University of Pennsylvania
School of Social Policy & Practice
SW 899
Structural Equation Modeling

Spring 2010

I. Course Description

This course is an introduction to linear structural equation modeling and its application to social and policy research. This course will cover various data analytic techniques ranging from simple regression, path models, and factor analysis to multiple group analysis, incomplete case analysis, and advanced longitudinal models. Within each technique we will examine algebraic and graphic model specification, estimation procedures, identification, goodness-of-fit criteria, and alternative models comparison. The goals of this course are to develop an understanding of the conceptual, mathematical, and application bases of structural equation modeling, to learn how to specify and estimate models, and to evaluate them in relation to alternative models using statistical and practical criteria. Classes will include both theoretical and practical sections using M*plus*. Pre-requisite: Graduate Course on Regression or Linear Modeling.

II. Educational and Learning Objectives

By the end of Structural Equation Modeling students are expected to demonstrate:

1. a strong foundation in linear structural equation modeling;
2. their knowledge of various SEM techniques;
3. how to fit path models, confirmatory factor analytic models, structural regressions with latent variables, latent growth/change models, latent class models, and growth mixture models;
4. their competence in fitting SEMs in the M*plus* framework;
5. how to construct and employ path diagrams;
6. how to interpret various coefficients;
7. how to interpret various fit statistics;
8. how to estimate indirect and total effects;
9. how to analyze incomplete cases in SEM;
10. how to analyze and test for invariance with multiple groups and time measurements;
11. a strong competence in the selection of appropriate SEM techniques given particular research questions;
12. how to test alternative models in SEM;
13. how to effectively communicate, in writing, the results for a professional publishable journal article (including path diagrams, tables, coefficients, etc.).

III. Course requirements:

Expectations

Classroom learning is a fundamental component of your professional education. Students are therefore expected to attend each class, arrive to class on time, and be in attendance for the full class. In the event that you are unable to attend class for any reason, you must notify the instructor in advance and learn how you are to make up the content you missed. Excessive absenteeism (i.e., missing more than two classes) is considered a serious problem the instructor will handle by meeting with the student and determining whether the student's educational adviser should be notified. Excessive absenteeism could result in course failure.

Students are expected to: (A) participate substantively in class discussions; (B) read on a weekly basis and come to class prepared to apply and discuss the reading assignments; (C) submit assignments by the due date and in accordance with the specified format.

Grades will be based on three minor assignments, a paper critique, a final project paper written as would be reported in the results section of a publishable manuscript, and a final project presentation. The first three assignments will be worth 15% each of your course grade and the paper critique will be worth 5%. The final project paper will be worth 35% and the final project presentation 15% of your overall course grade.

Assignments

Students will be responsible for six graded assignments during the semester. These assignments will require a specific analytic task of structural equation modeling and students will be required to perform and show all work. This will include submitting print outs of the output to analyses and, for the final project paper, writing up the results as you would report in the results section of a publishable manuscript. Specific instructions for completing each assignment will be provided during the semester.

Format

All papers must be typewritten, in 12-point font, double-spaced, page-numbered, with 1" margins at the left, right, top and bottom. The cover page (not included in the page limit) should include the title of the paper, student's name, assignment number, professor's name and date submitted. Papers should be stapled, not paper-clipped. Papers **must be proofread** carefully for clarity, organization, spelling, punctuation, and other potential errors before submission.

I**n-text citations following APA style guidelines are required** for all written assignments, with the specific source including authors' last names and year of publication, regardless of whether you are paraphrasing or using specific quotes. Direct quotes must have the specific source as above but with page number(s). **A list of references cited or consulted must be included at the end of each paper in proper APA bibliographic form**. Footnotes may be used where appropriate to further explicate a concept or issue. **American Sociological Association style may be used, but this must be consistent throughout the assignment.**

You should keep a copy of each paper submitted. The instructor will gladly answer any questions regarding format, citing or organization. Papers written for other classes may not be submitted

for written assignments in this course. Direct substitution of papers between courses may result in a failing grade for that assignment.

Plagiarism
Students are expected to conduct themselves consistent with the University of Pennsylvania's Code of Academic Integrity, which presents standards regarding plagiarism, multiple submissions and other actions. Students are expected to be familiar with the Code, which can be found at http://www.vpul.upenn.edu/osl/acadint.html

Evaluation
Assignments will be evaluated based on the following criteria:

1. demonstrates understanding of the particular task/application of structural equation modeling and how to appropriately analyze;
2. effective use of M*plus*;
3. shows all analyses;
4. utilizes path diagrams and tables and reports data/coefficients appropriately, as would be expected for the results section of a peer-review journal article;
5. and, appropriately interprets data.

Grading Policies
The final course grade is based on the student's performance on all assignments. Students whose performance is minimal or failing at midterm will be notified in writing.

Readings
It is expected that students will read required class assignments from the recommended texts and/or articles, and from relevant materials of their own choosing.

Required Text
Kline, Rex B. 2005. *Principles and Practice of Structural Equation Modeling* (Second Edition). New York NY: The Guilford Press.

Recommended:
Muthén, Linda K. and Muthén, Bengt O. 1998-2007. *Mplus User's Guide* (Fifth Edition). Los Angeles, CA: Muthén & Muthén. (http://www.statmodel.com/ugexcerpts.shtml)

Additional readings will be posted on-line via blackboard at:
https://courseweb.library.upenn.edu/

Required Software Package: M*plus*
The free M*plus* Version 5.21 Demo can be accessed at the following website:
http://www.statmodel.com/demo.shtml.

TOPIC AND READING LIST BY WEEK

Section I: Introduction to Course and Structural Equation Modeling

Week 1: January 13
Course Introduction. Review of the syllabus, and course requirements. What is structural equation modeling? What are latent variable models? What is the utility of these methods?

Week 2: January 20
Regression & the M*plus* Modeling Framework.

Readings:
Kline, text, Chs. 1 & 2

M*plus* User Guide, p. 1-21

Section II: Path Analysis, Factor Analysis, & Structural Equations with Latent Variables

Week 3: January 27
Path Diagrams & Structural Regressions.

Readings:
Kline, text, Chs. 4

Week 4: February 3
Path Analysis.

Readings:
Kline, text, Chs. 5-6

Week 5: February 10 ***Minor Assignment 1 Due: Path Diagram & Analysis***
Confirmatory Factor Analysis.

Readings:
Kline, text, Chs. 7

Week 6: February 17
Recursive Structural Equations with Latent Variables.

Readings:
Kline, text, Ch. 8

Section III: Advanced Techniques in Structural Equation Modeling

Week 7: February 24 ***Paper Critique Due***
Non-Recursive Structural Equations with Latent Variables.

Readings:
Kline, text, Ch. 9

Week 8: March 3
Structural Equation Models for Categorical Data.

Readings:
Glöckner-Rist, A. & Hoijtink, H. 2003. "The best of both worlds: Factor analysis of dichotomous data using item response theory and structural equation modeling". *Structural Equation Modeling, 10*:544-565.

Note: No class on March 10 (Spring Break).

Week 9: March 17 ***Minor Assignment 2 Due: Structural Equation with Latent Variables***
Mean & Covariance Structure.

Readings:
Grimm, Kevin J. and McArdle, John J. A note on the computer generation of structural expectations. In F. Dansereau & F. Yammarino (Eds.) *Multi-level issues in strategy and research methods* (Volume 4 of Research in multi-level issues) (pp. 335-372). Amsterdam: JAI Press/Elseiver.

Kline, text, p. 263-272

Week 10: March 24
Latent Growth/Change Analysis.

Readings:
Kline, text, p. 272-287

McArdle, John J. and Edward Anderson. 1990. "Latent Variable Growth Models for Research on Aging". in J. Birren and K. Warner Schaie (Eds.) *Handbook of the Psychology of Aging* (Third Edition). New York NY: Academic Press Inc.

Week 11: March 31
Multiple Group Analysis.

Readings:
Kline, text, Ch. 11

Week 12: April 7 ***Assignment 3 Due: Multiple Group Analysis***
Incomplete Case Analysis in SEM.

Readings:

McArdle, J. J. (1994). Structural factor analysis experiments with incomplete data. *Multivariate Behavioral Research, 29,* 409-454.

Recommended:

Peng, Chao-Ying Joanne, Michael Harwell, Show-Mann Liou, and Lee H. Ehman. 2007. "Advances in Missing Data Methods and Implications for Educational Research." in *Real Data Analysis.* edited by S.S. Sawilowsky. Charlotte, NC: Information Age Publishing. (Pp. 31-78)

Week 13: April 14
Latent Class/Growth Mixture Modeling.

Readings:

Nylund, Karen, Tihomir Asparouhov, Bengt Muthén. 2007. "Deciding on the Number of Classes in Latent Class Analysis and Growth Mixture Modeling: A Monte Carlo Simulation Study". *Structural Equation Modeling,* 14:535-569.

Muthén, Bengt et. al. 2002. "General growth mixture modeling for randomized preventive interventions." *Biostatistics,* 3:459-475.

Wang, Mo and Todd E. Bodner. 2007. "Growth Mixture Modeling: Identifying and Predicting Unobserved Subpopulations with Longitudinal Data." *Organizational Research Methods,* 10:635-656.

Week 14: April 21
Final Project Presentations.

Final Project Papers Due April 28th (No Later Than 5pm)

Three Minor Assignments (15% Each)

You will have three minor assignments on three different tasks in structural equation modeling: path diagram and analysis, structural equation with latent variables, and multiple group analysis. You will be asked to conduct the analyses in each task, present your output, and brief (2 to 3 page) write up of what you did, reporting the results of the model, and interpreting the results of the model.

Paper Critique (5%)

The goal of the paper critique is to make yourself familiar with SEM related research in your substantive area of expertise. You will read a paper in your substantive field of interest in which the authors use SEM to analyze data to evaluate their substantive research question, summarize the paper highlighting the use of SEM, and comment on the use of SEM in the paper – its benefits/advantages and limitations compared with other available methods. The paper summary is due **February 24, 2010**.

Final Project Paper (35%) & Presentation (15%)

You will have a final project using any technique of structural equation modeling covered in the course this semester on any data set of your choosing. You may use this as an opportunity to do the modeling for a thesis/dissertation, for a research article, or for fun. The final project paper is expected to have a brief introduction, methods section, results section as reported in a results section of a publishable manuscript, and brief discussion. In your brief discussion, it is expected that you will speak to the limitations. You will also have to do a 10 to 15 minute presentation of your final project on the last day of class.