An introduction to LISREL 8.80 for Windows

1. Introduction

LISREL 8.80 for Windows (Jöreskog & Sörbom 2006) is a Windows software product for structural equation modeling, multilevel structural equation modeling, generalized linear modeling, multilevel linear modeling, multilevel generalized linear modeling, multilevel nonlinear modeling, and formal inference-based recursive modeling. This product consists of a 32-bit Windows Graphical User Interface (GUI) application LISWIN that interfaces with the 32-bit statistical applications LISREL, PRELIS, MULTILEV, SURVEYGLIM, MAPGLIM, CATFIRM, and CONFIRM.

PRELIS is a 32-bit application for manipulating data, transforming data, generating data, computing moment matrices, computing asymptotic covariance matrices, performing multiple linear, censored, logistic, and probit regression analyses, performing exploratory factor analyses for continuous and ordinal variables, etc.

The 32-bit application LISREL is intended for standard and multilevel structural equation modeling. The Full Information Maximum Likelihood (FIML) method for incomplete data is also available for both standard and multilevel structural equation modeling. In the case of continuous variables, standard structural equation modeling is also available for complex survey data.

MULTILEV fits multilevel linear and nonlinear models to raw data. In the case of continuous response variables, MULTILEV allows for design weights at each level of the hierarchy.

SURVEYGLIM fits generalized linear models to simple random sample and complex survey data.

MAPGLIM fits generalized linear models to multilevel data.

CATFIRM and CONFIRM implement formal inference-based recursive modeling for raw categorical and continuous data respectively.

LISREL 8.80 for Windows imports external data in formats such as SPSS, SAS, STATA, Statistica, Microsoft Excel, SYSTAT, BMDP, etc. as a PRELIS System File (PSF).

This document is intended as a brief overview to familiarize new users of LISREL 8.80 for Windows with the features of the application. Section 2 describes the various files used and generated by LISREL 8.80 for Windows. A procedure to import an SPSS data file as a PSF to be used by LISREL 8.80 for Windows is described in Section 3. Some of the descriptive graphics of LISREL 8.80 for Windows are illustrated in Section 4. A data screening, a multiple linear regression analysis, and a logistic regression analysis with LISREL 8.80 for Windows are illustrated in Sections 5, 6, and 7 respectively. Section 8 demonstrates an

exploratory factor analysis for continuous and ordinal variables with LISREL 8.80 for Windows. Section 9 illustrates how LISREL 8.80 for Windows can be used to run SIMPLIS syntax files. Section 10 demonstrates some of the features of the path diagram (PTH) window of LISREL 8.80 for Windows. The use of LISREL syntax files is illustrated in Section 11.

2. Files

LISREL 8.80 for Windows uses a PRELIS System File (PSF) to store raw data. The statistical applications LISREL, PRELIS, MULTILEV, SURVEYGLIM, and MAPGLIM read the raw data values directly from a PSF.

Whenever PRELIS or LISREL processes a PSF, a Data System File (DSF), which has the same file name as the PSF, but with a DSF extension, is created. This DSF contains all the summary data information that LISREL requires to fit standard structural equation models to complete data.

A structural equation model can be specified by means of a path diagram, a SIMPLIS project file, a LISREL project file, a SIMPLIS syntax file, or a LISREL syntax file. LISREL 8.80 for Windows uses a graphics file with the default extension PTH to capture a path diagram. The extensions SPJ and LPJ are used for SIMPLIS and LISREL project files respectively. SIMPLIS and LISREL syntax files are text files with the default extensions SPL and LS8 respectively. These five file types access the raw data from the PSF or the summary data from the DSF. If a user has prepared any of these files, then LISWIN and LISREL can be used to fit the specified model to the raw data specified in the corresponding PSF or the summary data in the corresponding DSF.

Path diagram, SIMPLIS project and LISREL project files are described in Du Toit & Du Toit (2001). SIMPLIS syntax files are described in Jöreskog & Sörbom (1999c) while LISREL syntax files are outlined in Jöreskog & Sörbom (1999b). All these files are also described in the online help file, which can be accessed by using the *LISREL Help* option on the **Help** menu of LISREL 8.80 for Windows. In addition, SIMPLIS syntax files are also described in
http://www.ssicentral.com/lisrel/techdocs/SIMPLISSyntax.pdf
while LISREL syntax files are described in
http://www.ssicentral.com/lisrel/techdocs/LISRELSyntax.pdf#pagemode=bookmarks

Whenever PRELIS processes a PSF interactively, a PRELIS syntax file with the same file name as the PSF is created. A PRELIS syntax file is a text file with default extension PR2. PRELIS syntax files are described by Jöreskog & Sörbom (1999a) as well as in the online help file of LISREL 8.80 for Windows and in
http://www.ssicentral.com/lisrel/techdocs/IPUG.pdf

Multilevel modeling, generalized linear modeling, multilevel generalized linear modeling, and formal inference-based recursive modeling syntax files are also text files with default extension PR2. Multilevel modeling and generalized linear modeling syntax files are described in Du Toit et al. (2005) while formal inference-based recursive modeling syntax

files are described in Du Toit & Du Toit (2001). These types of syntax files are also described in the online help file of LISREL 8.80 for Windows. MULTILEV and SURVEYGLIM syntax files are also described in
http://www.ssicentral.com/lisrel/techdocs/MLUG.pdf
and
http://www.ssicentral.com/lisrel/techdocs/SGUG.pdf#pagemode=bookmarks
respectively.

LISREL 8.80 for Windows starts up by opening a main window with three menus entitled *File*, *View*, and *Help*. The *Open* option on the *File* menu is used to open an existing PSF or PTH file in a PSF and a PTH window respectively. It can also be used to open existing LISREL and SIMPLIS project files in LISREL and SIMPLIS project (LPJ and SPJ) windows. Text editor windows are used to display existing syntax files and output files. PTH, PSF, LPJ, SPJ and text editor windows have window-specific menus.

The *LISREL Help* option on the *Help* menu opens the online help file of LISREL 8.80 for Windows. The *About LISREL* option loads the *About LISREL* dialog box which shows the product information for LISREL 8.80 for Windows.

3. Importing data as a PRELIS System File (PSF)

The PRELIS System File (PSF) is a binary file that LISREL 8.80 for Windows uses to store, display and analyze raw data. LISREL 8.80 for Windows opens a PSF in a *PSF* window with menus entitled *File*, *Edit*, *Data*, *Transformation*, *Statistics*, *Graphs*, *Multilevel*, *SurveyGLIM*, *View*, *Window*, and *Help*. In this section, we will import an SPSS data file as a PSF. Then, we demonstrate how to set up the PSF for further processing with LISREL 8.80 for Windows.

The Data
The data set forms part of the data library of the Multilevel Project at the University of London, and emanates from the Junior School Project (Mortimore et al, 1988). Mathematics and language tests were administered in three consecutive years to more than 1000 students from 50 primary schools, which were randomly selected from primary schools maintained by the Inner London Education Authority. The data are provided in the location *C:\LISREL 8.8 Student Examples\WORKSHOP* as the SPSS data file *JSP2.SAV*. The first portion of this file is shown in the following SPSS data window.

Creating the PSF

- ➢ Use the *Import Data* option from the *File* menu of the main window of LISREL 8.80 for Windows to load the *Open* dialog box.
- ➢ Select *SPSS for Windows (*.sav)* from the *Files of type* dropdown list box.
- ➢ Browse for the location *C:\LISREL 8.8 Student Examples\WORKSHOP*.
- ➢ Select the file *JSP2.SAV* by clicking on it.
- ➢ Click on the *Open* button to load the *Save As* dialog box.
- ➢ Enter the name *JSP2* in the *File name* string field.
- ➢ Click on the *Save* button to open the following *PSF* window.

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	SCHOOL	GENDER	MATH1	MATH2	MATH3	ENG1	ENG2
1	1.000	0.000	23.000	24.000	23.000	72.000	80.
2	1.000	1.000	14.000	11.000	-9.000	7.000	17.
3	1.000	1.000	36.000	32.000	39.000	88.000	89.
4	1.000	1.000	24.000	26.000	32.000	12.000	25.
5	1.000	0.000	22.000	23.000	-9.000	67.000	78.
6	1.000	0.000	19.000	23.000	11.000	52.000	76.
7	1.000	1.000	22.000	22.000	26.000	37.000	68.
8	1.000	0.000	18.000	29.000	28.000	57.000	86.
9	1.000	1.000	30.000	31.000	-9.000	42.000	59.
10	1.000	0.000	29.000	29.000	-9.000	46.000	79.
11	1.000	0.000	31.000	28.000	32.000	69.000	84.
12	1.000	0.000	18.000	26.000	-9.000	54.000	74.
13	1.000	0.000	23.000	-9.000	27.000	63.000	-9.
14	1.000	0.000	39.000	35.000	36.000	83.000	88.
15	1.000	0.000	24.000	30.000	33.000	37.000	44.

Note that the **–9.000** entries refer to missing values.

Prepare the PSF for Data Processing
➢ Select the **Define Variables** option on the **Data** menu to load the **Define Variables** dialog box.
➢ Select the labels **MATH1**, **MATH2**, **MATH3**, **ENG1**, **ENG2**, and **ENG3**.
➢ Click on the **Variable Type** button to load the **Variable Types for …** dialog box.
➢ Activate the **Continuous** radio button.
➢ Click on the **OK** button on the **Variable Types for …** dialog box.
➢ Click on the **Missing Values** button to load the **Missing Values for …** dialog box.
➢ Enter the value **–9.000** in the first **Global missing values** string field.
➢ Click on the **OK** button of the **Missing Values for …** dialog box.
➢ Click on the **OK** button on the **Define Variables** dialog box.
➢ Select the **Save** option on the **File** menu to save the changes to the PSF.
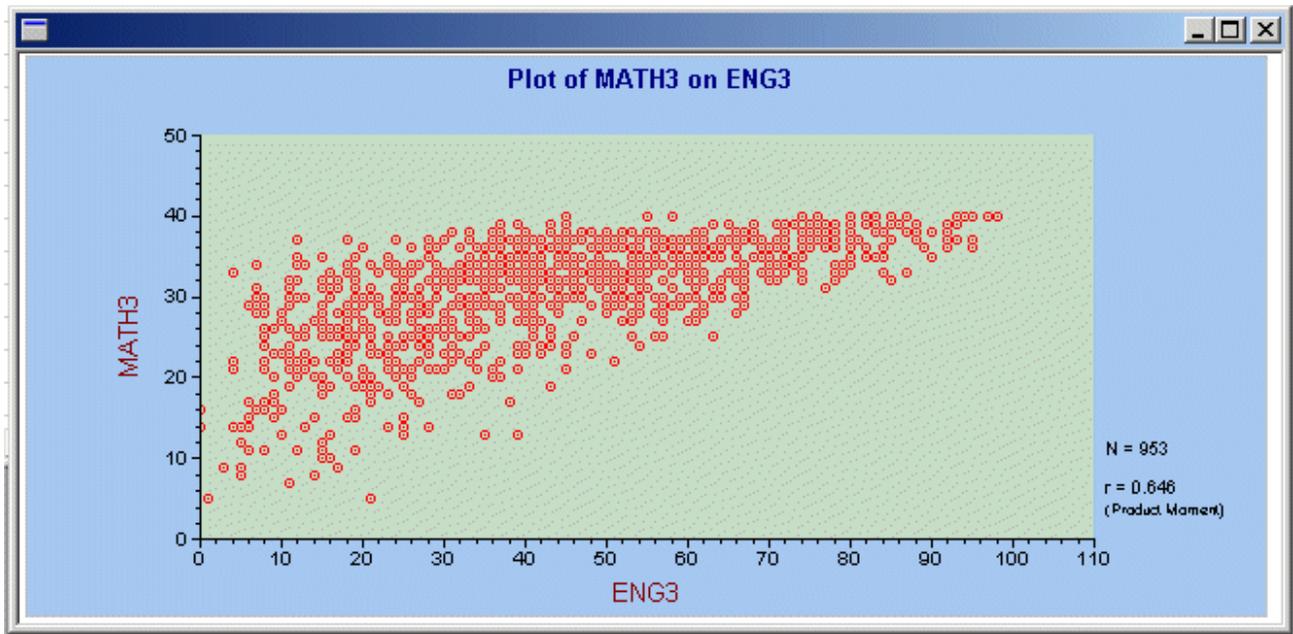
4. Descriptive graphics

A Histogram for MATH1
➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
➢ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
➢ Select the **PRELIS Data (*.psf)** option from the **Files of type** dropdown list box.
➢ Select the file **JSP2.PSF** by clicking on it.
➢ Click on the **Open** button to open the PSF window for **JSP2.PSF**.
➢ Select the **Univariate** option on the **Graphs** menu of the PSF window to load the **Univariate Plots** dialog box.
➢ Select the variable **MATH1**.
➢ Check the **Normal curve overlay** checkbox.

➢ Click on the *Plot* button of the *Univariate Plots* dialog box to produce following plot window.
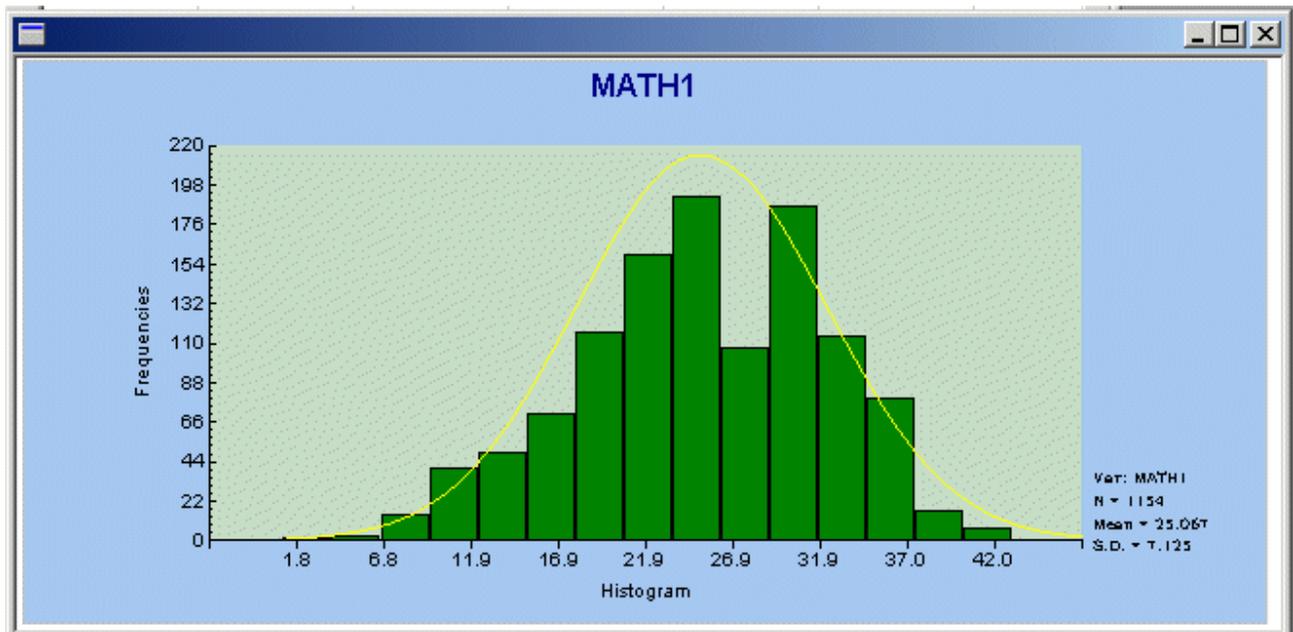
A Scatter Plot for MATH3 and ENG3
➢ Close the plot window above.
➢ Select the *Bivariate* option on the *Graphs* menu of the PSF window to load the *Bivariate Plots* dialog box.
➢ Select the variable *MATH3* by clicking on it.
➢ Click on the *Select* button in the *Y-Variable* section.
➢ Select the variable *ENG3* by clicking on it.
➢ Click on the *Select* button in the *X-Variable* section.
➢ Check the *Scatter Plot* checkbox.
➢ Click on the *Plot* button to produce following plot window.

Plot of MATH3 on ENG3

5. Data screening

➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
➢ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
➢ Select the **PRELIS Data (*.psf)** option from the **Files of type** dropdown list box.
➢ Select the file **JSP2.PSF** by clicking on it.
➢ Click on the **Open** button to open the PSF window for **JSP2.PSF**.
➢ Select the **Data Screening** option on the **Statistics** menu of the PSF window to open the following text editor window for **JSP2.OUT**.


```
JSP2.OUT

Number of Missing Values per Variable

    SCHOOL      GENDER       MATH1       MATH2       MATH3        ENG1        ENG2        ENG3
  --------    --------    --------    --------    --------    --------    --------    --------
         0           0          38          63         239          38          63         239


Distribution of Missing Values

Total Sample Size =    1192

Number of Missing Values       0       1       2       3       4
           Number of Cases    887       0     270       0      35
```
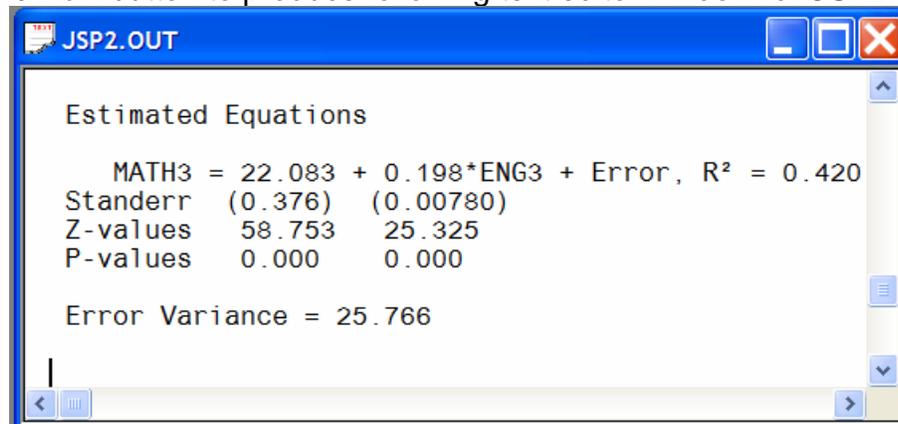
6. Multiple linear regression analysis

- ➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
- ➢ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- ➢ Select the **PRELIS Data (*.psf)** option from the **Files of type** dropdown list box.
- ➢ Select the file **JSP2.PSF** by clicking on it.
- ➢ Click on the **Open** button to open the PSF window for **JSP2.PSF**.
- ➢ Select the **Regressions** option on the **Statistics** menu of the PSF window to load the **Regression** dialog box.
- ➢ Select the variable **MATH3** by clicking on it.
- ➢ Click on the **Select** button in the **Y-Variables** section.
- ➢ Select the variable **ENG3** by clicking on it.
- ➢ Click on the **Select** button in the **X-Variables** section.
- ➢ Click on the **Run** button to produce following text editor window for **JSP2.OUT**.


```
JSP2.OUT

    Estimated Equations

        MATH3 = 22.083 + 0.198*ENG3 + Error, R² = 0.420
    Standerr   (0.376)   (0.00780)
    Z-values    58.753     25.325
    P-values     0.000      0.000

    Error Variance = 25.766
```

7. Logistic regression analysis

- ➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
- ➢ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- ➢ Select the **PRELIS Data (*.psf)** option from the **Files of type** dropdown list box.
- ➢ Select the file **USA.PSF** by clicking on it.
- ➢ Click on the **Open** button to open the PSF window for **USA.PSF**.
- ➢ Select the **Logistic Regressions** option on the **Statistics** menu of the PSF window to load the **Logistic Regression** dialog box.
- ➢ Select the variable **NOSAY** by clicking on it.
- ➢ Click on the **Add** button in the **Ordinal Variables** section.
- ➢ Select the variables **GENDER** and **EDUCAT**.
- ➢ Click on the **Add** button in the **Covariates** section.
- ➢ Click on the **Run** button to produce following text editor window for **USA.OUT**.

```
usa.OUT

    Univariate Logit Regression for    NOSAY
    Standard Parameterization

    Thresholds:   -1.132    0.568    3.572


        NOSAY = 0.00902*GENDER + 0.576*EDUCAT + Error, R² = 0.131
    Standerr  (0.118)             (0.0893)
    Z-values   0.0761               6.442
    P-values   0.939                0.000
```
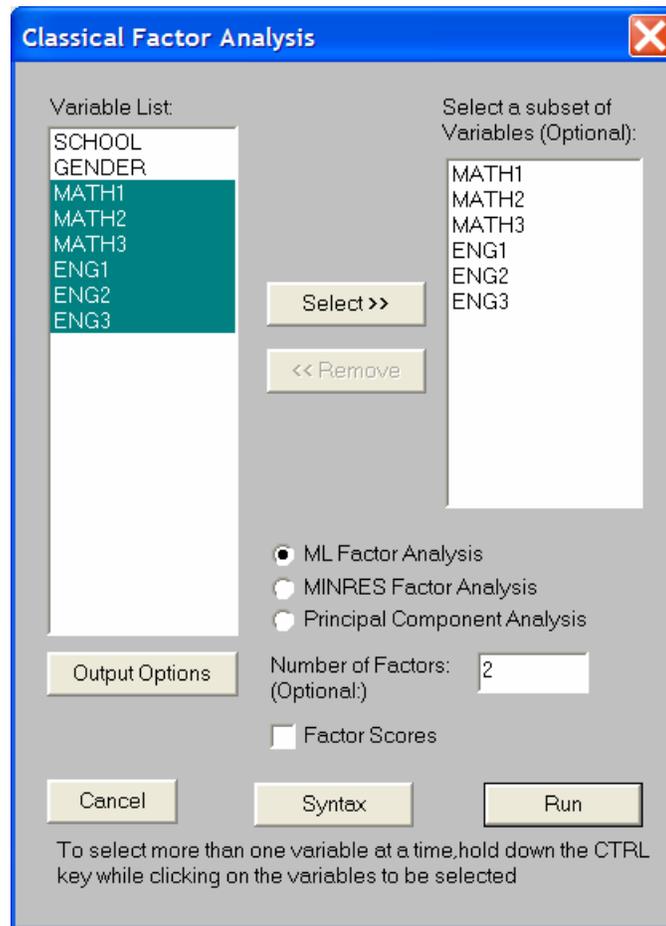
8. Exploratory factor analysis (EFA)

Continuous variables

➢ Use the *Open* option on the *File* menu to load the *Open* dialog box.
➢ Browse for the location *C:\LISREL 8.8 Student Examples\WORKSHOP*.
➢ Select the *PRELIS Data (*.psf)* option from the *Files of type* dropdown list box.
➢ Select the file *JSP2.PSF* by clicking on it.
➢ Click on the *Open* button to open the PSF window for *JSP2.PSF*.
➢ Select the *Classical Factor Analysis* option on the *Statistics* menu of the PSF window to load the *Classical Factor Analysis* dialog box.
➢ Select the variable labels *MATH1*, *MATH2*, *MATH3*, *ENG1*, *ENG2*, and *ENG3* from the *Variable List* box.
➢ Enter *2* in the *Number of factors* string field.
➢ Click on the *Select* button to produce the following *Classical Factor Analysis* dialog box.

➤ Click on the *Run* button to produce the following text editor window for *JSP2.OUT*.


```
JSP2.OUT

   Promax-Rotated Factor Loadings

              Factor 1   Factor 2  Unique Var
              --------   --------  ----------
      MATH1      0.635      0.263      0.290
      MATH2      0.867      0.030      0.210
      MATH3      0.786      0.074      0.294
       ENG1      0.037      0.889      0.161
       ENG2      0.121      0.786      0.231
       ENG3      0.224      0.678      0.273
```

Ordinal variables
➤ Use the *Open* option on the *File* menu to load the *Open* dialog box.
➤ Browse for the location *C:\LISREL 8.8 Student Examples\WORKSHOP*.
➤ Select the *PRELIS Data (*.psf)* option from the *Files of type* dropdown list box.

- ➢ Select the file *USA.PSF* by clicking on it.
- ➢ Click on the *Open* button to open the PSF window for *USA.PSF*.
- ➢ Select the *Ordinal Factor Analysis* option on the *Statistics* menu of the PSF window to load the *Ordinal Factor Analysis* dialog box.
- ➢ Select the variable labels *NOSAY*, *VOTING*, *COMPLEX*, *NOCARE*, *TOUCH*, and *INTEREST* from the *Variable List* box.
- ➢ Enter *2* in the *Number of factors* string field.
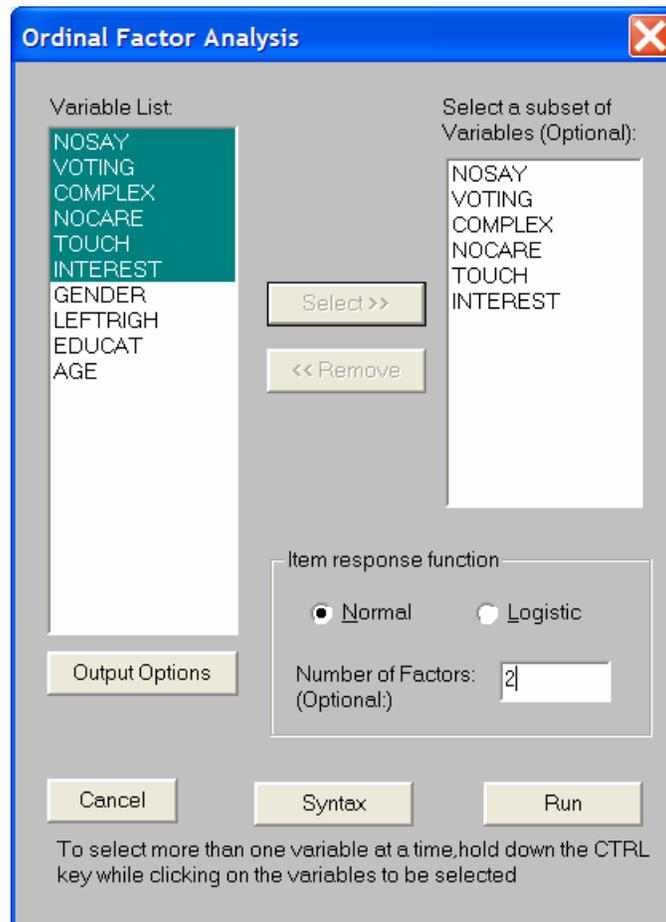- ➢ Click on the *Select* button to produce the following *Ordinal Factor Analysis* dialog box.

- ➢ Click on the *Run* button to produce the following text editor window for *JSP2.OUT*.

```
 usa.OUT                                    _ □ X

  Promax-Rotated Factor Loadings

                  Factor 1   Factor 2 Unique Var
                  --------   -------- ----------
        NOSAY       0.715      0.027     0.465
       VOTING       0.451     -0.056     0.824
      COMPLEX       0.456      0.069     0.750
       NOCARE       0.530      0.426     0.266
        TOUCH       0.066      0.801     0.291
     INTEREST       0.224      0.670     0.320

  Factor Correlations

                  Factor 1   Factor 2
                  --------   --------
    Factor 1       1.000
    Factor 2       0.601      1.000
```

9. Using SIMPLIS syntax files

➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
➢ Browse for the location **C:\LISREL 8.8 Student Examples\SPLEX**.
➢ Select the file **EX9A.SPL** by clicking on it.
➢ Click on the **Open** button to open the following text editor window for **EX9A.SPL**.

```
 EX9A.SPL                                              _ □ X

  Panel Model for Political Efficacy
  See Aish and Joreskog, Quality and Quantity (1990)
  Observed Variables from File PANEL.LAB
  Correlation Matrix from File PANELUSA.PME
  Asymptotic Covariance Matrix from File PANELUSA.ACP
  Sample size: 410
  Latent Variables: Efficac1 Respons1 Efficac2 Respons2
  Relationships:
      NOSAY1 - NOCARE1 = Efficac1
      NOCARE1 - INTERES1 = Respons1
      NOSAY2 - NOCARE2 = Efficac2
      NOCARE2 - INTERES2 = Respons2
      Efficac2 = Efficac1
      Respons2 = Respons1
  Let the Errors for Efficac2 and Respons2 correlate
  Method of Estimation: Weighted Least Squares
  Path Diagram
  End of Problem
```

Lines 1-2 specify a title for the analysis.
Line 3 specifies source for the labels for the observed variables.
Line 4 specifies the source for the polychoric correlation matrix.
Line 5 specifies the source for the estimated asymptotic covariance matrix of the polychoric correlations.
Line 6 specifies that the data consist of **410** observations.
Line 7 specifies the labels for the 4 latent variables.
Lines 8-15 specify the model to be fitted to the data.
Line 16 specifies that the Weighted Least Squares (WLS) method for polychoric correlations should be used to fit the model to the data.
Line 17 requests a path diagram with the results.
Line 18 specifies that no more SIMPLIS commands be processed.

➢ Click on the *Run LISREL* icon on the main toolbar to produce the following PTH window for *EX9A.PTH*.

Chi-Square=113.83, df=48, P-value=0.00000, RMSEA=0.058
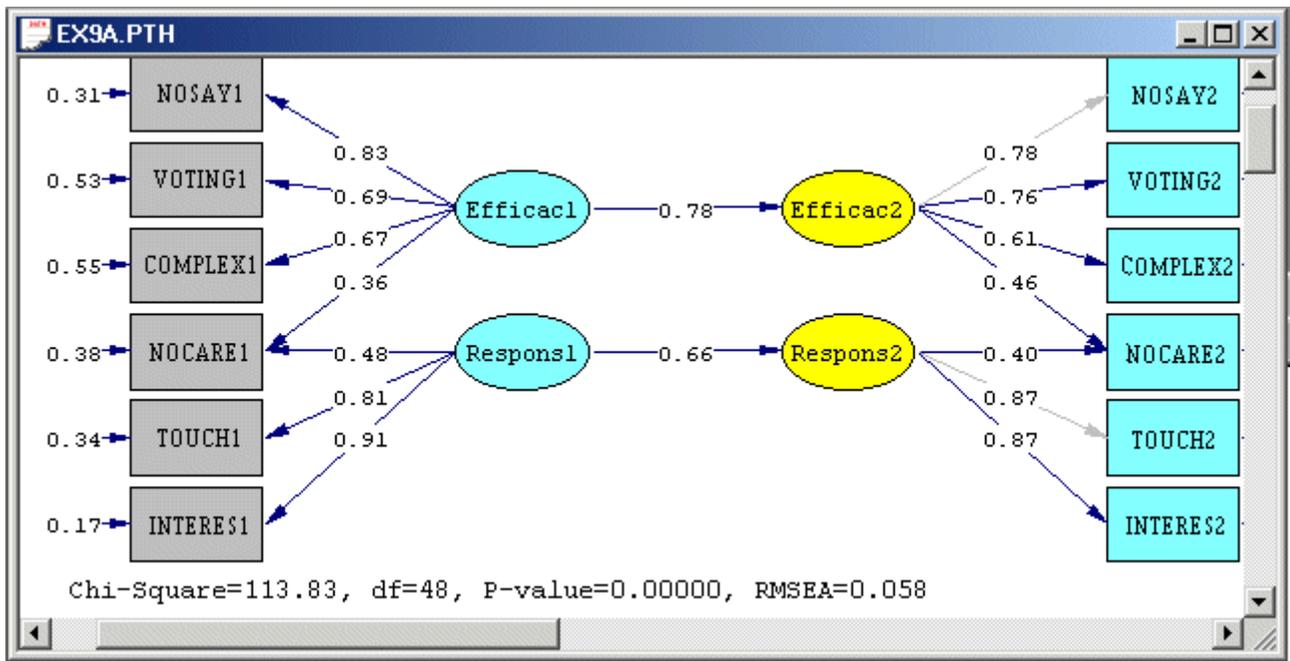
10. The PTH window for EX9A.PTH

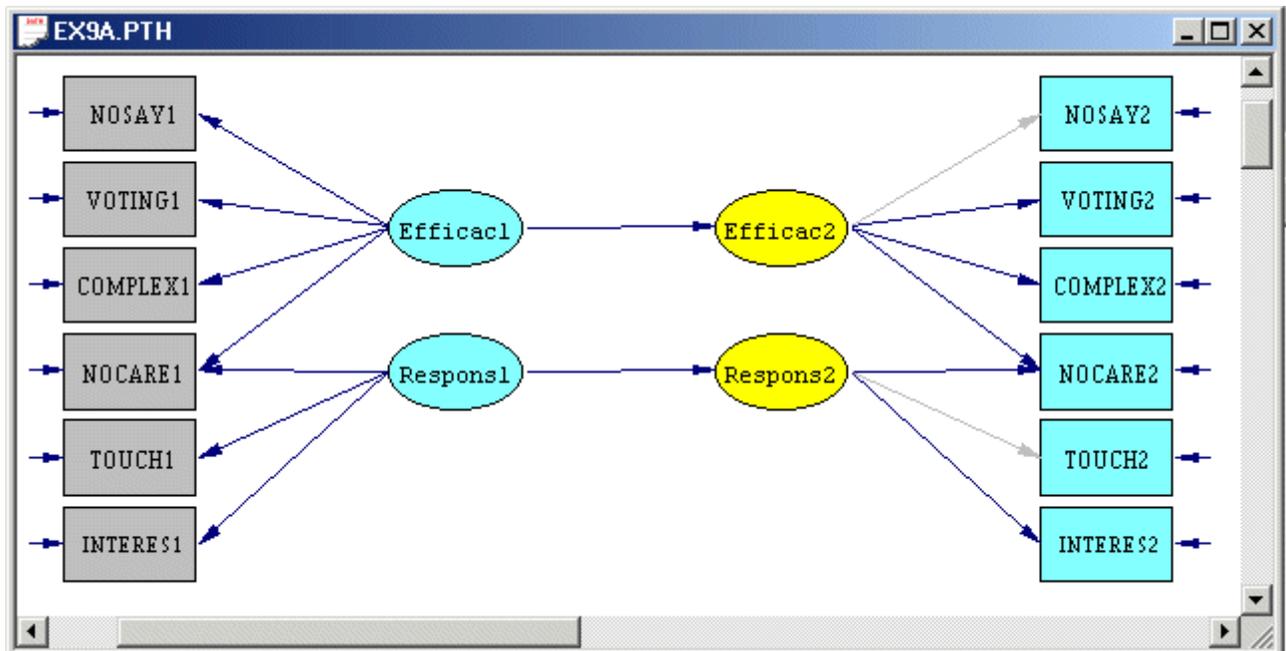## Structural Model

➢ Select the *Structural Model* option from the *Model* dropdown list box to produce the following PTH window.

```
EX9A.PTH                                                    _ □ ×

           1.00   Efficac1    0.78    Efficac2  0.39

        0.77                                         0.42

           1.00   Respons1    0.66    Respons2  0.57


        Chi-Square=113.83, df=48, P-value=0.00000, RMSEA=0.058
```
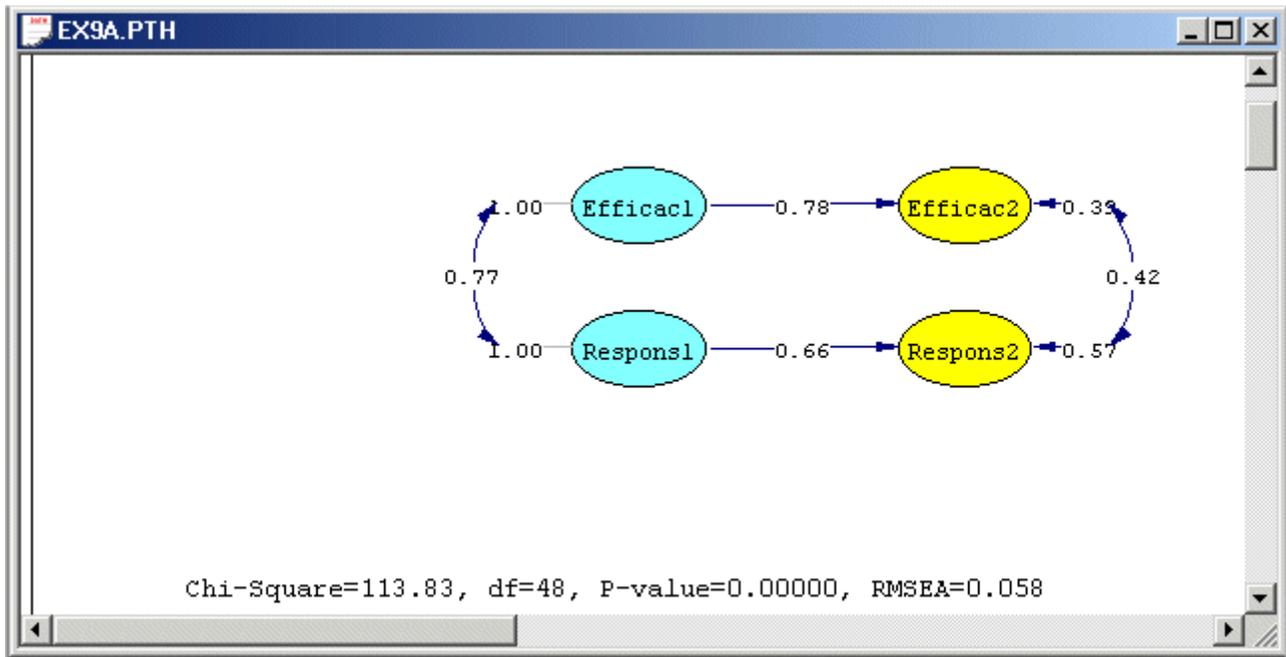
Conceptual Path Diagram
➢ Select the **Basic Model** option from the **Model** dropdown list box.
➢ Select the **Conceptual Diagram** option from the **Estimates** dropdown list box to produce the following PTH window.


```
EX9A.PTH                                                    _ □ ×

  NOSAY1                                                NOSAY2

  VOTING1                                               VOTING2
             Efficac1              Efficac2
  COMPLEX1                                              COMPLEX2

  NOCARE1                                               NOCARE2
             Respons1              Respons2
  TOUCH1                                                TOUCH2

  INTERES1                                              INTERES2
```

T-Values

➢ Select the **Basic Model** option from the **Model** dropdown list box.
➢ Select the **T-values** option from the **Estimates** dropdown list box to produce the following PTH window.

Chi-Square=113.83, df=48, P-value=0.00000, RMSEA=0.058
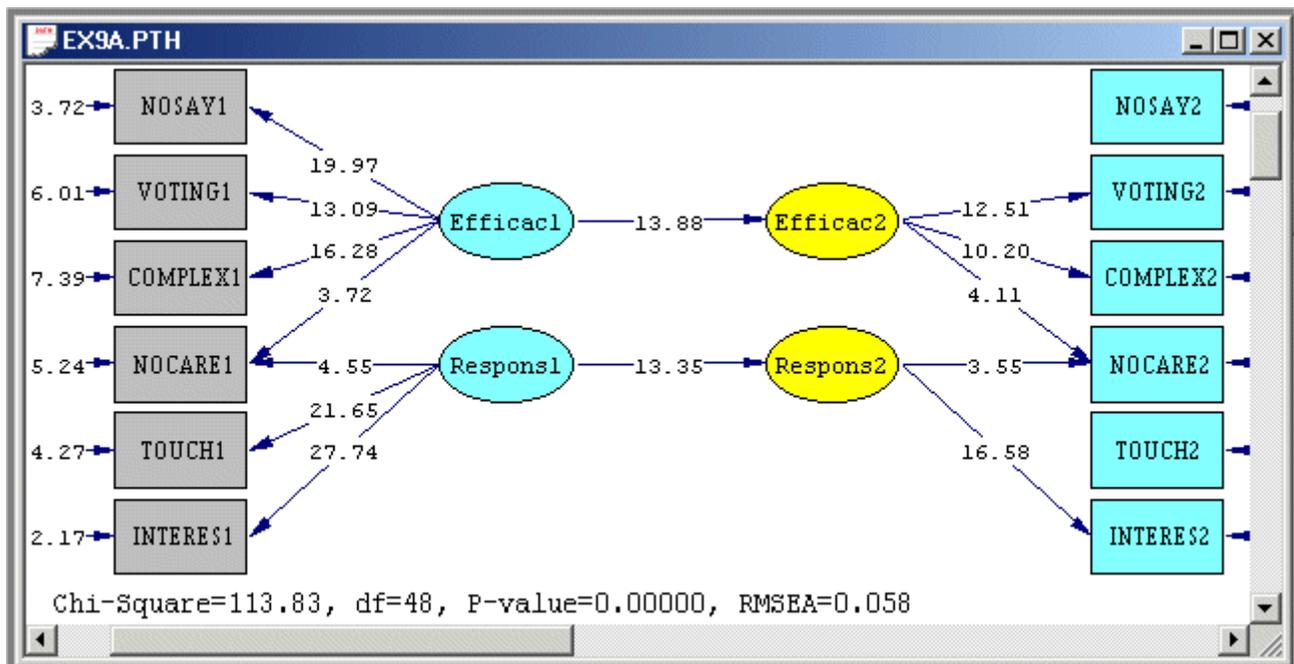
11. Using LISREL syntax files

➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
➢ Browse for the location **C:\LISREL 8.8 Student Examples\LS8EX**.
➢ Select the file **EX1. LS8** by clicking on it.
➢ Click on the **Open** button to open the following text editor window for **EX1.LS8**.

```
EX1.LS8

HYPOTHETICAL MODEL ESTIMATED BY ML
DA NI=11 NO=100
CM SY FI=EX1.COV
MO NY=4 NX=7 NE=2 NK=3 BE=FU PS=SY,FR
FR LY 2 1 LY 4 2 LX 2 1 LX 3 1 LX 3 2 LX 5 2 LX 7 3 BE 2 1 BE 1 2
FI GA 1 3 GA 2 2
VA 1 LY 1 1 LY 3 2 LX 1 1 LX 4 2 LX 6 3
PD
OU MI RS EF MR SS SC
```

Line 1 specifies a title for the analysis.
Line 2 specifies the number of observations (**NO=100**) and the number of observed variables of the model (**NI=10**).
Line 3 specifies the source for the sample covariance matrix of the observed variables of the model.
Lines 4-7 specify the model to be fitted to the sample covariance matrix specified in line 3.
Line 8 requests a path diagram with the results.
Line 9 specifies the additional results to be written to the output file.

➢ Click on the **Run LISREL** icon on the main toolbar to produce the following PTH window for **EX9A.PTH**.

Chi-Square=113.83, df=48, P-value=0.00000, RMSEA=0.058
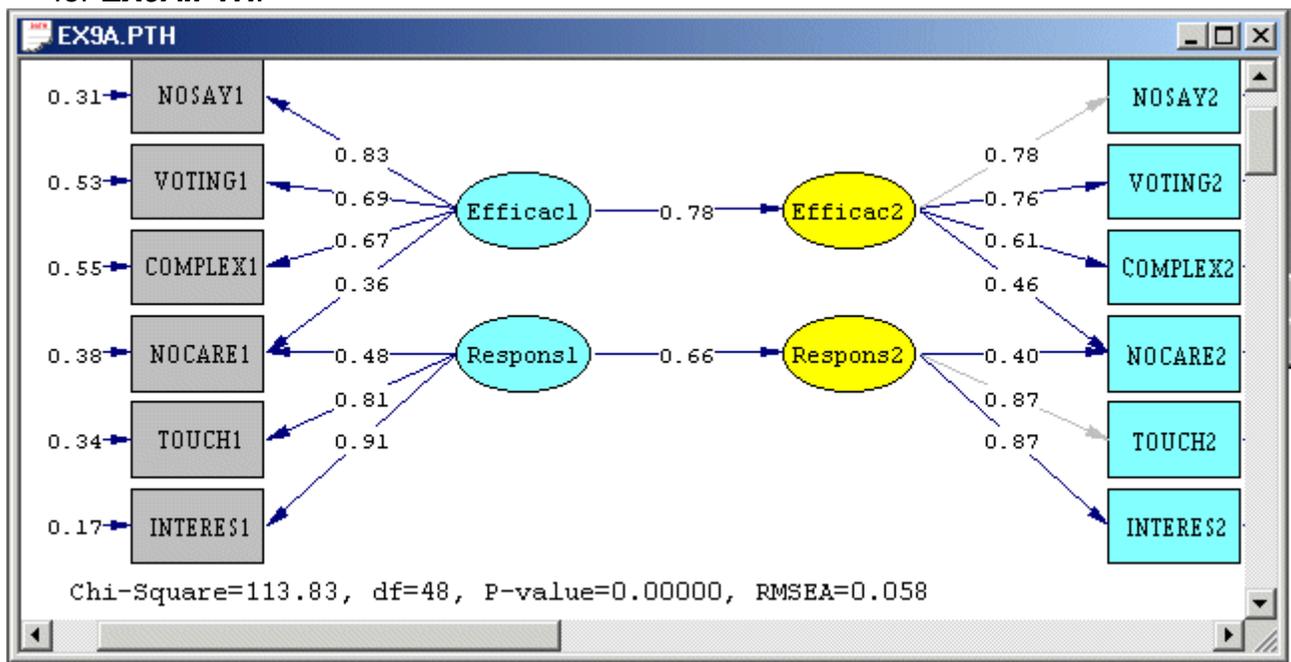
References

du Toit, S.H.C. & du Toit, M., Mels, G. & Cheng, Y. (2005).
Analysis of complex survey data using LISREL.
Lincolnwood, IL: Scientific Software International, Inc.

Jöreskog, K.G. & Sörbom, D. (1999a).
PRELIS 2: User's Reference Guide.
Lincolnwood, IL: Scientific Software International, Inc.

Jöreskog, K.G. & Sörbom, D. (1999b).
LISREL 8: User's Reference Guide.
Lincolnwood, IL: Scientific Software International, Inc.

Jöreskog, K.G. & Sörbom, D. (1999c).
Structural Equation Modeling with the SIMPLIS Command Language.
Lincolnwood, IL: Scientific Software International, Inc.

Jöreskog, K.G. & Sörbom, D. (2006).
LISREL 8.80 for Windows [Computer Software].
Lincolnwood, IL: Scientific Software International, Inc.

Jöreskog, K.G., Sörbom, D., Du Toit, S.H.C. & Du Toit, M. (2001).
LISREL 8: New Statistical Features (Third Printing with Revisions).
Lincolnwood, IL: Scientific Software International, Inc.

Mortimore, P., Sammons, P., Stoll, L., Lewis, D. & Ecob, R. (1988).
School Matters: The Junior Years. Wells: Open Books.