Structural equation modeling for dummies pdf

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1. Basics of Structural Equation Modeling by Dr. Sean. Mackinnon 2. Virtually every model you've done already using the Ordinary Least Squares approach (linear regression; uses square amounts) can also be done using SEM Difference in the first place as the settings and SEs are calculated (SEM uses maximum probability estimate instead of squares) First, let's get used to the SEM notation chart 3. The Depression Anxiety Correlation Ratio .50 Rectangles indicate observed variables two-headed arrows indicate covarians (so if standardized variables are used, it's Pearson d) 4. Linear regression depression Anxiety .50 Single-headed arrow path In this example, depression is IV and anxiety DV IVs - exogenous variables (without arrows pointing to them) DVs and endogenous variables (arrows pointing to them) 5. Deviations and residual deviations of Depression Anxiety .50 Exogenous variables also have variance, as the Edogenic variables have residual variance as a parameter (i.e. error; part of the variance unexplained by model) They are rarely stretched explicitly in charts, but it is worth remembering later when we count the parameters and for more advanced applications. 6. Multiple regression Perfection Anxiety .40 Correlations between DVs indicated in SPSS too you just don't get a way out of it R2 values are often put in the top right corner of DVs Depression SES .26 -.11 .25 .09 .30 .01 7. Moderation Perfectionism Depression .40 Moderation is defined in the same way as multiple regression Only the difference is that one of the variables is the interaction of Stress Perfectionism and Stress .26 -.11 .25 .09 .30 .01 8. Perfectionism Depression Conflict a-path b-path c'-way Instead of a two-step process, this is done all in one analysis If you want to get a c-way, run another linear regression w/o conflict variable included Normally you would use the boot to test the indirect effect (a'b) in SEM Mediation 9. Independent t-test Sex Anxiety B No. 1.25 Sex encoded as 0 (women) or 1 (male) Use of non-standard coefficents Value for interception means for women Value for Slope and Interception Value for Men If p-value for slope qlt; .05, means different 10. One-Way ANOVA (3 groups) Treatment 1 (dummy) Anxiety treatment 2 (dummy) Original variable: 1 - Control Group; 2 - Treatment 1; 3 - Treatment 2 Treatment 1 (chip): 1 - Treatment 1, 0 - Other Groups Treatment 2 (dummy): 1 - Treatment 2, 0 - other groups similar to t-test, you can get funds for each group This type of fictitious coding compares the procedures with the control group 11. SEM can also address more complex issues 12. Complex relationships between variables can be used to test the Mackinnon et al. (2011) 13 theory. Confirming analysis The Negative Impact Of Anger Shame Sadness Ovals represent variables of Factor Loads pathways in this chart conceptually, it's like EFA, except you have an idea in advance that the elements should consist of a hidden variable (and we can test the hypothesis!) 14. Structural Simulation of the Equation How to Analyze the Path, except looks at the relationship between hidden variables Useful because it explains the unreliability of measurement, so it offers more biased parameters also allows you to test almost any theory you may have McKinnon et al (2012) 15. Model Building Rules - Each way, correlation and variance - is a parameter - the number of parameters can not exceed the number of data points - If so, your model is under-sufficient, and cannot be evaluated using SEM - data points are calculated by: - p (p'1) / 2 - Where p - number of observed variables - Ex. With 3 variables: 3(4) / 2 6 16. Just identified or saturated models of Perfectionism Anxiety In this case, 4 variables: 4'5/2 and 10 possible data points Ten parameters: 4 deviations and 6 insidious Depression SES So in fact, this is a model where everything is connected to everything else! Not a very stingy 17. Another newly identified perfectionism anxiety model In this case, 3 variables: 3'4/2 and 6 possible data points Six parameters: 3 deviations 1 kovarians 2 Pathway Depression Note that the differences for endogenous variables will be residual deviations (parts unexplained predictors) 18. More Parsimonious Models Just defined models are interesting, but often not stingy (i.e. everything is related to everything) Are there paths or covariances in your model that you can remove but still end up with a well-suited model? Path analysis and SEM can answer these questions. When we fit a model with fewer options than data points, we can see if the model is still well suited with some ways omitted 19. Identified perfectionism Depression Conflict a-path b-path Fix to zero In this case 3 variables: 3'4/2 and 6 possible data points Five parameters: 3 deviations 2 paths (path fixed to zero, was released) Can we remove c' path from this mediation model? This model is more stingy, so it would be preferable. Appropriate indices judge the adequacy of this model. 20. The Fit Fit model refers to the model's ability to reproduce data (i.e., usually the variance and covarian matrix). 1 2 3 1. Ideal 2.6 2. Conflict .40 5.2 3. Depression 0 .32 3.5 1 2 3 1. Ideal 2.5 2. Conflict .39 5.3 3. Depression .03 .40 3.1 Predicted by the model Is actually observed in your data So in SEM we compare these matrixes (a model created compared to actually observed in your data) and see how invulnerable they are. If they are basically identical, the model fits well 21. Fit model We condense these matrix comparisons into SINGLE NUMBER: Chi-square (χ2) df (data points) - (estimated parameters) It tests zero hypothesis that the model fits well into the data (i.e. the model covariance matrix is very similar to the observed covariance matrix) thus, no significant chi-squares are better! 22. Problems with χ2 simulations show that the chi-square is TOO sensitive. He rejects models much more often than he should. More importantly, it is tied to the sample size. As the sample size increases, the probability of a significant chi-square increases. Thus, there is a very high rate of type II errors, and it deteriorates as the sample size increases. So we need alternative methods that take that into account. 23. Incremental Fit Incremental Incremental Fit Indices Compare Your Model with a Fit Of Basic or Zero Model: Perfectionism Depression Conflict Fix to zero Fix zero model fixes all insidiouss and ways to be zero So, each variable is not technically connected, the most stingy model, but not useful one 24. Incremental Fit Indices Confirming Fit Index (CFI) d (Null Model) - d (Proposed Model) d (Null Model) Let d q χ2 - df, where df are the degree of freedom model. If the index is larger than one, it is set on one, and if less than zero, it is set at zero. Values range from 0 (not suitable) to 1.0 (perfect) 25. Tucker-Lewis Tucker-Lewis Index (TLI) imposes a fine for the complexity of the model (prefers more stingy models). χ2/df (Null Model) - χ2/df (Proposed Model) χ2/df (Null Model) - 1 Range of values from 0 (not suitable) to 1.0 (ideally suited) TLI is more conservative, will almost always reject more models than CFI 26. Parsimonious Root Indices Average Square Approximation Error (RMSEA) Similar to others, except that it doesn't actually compare with the invalid model, and (like TLI) offers a penalty for more complex models: √ (χ2 - df) √ df(N - 1) can also calculate 90% for CI RMSEA 27. Absolute indexes of standardized root average residual area (SRMR) formula are kind of tricky, so conceptual understanding is better. This one uses leftovers. SRMR is an absolute measure of compliance and is defined as a standardized difference between the observed correlation matrix and the predicted correlation matrix. Value 0 and ideal (i.e. zero residues) SRMR has no penalty for the complexity of the model. 28. Fit Indexes Switched Off - χ2 - ideally not significant, p .01 or even p .001 - CFI and TLI - Ideally more than 0.95 - RMSEA - Ideally less than 0.06 - Ideally, 90% CI for RMSEA does not contain 0.08 or above - SRMR - Ideally less than 0.08 Citations for papers: Kline, R. B. (2011). Principles and practice of structural modeling of equations (3rd Note. New York, NY: Guildford. Hooper, D., Coughlan, J., Mullen, M. (2008). Structural modeling of equations: equations: to determine the model fit. Electronic Journal of Business Research Methods, 6, 53-60. 29. Problem with hidden variables In this case, 3 variables: 3'4/2 and 6 possible data points Seven parameters: 3 deviations for observed vars 1 variance for LATENT variables 3 ways (factor loads) This model cannot be evaluated! Also, the hidden variable has no metric (which means 1 on this hidden variable even means? (In fact, all this time we have limited the means to be zero to simplify the mathematics of saturated average structuring. Normally we don't care about funds for our theory so they are not explicitly modeled) The limitation will be 1.0 Negative impact of Anger Shame Sadness 31. Problem with hidden variables Alternative Solution: Fix one of the coefficient groups (usually expected to be the biggest download) to 1. It also releases one option. The hidden variable will have the same variance as the observed variable, which has been limited to 1.0 Either the solution works, and will not affect the suitable Restriction indices to be 1.0 Negative impact Anger Shame Sadness 32. Let's try a sample analysis in R A confirming factor analysis with 10 points and 1 hidden variable (general self-assessment). 33. Installing the packages you need #For converting the SPSS file to R install.packages (foreign, dependency and TRUE) #For works structural modeling of install.packages equations (lavaan, dependency and truth) you need to do this only once (not every time you download R) 34. Get the SPSS file in R #Load a library of foreign packages (foreign) #Set the work directory where the dataset is located. Here will also save files. I'd create a new folder for this somewhere on your computer setwd (C:/Users/Sean Mackinnon/Desktop/R Analyses) #Take datafile and read it in R. This datafile will henceforth be called lab9data when working in R lab9data qlt;- read.spss (A4.selfeestem.sav, use.books.books.mark.list. Include the model #Load lavaan package (you only need to do once in the time you open the R) library (lavaan) #Specify model you're testing, call this model se.g.model1 (can call it anything) #By by default, will limit the first indicator to be 1.0 se.g.g.model1 qlt;- se_g s3 - se16r - se29 - se42r - se55 - se68 - se81r - se94 - se107r - se120r - se131 - se135r ' 36. Fit models #Fit data, called that the installed model fits (or whatever you want) #Estimator - MLR is a reliable evaluator. I recommend always using this instead of by ML #missing is to process the missing data using the maximum probability of complete information #fixed.x #fixed.x is optional. I turn it on because I want the results to be similar to Mplus, which is another program that I use often. For more information, see the lavaan documentation. (se.g.model1, data - lab9data, appraiser - MLR, missing - ML, fixed.x - TRUE) 37. Request a severance #request composite statistics to interpret #In this case, I ask fit indices and standardized values in addition to the default output summary (fits, fit.measures - TRUE, standardized and TRUE) TRUE) TRUE) structural equation modeling for dummies pdf

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