Modification Index Examples

Mplus

(output excerpts)

```
INPUT INSTRUCTIONS


  title:  Self-esteem CFA Example--One Factor;

  ! I recommend using free format with tab-delimited data, however;
  data:  file=c:\jason\spsswin\arc\se1.dat;  format=free;
   ! there are no missing values in this data set

  variable:  names = rnotworr rnumqal ramfailr ramable rnotprdr rfelpos;

  !  For now, use the following analysis commands to estimate using ML, non-robust,
  !   with no missing data estimation and no meanstructure (the default in most packages);

  analysis:  type=general; estimator=ml;
     model=nomeanstructure; information=expected;

  model: se by rnotworr-rfelpos;

  output:  stdyx modindices(all 3.84);
  ! The keyword all means modification indices for associations
  !  with covariates are included and the 3.84 requests any modification
  ! indices over the chi-square critical value for 1 df.



INPUT READING TERMINATED NORMALLY



Self-esteem CFA Example--One Factor;

SUMMARY OF ANALYSIS

Number of groups                                                 1
Number of observations                                         118

Number of dependent variables                                    6
Number of independent variables                                  0
Number of continuous latent variables                            1


Estimator                                                       ML

MODEL FIT INFORMATION

Number of Free Parameters                       12

Loglikelihood

          H0 Value                       -757.201
          H1 Value                       -747.474

Information Criteria

          Akaike (AIC)                   1538.402
          Bayesian (BIC)                 1571.650
          Sample-Size Adjusted BIC       1533.715
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit

          Value                             19.454
          Degrees of Freedom                    9
          P-Value                           0.0216
```

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.099	
90 Percent C.I.	0.036	0.160
Probability RMSEA <= .05	0.086	

CFI/TLI

CFI	0.910
TLI	0.850

Chi-Square Test of Model Fit for the Baseline Model

Value	131.265
Degrees of Freedom	15
P-Value	0.0000

SRMR (Standardized Root Mean Square Residual)

Value	0.061

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
SE BY				
RNOTWORR	1.000	0.000	999.000	999.000
RNUMQAL	0.637	0.159	4.012	0.000
RAMFAILR	0.969	0.220	4.405	0.000
RAMABLE	0.265	0.202	1.309	0.190
RNOTPRDR	1.262	0.279	4.521	0.000
RFELPOS	0.478	0.174	2.751	0.006
Variances				
SE	0.231	0.094	2.460	0.014
Residual Variances				
RNOTWORR	0.793	0.111	7.134	0.000
RNUMQAL	0.228	0.033	6.866	0.000
RAMFAILR	0.300	0.050	6.029	0.000
RAMABLE	0.860	0.112	7.650	0.000
RNOTPRDR	0.116	0.051	2.269	0.023
RFELPOS	0.488	0.065	7.496	0.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
SE BY				
RNOTWORR	0.475	0.083	5.724	0.000
RNUMQAL	0.539	0.078	6.898	0.000
RAMFAILR	0.648	0.071	9.174	0.000
RAMABLE	0.136	0.100	1.361	0.173
RNOTPRDR	0.872	0.062	14.068	0.000
RFELPOS	0.312	0.093	3.349	0.001
Variances				
SE	1.000	0.000	999.000	999.000
Residual Variances				
RNOTWORR	0.775	0.079	9.833	0.000
RNUMQAL	0.709	0.084	8.415	0.000
RAMFAILR	0.581	0.091	6.353	0.000
RAMABLE	0.982	0.027	36.213	0.000
RNOTPRDR	0.240	0.108	2.219	0.026

```
    RFELPOS            0.903      0.058     15.525      0.000


R-SQUARE

    Observed                                        Two-Tailed
    Variable        Estimate       S.E.  Est./S.E.    P-Value

    RNOTWORR           0.225      0.079      2.862      0.004
    RNUMQAL            0.291      0.084      3.449      0.001
    RAMFAILR           0.419      0.091      4.587      0.000
    RAMABLE            0.018      0.027      0.681      0.496
    RNOTPRDR           0.760      0.108      7.034      0.000
    RFELPOS            0.097      0.058      1.675      0.094


QUALITY OF NUMERICAL RESULTS

     Condition Number for the Information Matrix              0.608E-02
       (ratio of smallest to largest eigenvalue)


MODEL MODIFICATION INDICES

NOTE:  Modification indices for direct effects of observed dependent variables
regressed on covariates may not be included.  To include these, request
MODINDICES (ALL).

Minimum M.I. value for printing the modification index     3.840

                                  M.I.     E.P.C.  Std E.P.C.  StdYX E.P.C.

WITH Statements

RNUMQAL  WITH RNOTWORR            9.518    -0.138     -0.138       -0.324
RAMFAILR WITH RNOTWORR           11.227     0.191      0.191        0.392
RNOTPRDR WITH RNUMQAL            12.913     0.154      0.154        0.945
RNOTPRDR WITH RAMFAILR            6.645    -0.181     -0.181       -0.970
```

Lavaan

```
> library(lavaan) # always call lavaan library first
> # first time use on the computer, install the lavaan package with the following command
> # install.packages("lavaan", dependencies=TRUE)
>
> ## On-factor CFA example, Newsom's SEM Class, self-esteem
>
>
> #because the data were fixed format, special statements were needed
> se1 = read.fortran('c:/jason/mplus/semclass/se1.dat',
+         c("F2.0","F2.0","F2.0","F2.0","F2.0","F2.0"))
> names(se1) = c("rnotworr","rnumqal","ramfailr","ramable","rnotprdr","rfelpos")
>
> # Note: there were no missing values in the data set, so we do not need to identify a missing data co
de
>
> model = '
+        se =~ rnotworr + rnumqal + ramfailr + ramable + rnotprdr + rfelpos
+ '
>
> # For now, I use the following analysis commands to estimate using ML, non-robust,
> #   with no missing data estimation and no meanstructure
> fit = sem(model, data = se1)
> summary(fit,fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)

lavaan 0.6-18 ended normally after 30 iterations

  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                        12

  Number of observations                           118

Model Test User Model:

  Test statistic                                19.454
  Degrees of freedom                                 9
```

```
  P-value (Chi-square)                           0.022

Model Test Baseline Model:

  Test statistic                               131.265
  Degrees of freedom                            15
  P-value                                        0.000

User Model versus Baseline Model:

  Comparative Fit Index (CFI)                    0.910
  Tucker-Lewis Index (TLI)                       0.850

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)               -757.201
  Loglikelihood unrestricted model (H1)       -747.474

  Akaike (AIC)                                1538.402
  Bayesian (BIC)                              1571.650
  Sample-size adjusted Bayesian (SABIC)       1533.715

Root Mean Square Error of Approximation:

  RMSEA                                          0.099
  90 Percent confidence interval - lower         0.036
  90 Percent confidence interval - upper         0.160
  P-value H_0: RMSEA <= 0.050                    0.086
  P-value H_0: RMSEA >= 0.080                    0.737

Standardized Root Mean Square Residual:

  SRMR                                           0.061

Parameter Estimates:

  Standard errors                             Standard
  Information                                 Expected
  Information saturated (h1) model          Structured


                   Estimate  Std.err  Z-value  P(>|z|)   Std.lv  Std.all
Latent variables:
  se =~
    rnotworr          1.000                               0.480    0.475
    rnumqal           0.637    0.159    4.012    0.000    0.306    0.539
    ramfailr          0.969    0.220    4.405    0.000    0.466    0.647
    ramable           0.265    0.202    1.309    0.190    0.127    0.136
    rnotprdr          1.262    0.279    4.521    0.000    0.606    0.872
    rfelpos           0.478    0.174    2.751    0.006    0.229    0.312

> modificationIndices(fit)
        lhs op      rhs     mi    epc sepc.lv sepc.all sepc.nox
14 rnotworr ~~  rnumqal  9.519 -0.138  -0.138   -0.324   -0.324
15 rnotworr ~~ ramfailr 11.226  0.191   0.191    0.392    0.392
16 rnotworr ~~  ramable  0.301 -0.043  -0.043   -0.052   -0.052
17 rnotworr ~~ rnotprdr  0.261 -0.035  -0.035   -0.114   -0.114
18 rnotworr ~~  rfelpos  0.035 -0.011  -0.011   -0.018   -0.018
19  rnumqal ~~ ramfailr  2.016 -0.048  -0.048   -0.182   -0.182
20  rnumqal ~~  ramable  0.229  0.021   0.021    0.046    0.046
21  rnumqal ~~ rnotprdr 12.914  0.154   0.154    0.945    0.945
22  rnumqal ~~  rfelpos  0.006  0.003   0.003    0.008    0.008
23 ramfailr ~~  ramable  1.209  0.056   0.056    0.111    0.111
24 ramfailr ~~ rnotprdr  6.644 -0.181  -0.181   -0.970   -0.970
25 ramfailr ~~  rfelpos  0.560  0.030   0.030    0.079    0.079
26  ramable ~~ rnotprdr  0.703 -0.043  -0.043   -0.137   -0.137
27  ramable ~~  rfelpos  0.003 -0.004  -0.004   -0.005   -0.005
28 rnotprdr ~~  rfelpos  0.299 -0.023  -0.023   -0.098   -0.098
```