The scope of structural equation modeling

- types of variables
- multi-sample analysis
- measurement models and structural models
- PRELIS and LISREL

The program

March 1 and 2

- Path models with manifest variables
- Models of Classical Test Theory
- Latent state-trait models
- Latent change models
- Latent growth curve models

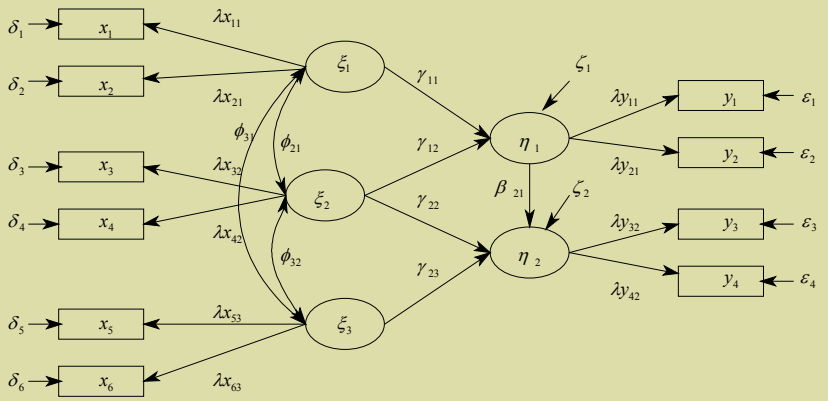
March 3 and 4

- Individual causal effect models
- Multigroup models
- Ordinal variable models
- Multitrait-multimethod models

Emphasis

- Theory
- Data generation according to a model
- Analyzing data including empirical data

The scope of structural equation modeling



LISREL notation, exogeneous and endogenous variables

The scope of structural equation modeling

– Model equations for structured means

- Measurement model for $\boldsymbol{y}$: $\boldsymbol{y} = \boldsymbol{\tau}_y + \boldsymbol{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\varepsilon}$
- Measurement model for $\boldsymbol{x}$: $\boldsymbol{x} = \boldsymbol{\tau}_x + \boldsymbol{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta}$
- Structural model: $\boldsymbol{\eta} = \boldsymbol{\alpha} + \boldsymbol{B}\,\boldsymbol{\eta} + \boldsymbol{\Gamma}\,\boldsymbol{\xi} + \boldsymbol{\zeta}$

The scope of structural equation modeling

– Implied covariance structure

$$\boldsymbol{\Sigma} = \begin{bmatrix} \mathbf{A}(\boldsymbol{\Gamma}\boldsymbol{\Phi}\boldsymbol{\Gamma}' + \boldsymbol{\Psi})\mathbf{A}' + \boldsymbol{\Theta}_{\varepsilon} & \mathbf{A}(\boldsymbol{\Gamma}\boldsymbol{\Phi}\boldsymbol{\Lambda}_x') \\ \boldsymbol{\Lambda}_x\boldsymbol{\Phi}\boldsymbol{\Gamma}'\mathbf{A}' & \boldsymbol{\Lambda}_x\boldsymbol{\Phi}\boldsymbol{\Lambda}_x' + \boldsymbol{\Theta}_{\delta} \end{bmatrix}$$

– where

$$\mathbf{A} := \boldsymbol{\Lambda}_y(\mathbf{I} - \mathbf{B})^{-1}$$

The scope of structural equation modeling

– Implied mean structure

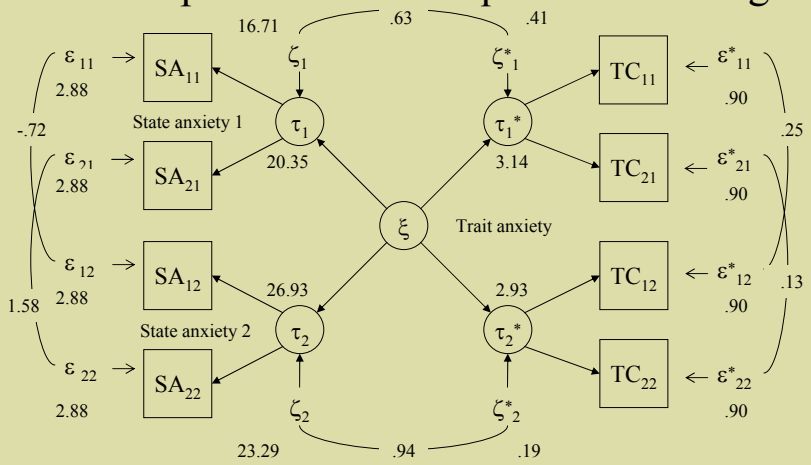
$$E(\boldsymbol{\xi}) =: \boldsymbol{\kappa}$$

$$\boldsymbol{\mu}_y = \boldsymbol{\tau}_y + \boldsymbol{\Lambda}_y (\boldsymbol{I}-\boldsymbol{B})^{-1} (\boldsymbol{\alpha} + \boldsymbol{\Gamma}\boldsymbol{\kappa})$$

$$\boldsymbol{\mu}_x = \boldsymbol{\tau}_x + \boldsymbol{\Lambda}_x \boldsymbol{\kappa}$$

$$E(\boldsymbol{\eta}) = (\boldsymbol{I}-\boldsymbol{B})^{-1} (\boldsymbol{\alpha} + \boldsymbol{\Gamma}\boldsymbol{\kappa})$$

The scope of structural equation modeling



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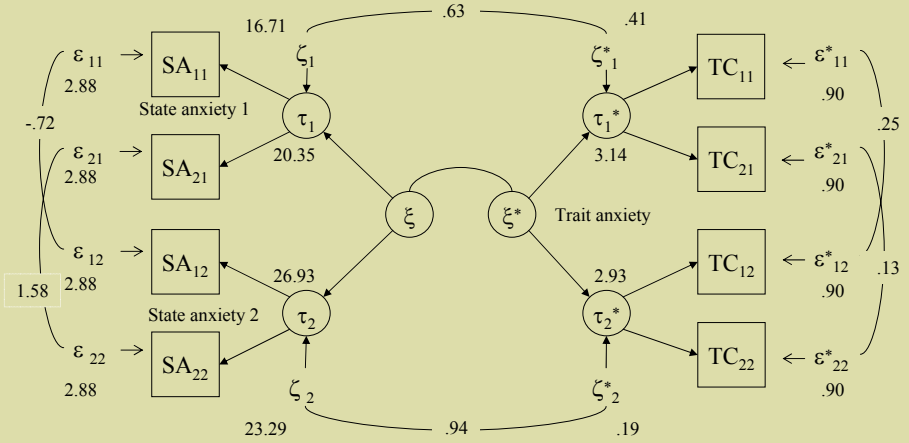

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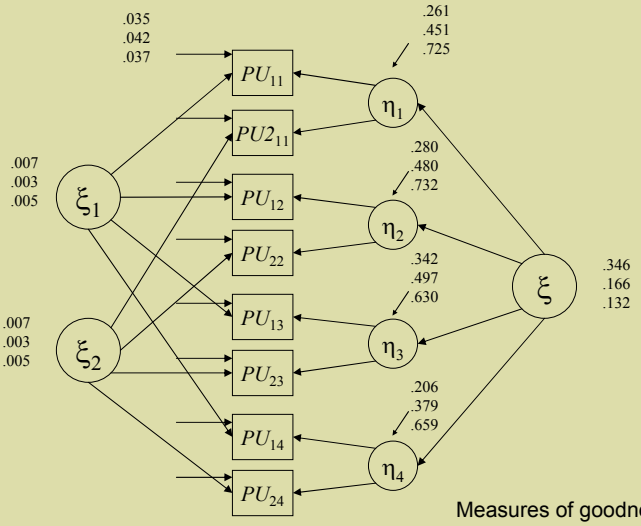
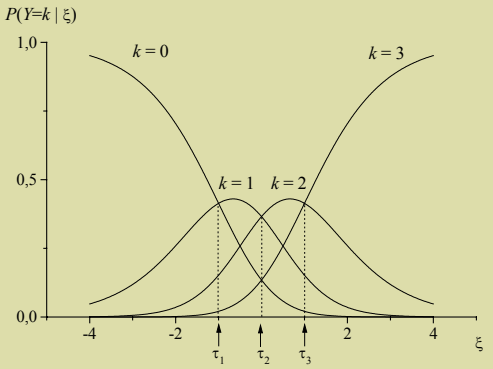


Measures of goodness-of-fit:
χ^2=103.39, *P*=0.11

The scope of structural equation modeling

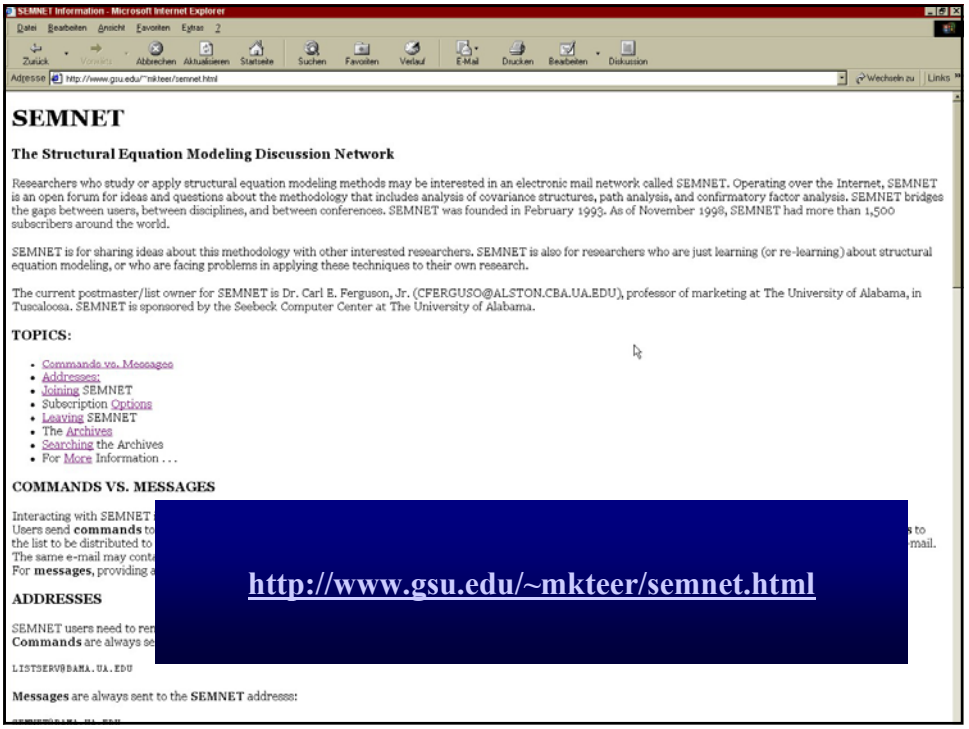


The scope of structural equation modeling

Math. notation	Θ_δ	Λ_x	Φ	Γ	B	Ψ	Λ_y	Θ_ε
Lisrel-notation	TD	LX	PH	GA	BE	PS	LY	TE
Default form	DI	FU	SY	FU	ZE	SY	FU	DI
Default mode	FR	FI	FR	FR	FI	FR	FI	FR
Order	NX×NX	NX×NK	NK×NK	NE×NK	NE×NE	NE×NE	NY×NE	NY×NY
ID Identity		*	*	*			*	
IZ Identity / Zero		*		*			*	
ZI Zero/Identity		*		*			*	
DI diagonal	*	*	*	*		*	*	*
FU rectangular		*		*	*		*	
SD Diagonal 0, all others free					*			
SY symmetric, no diagonal		*		*			*	
ST symmetric, 1 in diagonal			*					
ZE 0	*				*	*		*

The scope of structural equation modeling

- Internet resources about SEM
  - SEMnet Discussion List
    - http://www.gsu.edu/~mkteer/semnet.html
  - Joel West's SEM page
    - http://www.gsm.uci.edu/~joelwest/SEM/
  - Ed Rigdon's SEM faq
    - http://www.gsu.edu/~mkteer/semfaq.html



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STRUCTURAL EQUATION MODELING: Concepts, Issues and Applications

Edited by RICK H. HOYLE, *University of Kentucky*

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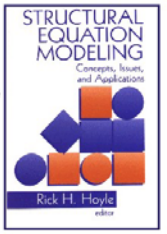

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Though technically sound, the chapters are pri
introduction to the structural equation modelin
devoted to fundamental concepts such as estim
use of computer programs for applying the app

Contents:

Foreword *Kenneth A. Bollen*

Preface *Rick H. Hoyle*

1. The Structural Equation Modeling Approach: Basic Concepts and Fundamental Issues *Rick H. Hoyle*
2. Model Specification: Procedures, Strategies, and Related Issues *Robert C. MacCallum*
3. Estimates and Tests in Structural Equation Modeling *Chih-Ping Chou & Peter M. Bentler*
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9. Writing About Structural Equation Models *Rick H. Hoyle & Abigail T. Panter*
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12. Modeling the Relation of Personality Variables to Symptom Complaints: The Unique Role of Negative Affectivity *Jay G. Hull, Judith C. Tedlie, & Daniel A. Lehn*
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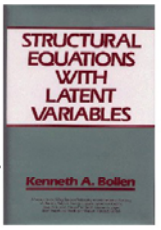
STRUCTURAL EQUATIONS WITH LATENT VARIABLES

By KENNETH A. BOLLEN, *University of North Carolina*

Structural Equations with Latent Variables is a comprehensive treatment of the general structural equation system. The book serves three purposes. First, it demonstrates the generality of this model. Rather than treating path analysis, recursive and nonrecursive models, classical econometrics, and confirmatory factor analysis as unique, they are treated as special cases of a common model. The second purpose is to emphasize the application of these techniques. Empirical examples appear throughout. Several chapters contain some of the programs the author used to obtain the results for the empirical examples. Finally, the book explores the crucial role played by substantive expertise in most stages of the modeling process.



Structural equation models can be presented two ways--from the general model to simpler models, or from simpler models to the general model. *Structural Equations with Latent Variables* develops from the latter strategy, starting with the regression/econometric and factor analysis models and presenting them from the perspective of the general model.

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Contents:

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3. Causality and Causal Models
4. Structural Equation Models with Observed Variables
5. The Consequences of Measurement Error
6. Measurement Models: The Relation Between Latent and Observed Vari
7. Confirmatory Factor Analysis
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9. The General Model, Part II: Extensions
10. Appendix A: Matrix Algebra Review
11. Appendix B: Asymptotic Distribution Theory

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Edited by GEORGE A. MARCOULIDES, *California State University at Fullerton,* and **RANDALL E. SCHUMACKER,** *University of North Texas*

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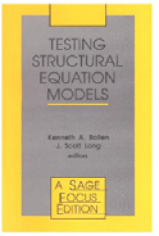
Edited by KENNETH A. BOLLEN, *University of North Carolina,* and **J. SCOTT LONG,** *Indiana University*

"This book is a valuable adjunct to the extant literature on specification, estimation, and identification. My overall impression is that this volume is indispensable for those wishing to keep current with this fast-moving field. I recommend that this book be used as a supplementary text in a graduate-level course in structural equation modeling." *Structural Equation Modeling.*

Highly integrated and valuable, this book is a must for every researcher's shelf, particularly with coverage like testing structural equation models, multifaceted conceptions of fit, Monte Carlo evaluations of goodness of fit indices, specification tests for the linear regression model, bootstrapping goodness of fit measures, Bayesian model selection, alternative ways of assessing model fit, power evaluations, goodness of fit with categorical and other non-normal variables, new covariance structure model improvement statistics, and nonpositive definite matrices.



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