

Advanced Quantitative Methods and Research Design¹

Department of Peace and Conflict Research, Uppsala University.

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Course Sponsors:

Department of Peace and Conflict Research, Uppsala University
European Network for Conflict Research

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Course Description

This is an intensive two week course that will cover a wide range of advanced topics in quantitative methodology and research design. The recurrent theme will be the challenge of drawing reliable causal inferences from quantitative data. The course will involve morning lectures, afternoon sections with the TA, daily homework, and a final exam. The topics covered will include: model-based and design-based inference, Bayesian inference, the potential outcomes framework, permutation inference, the likelihood theory of inference, MLE, and in particular Logistic regression, design-based methods such as natural experiments, instrumental variables, and regression discontinuity designs, conditioning strategies and causal graphs, matching, tests of design, and time-series cross-sectional data. The course will emphasize good practices in carrying out quantitative analysis, the use of simulation methods to understand estimators and to estimate quantities of interest, and graphical analysis and presentation. The broader aim of the course is to provide students with the statistical background necessary to critically read and conduct quantitative research. The course assumes that students have familiarity with the linear regression model, basic probability theory, and matrix algebra, such as through a first graduate course in statistics. Students will learn to use R.

¹This course is related to a course taught by Allan Dafoe in the Yale Ph.D. program: PLSC 504 - Advanced Quantitative Methods. These courses build from other courses, including courses by Ken Scheve, [Jas Sekhon](#), [Gary King](#), David Freedman, [Donald Green](#), [Matthew Golder](#), [Jake Bowers](#) and [Kosuke Imai](#).

Admission to and Logistics for the Course

This course is designed for PhD students in the social sciences, especially those who study interstate or civil conflict. Transportation, accommodations, and tuition are paid for by the course sponsors for admitted students. Admission to the course is based on a number of criteria, including performance on an entry exam. To apply, please provide your information at this website: <http://goo.gl/C2NKE>. Details about the entry exam will be sent to you. We will make admissions decisions starting in March 1st, but the admission process will be open until June 15th. Earlier applicants will have a better chance of admission.

Preparation for the Course

R

The course homework will be done almost entirely in R. R is a very powerful statistics program that requires a few hours initial investment. While most analysis in political science is still done using Stata, R has a number of benefits: advanced methods generally come out first for R, R is much better for doing advanced and customized analysis, R is much more powerful for graphical analysis, and R is free and open source.

A few hours in section will be devoted to learning R. However, you should prepare by going through the R preparation material in the [course dropbox folder](#) and by working through some introductory books or tutorials. The blog [here](#) has a nice overview of introductory R materials. I recommend Peter Dalgaard's Introductory Statistics with R. There is also the official introduction to R here: <http://cran.r-project.org/doc/manuals/R-intro.html>. And I recommend the UCLA material here: <http://www.ats.ucla.edu/stat/r/sk/>.

Basic Ph.D.-Level Statistics

If you haven't taken a graduate level statistics course in a while then you probably want to brush up on some material. You may want to start by working through the two required books for this course:

- Stephen L Morgan and Christopher Winship (2007). *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. Cambridge University Press
- Andrew Gelman and Jennifer Hill (2006). *Data Analysis Using Regression and Hierarchical/Multilevel Models*. New York: Cambridge University Press

Doing so might suggest what material you need to brush up on.

There are many excellent textbooks that you could use. For undergraduate level statistics, I recommend: David Freedman, Robert Pisani, and Roger Purves (2007). *Statistics*. Fourth Edition. WW Norton & Company, Inc.

For advanced statistics using matrix algebra I recommend: David A Freedman (2009). *Statistical Models: Theory and Practice*. 2nd Edition. Cambridge University Press.

To get into the spirit of learning advanced quantitative methods, you could listen in on the lectures from Gary King's [Spring 2012 Advanced Quantitative Research Methodology](#). King's course overlaps about 30% with our course.

Section

The purpose of section is to complement the lectures. As such, section will often go over some material in more depth than covered in lecture. In some cases, this will include going over published or working papers in the discipline that use the methods discussed in class. Section will introduce you to R^2 and \LaTeX ; you are encouraged but not required to submit your work in \LaTeX . Section will sometimes cover additional topics. Lastly, section is another opportunity for you to ask questions and discuss various topics. Some sections will require extra readings not covered in lecture. These readings will be specified in the relevant section of the course outline.

Problem Sets and Solution Keys

You will have regular problem sets. Each problem set will be graded “check” or “no check”, where a “check” is given for a problem set in which you made a serious individual effort for each question. Since problem sets are not graded for performance, this is your opportunity to try new things, let yourself make mistakes, and try to figure out problems on your own. You are encouraged to try to answer all the questions by yourself first, and then to discuss and compare your solutions with your classmates. The TA will be available to offer some guidance for any difficulties that you are having. Your final problem set must be written up on your own, in your own words and using your own understanding of the solution. Avoid the temptation to copy someone else’s solution.

Your TA will put together a solution key for each problem set. You should compare your answers to this solution key to evaluate your understanding of the material, and see how to improve your answers. Exceptional answers may be used for this solution key (with attribution).

Daily Schedule

Lectures will be held every day from 9 to 12.15 (with a break). Section will be held 16-18 (with a break). The first hour of section will often involve more advanced materials, the second hour more basic. Section is optional. Allan will have office hours right after lecture (12.15-13.15). Guadalupe will have office hours 14-16. Problem sets are due by 22.00.

Asking Questions

Ask lots of questions. It is, I think, the best way to learn. Ask questions of your classmates, TA, and me. Spontaneous questions during lecture and section are welcome.

Evaluation

Final grades will be based on problem sets (20%) and the final exam (80%).

Course Material

Lecture and section slides, problem sets and supporting material will be hosted in a shared dropbox folder, accessible [here](#). Looking through the material in advance is strongly encouraged.

²Reflections on what one’s choice of statistics programs signals to others [here](#).

Primary References

- Stephen L Morgan and Christopher Winship (2007). *Counterfactuals and Causal Inference: Methods and Principles for Social Research*. Cambridge University Press.
- Andrew Gelman and Jennifer Hill (2006). *Data Analysis Using Regression and Hierarchical/Multilevel Models*. New York: Cambridge University Press.

For this course you should acquire a copy of Morgan and Winship 2007 and Gelman and Hill 2006. It is not necessary that you acquire copies of the remaining required readings, as scans of the required chapters will be provided. Though I do strongly recommend each of these books.

Other Recommended References

- J Scott Long (1997). *Regression Models for Categorical and Limited Dependent Variables*. Sage Publications. A useful supplementary textbook that goes into more detail about various regression models
- J Scott Long and Jeremy Freese (2001). *Regression Models for Categorical Dependent Variables Using Stata*. Especially helpful for those of you planning to use Stata.
- Guido W Imbens and Donald B Rubin. *Causal Inference in Statistics and Social Sciences*. A recent (not yet out!), authoritative, advanced textbook on many of the topics covered in this course.
- Alan S Gerber and Donald P Green (2012). *Field Experiments: Design, Analysis, and Interpretation*. W. W. Norton and Company. An excellent and accessible textbook on experimental statistics and design. This book is a must-have for anyone doing experimental methods.
- David A Freedman (2009). *Statistical Models: Theory and Practice*. 2nd Edition. Cambridge University Press. An excellent, concise, and brilliantly skeptical graduate level statistics textbooks covering mainstream topics. A great reference for understanding the assumptions and theorems behind regression.
- Jeffrey Wooldridge (2008). *Econometric Analysis of Cross Section and Panel Data, 2nd Edition*. In my opinion, the best graduate level econometric textbook. Covers almost all topics, but with a subtle awareness to lurking issues of causal inference and the importance of assumptions.
- Joshua David Angrist and Jörn-Steffen Pischke (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, N.J.: Princeton University Press. A recent, excellent, concise, and dense textbook that combines the approaches of econometrics and causal inference.
- David A Freedman (2010). *Statistical Models and Causal Inference: A Dialogue with the Social Sciences*. Ed. by David Collier, Jasjeet S Sekhon, and Philip B Stark. Cambridge University Press. A wonderful collection of Freedman's papers, with thoughtful commentary by the editors.
- Gary King (1998). *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. Techniques in Political Analysis. University of Michigan Press. A valuable reference for understanding the Likelihood Theory of inference.

- Paul R Rosenbaum (2010). *Design of Observational Studies*. Springer Series in Statistics. New York: Springer. Rosenbaum is one of the pioneers of and authorities on non-parametric statistics and causal inference. His 2002 book *Observational Studies* is more advanced. His 2010 book *Design of Observational Studies* is more accessible.
- Paul R Rosenbaum (2002). *Observational Studies*. 2nd Edition. New York: Springer
- John Fox (1997). *Applied Regression Analysis, Linear Models, and Related Methods*. Sage Publications. An advanced undergraduate textbook. Does a good job introducing many topics, especially the importance of looking at your data, checking for outliers, violations of specification, etc... There is also a companion textbook that provides R code for this material.
- William Greene (2011). *Econometric Analysis (7th Edition)*. 7th ed. Prentice Hall. **The** authoritative econometric textbook. Dense, largely unconcerned with causal inference, necessary for anyone who wants to work with econometrics.
- J M Wooldridge (2009). *Introductory econometrics: A modern approach*. South-Western Cengage Learning. An introductory graduate econometrics textbook. Sometimes called “baby Wooldridge” by comparison with his other textbook. Wooldridge explains central concepts clearly. I often find it helpful to have Wooldridge’s perspective on various issues.
- Phillip Good (2005). *Permutation, Parametric and Bootstrap Tests of Hypotheses*. 3rd. New York: Springer. A useful textbook, especially for permutation tests.
- Richard A Berk (2004). *Regression Analysis: A Constructive Critique*. London: Sage Publications Ltd. Like an easy reading version of Freedman. Very skeptical. Agonizes over assumptions. Refreshing reading whenever one is facing regressions.
- Lectures from Gary King’s [Spring 2012 Advanced Quantitative Research Methodology](#). You can sit in with the Ph.D. students at Harvard and learn from Gary King, except you get to participate in your pajamas while eating dinner.

Course Outline

1. MONDAY JULY, 1ST.

Lecture: Introduction

- Morgan and Winship [2007](#) Ch 1
- Freedman [2005](#) Ch 10 ([pdf](#))
- Optional: Fox [1997](#) Ch 1 & 2
- Optional: King [1998](#) Ch 2

Lecture: Model-Based and Design-Based Inference

- Dunning [2010](#)
- Sekhon [2009](#)
- Rosenbaum [2010](#) Ch 1

Section: Introduction to R

2. TUESDAY JULY, 2ND.

Lecture: Graphics and Coding

- Gelman and Hill [2006](#) Appendix B
- Kastelec and Leoni [2007](#)
- Bowers [2011](#)
- Optional: Donahue [2011](#) ([pdf](#))
- Optional: King [1995](#)
- Optional: Tufte [2008](#) p1-15, 123-137
- Optional: On *Active Citation* in Qualitative Methods, see Moravcsik [2010](#)
- Optional: Wickham (2009) *ggplot2: Elegant Graphics for Data Analysis*. ([pdf here](#))³

Lecture: Probability Theory and Bayesian Inference

- Gelman and Hill [2006](#) Ch. 2
- Optional: Freedman [2010](#) Ch 1 (Freedman's perspective on Bayesian vs Frequentist Approaches)
- Optional: Jaynes [2003](#) Ch 1-5 (Readable, smart, and opinionated introduction to probability theory.)

Lecture: Potential Outcomes Framework

- Gerber and Green [2012](#) Ch 2
- Morgan and Winship [2007](#) Ch 1 and 2
- Gelman and Hill [2006](#) Ch 9.2
- Optional: *Causal Inference in Statistics and Social Sciences* Ch 1

Section: Graphics

³Some other useful references to get started with ggplot2 are [1](#), [2](#), and [3](#).

3. WEDNESDAY JULY, 3RD.

Lecture: Permutation/Randomization Inference

- Edgington and Onghena 2007. Ch 1.
- Fisher 1935 Ch 1, 2
- Gerber and Green 2012 Ch 3.4 and 3.5 (Optional: the rest of Ch 3)
- Keele, McConnaughy, and White 2012
- Optional: *Causal Inference in Statistics and Social Sciences* Ch 5
- Optional: Good 2005
- Optional: Chang and Lee 2011
- Optional: Rosenbaum 2010 Ch 2
- Optional: Lehmann 2009

Lecture: Permutation II - Test Statistics, NPC, Confidence Intervals

- Optional: *Causal Inference in Statistics and Social Sciences* Ch 6
- Optional: Caughey, Dafoe, and Seawright 2012
- Optional: Pesarin and Salmaso 2011
- Optional: Good 2005 3.3
- Optional: Rosenbaum 2010 2.6
- Optional: Rosenbaum 2003

Section: P-values and NPC.

- Dafoe and Caughey 2012

4. THURSDAY JULY, 4TH.

Lecture: Repeated Sampling/Parametric Inference and Estimation

- Gerber and Green [2012](#) Ch 3
- Optional: Wooldridge [2009](#) Appendix C
- Optional: *Causal Inference in Statistics and Social Sciences* Ch 6

Lecture: Likelihood Theory.

Section: Survey Experiments

- Trager and Vavreck [2011](#)

5. FRIDAY JULY, 5TH.

Lecture: Maximum Likelihood Estimation

- Background on Regression: Gelman and Hill [2006](#) Ch 3
- Gelman and Hill [2006](#) Ch 5
- Optional: King [1998](#) Ch 2-4
- Optional: Long [1997](#) Ch 2.6-2.7

Lecture: Models of Dichotomous Dependent Variables I.

6. MONDAY JULY, 8TH.

Lecture: Models of Dichotomous Dependent Variables II

- Gelman and Hill [2006](#) Ch 5
- Optional: King [1998](#) Ch 5
- Optional: Long [1997](#) Ch 3

Lecture: Generalized Linear Models

- Gelman and Hill [2006](#) Ch 6
- Optional: King [1998](#) Ch 5
- Optional: Long [1997](#) Ch 5-9

7. TUESDAY JULY, 9TH.

Lecture: Natural Experiments and Instrumental Variable Estimation

- Angrist and Pischke [2009](#) Ch 4
- Sovey and Green [2010](#)
- Gelman and Hill [2006](#) Ch 10.5-10.6
- Morgan and Winship [2007](#) Ch 7

Lecture: Regression Discontinuity Design

- Gelman and Hill [2006](#) Ch 10.4
- Morgan and Winship [2007](#) Ch 9.2
- Angrist and Pischke [2009](#) Ch 6
- Optional: Caughey and Sekhon [2011](#)
- Optional: Eggers and Hainmueller [2009](#)

Section: Regression Discontinuity Design.

- Bertoli [2012](#)

8. WEDNESDAY JULY, 10TH.

Lecture: Conditioning Strategies and Causal Graph Analysis

Lecture: Conditioning Strategies and Causal Graph Analysis II

- Morgan and Winship [2007](#) Ch 3
- Gelman and Hill [2006](#) Ch 9
- Optional: Glynn and Gerring [2012](#)
- Optional: Hernan and Robins [2012](#) Ch 6-9
- Optional: Freedman [2005](#) Ch 6
- Optional: Elwert and Winship [2012](#); Pearl [2000](#);

Lecture: Matching I

Section: Natural Experiments.

- Lyall [2010](#)
- Jha and Wilkinson [2012](#)

9. THURSDAY JULY, 11TH.

Lecture: Matching II

- Sekhon [2009](#)
- Gelman and Hill [2006](#) Ch 10.0 - 10.4
- Morgan and Winship [2007](#) Ch 4
- Optional: *Causal Inference in Statistics and Social Sciences* Ch 13-19
- Optional: Ho et al. [2007](#)

Lecture: Tests of Design

- Hartman and Hidalgo [2011 \(pdf\)](#). Provides a clear introduction to “tests of design”, and clarifies how to do tests of equivalence.
- *Causal Inference in Statistics and Social Sciences*. Ch 20
- Rosenbaum [2010](#). Ch 5.2 (esp 5.2.4, though all of Ch 5 is recommended)
- Sekhon and Titiunik [2012](#) (esp. analysis surrounding Table 1 and Table 2)
- Skim: DiNardo and Pischke [1997](#)
- Heckman and Hotz [1989](#)
- Optional: Dunning [2012](#) Ch 8
- Optional: Rosenbaum [2002](#) Ch 6
- Optional: Caughey and Sekhon [2011](#)
- Optional: Rosenbaum [1989](#)

Section: Missing Data and Multiple Imputation.

- Gelman and Hill [2006](#) Ch 25
- Honaker and King [2010](#)
- King et al. [2001](#)
- For additional reading, see: Little and Rubin [2002](#)

10. FRIDAY JULY, 12TH.

Lecture: Time Series Cross Sectional Data I

Lecture: Time Series Cross Sectional Data II

- Morgan and Winship [2007](#) Ch 9
- Angrist and Pischke [2009](#) Ch 5
- Gelman and Hill [2006](#) Ch 10.7

Section: Final Review.

Optional Readings:

- King [1998](#) Ch 7
- For more discussion of the theoretical basis for subtracting a lagged outcome from the outcome vs including it as a regressor, see: Allison [1990](#)
- An easy introduction to ARIMA models: Ch 16 of Fox [1997](#)
- On inconsistency of SEs in time series (D-in-D) designs, and how to address: Bertrand, Duflo, and Mullainathan [2002](#)
- An excellent econometric text on TSCS: Wooldridge [2008](#)
- For an introduction to multi-level modeling, read Ch 11-12 (and if interested all of Part II): Gelman and Hill [2006](#)

11. ADDITIONAL LECTURE: FORMAL ROBUSTNESS TESTS, PUBLICATION BIAS, PREVENTING FRAUD

- [Cleaning Up Science](#) in New Yorker blog December 24, 2012.
- Special [Issue](#) on “Replicability in Psychological Science: A Crisis of Confidence?” in Perspectives on Psychological Science.
- Ioannidis [2005](#)
- Simmons, Nelson, and Simonsohn [2011](#)
- Peto [2011](#)
- Shea Atlantic article on Uri Simonsohn [here](#)
- Yarkoni blog entry on Bem ESP finding ([link](#))
- Montgomery and Nyhan [2010](#)
- Optional: Gerber and Malhotra [2008](#)
- Optional: Dafoe and Caughey [2012](#) (see p-value plot)
- Optional: Bazzi and Blattman [2011](#) (see p-value plot)
- Humorous Optional: Bones [2012](#)

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- Angrist, Joshua David and Jörn-Steffen Pischke (2009). *Mostly Harmless Econometrics: An Empiricist’s Companion*. Princeton, N.J.: Princeton University Press.
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- Chang, Pao-Li and Myoung-Jae Lee (2011). “The WTO Trade Effect”. In: *Journal of International Economics* 85.1, pp. 53–71.
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- Elwert, Felix and Christopher Winship (2012). “Endogenous Selection Bias”.
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The use of advanced quantitative methods within mixed methods research has been investigated in a limited capacity. In particular, hierarchical linear models are a popular approach to account for multilevel data, such as students within schools, but its use and value as the quantitative strand in a mixed methods study remains unknown.Â Given the growing popularity of mixed methods research, the use of rigorous quantitative and qualitative methods is paramount to producing valid, high quality studies across disciplines. It is often the case, however, that mixed methods studies rely on simpler quantitative methods, which leads to less complex research questions and limited inferenc Cite. Request full-text. Quantitative methods, on the other hand, tend to involve defining variables in advance and then quantifying observations of those variables. Thus, one might ask college students to complete a survey in which questions ask for ratings about various aspects of the dormitory experience, such as how much they liked the food on a 1-to-5 scale.Â Although we cover a variety of practical research designs in quantitative, qualitative, and mixed methods, this book is not intended to be a complete reference guide for individuals conducting program evaluations. We briefly address this issue at the end of this guide. We revealed through our research for this book that many of these sound research designs presented within are underused in education and the social and behavioral sciences. Quantitative Research refers to the systematic investigation in the case in which a person doing the researcher collects the data from the different respondents that are based on numerical figures and data obtained is then analyzed for obtaining the results using different mathematical, statistical and computational tools. In its purpose, it is conclusive as it quantifies the problem under consideration and provides statistical results to measure its impact.Â Using the survey research as the method of research, an organization conducting survey ask different survey questions from the respondents using the various types like online surveys, online polls, paper questionnaires, etc. and then collect data and analyze collected data in order to produce the numerical results.