Structural Equation Models (PSY 60130)
Spring 2010, Time: MW 1:30–2:45, Place: Haggar Hall 212
Ke-Hai Yuan (email: kyuan@nd.edu, phone: 631-4619)
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Office hours (Ke-Hai Yuan, Haggar 123a) Monday 10:00-12:00 and Thursday 1:00 to 3:00 or
(Stephen Tueller) by appointment

Topics:

1. Introduction (correlation, regression, measurement error, confirmatory factor models, structural equation models, path diagrams and direct and indirect effects, causal and effect indicators).


5. Model evaluation and fit indices, Lagrange multiplier and Wald tests.

6. Multiple groups and mean structures.

7. Multilevel models.

8. Estimation methods, test statistics, and power.


10. Outliers, model diagnosis and robust methods.


12. Cross validation, simulation and bootstrap.

Objectives: The primary objective is to develop skills in using SEM and related techniques. This includes: (1) the ability to recognize situations where SEM may be useful in research; (2) an understanding of rules in making these techniques useful; (3) being aware of limitations of different methods; (4) being able to use available software in conducting research; and (5) the ability to critically evaluate others’ modeling research reports.

Reading materials: The material of the lectures will be based on Structural equations with latent variables by Bollen (1989), Latent variable models by Loehlin (2004), Modeling covariances and latent variables using EQS by Dunn et al. (1993), and EQS 6 structural equations program manual by Bentler (2006). Certain lectures will be based on articles as listed below. Loehlin (2004) aims for a broad audience while Bollen (1989) involves more equations and is
intended for readers familiar with matrices. Dunn et al. (1993) contains many examples of practical modeling while Bentler (2006) contains instructions for using advanced methodology in EQS. We will also learn Mplus and SAS Calis.

Homework (Book of Dunn, Everitt, & Pickles, 1993): Exercises 1.3, 1.5, 1.6; 2.1, 2.2, 2.3, 2.5; 3.1, 3.3, 3.4, 3.6; 4.1, 4.2, 4.3; 5.1, 5.3; 6.2, 6.3; 6.6; 7.2, 7.4. I will distribute data sets for extra exercises.

Final project: The final is a paper or a project in which you use SEM to analyze some data sets, on a topic you have a real interest. The paper should be written like a typical publication in your research area. Ideally, it is a first time modeling report on a data set (perhaps your own data) that has been analyzed by another methods, but for which SEM seems especially appropriate. If you have no interest in real data, by letting me know, you can also choose to do a mathematical or simulation study.

Grades: If all the homework are well done, you will get a B- for this course. Grades above B depend on your final project.

Reading material and references

Books:

Articles:


Recursive path models are always identified. CFA models have their own rules of identification (below). Degrees of freedom (DF) is the difference between pieces of known information and number of unknown parameters. In CFA and other structural equation models the counted information is a number of unique elements in variance-covariance matrix of observed variables. Number of unique elements in variance-covariance matrix of observed variables: $N_{\text{obs}} = \frac{k(k+1)}{2}$, where $k$ is a number of observed variables. There are at least 3 indicators in 1-factor model and at least 2 indicators in multifactor models; residual covariances consume degrees of freedom, so check if $\text{df} \geq 0$. Sorts of identification. How are the constructs related to measured variables? Structural model. What are the relationships between the constructs? Conrmatory Factor Analysis.

Types of relationships in SEM. 1. Relationship between a Construct and a Measured Variable. Exogenous. X. Measurement model – Structural model.

Conrmatory Factor Analysis 25.01.16 20. Modeling strategies.
- Measurement model with a single construct and only 2 indicators is under-identified (= there are more parameters than unique covariances).
- Remember: the number of unique variances and covariances in the observed covariance matrix = degrees of freedom. Conrmatory Factor Analysis 25.01.16 32.

Test a simple mediation model Calculate direct and indirect effects. Cross-sectionally and longitudinally Create a cross-lagged panel model Distinguish between mediation, moderation, confounding, suppressor effects and antecedent variables Build a life course structural equation model in Mplus Introduce latent variables into path models. Morning session.

Direct and indirect effects. X predicts Y. XY. c. Direct effect, quantified by c. Amount by which two participants who differ by one X unit are expected to differ on Y. Linear regression. $Y = B0 + B1X + e$. X measured without error, Y with error.

Reliability and validity established prior to modelling. Aberdeen Children of the 1950s (ACOF). Leon et al. Each Structural equation model is associated with a graph that represents the causal structure of the model and the form of the linear equations. There is a directed edge from X to Y (X→Y) if the coefficient of X in the structural equation for Y is nonzero (i.e., X is a direct cause of Y). In addition, there is a bi-directed edge between the error terms $\epsilon_X$ and $\epsilon_Y$ if and only if the covariance between the error terms is nonzero. Here, in path diagrams, latent substantive variables are enclosed in ovals, and measured variables are enclosed in rectangles. In the structural modeling, theoretical In structural equation modeling, the confirmatory factor model is imposed on the data. In this case, the purpose of structural equation modeling is twofold. The factors $\epsilon_{v\_w}$ to $\epsilon_{w\_w}$ to the right of Figure 1 represent measurement errors. We expect that the verbal and spatial factor will not perfectly predict the observed variables, and this is modeled by specifying a specific error factor for each observed variable. These measurement errors are often pictured as single arrows. The Path Model with Latent Factors Structural equations models can be quite complex, and incorporate both latent factors and observed variables, with either directed or undirected paths among them. Figure 4 is a. Introduction Structural Equation Modeling.