SOC 681: INTRODUCTION TO LINEAR STRUCTURAL EQUATION MODELS

Spring 2011 Tu, Th
STONE 215/ SRI Laboratory 4:30-5:45 PM

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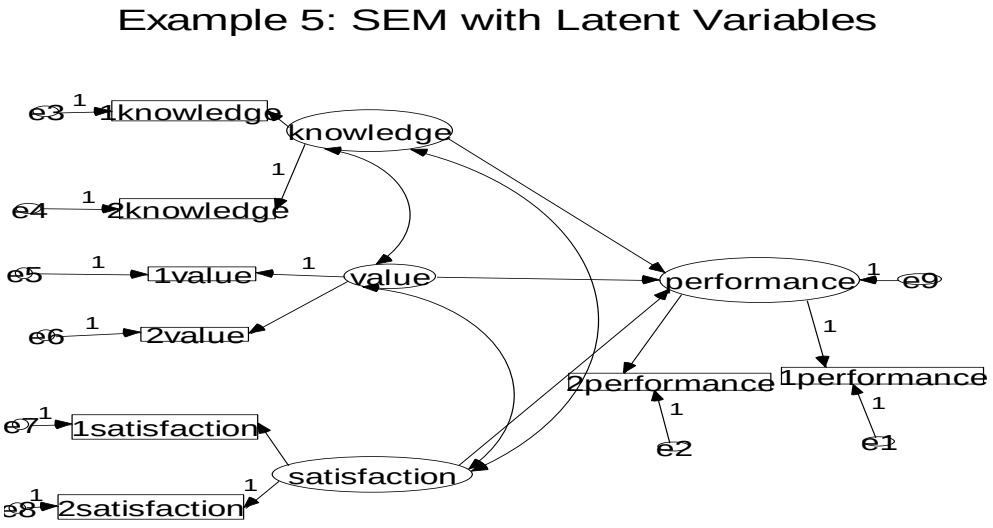
The course will introduce participants to Structural Equation Models (SEMs) using AMOS, one of the most widely available computer programs for structural equation modeling in social, behavioral, and economic research. SEMs simultaneously model the measurement and conceptual structure of social phenomena and thus combine the strengths of factor analysis, path analysis, and simultaneous equation models. The course will be taught in the Social Research Institute Laboratory. Participants will be assisted in constructing, estimating and interpreting SEMs based on their own data. They will be expected to make an oral presentation based on their research and to prepare a manuscript that may be submitted to a professional journal in their field.

Topics will include:

1. Basics: Causality and Causal Models
2. Models with Directly Observed Variables
3. Measurement Models: Confirmatory Factor Analysis
4. Structural Equation Models with Latent Variables
5. Model Building: Testing Goodness of Fit
6. Multiple Groups Analysis
7. Analysis of Longitudinal Data
8. Latent Growth Curve Analysis Basics: Causality and Causal Models
9. Writing about SEMs.
10. Estimating and Testing Hypotheses about Means
11. Advanced Methods



COURSE DESCRIPTION

Throughout the course, participants will use data analysis exercises to illustrate the various topics covered in class. You will be expected to construct, critique, and estimate structural equation models using AMOS. Exercises will be completed in the SRI lab. You will also be expected to complete a term project involving the construction, the estimation, and testing of a structural equation model involving measurement error and latent variables. The project is to be written in article format and you are encouraged to submit it to a journal for possible publication. All assignments are due on the date indicated.

TEXTS

Required:

Anderson, J.G. Introduction to Linear Structural Equation Models. Syllabus
http://web.ics.purdue.edu/~janders1

Arbuckle, J.L., *AMOS 17.0 User's Guide*. Chicago, IL: SPSS, 2008.

Kline, R.B., *Principles and Practice of Structural Equation Model*ing, 2nd Ed. New York: Guilford Press, 2005.

Brown, T.A. *Confirmatory Factor Analysis for Applied Research*. New York: Guilford Press, 2006.

Recommended:

McKnight et al. *Missing Data*. New York: Guilford Press, 2007.

Bollen, K.A. and Curran, P. J. (2005). *Latent Trajectory Models: A Structural Equation Approach.* Indianapolis, IN: Wiley, Inc.

GRADING

Attendance/Class Exercises		**20**
Research Paper		**60**
Proposal	**5**	
Data Analysis	**5**	
Preliminary Report	**5**	
Final Report	**45**	
Class Presentation		**20**
Total		**100**

Points will be deducted for failure to turn in class exercises, your preliminary outline, data analysis, preliminary and final reports on time and to present your research project on the assigned date. One point will be deducted for every day the assignment is late. You are expected to attend and participate in each class. Two points will be deducted for each class that you miss. In case of an illness or emergency, please notify me before class. I will determine whether or not to excuse you from class on that day. Assignments are due on the date indicated in the syllabus. A point will be deducted for each day that an assignment is late.

Final grades will be based on the following:

Points	**Grade**
100-99	**A+**
98-93	**A**
92-90	**A-**
89-88	**B+**
87-83	**B**
82-80	**B-**
79-78	**C+**
77-73	**C**
72-70	**C-**
69-68	**D+**
67-63	**D**
62-60	**D-**
59-0	**F**

SCHEDULE

Jan 11	**Introduction to Structural Equation Models**	Chapt. 1
Jan 13	**Setting up an AMOS Program** Exercise 1: Setting up an AMOS program	Chapt. 1
Jan 18,20	**Data Preparation**	
Jan 25,27	**Causal Models with Directly Observed Variables** Exercise 2: Causal Models with Directly Observed Variables	Chapt. 2
Jan 27	**Preliminary Outline of Research Project**	Due
Feb 1, 3	**Confirmatory/Exploratory Factor Analysis** Exercise 3: Confirmatory/Exploratory Factor Analysis	Chapt. 3
Feb 8,10	**Structural Equation Models with Latent Variables** Exercise 4: Structural Equation Models with Latent Variables	Chapt. 4
Feb 15	**Model Fit**	
Feb 17	**Non-Normal and Categorical Data**	
Feb 17	**Data Analysis**	Due
Feb 22,24	**Work on Research Project**	
Mar 1,3	**Model Building** Exercise 5: Model Building – Alternative Models Testing Goodness of Fit	Chapt. 5
Mar 8,10	**Multiple Groups Analysis** Exercise 6: Multiple Groups Analysis	Chapt. 6
Mar 15,17	**Spring Break**	
Mar 22,24	**Analysis of Longitudinal Data** Exercise 7: Analysis of Longitudinal Data	Chapt. 7
Mar 29	**Latent Growth Curve Analysis**	Chapt. 8
Mar 31	**Writing about SEMs**	Chapt. 9
Apr 5	**Advanced Methods** Estimating and Testing Hypotheses about Means	Chapt. 10
Apr 7	**Advanced Methods** Bootstrapping	Chapt. 11
April 12,14	**Work on Research Projects**	
April 14	**Preliminary Research Reports**	Due
April 19,21 April 26, 28	**Presentation of Research Projects**	
April 28	**Final Research Reports**	Due

Preliminary Proposal (5 points)

Develop and hand in a preliminary proposal for your research project to include:

1. Introduction

   A. Provide a description of the research question that you plan to address.

   B State the specific hypotheses that you plan to test. **Include a path diagram**.

   C. Include pertinent references from the literature that provide the theoretical background and support for your hypotheses.

2. Methods
   A. Describe the data that you plan to analyze to test your hypotheses.

   B. Briefly describe the analytic methods that you plan to use. Justify the method that you selected compared to alternative methods.

   C. Describe the variables (latent constructs) you plan to use in your analysis. Indicate how each variable will be operationally defined.

Data Analysis (5 points)

Hand in a preliminary analysis of the data that you are analyzing for your research project to include:

1. A description of how you operationalized each of your latent or theoretical concepts.
2. How you coded/recoded/transformed any of your indicators.
3. Descriptive statistics on your indicators/variables.
4. A discussion of whether or not your data meets the assumptions of SEM.
   If not, indicate how you plan to deal with violations of assumptions.
5. Results of exploratory/confirmatory factor analyses for your constructs.
6. A **path model** that indicates the SEM that you plan to analyze.

Preliminary Draft (5 points)

Hand in a preliminary draft of your final report before you present your research in class**.**

Class Presentation

Points	Topic
(5)	**Introduction:** Introduce your research problem, its significance and your specific objectives.
(3)	**Methods:** Describe the data you analyzed and your analytic strategy.
(5)	**Results:** Present your results organized around your research objectives and hypotheses.
(5)	**Discussion:** Summarize your major findings; point out the extent to which your results agree or disagree with the published literature and interpret similarities and/or differences; discuss the limitations of your study and future directions for your research.
(2)	**Instructional Aids:** Use Power Point to present your research.
(20)	**TOTAL**

Final Report

Points	Topic
(5)	**Abstract:** Provide a one page summary of your research project to include Objectives, Methods, Major Findings, and Implications
(5)	**Introduction:** Provide a clear statement of the objectives of your study**.**
(10)	**Literature** Review: Summarize the pertinent literature that provides the theoretical/conceptual basis of your research. Include a statement of your hypotheses and a path diagram.
(5)	**Methods:** Describe the data that you analyzed; include data collection instruments if pertinent; describe preliminary analyses of your data and include correlation matrices, descriptive statistics for your indicators, results of factor analyses, etc.
(5)	**Results/Findings:** Present the results of your analyses in graphical and/or tabular form. Interpret the findings in the text.
(10)	**Conclusions/Implications**: Provide a clear statement of the implications of your findings; discuss the limitations of your research and future directions for your research.
(5)	**References**: List all references cited in the text. Use a standard format (e.g., APA). **Appendices**: Include copies of data collection instruments, etc.
(45)	**TOTAL**

Chapter 1 – Introduction to Structural Equation Models

1. Causal Theories
   - A. Variables – Manifest and Latent
   - B. Relationships
   - C. Covariation
   - D. Causal Relationships
   - E. Formulation of Causal Theories

2. Data preparation
   - A. Data screening
   - B. Missing Data

3. Setting up an AMOS program.
   Class Exercise 1: Tutorial: Get Started with AMOS Graphics
   AMOS Part I, Chapter 2

Reading Assignments:

Kline, Chapters 1-4
AMOS Part I, Chapter 2; Part II, Chapters 1-3, 17-18
McKnight, Missing Data

Chapter 2 - Causal Models with Directly Observed Variables

1. Multiple regression analysis

2. Causal models with directly observed variables: Path Analysis.

3. Interpreting the results.
   A. Examining values of the parameters
   B. Testing parameter estimates for significance

4. Measures of Fit

5. Class Exercise 2: Causal Models with Directly Observed Variables
   AMOS Exercise 4: Conventional Linear Regression
   AMOS Exercise 7: Nonrecursive Model

Reading Assignments:

Kline, Chapters 5-6, 9
AMOS Part II, Chapters 4, 7, Appendix B
Anderson , JG and Evans, FB, "Causal Models in Educational Research: Recursive Models, AERJ, Winter 1974;11(1):29-39.
Anderson , JG , "Causal Models in Educational Research: Nonrecursive Models, AERJ, Winter 1978;15(1):81-97.

Chapter 3- Confirmatory Factor Analysis

1. Manifest and Latent Variables.

2. Confirmatory Versus Exploratory Factor Analysis.

3. Structural Relations among the Factors.

4. Specification of the Confirmatory Factor Model

5. Identification of the Confirmatory Factor Model.
   A. Conditions for Identification
   B. Scale Indeterminancy/Setting a Metric

6. Estimation of the Confirmatory Factor Model.

7. Class Exercise 3:
   AMOS Exercise 8: Factor Analysis
   AMOS Exercise 23: Exploratory Factor Analysis by Specification Search.

Reading Assignments:

Kline, Chapter 7
AMOS, Part II, Chapters 8, 23
Brown, Confirmatory Factor Analysis
B. Thompson and LG Daniel, " Factor Analytic Evidence for the Construct Validity of Scores: A Historical Overview and Some Guidelines," Educational and Psychological Measurement, 1996;56:197-208.

Chapter 4 - Structural Equation Models with Latent Variables

1. Steps in Structural Equation Modeling
   - A. Model Specification
   - B. Identification
   - C. Estimation
   - D. Testing Fit
   - E. Respecification

2. The Models.
   - A. The Measurement Model
     - (1). Specification of the Measurement Model
     - (2). The Covariance Structure
   - B. The Structural Model
     - (1) Specification of the Structural Model
     - (2) The Covariance Structure
     - (3) Types of Structural Equation Models

3. Standardized Solutions

4. Total, Direct and Indirect Effects

5. Path Diagrams

6. Class Exercise 4: Structural Equation Models with Latent Variables
   AMOS Example 5: Unobserved Variables

Assignment

Wilson and N. Lankton, "Modeling Patients' Acceptance of Provider-Delivered E-Health," JAMIA, 2004;11(4):242-248.
Kline, Chapter 8

Chapter 5 - Model Building

1. The Model Building Process
   - A. Verbal Theory
   - B. Specification of a Theoretical Model
   - C. Data Collection
   - D. Model Specification
   - E. Identification
   - F. Parameter Estimation
   - G. Testing Model's Goodness of Fit
   - H. Respecification of the Model
   - I. Inferences from the Model

2. Assessment of the Goodness of Fit of a Structural Equation Model

7. Exercise 5: Model Building
   AMOS Example 22: Specification Search

Reading Assignments:

J.G. Anderson, "Structural Equation Models in the Social and Behavioral Sciences: Model Building," Child Development 1987;58:49-64.
AMOS, Part II, Chapter 22

Chapter 6 - Multiple Groups

1. Simultaneous Analysis of Data from Two or More Groups
   A. Use of Covariance Matrices
   B. Input Data for AMOS

2. Multiple Groups Analysis
   A. Testing for the Invariance of the Covariance Matrix
   B. Testing for the Invariance of the Measurement Models
      (1) Testing the Factor Loadings
      (2) Testing the Errors of Measurement
      (3) Testing the Correlations Among the Factors
   C. Testing for the Invariance of the Structural Models
      (1) Testing the Structural Parameters
      (2) Testing the Errors in the Equations

3. Class Exercise 7: Multiple Groups Analysis
   AMOS Example 11: Simultaneous Analysis of Two Groups
   AMOS Example 12: Simultaneous Factor Analysis for Several Groups

Reading, Assignments:

Kline, Chapter 11
AMOS Part II, Chapters 10-12, 24, 25
JG Anderson, "What do physicians think about computers: A Comparison of house staff and medical staff"

Chapter 7 - Analysis of Longitudinal Data

1. The Causal Analysis of Change
    A. Inferring a Causal Relationship
    B. Research Designs
        (1) Experimental Research
        (2) Cross-Section Analysis
            a. Multiple Regression Analysis
            b. Path Analysis
        (3) Panel Analysis

2. Identification of Panel Models
    A. Fixing Values of Parameters
    B. Constraining Associations with Control Variables
    C. Consistency Constraints in Multi-Wave Models

3. Types of Effects
    A. Stability Effects
    B. Cross-Sectional Effects
    C. Cross-Lagged Effects

4.Class Exercise: Panel Analysis
AMOS Example 6: Exploratory Analysis

Reading Assignments:

AD Farell, Structural Equation Modeling with Longitudinal Data: Strategies for Examining Group Differences and Reciprocal Relationships," Journal of Consulting and Clinical Psychology, 1994;62(3):477-487.

Chapter 8 – Latent Growth Curve Analysis

1. Introduction: Why LGC Analysis?
   A. Other Methods of Examining Change over Time
   B. Problems with Traditional Methods

2. Basics

3. Components
   A. Intercept
   B. Slope

4. The Linear Model

5. The Nonlinear Model

Class Exercise 8:
Kline, Chapter 10, An Empirical Example, pp. 274-287.

Reading Assignment:
Kline, Chapter 10
Bollen, K.A. and Curran, P. J.
AC Acock and F. Li, "Latent Growth Curve Analysis: A Gentle Introduction"

Chapter 9 – Writing About Structural Equation Models

1. Describing the Conceptual and Statistical Models

2. Describing the Data and Methods

3. Describing the Results

4. Interpretation of the Results

5. Conclusions

Reading Assignment:
Kline, Chapter 12

Chapter 10 – Estimating and Testing Hypotheses about Means

1. Introduction to mean structures
2. Identification of mean structures
3. Estimation of mean structures
4. Structured means in measurement models
5. Class Exercises: 9

AMOS Example 13: Estimating and Testing Hypotheses about Means
AMOS Example 14: Regression with an Explicit Intercept
AMOS Example 15: Factor Analysis with Structured Means

Reading Assignments:
Kline Chapter 10
AMOS Part II, Chapters 13-15.

Chapter 11 – Advanced Methods

1. Bootstrapping

Class Exercise 10:

AMOS Example 19 Bootstrapping

Reading Assignment:
Kline Chapter 13
AMOS Part II, Chapters 19-21