Mplus Example with Satorra-Bentler Rescaled χ^2 and Robust Standard Errors

```
INPUT INSTRUCTIONS
    title:  CFA of three negative exchanges factors;

    data:  file=c:\jason\mplus\semclass\nonnorm1.dat;
                format=12f1.0;
                listwise=on;


    variable:  names = neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;

    usevariables=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;

    analysis:  type=general; estimator=mlm;

    model: hostile by neg6-neg35;
           badadv by neg11-neg14;
           demands by neg16-neg20;

    output: stdyx;
```

(excerpts from results)

```
CFA of three negative exchanges factors;

SUMMARY OF ANALYSIS

Number of groups                                                 1
Number of observations                                         194


Estimator                                                      MLM
Information matrix                                        EXPECTED
Maximum number of iterations                                 1000
Convergence criterion                                   0.500D-04
Maximum number of steepest descent iterations                  20


THE MODEL ESTIMATION TERMINATED NORMALLY

TESTS OF MODEL FIT

Chi-Square Test of Model Fit

          Value                             90.344*
          Degrees of Freedom                    51
          P-Value                           0.0006
          Scaling Correction Factor          1.463
            for MLM

*   The chi-square value for MLM, MLMV, MLR, ULSMV, WLSM and WLSMV cannot be used
    for chi-square difference tests.  MLM, MLR and WLSM chi-square difference
    testing is described in the Mplus Technical Appendices at www.statmodel.com.
    See chi-square difference testing in the index of the Mplus User's Guide.

Chi-Square Test of Model Fit for the Baseline Model

          Value                            870.347
          Degrees of Freedom                    66
          P-Value                           0.0000

CFI/TLI

          CFI                                0.951
          TLI                                0.937

Loglikelihood

          H0 Value                       -2102.720
          H1 Value                       -2036.636

Information Criteria
```

Number of Free Parameters	39
Akaike (AIC)	4283.440
Bayesian (BIC)	4410.886
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	4287.342

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.063

SRMR (Standardized Root Mean Square Residual)

Value	0.051

WRMR (Weighted Root Mean Square Residual)

Value	0.757

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
HOSTILE BY				
NEG6	1.000	0.000	999.000	999.000
NEG26	1.406	0.165	8.531	0.000
NEG30	1.252	0.149	8.423	0.000
NEG35	1.172	0.121	9.681	0.000
BADADV BY				
NEG11	1.000	0.000	999.000	999.000
NEG12	1.036	0.155	6.668	0.000
NEG13	1.369	0.155	8.856	0.000
NEG14	1.490	0.151	9.857	0.000
DEMANDS BY				
NEG16	1.000	0.000	999.000	999.000
NEG17	1.037	0.103	10.080	0.000
NEG19	0.966	0.177	5.446	0.000
NEG20	0.934	0.151	6.186	0.000
BADADV WITH				
HOSTILE	0.174	0.042	4.118	0.000
DEMANDS WITH				
HOSTILE	0.215	0.068	3.157	0.002
BADADV	0.200	0.045	4.464	0.000

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
HOSTILE BY				
NEG6	0.659	0.066	10.057	0.000
NEG26	0.875	0.030	29.379	0.000
NEG30	0.803	0.043	18.795	0.000
NEG35	0.720	0.059	12.229	0.000
BADADV BY				
NEG11	0.726	0.048	15.191	0.000
NEG12	0.761	0.043	17.600	0.000
NEG13	0.813	0.031	26.002	0.000
NEG14	0.831	0.038	21.952	0.000
DEMANDS BY				
NEG16	0.701	0.059	11.863	0.000
NEG17	0.812	0.043	18.951	0.000
NEG19	0.573	0.051	11.131	0.000
NEG20	0.667	0.054	12.288	0.000
BADADV WITH				
HOSTILE	0.734	0.050	14.673	0.000
DEMANDS WITH				
HOSTILE	0.831	0.056	14.880	0.000
BADADV	0.753	0.049	15.330	0.000

Same Model without Robust Statistics

```
    title:  CFA of three negative exchanges factors;

    data:  file=c:\jason\mplus\semclass\nonnorm1.dat;
                format=12f1.0;
             listwise=on;

    variable:  names = neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;

    usevariables=neg6 neg26 neg30 neg35
        neg11 neg12 neg13 neg14
        neg16 neg17 neg19 neg20;

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

    model: hostile by neg6-neg35;
           badadv by neg11-neg14;
           demands by neg16-neg20;

    output: standardized;
```

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
HOSTILE BY				
NEG6	1.000	0.000	999.000	999.000
NEG26	1.406	0.139	10.089	0.000
NEG30	1.252	0.132	9.512	0.000
NEG35	1.172	0.134	8.714	0.000
BADADV BY				
NEG11	1.000	0.000	999.000	999.000
NEG12	1.036	0.103	10.040	0.000
NEG13	1.369	0.128	10.683	0.000
NEG14	1.490	0.137	10.902	0.000
DEMANDS BY				
NEG16	1.000	0.000	999.000	999.000
NEG17	1.037	0.105	9.854	0.000
NEG19	0.966	0.134	7.231	0.000
NEG20	0.934	0.112	8.340	0.000
BADADV WITH				
HOSTILE	0.174	0.030	5.850	0.000

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
HOSTILE BY				
NEG6	0.659	0.045	14.565	0.000
NEG26	0.875	0.025	35.588	0.000
NEG30	0.803	0.031	25.724	0.000
NEG35	0.720	0.039	18.266	0.000
BADADV BY				
NEG11	0.726	0.039	18.391	0.000
NEG12	0.761	0.036	21.169	0.000
NEG13	0.813	0.031	26.245	0.000
NEG14	0.831	0.029	28.463	0.000
DEMANDS BY				
NEG16	0.701	0.044	16.085	0.000
NEG17	0.812	0.034	23.912	0.000
NEG19	0.573	0.054	10.520	0.000
NEG20	0.667	0.047	14.327	0.000
BADADV WITH				
HOSTILE	0.734	0.045	16.427	0.000
DEMANDS WITH				
HOSTILE	0.831	0.039	21.472	0.000
BADADV	0.753	0.047	16.064	0.000

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
neg6 Act angry or hostile	194	.59	.731	1.222	.175	1.821	.347
neg26 Behave insensitively toward you	194	.57	.774	1.332	.175	1.649	.347
neg30 Do thoughtless things	194	.64	.751	1.075	.175	1.248	.347
neg35 Make you feel inferior	194	.47	.783	1.969	.175	4.360	.347
neg11 Give you bad advice	194	.45	.683	1.401	.175	1.364	.347
neg12 interfere or meddle with problems	194	.44	.674	1.355	.175	.927	.347
neg13 Question your decisions	194	.85	.835	.719	.175	.122	.347
neg14 Give unwanted advice	194	.80	.889	1.021	.175	.785	.347
neg16 Not give help	194	.50	.770	1.822	.175	4.016	.347
neg17 Take advantage of you	194	.38	.690	2.111	.175	5.228	.347
neg19 Make demands or favors	194	1.00	.911	.749	.175	.250	.347
neg20 Ask for more help than you can give	194	.65	.756	.755	.175	-.602	.347
Valid N (listwise)	194						

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Amos Bootstrap Example for Nonnormal Data

nonnormal1: Thursday, February 18, 2010 11:00 AM
Sample size = 194

View→Analysis Properties, Bootstrap tab, check "Perform Bootstrap" "Bootstrap ML" and "Bollen-Stine Bootstrap" *(note: I left the default number of bootstrap samples at 200, but I often hear 500 as a recommended number)*

(From separate analysis—Bollen-Stine bootstrap cannot be obtained in the same analysis as the bias corrected standard errors).

Bollen-Stine Bootstrap (Default model)

The model fit better in 198 bootstrap samples.
It fit about equally well in 0 bootstrap samples.
It fit worse or failed to fit in 2 bootstrap samples.
Testing the null hypothesis that the model is correct, Bollen-Stine bootstrap p = .015

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	27	131.487	51	.000	2.578
Saturated model	78	.000	0		
Independence model	12	1280.401	66	.000	19.400

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.032	.903	.852	.590
Saturated model	.000	1.000		
Independence model	.259	.283	.153	.240

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.090	.072	.110	.000
Independence model	.309	.294	.324	.000

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
neg6	<---	hostile	1.000				
neg26	<---	hostile	1.406	.140	10.063	***	
neg30	<---	hostile	1.252	.132	9.488	***	
neg35	<---	hostile	1.172	.135	8.691	***	
neg11	<---	badadv	1.000				
neg12	<---	badadv	1.036	.103	10.014	***	

	Estimate	S.E.	C.R.	P	Label
neg13 <--- badadv	1.369	.128	10.656	***	
neg14 <--- badadv	1.490	.137	10.873	***	
neg16 <--- demands	1.000				
neg17 <--- demands	1.037	.105	9.829	***	
neg19 <--- demands	.966	.134	7.212	***	
neg20 <--- demands	.934	.112	8.319	***	

View→Analysis Properties, Bootstrap tab, check "Perform Bootstrap", "Bias-corrected confidence intervals"
(note: I left the default number of bootstrap samples at 200, but I often hear 500 as a recommended number)

(Boostrap standard errors from separate analysis)

Bootstrap standard errors (Group number 1 - Default model)

Regression Weights: (Group number 1 - Default model)

Parameter	SE	SE-SE	Mean	Bias	SE-Bias
neg6 <--- hostile	.000	.000	1.000	.000	.000
neg26 <--- hostile	.207	.010	1.424	.017	.015
neg30 <--- hostile	.200	.010	1.254	.001	.014
neg35 <--- hostile	.144	.007	1.192	.020	.010
neg11 <--- badadv	.000	.000	1.000	.000	.000
neg12 <--- badadv	.186	.009	1.062	.026	.013
neg13 <--- badadv	.178	.009	1.371	.002	.013
neg14 <--- badadv	.171	.009	1.498	.008	.012
neg16 <--- demands	.000	.000	1.000	.000	.000
neg17 <--- demands	.133	.007	1.051	.014	.009
neg19 <--- demands	.256	.013	1.005	.039	.018
neg20 <--- demands	.211	.011	.975	.041	.015

SE - is the standard error estimate. This estimate is the empirical standard deviation from the bootstrap samples (standard deviation of the bootstrap sampling distribution for the parameter e.g., loading or path coefficient).

SE-SE - is the standard error estimate of the standard error. I was unable to find any documentation on how this is computed, but it may be derived from the empirical standard deviation estimate of standard error estimates for each bootstrap sample. I'm not sure I see much practical use of this measure.

Mean - is the average parameter estimate (e.g., unstandardized loading, path coefficient). This will often be similar to the ML estimate, but it is likeliy to differ somwhat (as it does in our case).

Bias - is the estimated bias of the coefficient as estimated by the bootstrap method. In other words, how much is the mean bootstrap estimate over or under the ML value. Within rounding, this value should be the difference between the ML estimate and the value in the "mean" column.

SE - bias is the standard error estimate of the bias. i.e., how stable is the bias estimate likely to be. This value is not likely to be much use to the average researcher.

Bias-corrected percentile method (Group number 1 - Default model)
90% confidence intervals (bias-corrected percentile method)

Regression Weights: (Group number 1 - Default model)

Parameter	Estimate	Lower	Upper	P
neg6 <--- hostile	1.000	1.000	1.000	...
neg26 <--- hostile	1.406	1.213	1.988	.003
neg30 <--- hostile	1.252	1.052	1.824	.003
neg35 <--- hostile	1.172	1.021	1.482	.008
neg11 <--- badadv	1.000	1.000	1.000	...
neg12 <--- badadv	1.036	.734	1.348	.015
neg13 <--- badadv	1.369	1.124	1.695	.007
neg14 <--- badadv	1.490	1.207	1.738	.015
neg16 <--- demands	1.000	1.000	1.000	...
neg17 <--- demands	1.037	.851	1.298	.008
neg19 <--- demands	.966	.697	1.531	.008
neg20 <--- demands	.934	.637	1.285	.025

In the confidence interval box, the estimate column refers to the orginal ML estimate (this is the generally prefered value, given simulations suggest that the coefficient estimates themselves are not impacted by nonormality). The Lower and Upper columns give the confidence limits (the Amos menus allow you to request various percentage, e.g., 90%). I was unable to find any documentation on how exactly Amos constructs their confidence limits, but you will notice that they are asymmetric. It is not uncommon in bootstrap estimation to use asymetric. The P column is the p-value for the estimate using the bootstrap standard error.