



Structural Equation Modeling

Mgmt 290
Lecture 7
Explanation of LISREL Results
& Evaluation of Models
Nov. 7, 2005



More on LISREL ML Estimation

Normal Distributions
Assumptions Used

To minimize
 $\text{Log}|\Sigma(\Theta)| + \text{tr}(S \Sigma^{-1}(\Theta)) - \log|S| - (p+q)$

F_{ml}

tr --- sum of diagonal elements
 $\Sigma(\Theta)$ -- model implied matrix
S -- observed matrix

endogenous

exogenous

$F_{ml} = 0$ if $\Sigma = S$



Iterative

Partial derivatives
Algebraic solution

- Starting values
 - - prior research, OLS results, LISREL automatic (by IV & 2SLS)
- Methods to proceed
 - partial derivative of F_{ml} of Θ $\Theta^1, \Theta^2, \Theta^3 \dots, \Theta^l$
- Final conversion

More on to Specify Outputs (1)

RC The ridge constant. This constant will be multiplied repeatedly by 10 until the matrix becomes positive-definite. Default: RC=0.001

■ OU ME
= IV/TS/UL/GL/ML/WL/DW RC=C

NS

NS If this option appears, the program will not compute starting values. The user must supply starting values with ST or NL commands.

IV Instrumental variables TS Two-stage least squares
UL Unweighted least squares GL Generalized least squares
ML Maximum likelihood GL Generally weighted least squares
DW Diagonally weighted least squares

More on to Specify Outputs (2)

■ OU St Dev T Values Residuals Total Indirect Modification Indices

■ SE TV RS EF MI ALL

■ Get more outputs

■ OU matrix₁ = matrix₂ = ...

■ save matrix LY, LX, BE, GA, PH, PS, TE, TD

■ OU TM=t IT=n

TM The maximum number of CPU seconds for the current problem. Default: PC version, TM=172800 (2 days);
IT Maximum number of iterations for the current problem. Default: IT=ten times the number of free parameters

Explanation of LISREL Results (1) Outputs for Path Analysis

- Path coefficients
- Hypothesis testing results



Equation Coefficients

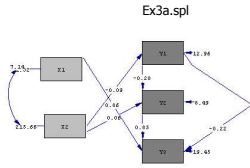
LISREL Estimates (Maximum Likelihood)

Structural Equations

Y1 = - 0.087*X2, Errorvar.= 12.96,
 (0.019) (1.41)
 -4.65 9.22

Y2 = - 0.28*Y1 + 0.058*X2, Errorva
 (0.062) (0.016) (0.92)
 -4.58 3.59 9.22

Y3 = - 0.22*Y1 + 0.85*Y2 + 0.86*X1, Errorvar.= 19.45, R² = 0.39
 (0.098) (0.11) (0.34) (2.11)
 -2.23 7.53 2.52 9.22



Sample size < 120
 Use T table
 Otherwise, use Z table



Total & Indirect Effects

Total Effects of Y on Y

Use OU EF
 See Ex3aef.ls8

	Y1	Y2	Y3
Y1	--	--	--
Y2	-0.28 (0.06) -4.58	--	--
Y3	-0.46 (0.10) -4.41	0.85 (0.11) 7.53	--

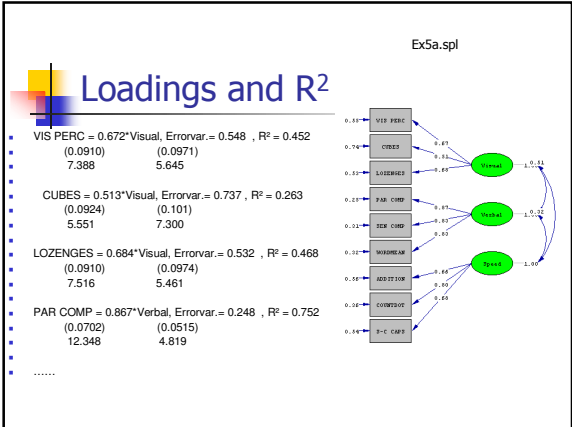
OR

LISREL OUTPUT: EF
 In SIMPLIS



Explanation of LISREL Results (2) Output for CFA

- Loadings
- Error variances
- R²



Explanation of LISREL Results (3) Hybrid Model Outputs

- A combination of
- Path coefficients
- Loadings

Path Coefficients & Loadings

LISREL Estimates (Maximum Likelihood)

- Measurement Equations
- ANOMIA67 = 2.66*Alien67, Errorvar.= 4.74 , R² = 0.60
- (0.45) (0.45)
- 10.43
- ...
- Error Covariance for ANOMIA71 and ANOMIA67 = 1.62
- (0.31) (0.31)
- 5.17 5.17
- ...
- Structural Equations
- Alien67 = - 0.56*Sex, Errorvar.= 0.68 , R² = 0.32
- (0.047) (0.066)
- -12.09 10.35
- Alien71 = 0.57*Alien67 - 0.21*Sex, Errorvar.= 0.50 , R² = 0.50
- (0.048) (0.046) (0.050)
- 11.89 -4.52 10.10



Fit Indices

- RMR $RMR = [2 \sum \sum (s_{ij} - \delta_{ij})^2 / q(q+1)]^{1/2}$
- Root Mean squared Residual
Close to 0
- SRMR – Standardized Root Mean Squared Residual
- RMSEA – Root Mean Square Error of Approximation



Parsimonious Fit

- AIC ← Chi-square adjusted for df - 2df
- CAIC
- PNFI = $df_{model} / df_{indep} \times NFI$
- PGFI = $1 - (P/N)GFI$



Relative Fit

- NFI, NNFI – compare to indep model
- Compare nested model
- use Chi-square difference

Common Practice in Reporting - 3 must-report items

- Chi-square, DF, Significance
- GFI or NFI or CFI
- NNFI or AGFI
- SRMR

What is considered as a good fit

- Chi-square/df <3
- GFI >.95
- SRMR <.08

- And check residuals

Modification Indexes

- Each such modification index measures how much chi-square is expected to decrease if this particular parameter is set free and the model is re-estimated.

- (Comparative fit for ONE parameter)

3 Foundation for Model Re-specification

- Theory-based revisions
- Modification Indices
- Residual Matrix

Example SIMPLIS

- Bollen80.spl

The Modification Indices Suggest to Add the

Path to	from	Decrease in Chi-Square	New Estimate
x1	dem	13.7	-5.83
x4	dem	26.3	7.93
x5	lib	119.9	41.83
x8	lib	9.4	-5.88

- Bollen80n.spl

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
x2	x1	19.8	1.42
x4	x3	11.1	-0.63
x5	x3	18.0	0.51
x6	x3	13.4	-0.82
x6	x4	11.2	1.28
x6	x5	9.7	-0.74
x7	x3	8.1	-0.85
x7	x6	42.5	4.41
x8	x4	14.8	1.11
x8	x6	78.9	3.27
x8	x7	16.2	2.01


Example for LISREL

- Bollen80.ls8

Expected Change for LAMBDA-X

	pollib	demo
x1	--	-5.83
x2	--	-4.20
x3	--	1.27
x4	--	7.93
x5	41.83	--
x6	-5.24	--
x7	-4.61	--
x8	-5.88	--


- Use MI in OU

 **Two Roads to Parsimonious Model**
(1) Model Trimming

- Delete links to achieve a parsimonious model

To get a parsimonious model

- Start from the most complicated model

 **(2) Model Building**

- Add links to build a better model

To get a model of good fit

- You may start from the simplest model
- and move up
