KUANT Guides

The Satorra-Bentler χ^2:

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Geldhof, G.J., Selig, J.P. & McConnell, E.K. (2008)

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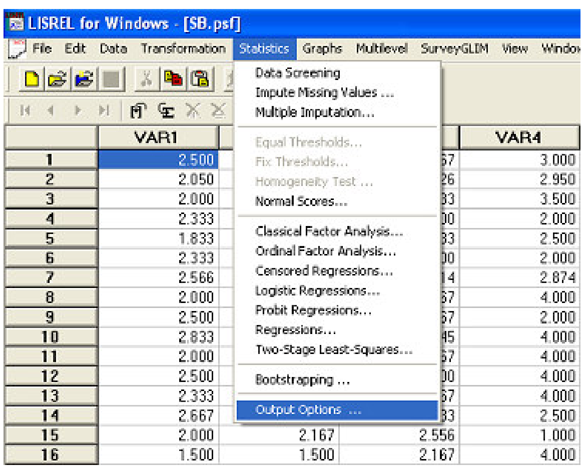
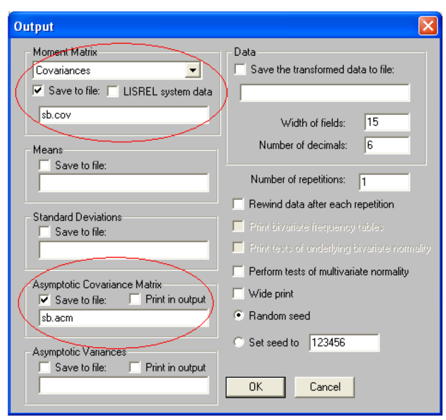
Estimation using maximum likelihood assumes that the data are multivariate-normally distributed. When this is not the case, researchers using LISREL have several options, two of which are discussed in these manuals: bootstrapping and the Satorra-Bentler χ^2. The Satorra-Bentler χ^2 (also called Robust Maximum Likelihood or Maximum Likelihood – Mean Adjusted) adjusts the χ^2 and standard error estimates by a scaling factor based on the data's non-normality, and can be applied using LISREL. The user is only required to provide a standard covariance matrix as well as an asymptotic covariance matrix (ACM). Bootstrapping is the topic of the next KUant guide.

A covariance matrix and the ACM can be simultaneously generated in PRELIS using the following steps:

1. Open your data in PRELIS
2. Click on Statistics > Output Options



3. In the Output window, choose "Covariances" in the "Moment Matrix" section.
4. Check the "Save to file" boxes in both the moment matrix and ACM sections, and provide a file name for each.
5. Hit OK.



After generation, these matrices can then be fed into LISREL by replacing the raw data (RA) statement with:

```
CM = SB.COV
AC = SB.ACM
```

This simple syntax change will adjust all parameter standard errors and add an additional fit index, the Satorra-Bentler Scaled Chi-Square.

```
                        Goodness of Fit Statistics

                          Degrees of Freedom = 24
              Minimum Fit Function Chi-Square = 28.642 (P = 0.234)
    Normal Theory Weighted Least Squares Chi-Square = 28.912 (P = 0.223)
           Satorra-Bentler Scaled Chi-Square = 25.898 (P = 0.358)
         Chi-Square Corrected for Non-Normality = 25.459 (P = 0.381)
            Estimated Non-centrality Parameter (NCP) = 1.898
          90 Percent Confidence Interval for NCP = (0.0 ; 18.450)
```

Examining the Difference Between two SBχ^2 Values:

Unlike chi-square values calculated using Maximum Likelihood, the difference between two SBχ^2 values is not distributed as chi square. You must instead calculate the T_s statistic (Satorra & Bentler, 1994; Brown, 2006). T_s is simply the difference between the two Maximum Likelihood chi-square values, divided by a 'difference test scaling correction' (c_d):

$$T_s = (\chi_0^2 - \chi_1^2) / c_d$$

c_d is a function of each model's degrees of freedom (df) and scaling correction (c):

$$c_d = [(df_0 * c_0) - (df_1 * c_1)] / (df_0 - df_1)$$

where

$$c_0 = \chi_0^2 / SB\chi_0^2 \qquad c_1 = \chi_1^2 / SB\chi_1^2$$

The statistic T_s is distributed as chi-square on ($df_0 - df_1$) degrees of freedom and can be treated like the difference between to ML χ^2 values.