PH.D. PROGRAM IN BROWN SCHOOL OF SOCIAL WORK
WASHINGTON UNIVERSITY IN ST LOUIS

FALL 2019

PROPENSITY SCORE ANALYSIS

S90-6905.01

CREDIT HOURS: 3    INSTRUCTOR: Shenyang Guo

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GRADE: L/G    OFFICE: Goldfarb 229B


9AM-12PM Tuesday, 270 Hillman    PHONE: 314-935-3092

TEACHING ASSISTANT: Xiaoyan Wang    TA E-MAIL: xiaoyan.wang@wustl.edu

TA OFFICE HOURS: To be announced    TA OFFICE: To be announced

I. COURSE DOMAIN AND BOUNDARIES

Propensity score analysis (PSA) is a relatively new and innovative class of statistical methods that has proven useful for evaluating the effects of treatments or interventions when using nonexperimental or observational data. Although regression analysis is most often used to adjust for potentially confounding variables, propensity score analysis is an attractive alternative. Results produced by propensity score methods are typically easier to communicate to lay audiences. And propensity score estimates are often more robust to differences in the distributions of the confounding variables across the groups being compared.

This course will review nine models developed for intervention research when randomized clinical trials are infeasible or unethical: (1) instrumental variable estimator; (2) Heckman’s sample selection model (Heckman, 1978, 1979) and Maddala’s (1983) treatment effect model; (3) propensity score greedy matching (Rosenbaum & Rubin, 1983) and optimal matching (Rosenbaum, 2002); (4) propensity score subclassification (Rosenbaum & Rubin, 1983, 1984); (5) propensity score weighting (Hirano & Imbens, 2001; McCaffrey, Ridgeway, & Morral, 2004); (6) matching estimators (Abadie & Imbens, 2002, 2006); (7) propensity score analysis with nonparametric regression (Heckman, Ichimura, & Todd, 1997, 1998); (8) dosage analysis (Joffe & Rosenbaum, 1999; Imbens, 2000; Hirano & Imbens, 2004), and (9) Rosenbaum’s (2002) sensitivity analysis to address hidden selection bias. Learning of these models will be guided by two conceptual frameworks: the Neyman-Rubin counterfactual framework and the Heckman (2005) scientific model of causality. The course will use examples from social and
behavioral research to illustrate the method applications. All illustrative examples are demonstrated by using the Stata and R software packages. Data and computing syntax can be downloaded from the following website: http://ssw.unc.edu/psa/.

II. COURSE OBJECTIVES

At the completion of the course, students will be able to:

1. Understand challenges posted by evaluation of quasi-experimental or observational data, contexts under which randomized experiments are infeasible, unethical, and expensive, and the importance of taking remedial strategies within such contexts;
2. Understand differences, debates, and similarities between statistical and econometric traditions in developing analytical strategies to overcome challenges posted by quasi-experimental and observational data;
3. Have a solid understanding of the Neyman-Rubin’s counterfactual framework and two fundamental assumptions: the strongly ignorable treatment assignment, and the stable unit treatment value. Understand Heckman’s critiques to the counterfactual framework and main features of the Heckman’s scientific model of causality;
4. Understand the main features of Heckman’s sample selection and related models, and know how to implement the analysis with Stata;
5. Understand the main features of propensity-score greedy matching, and know how to implement the analysis with Stata;
6. Understand the main features of propensity-score optimal matching and related models, and know how to implement the analysis with Stata and R;
7. Understand the main features of propensity-score subclassification, and know how to implement the analysis with Stata;
8. Understand the main features of propensity-score weighting estimator, and know how to implement the analysis with Stata;
9. Understand the main features of matching estimators, and know how to implement the analysis with Stata;
10. Understand the main features of kernel-based matching, and know how to implement the analysis with Stata;
11. Understand the main features of Rosenbaum’s sensitivity analysis to evaluate potential bias due to hidden selection, and know how to implement the analysis with Stata;
12. Know how to read, evaluate, and criticize evaluation studies.
III. EDUCATIONAL OUTCOMES

By taking the course, the students should demonstrate:

1. The ability to employ at least three propensity score methods to correct for the endogeneity problem encountered from an OLS regression model;
2. The ability to critically review observational studies and studies employing PSA;
3. The ability to present study findings using PSA in an organized, succinct, and accurate fashion;
4. The readiness for taking advanced statistical methods.

IV. ORGANIZATION OF COURSE

The content of this course is covered through reading, lectures, writing, and working with the computer. Best results are obtained when the reading is completed prior to each class meeting, and homework assignments are completed by the due times. The course will teach the application of Stata and R software packages to performing PSA analyses.

V. ROLES OF INSTRUCTORS AND TEACHING ASSISTANT

Instructor: Class meetings will be primarily lecture/discussion format. The instructor will be responsible for the preparation and response to student inquiries regarding the readings, exercises, and the course project. Additionally, the instructor will be available during office hours and by special appointment for questions regarding the course.

Teaching Assistant: The TA will lead most computer lab sessions to help students practice the software programs pertaining to topics covered by weekly lectures. The TA will grade students’ assignments and term papers based on guidelines provided by the instructor. The TA will hold weekly office hours.

Students should consult with the instructor for any disputable issue regarding grading. The instructor may or may not change the grade based on his evaluation. In this situation, the instructor’s evaluation and grade will be final.

VI. ROLES OF STUDENTS

This is an applied course that requires significant attention to out-of-class activities as well as readings. Students will get lost without regular attention to readings and attendance at all scheduled meetings. Students are expected to seek assistance and clarification when needed, complete assigned readings and exercises, and provide feedback regarding the effectiveness of the class.

Students are encouraged to participate in group discussions through learning communities. However, all assignments and term papers should be completed independently. Academic integrity in the completion of oral presentations and written assignments is expected. Violations of academic integrity (e.g., plagiarism) will result in
notification to the Associate Dean for the PhD program and advisor.

VII. WASHINGTON UNIVERSITY ACADEMIC SUPPORT POLICIES

Accommodations based upon sexual assault: The University is committed to offering reasonable academic accommodations to students who are victims of sexual assault. Students are eligible for accommodation regardless of whether they seek criminal or disciplinary action. Depending on the specific nature of the allegation, such measures may include but are not limited to: implementation of a no-contact order, course/classroom assignment changes, and other academic support services and accommodations. If you need to request such accommodations, please direct your request to Kim Webb (kim_webb@wustl.edu), Director of the Relationship and Sexual Violence Prevention Center. Ms. Webb is a confidential resource; however, requests for accommodations will be shared with the appropriate University administration and faculty. The University will maintain as confidential any accommodations or protective measures provided to an individual student so long as it does not impair the ability to provide such measures.

If a student comes to me to discuss or disclose an instance of sexual assault, sex discrimination, sexual harassment, dating violence, domestic violence or stalking, or if I otherwise observe or become aware of such an allegation, I will keep the information as private as I can, but as a faculty member of Washington University, I am required to immediately report it to my Department Chair or Dean or directly to Ms. Jessica Kennedy, the University’s Title IX Coordinator. If you would like to speak with the Title IX Coordinator directly, Ms. Kennedy can be reached at (314) 935-3118, jw kennedy@wustl.edu, or by visiting her office in the Women’s Building. Additionally, you can report incidents or complaints to Tamara King, Associate Dean for Students and Director of Student Conduct, or by contacting WUPD at (314) 935-5555 or your local law enforcement agency. You can also speak confidentially and learn more about available resources at the Relationship and Sexual Violence Prevention Center by calling (314) 935-8761 or visiting the 4th floor of Seigle Hall.

Bias Reporting: The University has a process through which students, faculty, staff and community members who have experienced or witnessed incidents of bias, prejudice or discrimination against a student can report their experiences to the University’s Bias Report and Support System (BRSS) team. See: brss.wustl.edu

Mental Health: Mental Health Services’ professional staff members work with students to resolve personal and interpersonal difficulties, many of which can affect the academic experience. These include conflicts with or worry about friends or family, concerns about eating or drinking patterns, and feelings of anxiety and depression. See: shs.wustl.edu/MentalHealth.
VIII. GRADES

Students are required to complete six assignments and a final exam. Weighting for the final course grade is shown below:

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<thead>
<tr>
<th>Component</th>
<th>Grade Percentage</th>
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<tbody>
<tr>
<td>Assignment 1</td>
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<tr>
<td>Assignment 2</td>
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<td>Assignment 3</td>
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<td>Assignment 4</td>
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<td>Assignment 5</td>
<td>10%</td>
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<tr>
<td>Final Exam (take home)</td>
<td>50%</td>
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Grading scale: the overall grade will be calculated according to the following scale:

- 98-100 A+ 77-79 C+ <60 F
- 95-97 A 74-76 C
- 90-94 A- 70-73 C-
- 87-89 B+ 67-69 D+
- 84-86 B 64-66 D
- 80-83 B- 60-63 D-

IX. TEXTBOOKS AND READINGS

Required Textbooks

Recommended Textbook


Required Articles for Reading
Required journal articles will be available on Blackboard and University’s online library.

X. CLASS SCHEDULE AND READING ASSIGNMENTS

8-27-19 Session 1: Introduction and Course Overview
1. Observational studies and challenges
2. History and development
3. Fisher’s randomized experiment
4. Why and when propensity score analysis is needed?
5. Course overview
**Readings:**
Guo & Fraser, chapter 1.

**9-3-19  Session 2: Counterfactual Framework**
1. The Neyman-Rubin’s counterfactual framework
2. The assumption about strongly ignorable treatment assignment
3. The stable unit treatment value assumption
4. Types of treatment effects

**Readings:**
Guo & Fraser, chapter 2 (pp.21-61).

**9-10-19  Session 3: Simple Methods for Data Balancing and the Instrumental Variable Method**
1. Review of three simple methods for data balancing
2. Key issues regarding the OLS regression
3. The instrumental variable method

**Readings:**
Guo & Fraser, chapter 3.

**9-17-19  Session 4: Sample Selection and Treatment Effect Models**
1. Truncation, censoring, and incidental truncation
2. Key features of Heckman’s sample selection model
3. Treatment effect model
4. Illustrations

**Readings:**
Guo & Fraser, chapter 4

9-24-19 **Session 5: Heckman’s Econometric Model of Causality**
1. Overview of Heckman’s econometric model of causality
2. Debates between econometricians and statisticians
3. Overview of Stata programs analyzing sample selection

9-24-19 **Computer Lab: Running Stata etregress**

Readings:
- Guo & Fraser, chapter 2 (pp. 62-67).

Assignment 1 out (Due: 10-1-19): Exercises about observational studies, study design, and running treatment effect model.

10-1-19 **Session 6: Propensity Score Greedy Matching**
1. Overview of propensity score matching
2. The Rosenbaum and Rubin’s model (1983)
3. Strategies to seek optimal propensity scores
4. Greedy matching

10-1-19 **Computer Lab: Running Greedy Matching with psmatch2**

Readings:
- Guo & Fraser, chapter 5: 5.1-5.3, 5.4.1, 5.5.1, 5.5.2.

Assignment 1 due

Assignment 2 out (Due: 10-8-19): Exercises of running propensity score greedy matching with a multivariate post-matching analysis.

10-8-19 **Session 7: Propensity Score Optimal Matching**
1. Optimal matching
2. Post-optimal-matching analysis

10-8-19 **Computer Lab: Running Optimal Matching with R optmatch**

Readings:
- Guo & Fraser, chapter 5: 5.4.2, 5.5.2-5.5.5, 5.7-5.8.
**Assignment 2 due**

10-15-19  **Happy Fall Break (No Class)**

10-22-19  **Session 8: Propensity Score Subclassification**
1. Propensity score subclassification
2. Strategy to deal with limited overlap

10-22-19  **Computer Lab: Post-Optimal-Matching Analysis and Trimming**

Readings:
- Guo & Fraser, chapter 6.

**Assignment 3 out (Due: 11-5-19):** Exercises of running optimal propensity score matching (pair, variable, and full matching) with a post-matching regression adjustment and a Hodges-Lehmann aligned rank test, subclassification, generalized boosted regression, and propensity score weighting.

10-29-19  **Session 9: Propensity Score Weighting**
1. Propensity score weighting
2. Running propensity score weighting in conjunction with SEM

10-29-19  **Computer Lab: Generalized Boosted Regression and Propensity Score Weighting**

Readings:
- Guo & Fraser, chapter 7.

11-5-19  **Session 10: Matching Estimators**
1. Simple matching estimator
2. Bias-corrected matching estimator
3. Variance estimator allowing for heteroscedasticity
4. Efficacy subset analysis

11-5-19  **Computer Lab: Running nnmatch**

Readings:
- Guo & Fraser, chapter 8.

**Assignment 3 due**
**Assignment 4 out (Due: 11-12-19):** Exercises comparing different methods and running matching estimators.

**11-12-19  Session 11: Propensity Score Analysis with Nonparametric Regression**  
1. The kernel-based matching estimator  
2. Review of the basic concepts of lowess  
**11-12-19  Computer Lab: Running Kernel-based Matching with psmatch2**

Readings:  
Guo & Fraser, chapter 9.  

**Assignment 4 due**  
**Assignment 5 out (Due: 11-26-19):** Exercises of running kernel-based matching and difference-in-differences analysis; and exercises of running Rosenbaum’s sensitivity analysis using Wilcoxon’s signed rank test.

**11-19-19  Session 12: Propensity Score Dosage Analysis**  
1. Overview of propensity score dosage analysis  
2. Modeling dosage with a multinomial logit model  
3. The generalized propensity score estimator  
**11-19-19  Computer Lab: Dosage Analysis**

Readings:  
Guo & Fraser, chapter 10.

**11-26-19  Session 13: Selection bias and Sensitivity Analysis**  
1. Overview of selection bias  
2. Rosenbaum’s sensitivity analysis  
**11-26-19  Computer Lab: Running Sensitivity Analysis with rbounds**

Readings:  
Guo & Fraser, chapter 11.  

**Assignment 5 due**  
**Final exam out (Due: 12-15-19):** In this take-home exam, you are required to write a paper comparing at least two propensity score methods. The paper should include: (1) a brief introduction to describe research questions
and hypotheses; (2) a method section to describe correction methods
being compared; (3) findings, and (4) discussion. The paper should meet
the requirements and standards for its publication in a peer-reviewed
journal.

12-3-19  Session 14: Course Conclusions

Readings:
Guo & Fraser, chapter 12

12-15-19: Final exam due