STRUCTURAL EQUATION MODELS AND LATENT VARIABLES:
AN INTRODUCTION

Kenneth Bollen
University of North Carolina at Chapel Hill
Chapel Hill, NC

Course Assistant:

Zachary Fisher
University of North Carolina at Chapel Hill

Structural Equation Models (SEMs) are most common in the social, behavioral, and health sciences, but continue to spread to even more disciplines. SEMs are general in that they incorporate multiple regression, panel data analysis, path analysis, classical simultaneous equation models, factor analysis, dichotomous and ordinal probit regression, latent growth curves, and numerous other procedures as special cases. SEMs can incorporate multiple indicators of latent variables ("factors"), can control for systematic and random measurement errors, and can test multiple equation measurement and latent variable models. Their popularity is indicated by the frequency of publications using SEMs, the existence of a journal, Structural Equation Modeling, devoted to these techniques, a 3200+ subscriber listserv SEMNET (http://www.gsu.edu/~mkteer/semnet.html), and the proliferation of SEM software programs.

This workshop provides an introduction to SEMs and the statistical software to estimate such models. The course provides an overview of and experience in constructing and estimating SEMs. The topics treated include: path analysis, confirmatory factor analysis, structural equations with observed variables, the incorporation of multiple indicators and measurement error into structural equations, alternative estimation procedures, and the assessment of model identification, fit, and modification.

Prerequisites

Participants should have a good grasp of multiple regression and be familiar with basic matrix notation and matrix operations. Background in factor analysis or path analysis is helpful, but is not required.

Texts:

Bollen (2016 draft) Foundations of Structural Equation Models. Readings will be provided to class. These draft chapters are intended only for members of this class, so please do not share them with others.

Optional Supplemental:

Schedule

**Monday to Thursday Schedule:**

9:00 am – 12:00 pm  Lecture
12:00 pm – 1:30 pm  Lunch Break
1:30 pm – 4:30 pm  Computer Lab
                   Go over computer exercises
                   Questions & Answers

**Friday Schedule:**

9:00 am – 12:00 pm  Lecture
12:00 pm – 1:00 pm  Lunch Break
1:00 pm - 3:00 pm  Computer Lab
                   Go over computer exercises
                   Questions & Answers

Note: On some days the morning or afternoon sessions might run over the allotted time.

**COURSE OUTLINE** (**=required reading, *=recommended):** A vast literature deals with SEMs. Due to the time constraints of the workshop, the syllabus concentrates on readings from the course text. Additional readings are in the bibliographies to the software manuals and in Bollen's (1989) SELV. Rick Hoyle's (ed.) *Handbook of Structural Equation Modeling* (2012, Guilford Press) is a useful source for a variety of topics and references. Furthermore, the journal *Structural Equation Modeling* has many current publications, and the SEMNET listserv archive is another source of references and discussion on SEMs.

I will make available draft chapters of: *Foundations of Structural Equation Models* (to be published by Wiley) for class use only.

I. INTRODUCTION

A. Overviews of Structural Equation Models

*Bollen 1989. *Structural Equations with Latent Variables* (Chapter 1)*


B. Building Blocks and Tools for SEMs


II. REGRESSION AS SEMs


III. SIMULTANEOUS EQUATIONS (Classical Econometric Methods)


*Bollen 1989. *SELV* (Ch.4).

*Duncan, O.D. 1975. *Introduction to Structural Equation Models*, (Chs.3-7).


IV. CONFIRMATORY FACTOR ANALYSIS (MEASUREMENT MODELS)


*Davis 1993 "The FC1 Rule of Identification for Confirmatory Factor Analysis."* 
*Sociological Methods and Research* 21:403-437.

*Bollen 1989. *SELV* (Ch.7).

V. STRUCTURAL EQUATIONS WITH LATENT VARIABLES


*Bollen 1989. *SELV* (Ch.8: 319-338; 349-355; 376-394).