

Illustration of Scaled Chi-square Difference Computation

To illustrate the scaled chi-square difference test, a weighted test for robust estimates when data are continuous non-normal (MLM or MLR in Mplus and lavaan), I used the values from handout "Examples of Estimates with non-normal data" from the lavaan output as the baseline model and the model below as the nested model and the Excel sheet created by Bryant and Satorra (2013). Note that my constraint of two factor correlations to be equal is not particularly theoretically driven and might not occur often in practice. Results here indicate that the difference is not significant, scaled $\Delta\chi^2(1) = .930$, $p = .335$.

```
> #retest model with two factor covariances constrained
> model2 = '
+   hostile =~ neg6 + neg26 + neg30 + neg35
+   badadv =~ neg11 + neg12 + neg13 + neg14
+   demands =~ neg16 + neg17 + neg19 + neg20
+
+   hostile ~~ psyl*badadv
+   hostile ~~ demands
+   badadv ~~ psyl*demands
+ '
> fit2 = sem(model2, data = nonnorm1, estimator="mlm")
> summary(fit2, fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
```

Number of observations	194	
Estimator	ML	Robust
Minimum Function Test Statistic	133.059	82.061
Degrees of freedom	52	52
P-value (Chi-square)	0.000	0.005
Scaling correction factor		1.621
for the Satorra-Bentler correction		
Model test baseline model:		
Minimum Function Test Statistic	1287.035	586.734
Degrees of freedom	66	66
P-value	0.000	0.000

The Mplus specification for constraining the two factor covariances to be equal is below.

```
hostile with badadv (1);
hostile with demands;
badadv with demands (1);
```

Satorra-Bentler (2001) Scaled Difference Chi-Square Test for LISREL 9, EQS, or Mplus			Baseline (less restrictive) model = more estimated parameters (SMALLER df)		
(see first sheet for scaled difference test for LISREL 8)			Nested (more restrictive) comparison model = fewer estimated parameters (LARGER df)		
Example data below are from the "Examples of Estimates with Non-normal Data" handout and "Illustration of scaled chi-square difference computation" handout (Newsom)					
	Baseline Model	Nested Model			
Min Fit ML chi-square (T1)	132.168	133.059			
ML scaled chi-square value (T3)	80.888	82.061			
df	51	52			
c: scale correction factor (T1/T3)	1.634	1.621			
c*df	83.334	84.292			
c*df difference			0.958		
m (difference in dfs)			1		
scaling factor for difference test (c-d)			0.958		
Min fit ML difference			0.891		
Scaled chi-square difference			0.9301		
df for scaled chi-square difference test			1		
		p value	0.334836941		
Bryant, F. B., & Satorra, A. (2012). Principles and practice of scaled difference chi-square testing. <i>Structural Equation Modeling</i> , 19(3), 372-398.					
Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. <i>Psychometrika</i> , 66, 507-514.					
INSTRUCTIONS:					
1. Enter T1 (row 5), T3 (row 6), & df (row 7) for both Baseline and Nested Comparison models in table above.					
2. Report final result of scaled chi-square difference test in terms of scaled difference chi-square value (row 14), df (row 15), & p value (row 16) for scaled difference test.					
Citation for the use of this macro file: Bryant, F. B., & Satorra, A. (2013). EXCEL macro file for conducting scaled difference chi-square tests via LISREL 8, LISREL 9, EQS, and Mplus. Available from the authors.					