

## CEP991B: Causal Inference as applied to the Diffusion of Innovations

Tuesday, 1:00-4:00 (Michigan Room in the Union Building)

### Contact Information

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### Overview:

There is currently great debate regarding the basis for causal inferences across the social sciences. Can we make causal inferences only from experiments? What about ethical or logistical limitations, or concerns that the experimental paradigm is artificial because of the necessity for extreme control over conditions? On the other hand, though observational studies are applied to natural conditions, can we rely on statistical control to make causal inferences? What about unmeasured, or unrecognized confounding factors? At what point does a statistical inference sustain a causal inference? Answers to these questions are more than merely academic and philosophical. For example they have immediate implications for policy-making regarding the implementation of innovations.

To address questions such as the above this course will explore causal inference from the perspectives of statistics and philosophy of science as applied to the diffusion of innovations. We will begin with a comparison of causal inferences in the social sciences with those of the experimental sciences. A key concern is the assumption of homogeneity of units (i.e., equivalence of treatment and control groups). In the physical sciences this is often achieved by dividing a single substance for application of treatment or by evaluating change induced by a treatment. In the social sciences, homogeneity of units is achieved through random assignment or statistical control, which we will explore in detail following the readings of Rubin, Holland, and the recent critique of Dawid. But absolute homogeneity may be unverifiable, therefore we will use sensitivity analyses to explore the robustness of statistical inferences to violations of the homogeneity assumption. When we deem statistical inferences to be robust, we can argue that causal inferences follow, recognizing that no inference is absolute. Ultimately this is consistent with the philosophy of probable causes.

In the last third of the course we will combine with CEP951: Technology, Society & Culture (Zhao), to apply ideas about causal inference to the diffusion of innovations. When can we infer that an innovation has a positive effect on an outcome? How robust is the inference to unmeasured factors or unrepresented populations? What level of certainty is needed to apply the innovation in other contexts? What is the strongest basis for evidence (e.g., experimental versus observational) that an innovation will have a positive effect in a new context or environment? This will take us into critical policy areas, with theory and principals applying within and outside of the educational context.

Students will be required to present one existing paper on causal inference and then to write a final paper. Students must have good working knowledge of the general linear model (e.g., regression & ANOVA), on which the statistical theory of causal inference is based. But note that just this basic knowledge allows one to engage recent theories of causal inference at a fairly high level!

Plan for the Course  
(pages in coursepack listed in *italics*)

**I: The counterfactual and Causal Inference (week 2 - Sept 3, 11-40)**

Rubin, Donald B. 1974. "Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies." *Journal of Educational Psychology* 66(5):688\_701. (11-24)

Holland, Paul W. 1986. "Statistics and Causal Inference." *Journal of the American Statistical Association* 81:945\_70. (25-40)

**II. Diffusion of Innovations: an Ecological Perspective with CEP951(Week 3 - Sept 10, 42)**  
Selection Theory  
Information Ecologies  
Ecological Perspectives

see guiding questions, page 41 of syllabus, look ahead to section VI

**III. Philosophical Underpinnings of Causal Inference (weeks 4 - Sept 17, 42-124)**

(understood in terms of the diffusion of innovations)

Sobel, Michael 1995. "Causal Inferences in the Social and Behavioral Sciences." In *Handbook of Statistical Modeling for the Social and Behavioral Sciences*. Gerhard Arminger, Clifford Clogg and Michael Sobel (eds). New York: Plenum Press. (43-80)

Abbott, Andrew. 1998. "The Causal Devolution." *Sociological Methods & Research* 27(2):148\_81. (81-97)

Salmon, Wesley C. 1994. "Causality Without Counterfactuals." *Philosophy of Science* 61:297\_312. (98-106)

Einhorn, Hillel J. and Robin M. Hogarth. 1986. "Judging Probable Cause." *Psychological Review* 99(1):3\_19. (107-123)

Supplemental: Pratt, John W. and Robert Schlaifer. 1988. "On the Interpretation and Observation of Laws." *Journal of Econometrics* 39:23\_52.

Dawid, A.P. 2000. "Causal Inference without Counterfactuals." *Journal of the American Statistical Association* 95: 407-448.

**IV. Application of counterfactual to the Diffusion of Innovations (Week 5 - Sept 24, 41)**

Students present to CEP951

(see guiding questions, page 41)

**III (return). Philosophical Underpinnings of Causal Inference (week 6 - Oct 1)**

**V. Application of the Counterfactual with propensity scores and instrumental variables (weeks 7 and 8 Oct 8 and 15, 125-278)**

- Winship, Christopher and Stephen L. Morgan. 2000. "The Estimation of Causal Effects From Observational Data." *Annual Review of Sociology* 25:659-706. (125-172)
- Morgan, Stephen L. 2001. "Counterfactuals, Causal Effect Heterogeneity, and the Catholic School Effect on Learning." *Sociology of Education* 74: 341-374. Personal Copy. (173-246)  
<http://www.soc.cornell.edu/faculty/morgan.shtml>
- Rosenbaum, Paul R. and Donald B. Rubin. 1983. "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika* 70(1):41\_55. (247-261)
- Angrist JD, Krueger AB Instrumental variables and the search for identification: From supply and demand to natural experiments *Journal of Economic Perspectives* 15 (4): 69-85. (262-278)  
[http://www.uibk.ac.at/~cb0189/dl/jep01fall/06\\_instrument.pdf](http://www.uibk.ac.at/~cb0189/dl/jep01fall/06_instrument.pdf)

**VI. Statistical Significance, Causal Inference, and Sensitivity Analysis (weeks 9 and 10 Oct 22, Oct 29, 280-347)**

- Rosenbaum, Paul R. 1986. "Dropping Out of High School in the United States: An Observational Study." *Journal of Educational Statistics* 11(3):207\_24. (280-289)
- Frank, K. 2000. "Impact of a Confounding Variable on the Inference of a Regression Coefficient." *Sociological Methods and Research*, 29(2), 147-194. (Will hand out in class)
- Frank, 2002. "Indexing the Robustness of Statistical Inferences to Inform Causal Inferences." Working Paper, Michigan State University. (290-320)
- Wilkinson, L & Task Force on Statistical Inference (1999). *Statistical Methods in Psychology Journals: Guidelines and Explanations*. *American Psychologist*, 54(8):594–604.(337-347)  
<http://www.apa.org/journals/amp/amp548594.html>

**VII. Causal Inference and Path Analysis (Weeks 11-12 Nov 5, Nov 12, 349-393)**

- Duncan, O. 1966. "Path Analysis: Sociological Examples" *American Journal of Sociology*, Vol 72 (1), 1-16. (349-365)  
JSTOR: <http://er.lib.msu.edu/>
- Freedman, David. 1997. "From Association to Causation Via Regression." *Advances in Applied Mathematics* 18:59\_110. (366-393)  
Supplemental: Judea Pearl: [http://bayes.cs.ucla.edu/jp\\_home.html](http://bayes.cs.ucla.edu/jp_home.html), including papers and a slide show (Reasoning with Cause and Effect)

**VIII. Applications to Diffusion of Innovations (weeks 13-15 Nov 19, Nov 26 Dec 3, 395-511)**  
( Integrate with CEP951: Technology, Society & Culture

- Cook, Thomas 2002. "Randomized Experiments in Education: Why are they so rare? (395-446)  
[http://www.northwestern.edu/ipr/publications/papers/2002/WP\\_02\\_19.pdf](http://www.northwestern.edu/ipr/publications/papers/2002/WP_02_19.pdf)  
Nell presents Nov 26.
- Dearing, James 2002. "Purposeful Diffusion for Social Betterment." Personal Copy (447-467)
- Pressley, Michael 2002. "The Experimental reading Instructional Research We Have; The Experimental Instructional Research We Need." Personal Copy. (468-485)
- Manski, Charles 2002. "Social Learning and the Adoption of Innovations." (486-511)  
<http://www.faculty.econ.northwestern.edu/faculty/manski/>