Dynamic Structural Equation Models: Promising Yet Concerning

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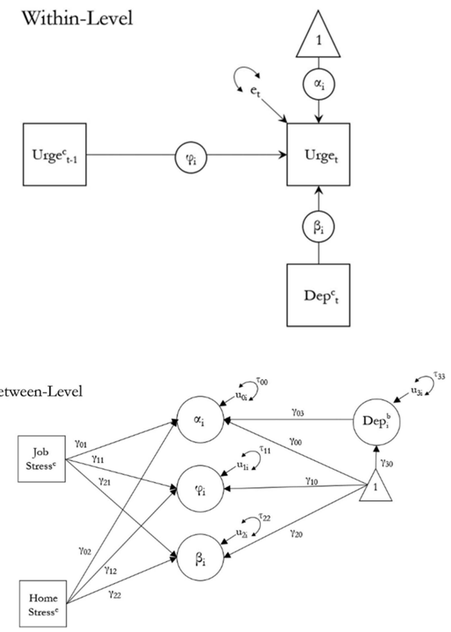


What is DSEM? Why use it?

DSEM is short for Dynamic Structural Equation Model

Extremely useful in intensive longitudinal data analysis

- COMBINES THE POWERS OF TIME SERIES ANALYSIS, MULTILEVEL MODELING AND STRUCTURAL EQUATION MODELING
- DSEM MODELS COMPLEX RELATIONSHIPS IN DATA OVER TIME
- USEFUL FOR STUDYING INDIVIDUAL-LEVEL CHANGE AND HEALTH-RELATED OUTCOMES
- ACCOUNTS FOR COMPLEX TEMPORAL DEPENDENCIES
- MODELS MULTIPLE VARIABLES SIMULTANEOUSLY
- IDENTIFIES KEY MEDIATORS AND MODERATORS OF RELATIONSHIPS

Recommendations

- **INCREASING NUMBER OF ITERATIONS IS NOT A GREAT IDEA**
- **USE STRICT CONVERGENCE THRESHOLDS**
- **YOU DECIDE FOR YOUR DATA**
  For DSEM, it is important to check the stability of parameter estimates. You do employ an approach similar to mine... run 1000 seeds

Take home points

DSEM IS AN EXTREMELY POWERFUL MODEL TO STUDY CO-DEVELOPMENTAL TRAJECTORIES

DSEM IS NOT READY FOR PRIME TIME
(YET...)

Tune the Instrument

NUMBER OF ITERATIONS OF THE MCMC ESTIMATOR
Adjust BITER to set the desired number of iterations for the MCMC estimator

MAKE THE CONVERGENCE THRESHOLD STRICTER
Change the BCONVERGENCE for the Potential Scale Reduction Factor (PSRF)

AND OTHERS...
But we focus on two for this project

Method

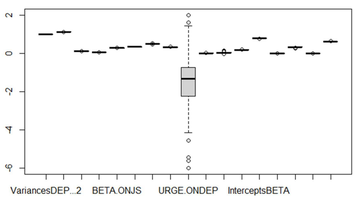
CHOOSE A MODEL → **TUNE THE INSTRUMENT** → **RUN 1000 MODELS** → **RESULTS** → **RECOMMEND BEST PRACTICE**

Iterations = 1000

Following McNeish and Hamaker (2020), BITER set to 1000. Some seeds did not converge...

Take home points

1 1000 ITERATIONS NOT ENOUGH



Iterations = 30000

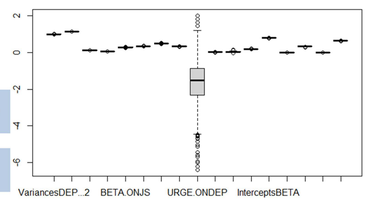
Very similar to BITER = 10000. URGE ON DEP still a random number generator

And, mean value of depression is still significant for 47 seeds

Take home points:

1 INCREASING ITERATIONS IS PROBABLY NOT GOING TO IMPROVE THE PARAMETER ESTIMATES

2 WILL TAKE MUCH LONGER TO RUN THAN BITER=10000



Iterations = 10000

BITER set to 10000. All seeds did converge, but...

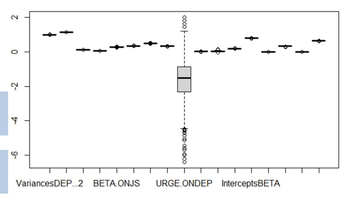
Mean value of depression became significant for 47 seeds out of 1000 seeds

URGE ON DEP is a random number generator

Take home points:

1 SOME PARAMETERS MIGHT GET TAGGED AS SIGNIFICANT BUT ACTUALLY ARE NOT

2 POSSIBILITY OF UNSTABLE PARAMETER ESTIMATES



Changing the number of iterations of the MCMC estimator does not improve the stability of the model estimates

The primary issue is that the estimator chains fail to converge to a consistent value in a timely manner.

Get to the bottom of the problem: The convergence threshold... Change the PSR

CONCLUSION

For this dataset, PSR=1.01 is the best

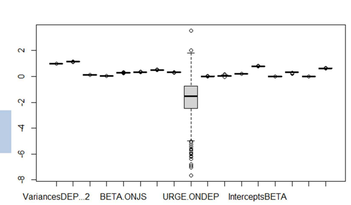
CONVERGENCE = 1.1

Setting the PSRF threshold of 1.1 was recommended by Gelman and Rubin (1998)

URGE ON DEP is not stable yet and, mean value of depression is still significant for 82 seeds

Take home points:

1 DSEM NEEDS A STRICTER CONVERGENCE THRESHOLD



CONVERGENCE = 1.01

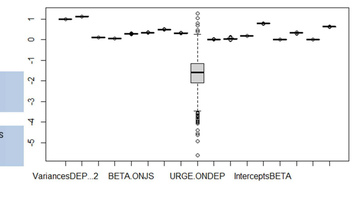
Setting the PSRF threshold of 1.01 which goes above and beyond what is traditionally considered "good enough"

URGE ON DEP is not stable yet but the variance is smaller than anything we have seen earlier. Moreover, mean value of depression is significant for only 10 seeds now

Take home points:

1 MUCH BETTER THAN PSR = 1.05

2 THIS CONVERGENCE THRESHOLD LOOKS PRETTY GOOD , BUT LET'S MAKE IT STRICTER



CONVERGENCE = 1.05

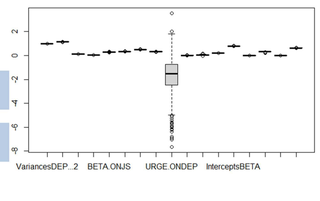
Setting the PSRF threshold of 1.05 which is considered to be a more conservative (Salam & Grzegorczyk, 2022) and stable for most models (Asparouhov & Muthén, 2010)

URGE ON DEP is not stable yet and, mean value of depression is still significant for 47 seeds

Take home points:

1 BETTER THAN PSR = 1.1

2 STRICTER CONVERGENCE THRESHOLD REQUIRED



CONVERGENCE = 1.005

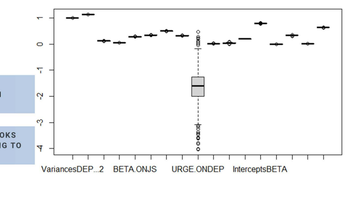
Setting the PSRF threshold of 1.005...

URGE ON DEP is not stable yet but the variance is smaller. Moreover, mean value of depression is significant for only 4 seeds now

Take home points:

1 NOT MUCH BETTER THAN PSR = 1.01

2 THIS CONVERGENCE THRESHOLD LOOKS PRETTY GOOD , BUT TAKES TOO LONG TO COMPUTE



References

Asparouhov, T., & Muthén, B. (2010). *Bayesian Analysis Using Mplus: Technical Implementation*. https://www.statmodel.com/download/Bayes3.pdfof who the client is and what they do.

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Salam, A., & Grzegorczyk, M. (2022). Model averaging for sparse seemingly unrelated regression using Bayesian networks among the errors. *Computational Statistics*. https://doi.org/10.1007/s00180-022-01258-9