Meta-Analysis: Introduction and Application

Lecture location: TBD

Lecture times: MTWRF 3:00–7:00 PM

Instructor: Colin Lewis-Beck
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Prerequisites: Introductory statistics class, and a basic understanding of regression analysis.

Course description: Meta-analysis broadly refers to the quantitative analysis of published research or study outcomes. This course introduces the basic theoretical and applied principles of meta-analysis in a manner geared toward students and researchers in the social sciences. Topics will include: problem specification and study retrieval, estimators of effect size, fixed and random effect models, subgroup analysis, meta-regression, publication bias, Bayesian methods/hierarchical models, and multivariate as well as network meta-analysis. Although statistical theory will be presented, the focus of the course is on application. Examples will be drawn from psychology, political science, education, public health, as well as the medicine. We will use the statistical software R for modeling as well as graphical displays of results. No prior experience with R is required.

Learning outcomes: Upon completion of this workshop students will
  • Understand the role of systematic reviews and meta-analysis in the social sciences
  • Develop a toolkit of meta-analysis statistical techniques
  • Produce and interpret numeric and graphical summaries of a meta-analysis
  • Be able to evaluate a published meta-analysis by applying concepts and methods from the course


Other useful references are:

Course Materials: All slides, code used in course sessions, and problem sets will be posted on Canvas. Canvas is the course management platform used by the University of Michigan and the ICPSR Summer Program.

Software: Prior experience with statistical software is not required. We will mainly use R. However, many of the meta-analysis methods are available in other software such as Stata and SAS. Depending on student interest, these other programs will be mixed into the course.

Grading: In addition to participation, if you are taking the course for credit, the following assignment will be due the Monday after the final day of class. Find a published meta-analysis in a field of your choice.
Write a critique of the meta-analysis. In addition to summarizing the scientific question of interest, discuss the selection of studies, modeling assumptions, and statistical techniques employed. A complete assignment will also discuss limitations and possible extensions of the results.

**Tentative Schedule:** I will balance each class so the first half is lecture, and the second half devoted to computing and working with real data. I will provide an introduction to R which will be the primary software used throughout the course. I will also introduce Rstan, an R package, to accompany the Bayesian topics. The topics covered on each day are as follows:

**Day 1:** Background and Motivation for Meta-Analysis.

**Readings:**
- Borenstein & Hedges, Chapters 1 - 2

**Computing:** Introduction to R and R Studio
- Paul Torfs and Claudia Brauer. A (very) short introduction to R. *Hydrology and Quantitative Water Management Group, Wageningen University, The Netherlands*, 2014
- A beginner’s guide to R programming (Computerworld)

**Day 2:** Data Collection

**Readings:**

**Computing:** R packages for Meta-Analysis

**Day 3:** Effect Size

**Readings:**

• Borenstein & Hedges, Chapters 4 - 7
• Robert Coe. It’s the effect size, stupid: What effect size is and why it is important. 2002

*Computing:* Estimating and Displaying Effect Sizes in R


**Day 4:** Quantifying Heterogeneity Across Studies, Fixed and Random Effects Models

*Readings:*

• Borenstein & Hedges, Chapters 10 - 13

*Computing:* Modeling and Summarizing Heterogeneity


**Day 5:** Subgroup analysis and Meta Regression

*Readings:*

• Borenstein & Hedges, Chapters 19 - 21

*Computing:* Estimating Models in R

Day 6: Small study effects and publication bias

Readings:

• Borenstein & Hedges, Chapter 30

Computing: Graphical Displays of Publication Bias


Day 7: Introduction to Bayesian statistics/hierarchical models

Readings:


Computing: Introduction to the R package Rstan

• [http://mc-stan.org/users/interfaces/rstan](http://mc-stan.org/users/interfaces/rstan)

Day 8: Meta Analysis as a Hierarchical Model

Readings:

Computing: Fitting Hierarchical Models in Rstan

Day 9: Reporting Results from a Meta Analysis

Readings:


Day 10: Advanced Topics: multivariate and network meta analysis Readings:


Computing: