variables and Quantile Treatment Effects
- D. The propensity-score paradox

READINGS

I. REGRESSION AND THE CEF

- G. Chamberlain, "Panel Data," Chapter 22 in *The Handbook of Econometrics*, Volume II, Amsterdam: North-Holland, 1983.
- Chesher and I. Jewitt, "The Bias of a Heteroskedasticity-Consistent Covariance Matrix Estimator," *Econometrica* 55, September 1987.
- J. Wooldridge, Chapters 1-4 in *Econometric Analysis of Cross-Section and Panel Data*, Cambridge: The MIT Press, 2002.

II. CAUSALITY, REGRESSION, REGRESSION VS. MATCHING

- J. Angrist and A. Krueger, "Empirical Strategies in Labor Economics," Chapter 23 in O. Ashenfelter and D. Card, eds., *The Handbook of Labor Economics*, Volume III, North Holland, 1999.
- J. Angrist, "Estimating the Labor Market Impact of Voluntary Military Service Using Social Security Data on Military Applicants," *Econometrica*, March 1998.
- C. Seltzer and S. Jablon, "Effects of Selection on Mortality," *American Journal of Epidemiology*, 1974.
- P. Holland, "Statistics and Causal Inference," *JASA* 81[396], December 1986, 945-970, with discussion.
- Rubin, D. B., 1974, "Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies," *Journal of Educational Psychology*, 66, 688-701.
- Rubin, D. B., 1977, "Assignment to Treatment Group on the Basis of a Covariate," *Journal of Educational Statistics* [1], Spring 1977 1-26.
- Haavelmo, Trygve, "The Probability Approach in Econometrics," *Econometrica* 12, July 1944.
- Rosenbaum, R., "Choice as an Alternative to Control in Observational Studies," *Statistical Science* 14 [3] (1999), 259-304.
- Donald T. Campbell, "Reforms as Experiments," *American Psychologist* 24 (April 1969), 409-429.

III. ESTIMATING THE EFFECT OF TRAINING PROGRAMS

- O. Ashenfelter, "Estimating the Effect of Training programs on Earnings," *The Review of Economics and Statistics* 60 (1978), 47-57.
- R. Lalonde, "The Promise of Public Sector-Sponsored Training Programs," *The Journal of Economic Perspectives* 9 (Spring 1995), 149-168.
- O. Ashenfelter and D. Card, "Using the Longitudinal Structure of Earnings to Estimate the Effect of Training Programs on Earnings," *The Review of Economics and Statistics* 67 (1985):648-66.
- R. LaLonde, "Evaluating the Econometric Evaluations of Training Programs with Experimental Data," *American Economic Review* 76 (September 1986): 604-620.
- J. Heckman and J. Hotz, "Choosing Among Alternative Nonexperimental Methods for Estimating the Impact of Social programs: The Case of Manpower Training," *JASA* 84 (1989): 862-8.
- P. Rosenbaum and R. Rubin, "Reducing Bias in Observational Studies Using Subclassification on the Propensity Score," *JASA* 79[387], September 1984, 516-524.

- Rosenbaum, P. R. And D. B. Rubin, 1983, "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika* 70[1], April 1983, 41-55.
- R. Dehejia and S. Wahba, "Causal Effects in Nonexperimental Studies: Re-evaluating the Evaluation of Training Programs," *JASA* 94 (Sept. 1999).
- J. Smith and P. Todd, "Reconciling Conflicting Evidence on the Performance of Propensity Score Matching Methods," *American Economic Review* 91 (May 2001).
- J. Smith and P. Todd, "Does Matching Overcome LaLonde's Critique of Nonexperimental Estimators?" *Journal of Econometrics*, forthcoming, 2004;
<http://www.ssc.uwo.ca/economics/centres/cibc/wp2003/Smith05.pdf>.
- R. Dehejia, "Practical propensity Score Matching, Columbia Department of Economics, 2004;
http://www.columbia.edu/~rd247/papers/practical_pscore.pdf.

IV. INSTRUMENTAL VARIABLES

A. Models with constant effects; the Wald estimator, grouping, and two-sample IV

- J. Angrist and A. Krueger, "Instrumental Variables and the Search for Identification," *Journal of Economic Perspectives*, Fall 2001.
- W. Newey, "Generalized Method of Moments Specification Testing," *Journal of Econometrics* 29 (1985), 229-56.
- W. Newey and K. West, "Hypothesis Testing with Efficient Method of Moments Estimation," *International Economic Review* 28, October 1987, 777-787.
- J. Angrist, "Grouped Data Estimation and Testing in Simple Labor Supply Models," *Journal of Econometrics*, February/March 1991.
- J. Angrist and A. Krueger, "The Effect of Age at School Entry on Educational Attainment: An Application of Instrumental Variables with Moments from Two Samples," *JASA* 87 (June 1992).
- J. Angrist and A. Krueger, "Split-Sample Instrumental Variables Estimates of the Returns to Schooling," *JBES*, April 1995.
- J. Angrist, "Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records," *American Economic Review*, June 1990.

B. Instrumental variables with heterogeneous potential outcomes

- 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 G. Imbens, "Two-Stage Least Squares Estimation of Average Causal Effects in Models with Variable Treatment Intensity," *JASA*, June 1995.
- J. Angrist and A. Krueger, "Does Compulsory Schooling Attendance Affect Schooling and Earnings?," *Quarterly Journal of Economics* 106, November 1991, 979-1014.
- J. Angrist, G. Imbens, K. Graddy, "The Interpretation of Instrumental Variables Estimators in Simultaneous Equations Models with an Application to the Demand for Fish," *Review of Economic Studies* 67[3], July 2000, 499-528.
- A. Abadie, "Semiparametric Estimation of Instrumental Variables Estimation of Treatment Response Models," *Journal of Econometrics* 113[2], 2003, 231-263.
- J. Angrist, "Treatment Effect Heterogeneity in Theory and Practice," *The Economic Journal* 114, March 2004, C52-C83.
- D. Card, "The Causal Effect of Education on Earnings," *The Handbook of Labor Economics, Volume IIIA*, Elsevier Science Publishers, 1999.

C. Additional IV Examples

McClellan, Mark, "Does More Intensive Treatment of Myocardial Infarction in the Elderly Reduce Mortality? An Instrumental Variables Analysis," *Journal of the American Medical Association* 272[11], September 1994, 859-866.

A. Krueger, "Experimental Estimates of Education Production Functions," *Quarterly Journal of Economics*, May 1999.

Permutt, T. and J. Hebel, "Simultaneous-Equation Estimation in a Clinical Trial of the Effect of Smoking on Birth Weight," *Biometrics*, 45[2], June 1989, 619-622.

Powers, D.E. and S.S. Swinton, "Effects of Self-Study for Coachable Test Item Types," *Journal of Educational Psychology*, 76, 1984, 266-78.

V. STATISTICAL PROBLEMS AND SPECIAL TOPICS

A. Bias of 2SLS

J. Bound, D. Jaeger, and R. Baker, "Problems with Instrumental Variables Estimation when the Correlation Between the Instruments and the Endogenous Regressors is Weak," *JASA* 90[430], June 1995, 443-50.

A. R. Hall, G. D. Rudebusch, D. W. Wilcox, "Judging Instrument Relevance in Instrumental Variables Estimation," *International Economic Review* 37[2], May 1996, 283-296.

J. Angrist, G. Imbens, and A. Krueger, "Jackknife Instrumental Variables Estimation," *Journal of Applied Econometrics* 14[1], Jan-Feb 1999, 57-67.

G. Imbens and D. Rubin, "Bayesian Inference for Causal Effects in Randomized Experiments with Noncompliance," *Annals of Statistics* 25[1], February 1997, 305-327.

S. Donald and W. Newey, "Choosing the Number of Instruments," *Econometrica* 69[5], September 2001, 1161-91.

B. Clustering and the Moulton problem

B. Moulton, "Random Group Effects and the Precision of Regression Estimates," *Journal of Econometrics* 32 (1986), pp. 385-97.

K. Liang, and Scott L. Zeger, "Longitudinal Data Analysis Using Generalized Linear Models," *Biometrika* 73 (1986), 13-22.

Z. Feng, P. Diehr, A. Peterson, and D. McLerran, "Selected Statistical issues in Group Randomized Trials," *Annual Review of Public Health* 22 (2001), 167-87.

C. Limited dependent variables and quantile treatment effects

J. Angrist, "Estimation of Limited-Dependent Variable Models with Binary Endogenous Regressors: Simple Strategies for Empirical Practice," with discussion, *JBES*, January 2001.

A. Abadie, J. Angrist, and G. Imbens, "Instrumental Variables Estimation of the Effect of Subsidized Training on the Quantiles of Trainee Earnings," *Econometrica*, November, 2001.

J. Angrist and W. Evans, "Children and their Parents' Labor Supply: Evidence from Exogenous Variation in Family Size," *American Economic Review*, June 1998, 450-477.

J. Angrist, V. Chernozhukov, and I. Fernandez-Val, "Quantile Regression Under Misspecification, with an Application to the U.S. Wage Structure," NBER Working Paper 10428, April 2004.

C. The propensity score paradox

- J. Hahn, "On the Role of the Propensity Score in Efficient Estimation of Average Treatment Effects," *Econometrica* 66, March 1998.
- J. Angrist and J. Hahn, "When to Control for Covariates? Panel-Asymptotic Results for Estimates of Treatment Effects," *Review of Economics and Statistics*, February 2004.
- K. Hirano, G. Imbens, and G. Ridder, "Efficient Estimation of Average Treatment Effects Using the Estimated Propensity Score," *Econometrica* 71(4), 2003.

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Problems

1. Discuss the relationship between regression and matching, as described below:
 - a. Suppose all covariates are discrete and you are trying to estimate a treatment effect. Prove that if the regression model for covariates is saturated, then matching and regression estimates will estimate the same parameter (i.e., have the same *plim*) in either of the following two cases: (i) treatment effects are independent of covariates; (ii) treatment assignment is independent of covariates.
 - b. Propose a weighted matching estimator that estimates the same thing as regression.
 - c. Why might you prefer regression estimates over matching estimates, even if you are primarily interested in the effect of treatment on the treated?
 - d. (extra credit) Calculate matching and regression estimates in the empirical application of your choice. Discuss the difference between the two estimates with the aid of a figure like the one used in Angrist (1998) for this purpose.
2. Discuss the link between causal effects and structural parameters in a Bivariate Probit model of the relationship between divorce and female labor force participation. The purpose of the model is to determine whether female employment strengthens a marriage or encourages divorce more by making it easier for women to live independently.

Organize your discussion as outlined below:

- a. Explain in words why the causal effect of employment on divorce is difficult to determine. Is the problem here primarily one of identification or estimation? Could you design an experiment to answer the question of interest?
- b. Write the potential outcomes and potential treatment assignments in your causal model in terms of latent indices with unobserved random errors in a structural model.
- c. What should the population be for this study? What does it mean for employment to be “endogenous” in the structural model? How about in the causal model?
- d. Show how to use the Probit structural parameters and distributional assumptions to calculate the population average treatment effect (ATE), the effect of treatment on the treated (ETT), and LATE. Which of these parameters are identified without distributional assumptions?
- e. Discuss the relationship between the three average causal effects, LATE, ATE, and ETT. Can you say which is likely to be largest and which is likely to be smallest?
- f. (extra credit) Compare OLS with Probit and IV with Bivariate Probit in the application of your choice (as in Angrist, 2001).

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SCHEDULE

Monday	December 6	15:00-16:15	Lecture I
Tuesday	December 7	09:00-10:45	Lecture II
Wednesday	December 8	15:45-17:30 17:30-19:00	Lecture III Meetings
Thursday	December 9	9:00-10:45 13:45-15:30	Lecture IV(A) Lecture IV(B) and wrap-up