
Contents

Preface	ix
Introduction	xi
Chapter 1. Structural Equation Modeling	1
1.1. Basic concepts	2
1.1.1. Covariance and bivariate correlation	2
1.1.2. Partial correlation	5
1.1.3. Linear regression analysis	7
1.1.4. Standard error of the estimate	10
1.1.5. Factor analysis	11
1.1.6. Data distribution normality	18
1.2. Basic principles of SEM	21
1.2.1. Estimation methods (estimators)	27
1.3. Model evaluation of the solution of the estimated model	36
1.3.1. Overall goodness-of-fit indices	36
1.3.2. Local fit indices (parameter estimates)	43
1.3.3. Modification indices	44
1.4. Confirmatory approach in SEM	45
1.5. Basic conventions of SEM	47
1.6. Place and status of variables in a hypothetical model	49
1.7. Conclusion	49
1.8. Further reading	50
Chapter 2. Structural Equation Modeling Software	53
2.1. R environment	54
2.1.1. Installing R software	55
2.1.2. R console	55

2.2. lavaan	58
2.2.1. Installing the lavaan package	58
2.2.2. Launching lavaan	58
2.3. Preparing and importing a dataset	60
2.3.1. Entry and import of raw data	60
2.3.2. What to do in the absence of raw data?	63
2.4. Major operators of lavaan syntax	65
2.5. Main steps in using lavaan	66
2.6. lavaan fitting functions	68
Chapter 3. Steps in Structural Equation Modeling	69
3.1. The theoretical model and its conceptual specification	70
3.2. Model parameters and model identification	71
3.3. Models with observed variables (path models)	73
3.3.1. Identification of a path model	74
3.3.2. Model specification using lavaan (step 2)	76
3.3.3. Direct and indirect effects	78
3.3.4. The statistical significance of indirect effects	80
3.3.5. Model estimation with lavaan (step 3)	81
3.3.6. Model evaluation (step 4)	82
3.3.7. Recursive and non-recursive models	83
3.3.8. Illustration of a path analysis model	85
3.4. Actor-partner interdependence model	90
3.4.1. Specifying and estimating an APIM with lavaan	92
3.4.2. Evaluation of the solution	93
3.4.3. Evaluating the APIM re-specified with equality constraints	94
3.5. Models with latent variables (measurement models and structural models)	95
3.5.1. The measurement model or Confirmatory Factor Analysis	97
3.6. Hybrid models	148
3.7. Measure with a single-item indicator	149
3.8. General structural model including single-item latent variables with a single indicator	151
3.9. Conclusion	152
3.10. Further reading	155
Chapter 4. Advanced Topics: Principles and Applications	157
4.1. Multigroup analysis	157
4.1.1. The steps of MG-CFA	162
4.1.2. Model solutions and model comparison tests	166
4.1.3. Total invariance versus partial invariance	171
4.1.4. Specification of a partial invariance in lavaan syntax	172

4.2. Latent trait-state models	172
4.2.1. The STARTS model	173
4.2.2. The Trait-State-Occasion Model	197
4.2.3. Concluding remarks	211
4.3. Latent growth models	213
4.3.1. General overview	213
4.3.2. Illustration of an univariate linear growth model	223
4.3.3. Illustration of an univariate non-linear (quadratic) latent growth model	228
4.3.4. Conditional latent growth model	232
4.3.5. Second-order latent growth model	240
4.4. Further reading	249
References	251
Index	269