SEM 1: Confirmatory Factor Analysis

Week 2 - Sample Size

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Sample Size

How big is 'big enough'?

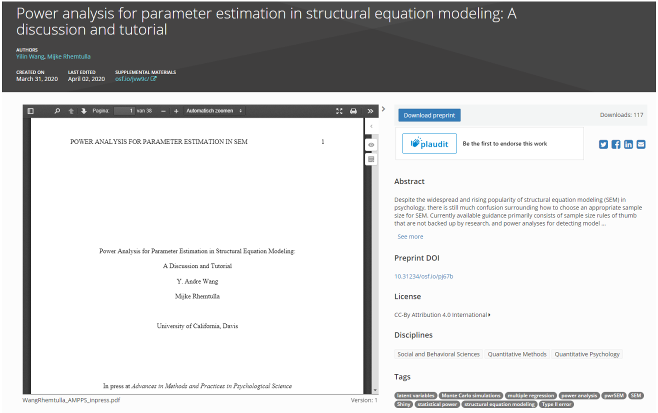
- $n : q$ ratio should be high
  - Theory: to efficiently estimate lots of parameters, a larger sample is needed (5-10 per parameter)
  - There's very little evidence that it matters (Jackson, 2003)
  - This ratio is less important than absolute sample size
- $n \approx 200$ people
  - This is median SEM sample size (Shah & Goldstein, 2006)
  - Appropriate for an average model with ML estimation
  - Other recommendations: 100-200 people minimum
- Use larger n if:
  - Assumptions are violated (e.g., data are nonnormal)
  - Model is complex (e.g., latent interactions, multilevel structure)
  - Indicators have low reliability (factor loadings are low)

Big enough for what?

- Big enough that $\boldsymbol{S}$ is a precise estimate of $\boldsymbol{\Sigma}$
  - No estimation problems (model converges)
  - Parameter estimates have small confidence intervals
- Power to detect model misspecification
  - Chi-square test statistic has sufficient power
  - Fit statistics are accurate

Power to detect non-zero parameters

- G-power cannot help you here: there are too many factors!
- To estimate power, you need to know (or estimate) the model, and all parameter values
- Simulation Method for Estimating Power
  1. Specify a population model with all parameter values
  2. Draw a large number of sample datasets of size *n* from this hypothetical population (e.g., 1000)
     - `simulateData` in lavaan
  3. Fit the model to each dataset and record whether the parameter value you care about is significant
  4. Count the proportion of significant parameter estimates out of 1000 datasets = power



https://yilinandrewang.shinyapps.io/pwrSEM/

Power to Detect Misspecification

- Again, Simulation:
  1. Specify a population model
  2. Draw a large number of sample datasets of size *n* from this hypothetical population (e.g., 1000)
  3. Fit a misspecified model to each dataset and record whether the chi-square test statistic is significant
  4. Count the proportion of significant test statistics out of 1000 datasets = power

Power for Test of (Not-)Close Fit

- RMSEA estimates a population value
  - Its sampling distribution has been worked out
  - So we can put a confidence interval around it
  - This confidence interval allows us to ask whether RMSEA is significantly different from a specified value
- If the population model fit is NOT CLOSE, what is power to reject H_0 by the test of close fit?
- If the population model fit is CLOSE, what is power to reject H_0 by the test of not-close fit?
- Method described in MacCallum et al. (1996) is implemented in online calculators:
  - Power and minimum sample size for RMSEA: `http://quantpsy.org/rmsea/rmsea.htm`
  - Power curves for RMSEA: `http://quantpsy.org/rmsea/rmseaplot.htm`
  - See also `findRMSEAsamplesize` in semTools

Sample size required to reject $RMSEA < 0.05$ is the true $RMSEA = 0.1$ and $DF = 20$:

```r
library("semTools")
findRMSEAsamplesize(rmsea0=.05, rmseaA=.1, df=20, power=.80)

## [1] 184
```

Sample size required to reject $RMSEA > 0.08$ is the true $RMSEA = 0.02$ and $DF = 20$:

```r
findRMSEAsamplesize(rmsea0=.08, rmseaA=.02, df=20, power=.80)

## [1] 194
```