Course Syllabus
USP 655 Advanced Data Analysis: Structural Equation Modeling
Winter 2010, Thurs 1:00-3:50 pm

Instructor

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Text

Maruyama, G.M. (1998). *Basics of structural equation modeling*. Thousand Oaks, CA: Sage. ISBN: 0-8039-7409-4.

Optional Text

Bollen, K.A. (1989). *Structural equations with latent variables*. New York: Wiley. Available at the bookstore or used copies may be obtainable online. ISBN: 0-471-01171-1.

Also recommended (not in bookstore):
Byrne, B.M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming (2nd Edition)*. New York: Routledge.

Prerequisites

I assume that students have taken a graduate statistics course that covers simple and multiple regression analysis.

Overview

This course is intended to introduce students to structural equation modeling. Structural equation modeling (sometimes referred to as covariance structural analysis) is a regression-based technique that incorporates elements of path analysis and confirmatory factor analysis. The general goal is to provide a thorough background in the conceptual aspects, statistical underpinnings, and application of this method, rather than a tutorial on a specific software package. At the end of the course, I expect students to have a solid, conceptual foundation of structural modeling issues, be able to analyze data using any SEM package, critically evaluate professional articles, and write-up SEM results.

Readings

There will be several readings assigned each week taken from the text and other sources. The readings will usually include an example article that applies SEM (readings will be available for download from the class website). Please read the material prior to class and be prepared for discussion.

Homeworks

There will be three homework assignments which will primarily consist of data analysis and write-ups of SEM problems using the student version of the statistical package, Mplus (Muthen & Muthen, 2007). Mplus is an extremely simple program to use, and therefore will allow us to focus more on statistical and applied issues rather than debugging programs and data conversion headaches. I will also provide examples using Amos in class. Some data preparation and descriptive analysis using SPSS may be required (let me know if this will be an inconvenience for some reason). The student ("demo") version of Mplus Version 5.21 can be downloaded from the following internet site: http://www.statmodel.com/demo.shtml. The demo version has no limitations on analysis types but allows no more than six dependent variables and two independent variables. Several copies will also be installed in the computer lab on the second floor of the Urban Center. Although you should not need it, the Mplus users guide can also be downloaded from the Mplus website (http://www.statmodel.com).

Homework due dates are: 1/28/10, 2/18/10, 3/18/10

Grades
Grades are based on an average of the three homework assignments and satisfactory class attendance and participation.

Other Resources
There are several internet sites devoted to SEM that may be of use. Dave Kenny has a great website with introductory material on most SEM topics at http://davidakenny.net/cm/causalm.htm (including a free pdf copy of his book, *Correlation and Causation*). Ed Rigdon has an excellent site that serves as a gateway to most of the SEM sites on the web at http://www.gsu.edu/~mkteer/ . There is a SEM discussion list called SEMNET which you can subscribe to (I think it would be a great idea if everyone would subscribe during this term) through the following site http://www.gsu.edu/~mkteer/semnet.html . The Mplus website has lots of example programs and a Mplus discussion section http://www.statmodel.com/. Finally, I have compiled a list of hundreds of articles and books on SEM organized by topic at my website http://www.upa.pdx.edu/IOA/newsom.

Disabilities
If you have a disability and are in need of academic accommodations, please notify me immediately to arrange needed supports.

Comments on Learning Statistics
Statistics of any kind is very difficult topic to learn. However, keeping in mind the following points learning statistics should greatly facilitate your learning in this course.

- **It's not like math, it is like math**. Statistics is considerably different from mathematics. In fact, the math required for this course is no more complex than what is needed to balance a check book. Statistics is like mathematics, however, in that it must be practiced to be learned. One has to work on exercises, analyze different problems, and get experience with different analytic situations in order to absorb the information. Do not think that you can just read through the material and remember everything. You may need to reread and apply the material several times. *So, don't wait until the last minute!*
- **It's like a foreign language**. Statistics does, however, use a lot of symbols like Greek letters, and for this reason it is a bit like learning a foreign language. Think of the symbols as a foreign language vocabulary that has to be learned in order to understand the sentences.
- **It's like other courses**. In this course, there will also be a great deal of practical, conceptual, and other substantive information that will have to be learned; so, you will also have to read the text material, study concepts, and do some memorization like other substantive courses.
- **It's progressive**. Everything builds on everything else. Don't let any misunderstandings slip through the cracks, or it will snowball on you.
- **It's weird**. Statistics is a unique and unusual topic involving some very abstract and weird ideas. The peculiar nature of the subject makes the material very difficult to learn and retain. Despite its seemingly abstract nature, statistics are extremely useful tools that will make you a highly skilled and valued researcher.

Course Readings
USP 655 Advanced Statistics: Structural Equation Modeling
Winter 2008

Primary Text: Maruyama, G.M. (1998). *Basics of structural equation modeling*. Thousand Oaks, CA: Sage.

1/14 Overview and History of SEM

Maruyama, Chapter 2, "History and logic of structural equation modeling"

Matrix Algebra

Chapter 3 (pp. 56-77 only) "The New Basics" in Hayduk, L.A. (1987). *Structural equation modeling with Lisrel: Essentials and advances.* Baltimore, MD: John Hopkins University Press.

Chapter 6, "General method of multiple regression analysis: Matrix operations." In E.J. Pedhazur, *Multiple regression in behavioral research: Explanation and prediction (3rd Edition)*. Fort Worth: Harcourt Brace.

Chapter 2, "Covariance Algebra" in Kenny, D.A. (1979). *Correlation and causation.* New York: Wiley.

Optional Regression Review: Chapter 2, "Simple linear regression and correlation," & Chapter 5, "Elements of multiple regression analysis: Two independent variables" in Pedhazur, E.J. (1997). *Multiple regression in behavioral research: Explanation and prediction (3rd Edition)*. Fort Worth, TX: Harcourt Brace.

1/21 Path Analysis

Maruyama, Chapter 3, "The basics: Path analysis and partitioning of variance."

Chapter 18 (pp. 765-807 only) "Structural equation models with observed variables: Path analysis" in Pedhazur, E.J. (1997). *Multiple regression in behavioral research: Explanation and prediction (3rd Edition)*. Fort Worth, TX: Harcourt Brace.

Maruyama, Chapter 5, "Effects of random and nonrandom error on path models."

Example article: Moeller, S.J., & Crocker, J. (2009). Drinking and desired self-images: Path models of self-image goals, coping motives, heavy-episodic drinking, and alcohol problems. *Psychology of Addictive Behaviors, 23*, 334–340

1/28 Confirmatory Factor Analysis I: Theory, Model Fitting Concepts, and Software

Maruyama, Chapter 7, "Introducing the logic of factor analysis and multiple indicators to path modeling"

Maruyama, Chapter 8, "Putting it all together: Latent variable structural equation modeling"

Preacher, K.J., & MacCallum, R.C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding Statistics, 2*, 13-43

Example article: Noar, S.M. (2003). The role of structural modeling in scale development. *Structural Equation Modeling, 10,* 622-647.

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2/4 Confirmatory Factor Analysis II: Model Comparisons and Fit indices

Maruyama, Chapter 10, "Logic of alternative models and significance tests"

Tanaka, J.S. (1993). Multifaceted conceptions of fit in structural equation models. In K.A. Bollen, & J.S. Long (eds.), *Testing structural equation Models* (pp. 10-39). Newbury Park, CA: Sage.

Hu, L.-T., & Bentler, P. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Example article: Mancini, J.A., & Marek, L.I. (2004). Sustaining community-based programs for families: Conceptualization and measurement. *Family Relations, 53*, 339-347.

2/11 Full Structural Models I: Practical Issues, Model Modifications, & Missing Data

Bentler, P.M., & Chou, C.-P. (1988). Practical issues in structural modeling. In J.S. Long (Ed.), *Common problems/proper solutions* (pp.161-192). Beverly Hills, CA: Sage.

MacCallum, R.C., Roznowski, M., & Necowitz, L.B. (1992). Model modifications in covariance structure analysis: The problem of capitalization on chance. *Psychological Bulletin*, *111*, 490-504.

Enders, C.K. (2006). Analyzing structural equation models with missing data. In G.R. Hancock & R.O. Mueller (Eds.), S*tructural equation modeling: A second course* (pp. 313-342). . Greenwich, CT: Information Age Publishing.

Example article: Hudson, C.G. (2005). Socioeconomic Status and Mental Illness: Tests of the Social Causation and Selection Hypotheses. *American Journal of Orthopsychiatry, 75*, 3-18.

2/18 Full Structural Models II: Nonnormality & Categorical Variables

Finney, S.J., & DiStefano, C. (2006). Non-normal and categorical data in structural equation modeling. In G.R. Hancock & R.O. Mueller (Eds.), *Structural equation modeling: A second course*. Greenwich, CT: Information Age Publishing.

Example article: Jones, R. N., & Gallo, J.J. (2002). Education and Sex Differences in the Mini-Mental State Examination: Effects of Differential Item Functioning**.** *Journals of Gerontology, Series B: Psychological and Social Sciences, 57B,* P548-P558.

2/25 Multigroup Structural Models and Second-Order Factor Models

Maruyama, Chapter 11, "Variations on the basic latent variable structural equation model".

Bontempo, D. E., & Hofer, S. M. (2007). Assessing factorial invariance in cross-sectional and longitudinal studies. In A.D. Ong & M. van Dulmen (Eds.)*, Handbook of methods in positive psychology (pp. 153-175)*. Oxford University Press.

Example article: Roth, D.L, Ackerman, M.L, Okonkwo, O.C, & Burgio, L.D. (2008). The four-factor model of depressive symptoms in dementia caregivers: A structural equation model of ethnic differences. *Psychology and Aging, 23*, 567-576.

3/4 Issues of Causality and Longitudinal Modeling

Chapter 1, "Structural Modeling," in Kenny, D.A. (1979). *Correlation and causation.* New York: Wiley.

Maruyama, Chapter 6, "Recursive and longitudinal models: Where causality goes in more than one direction and where data are collected over time"

Maruyama, Chapter 9, "Using latent variable structural equation modeling to examine plausibility of models"

Example article: Burkholder, G.J., & Harlow, L.L. (2003). An Illustration of a Longitudinal Cross-Lagged Design for Larger Structural Equation Models. *Structural Equation Modeling*, *10*, 465-486.

Optional article: Cole, D.A., & Maxwell, S.E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology, 112*, 558-577.

3/11 Growth Curve Models

Chapter 10, "Mean structures and latent growth curve models," in Kline (2005). *Principles and practice of structural equation modeling (Second Edition).* New York: Guilford.

Willett, J. B., & Sayer, A. G. (1994). Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychological Bulletin, 116*, 363-381.

Example article: Byrne, B.M. & Crombie, G. (2003). Modeling and testing change: An introduction to the latent growth curve model. *Understanding Statistics, 2, 177-203.*

3/18 Reporting Results and Limitations of SEM *Finals Day (class meets, no exam)*

Boomsma, A. (2000). Reporting analyses of covariance structures. Structural Equation Modeling, 7, 461-483.

Chapter 12, "How to fool yourself with SEM," in Kline, R.B. (2005). *Principles and practice of structural equation modeling (Second Edition)*. New York: Guilford.

McCoach, D.B., Black, A.C., & O'Connell, A.A. (2007). Errors of inference in structural equation modeling. *Psychology in the Schools, 44*, 461-470.