CFA Application using LISREL

Outline

The software

• There is a number of software packages (e.g. AMOS, EQS, LAVAN, LISREL, MPLUS)

• We use LISREL.

• … it is software that fits especially well with the path diagrams

• … it is basic and, therefore, supports the understanding of how this method works

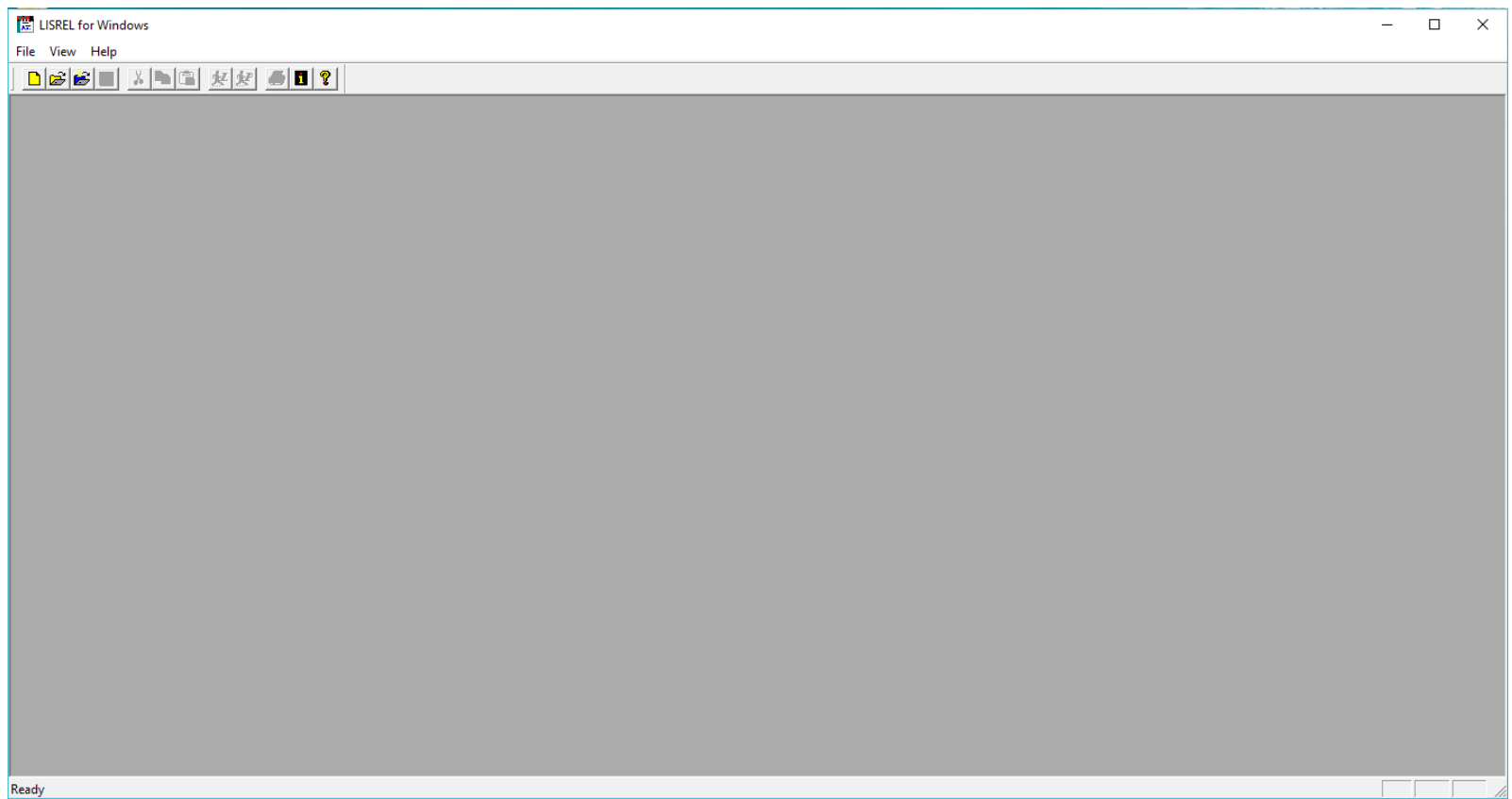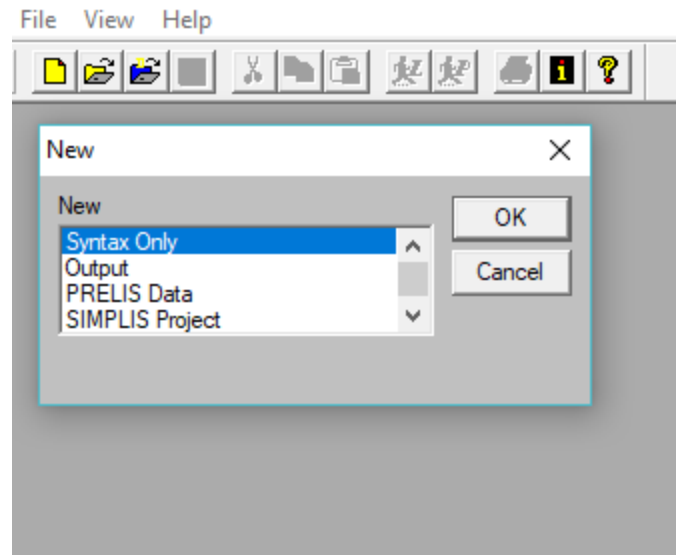• … it should be easy to switch to another software afterwards

Outline

The input

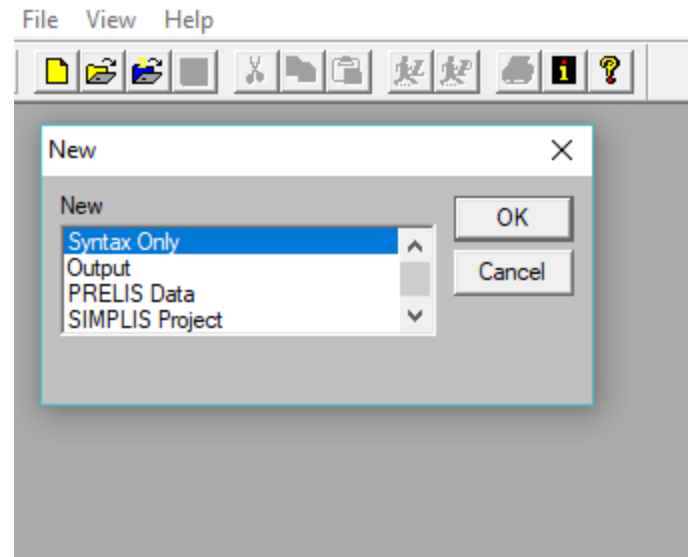• Starting LISREL by clicking the icon on the desk top leads to ...

The input

- Starting LISREL by clicking the icon leads to ...

- Next: click on „File" - a new window opens

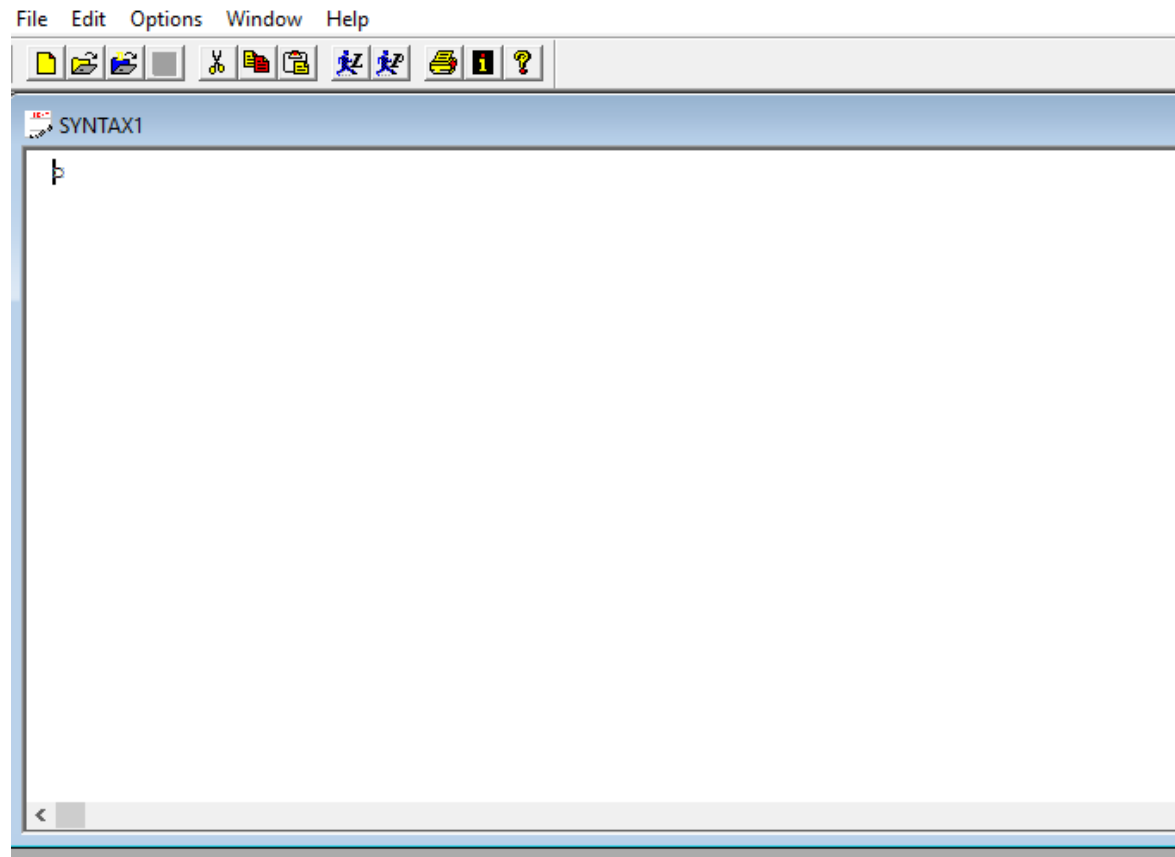- Next: click on „New" – another window opens.

The input

• Next: click on „OK" – to start a new statistical investigation.

The input

• A window opens that is to be used for providing the input for the statistical investigation.

File   Edit   Options   Window   Help

SYNTAX1

Outline

1. The software

2. The input
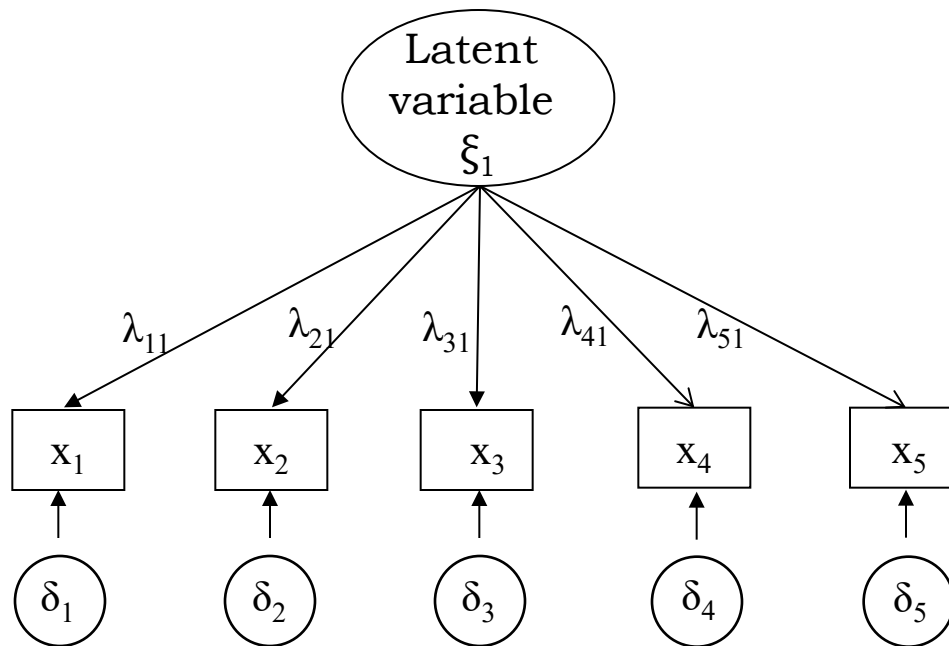
3. The first program

4. The first output

The first program

In the following a first program for investigating a model of measurement (a typical confirmatory factor model) is provided.

The to-be-investigated model

The first program: *the input*

```
FIRST SEM MODEL
DA NI=5 NO=500 MA=CM

! A model of measurement including 5 indicators and 1 latent variable

LA
I1 I2 I3 I4 I5

CM

0.148
0.033  0.178
0.024  0.033  0.153
0.034  0.028  0.033  0.117
0.023  0.023  0.027  0.037  0.106
```

First row: title

Second row: data description

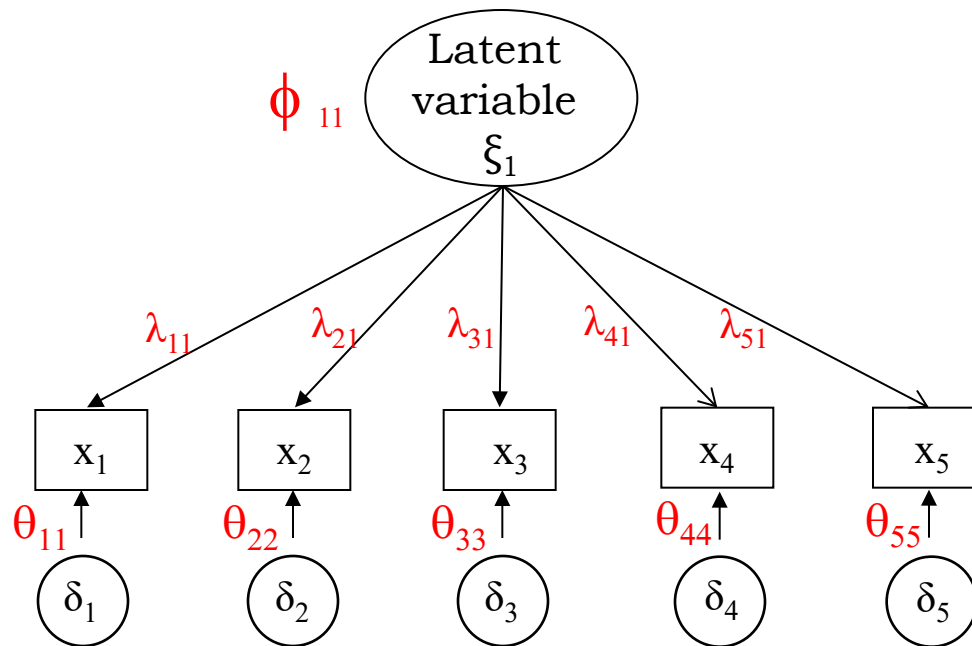   NI – number of input variables

    NO – number of observations

    MA – type of input data

LA row: labels for input variables

CM: the covariances to be analyzed

The to-be-investigated model

LISREL
Notation

VA 1 PH 1 1
FR LX 1 1
FR LX 2 1
....

FR TD 1 1
FR TD 2 2

Confirmatory factor analysis

The first program: the model

```
FIRST SEM MODEL
DA NI=5 NO=500 MA=CM

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CM

 0.148
 0.033  0.178
 0.024  0.033  0.153
 0.034  0.028  0.033  0.117
 0.023  0.023  0.027  0.037  0.106

MO NX=5 NK=1 TD=FU,FI PH=FU,FI

LK
LatVariable

FR LX 1 1
FR LX 2 1
FR LX 3 1
FR LX 4 1
FR LX 5 1

VA 1 PH 1 1

FR TD 1 1
FR TD 2 2
FR TD 3 3
FR TD 4 4
FR TD 5 5
```

First row: name of program
Second row: data description
    NI – number of input variables
    NO – number of observations
    MA – type of input data
LA row: labels for input variables
CM: the covariances to be analyzed

MO row: characteristics of the model

LK row: labels of latent variables

-specification of factor loadings

- specification of variance of latent variables

- specification of thetas

The first program: the output

```
FIRST SEM MODEL
DA NI=5 NO=500 MA=CM

! A model of measurement including 5 indicators and 1 latent variable

LA
I1 I2 I3 I4 I5

CM

 0.148
 0.033  0.178
 0.024  0.033  0.153
 0.034  0.028  0.033  0.117
 0.023  0.023  0.027  0.037  0.106

MO NX=5 NK=1 TD=FU,FI PH=FU,FI

LK
LatVariable

FR LX 1 1
FR LX 2 1
FR LX 3 1
FR LX 4 1
FR LX 5 1

VA 1 PH 1 1

FR TD 1 1
FR TD 2 2
FR TD 3 3
FR TD 4 4
FR TD 5 5

PD

OU ML SC IT=1000 ND=3
```

First row: name of program
Second row: data description
- NI – number of input variables
- NO – number of observations
- MA – type of input data

LA row: labels for input variables
CM: the covariances to be analyzed

MO row: characteristics of the model

LK row: labels of latent variables

-specification of factor loadings

- specification of variance of latent variables

- specification of thetas

- request of path diagram

OU row: characteristics of output

15

The first program

Start the program by clicking the "**L**".
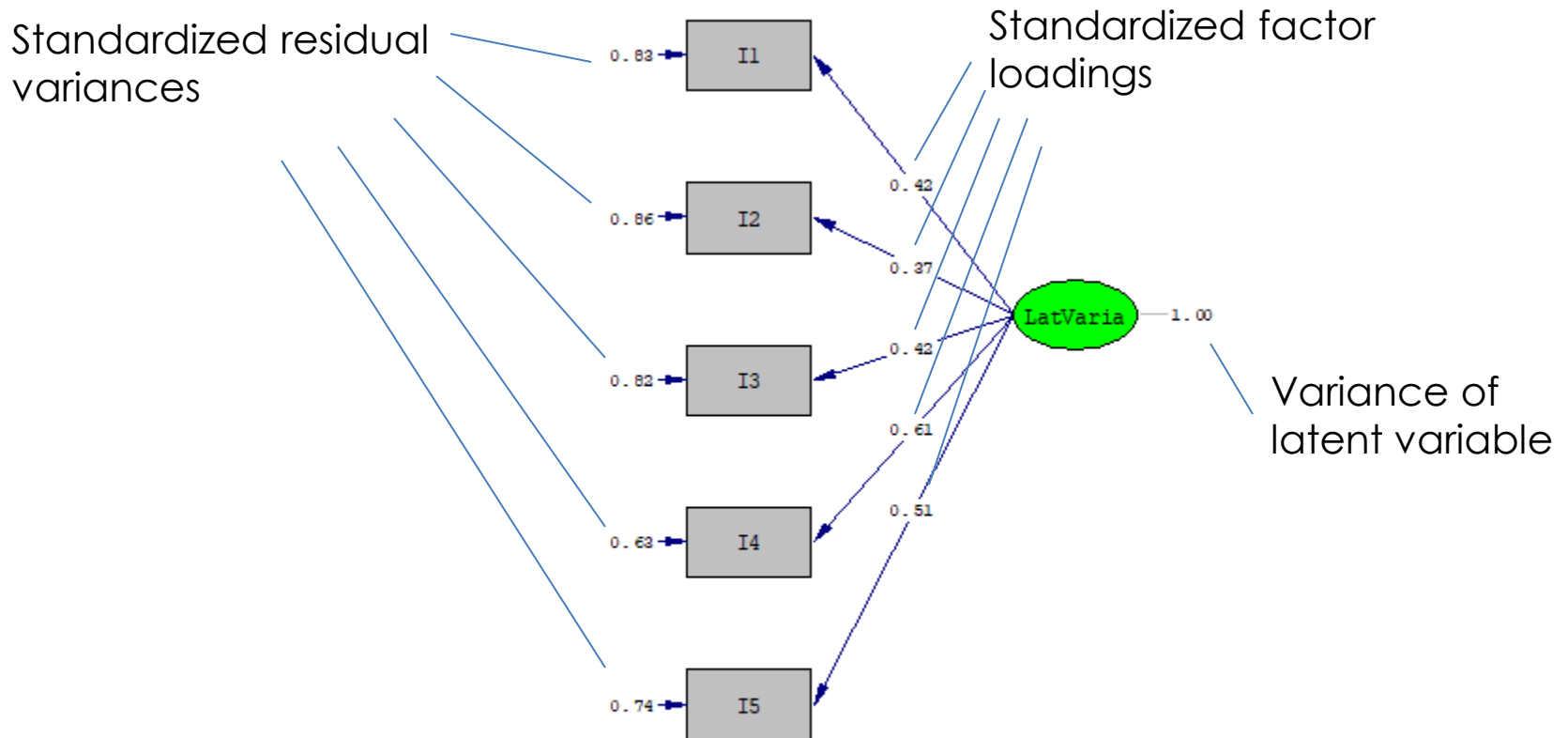
Outline

1. The software

2. The input

3. The first program

4. The first output

The first output

PATH DIAGRAM AS OUTPUT

Standardized residual variances

Standardized factor loadings

Variance of latent variable

0.83 → I1	
0.86 → I2	0.42
0.82 → I3	0.37
0.63 → I4	0.42
0.74 → I5	0.61
	0.51

LatVaria — 1.00

Chi-Square=5.79, df=5, P-value=0.32759, RMSEA=0.018

Important fit information (rest is given in the output)

The first output

The following lines were read from file C:\Users\dell\Documents\Schweizer\Lisrel_Lat

FIRST SEM MODEL
DA NI=5 NO=500 MA=CM

! A model of measurement including 5 indicators and 1 latent variable

LA
I1 I2 I3 I4 I5

CM

0.148
0.033 0.178
0.024 0.033 0.153
0.034 0.028 0.033 0.117

The output starts with repeating the input information.

The first output

FIRST SEM MODEL

Number of Iterations = 5

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

    LatVaria

I1   0.160
   (0.022)
    7.281
I2   0.157
   (0.024)
    6.536
I3   0.165
   (0.022)
    7.386
I4   0.208
   (0.020)
   10.160
I5   0.165
   (0.019)
    8.760

Factor loadings

Standard errors

t statistics

PHI

    LatVaria

    1.000

THETA-DELTA

I1	I2	I3	I4	I5
0.122	0.153	0.126	0.074	0.079
(0.009)	(0.011)	(0.009)	(0.008)	(0.007)
13.547	14.071	13.463	9.410	11.988

There is information on parameter estimation.

The first output

Goodness of Fit Statistics

Degrees of Freedom = 5
Minimum Fit Function Chi-Square = 5.768 (P = 0.329)
Normal Theory Weighted Least Squares Chi-Square = 5.786 (P = 0.328)
Estimated Non-centrality Parameter (NCP) = 0.786
90 Percent Confidence Interval for NCP = (0.0 ; 11.094)

Minimum Fit Function Value = 0.0116
Population Discrepancy Function Value (F0) = 0.00158
90 Percent Confidence Interval for F0 = (0.0 ; 0.0222)
Root Mean Square Error of Approximation (RMSEA) = 0.0178
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.0667)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.823

Expected Cross-Validation Index (ECVI) = 0.0517
90 Percent Confidence Interval for ECVI = (0.0501 ; 0.0723)
ECVI for Saturated Model = 0.0601
ECVI for Independence Model = 0.509

Chi-Square for Independence Model with 10 Degrees of Freedom = 244.057
Independence AIC = 254.057
Model AIC = 25.786
Saturated AIC = 30.000
Independence CAIC = 280.130
Model CAIC = 77.932
Saturated CAIC = 108.219

Normed Fit Index (NFI) = 0.976
Non-Normed Fit Index (NNFI) = 0.993
Parsimony Normed Fit Index (PNFI) = 0.488
Comparative Fit Index (CFI) = 0.997
Incremental Fit Index (IFI) = 0.997
Relative Fit Index (RFI) = 0.953

Critical N (CN) = 1306.293

Root Mean Square Residual (RMR) = 0.00335
Standardized RMR = 0.0222
Goodness of Fit Index (GFI) = 0.995
Adjusted Goodness of Fit Index (AGFI) = 0.986
Parsimony Goodness of Fit Index (PGFI) = 0.332

There is information on model fit.

The fit statistics indicate that there is good model fit.

The end