KUANT Guides

Guide No.
KUANT 003.2

Interpreting LISREL Output:

LISREL output can be broken down into eleven major sections. This handout discusses each of those.

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

1: Introduction

Every LISREL output file begins with the basic LISREL introduction, which consists of a header and the syntax that was run. This is useful when troubleshooting as you can examine your exact syntax without switching windows.

2: Model Specifications

The model specifications follow the LISREL introduction and provide a synopsis of the DA and MO lines. It is important to check this synopsis to ensure that the model you are fitting matches the model that you intended to fit. For example…

This section of code…

```
DA NG=1 NI=19 MA=CM ME=ML NO=380
RA=boot5.dat
LA
Agency1 Agency2 Agency3 Intrin1 Intrin2 Intrin3 Extrin1 Extrin2 Extrin3
PosAFF1 PosAFF2 PosAFF3 NegAFF1 NegAFF2 NegAFF3 Gender Ethnic2 Ethnic3 Ethnic4
!variable names should not exceed 7 characters

SE
4 5 6 1 2 3 10 11 12/

MO NY=9 NE=3 LY=FU,FI PS=SY,FI TE=DI,FI BE=FU,FI AP=1
```

…produces this set of model specifications:

```
Number of Input Variables          19
Number of Y-Variables               9
Number of X - Variables             0
Number of ETA - Variables           3
Number of KSI - Variables           0
Number of Observations            380
```

There are 19 input variables (NI = 19), 9 of which are selected by the SE statement and used as Y variables (NY = 9). These indicators load onto three eta variables (Y-side latent constructs), as is indicated by the code NE=3. Further, the code specifies 380 observations (NO=380), which is mirrored in the synopsis.

3: Covariance Matrix

Regardless of how your data were inputted into LISREL, the program computes a covariance matrix to analyze. This covariance matrix is printed in the LISREL output for your inspection.

S*tandardizing:* Covariances are difficult to interpret in their own metric. When it is necessary to examine a covariance matrix, it is generally advised to ask LISREL to standardize it for you. By specifying MA=KM instead of MA=CM in the data line, LISREL will present (and use) a correlation matrix in place of the covariance matrix. Note that this section will still be labeled “Covariance Matrix,” even when standardized.

Note: While standardizing this matrix is beneficial for troubleshooting, it introduces a small degree of rounding error into your results. All final models should make use of the covariance matrix.

4: Parameter Specifications

This next section of LISREL output provides a bird's eye view of the model that you have specified. Always check to make sure the parameter specifications used by LISREL are the ones that you have intended. The parameters are numbered sequentially, and are presented by matrix (i.e., all of LY together, all of PS together, etc.).

The following Lambda-Y specifications show that the three intrinsic indicators correctly load on the "Intrinsic" latent variable (parameters 1-3), the three agency indicators load on the "Agency" latent variable (parameters 4-6), etc.

Parameter Specifications

LAMBDA-Y

	Intrinsi	Agency	Positive
Intrin1	1	0	0
Intrin2	2	0	0
Intrin3	3	0	0
Agency1	0	4	0
Agency2	0	5	0
Agency3	0	6	0
PosAFF1	0	0	7
PosAFF2	0	0	8
PosAFF3	0	0	9

5: LISREL (Parameter) Estimates

After displaying your model's specifications, LISREL provides the actual parameter estimates that it has obtained. These estimates are presented by matrix in the same order that they were numbered in the parameter specifications.

LISREL Estimates (Maximum Likelihood)

LAMBDA-Y

	Intrinsi	Agency	Positive
Intrin1	0.580 (0.039) 15.044	- -	- -
Intrin2	0.638 (0.044) 14.656	- -	- -
Intrin3	0.591 (0.041) 14.521	- -	- -

For instance, the estimates for the first three parameters specified above (*Intrinsic*) in Section 4 would appear first in the LISREL output

As can be seen above, each estimate is presented by three values. The first (top) value is the actual parameter estimate assigned by LISREL. The parameter estimate is followed by its standard error. Because SEM assumes that your data are distributed normally, LISREL provides a Wald statistic (an estimate divided by its standard error) to represent the significance of each parameter. The Wald statistic is assumed to be distributed normally with a mean of zero and standard deviation of one, and can be thought of as a z-score. In the above example, the estimated loading for the "Intrin1" indicator is .58, which has a standard error of .039. This loading is considered significant because its associated Wald statistic is greater than the 1.96 cutoff for α = .05.

6: Squared Multiple Correlations

The squared multiple correlations for y-variables operate similarly to the coefficient of determination (R^2). They represent the amount of variance in each indicator that is accounted for by its latent construct(s). In the below example, we see that 57% of the Intrin1 indicator's variance is explained by the "Intrinsic" latent variable.

```
         Squared Multiple Correlations for Y - Variables

             Intrin1     Intrin2     Intrin3     Agency1     Agency2     Agency3
            --------    --------    --------    --------    --------    --------
               0.570       0.544       0.535       0.767       0.880       0.804
```

7: Goodness of Fit Statistics

After presenting the individual parameter estimates, LISREL next provides users with the model's overall fit statistics. This section of output is where users can find the model's degrees of freedom, χ^2, CFI, NNFI, AIC, etc. It is important for users to be aware that LISREL provides two different χ^2 computations and that the "Minimum Fit Function Chi-Square" should be used.

```
                        Goodness of Fit Statistics

                         Degrees of Freedom = 24
          Minimum Fit Function Chi-Square = 40.588 (P = 0.0185)
  Normal Theory Weighted Least Squares Chi-Square = 40.522 (P = 0.0188)
           Estimated Non-centrality Parameter (NCP) = 16.522
       90 Percent Confidence Interval for NCP = (2.764 ; 38.144)
```

8: Fitted Covariance Matrix

The above-described goodness of fit statistics compare the model-implied (fitted) covariance matrix with the actual covariance matrix produced by your data. The fitted covariance matrix is created by applying tracing rules to the "Parameter Estimates." For instance, the variance of any indicator can be represented by:

$$\lambda_{ij} * \psi_j * \lambda_{ij} + \theta_i$$

9: Fitted Residuals

The fitted residuals show to what degree the fitted covariance matrix differs from the inputted covariance matrix. They are simply calculated by:

$$\Sigma_{observed} - \Sigma_{fitted}$$

(where Σ represents a covariance matrix)

Fitted Residuals will only be presented when the RS option is added to the OU line of your model. Also note that when this option is used in conjunction with the SC command, separate matrices will be calculated for fitted and standardized residuals. Standardized residuals will be accompanied by a Q-Q plot that allows you to verify that your residuals are distributed normally.

Fitted Residuals (cont.)

Extreme values in your fitted residuals indicate areas of severe misfit. To assist you in finding such values, LISREL provides a summary of the largest and smallest residuals as well as a stem and leaf plot of all residuals. This plot helps determine a residual's extremeness relative to your model.

```
Summary Statistics for Fitted Residuals

Smallest Fitted Residual =   -0.052
  Median Fitted Residual =    0.000
 Largest Fitted Residual =    0.035
```

```
Stemleaf Plot

- 5|2
- 4|
- 3|81
- 2|2
- 1|854110
- 0|97411000000000000
  0|111123347
  1|1237
  2|16
  3|25
```

10: Modification Indices

When the MI option is used on the OU line, modification indices will be computed for each parameter <u>not</u> estimated in your model. A modification index represents the approximate drop in χ^2 expected to result from estimating its respective parameter. Standardized modification indices will also be computed when MI is used in conjunction with SC.

In this example, the model's χ^2 should drop by about 8.42 if the indicator "Intrin1" is allowed to freely load on both the "Intrinsic" and "Agency" latent variables instead of just loading on the "Intrinsic" variable. →

Modification Indices and Expected Change

Modification Indices for LAMBDA-Y

	Intrinsi	Agency	Positive
Intrin1	- -	8.420	0.117
Intrin2	- -	0.001	0.968
Intrin3	- -	8.773	1.802
Agency1	3.009	- -	5.175
Agency2	1.204	- -	5.827
Agency3	0.159	- -	0.321
PosAFF1	3.561	0.782	- -
PosAFF2	1.044	0.308	- -
PosAFF3	0.427	0.052	- -

Caveats: There are two caveats to keep in mind when examining modification indices. First, it is inappropriate to change a model solely on the basis of a large modification index. Model changes should be firmly couched in theory, so if freeing a parameter doesn't make sense, don't do it. Second, always remember that modification indices are not independent. Each index represents the expected change in χ^2 expected given no other changes to the model. Accordingly, parameters should be freed one at a time, with the modification indices re-examined after every change.

11: Standardized and Completely Standardized Solutions

When the SC option is added to the OU line, LISREL will also provide standardized and completely standardized versions of the parameter estimates. In the instance of standardized estimates, only the latent relationships have been standardized (interpretable as correlations or standardized regression coefficients). In the completely standardized estimates, all estimates are presented in a standardized metric.

Standardized and Completely Standardized Solutions (cont.)

In this example, the completely standardized loading between Intrin1 and its latent variable is .755, which corresponds to the squared multiple correlation (r^2) for that indicator ($.755^2 = .57$).

Completely Standardized Solution

LAMBDA-Y

	Intrinsi	Agency	Positive
Intrin1	0.755	- -	- -
Intrin2	0.737	- -	- -
Intrin3	0.731	- -	- -
Agency1	- -	0.876	- -
Agency2	- -	0.938	- -
Agency3	- -	0.897	- -
PosAFF1	- -	- -	0.844
PosAFF2	- -	- -	0.884
PosAFF3	- -	- -	0.907