Using LISREL project files

1 Introduction

LISREL allows the user to create LISREL syntax interactively by making use of a set of menus. As an illustration, we consider a second-order factor analysis model.

Second-order factor analysis

The following equation

$$\mathbf{y} = \mathbf{\Lambda}_y \mathbf{\eta} + \mathbf{\varepsilon}$$

is in the form of a factor analysis model for $\mathbf{y}$ with first order factors $\mathbf{\eta}$ and measurement errors $\mathbf{\varepsilon}$. Now suppose that the variables $\mathbf{\eta}$ in turn can be accounted for by a set of so called second-order factors $\mathbf{\xi}$, so that

$$\mathbf{\eta} = \mathbf{\Gamma}\mathbf{\xi} + \mathbf{\varsigma}$$

where $\mathbf{\Gamma}$ is a matrix of second-order factor loadings and $\mathbf{\varsigma}$ is a vector of unique components for $\mathbf{\eta}$.

To illustrate the model, we use data on some cognitive ability tests. The standard deviations and correlations of two forms of each of five tests are given in the table below. The sample size (N) is 267.

Table 2: Correlations and Standard Deviations for Some Cognitive Tests

GESCOM-A	2.42	1									
GESCOM-B	2.80	0.74	1								
CONWORD-A	3.40	0.33	0.42	1							
CONWORD-B	3.19	0.34	0.39	0.65	1						
HIDPAT-A	1.94	0.26	0.21	0.15	0.18	1					
HIDPAT-B	1.79	0.23	0.24	0.22	0.21	0.77	1				
THIROUND	5.63	0.15	0.12	0.14	0.11	0.17	0.20	1			
THIBLUE	3.10	0.14	0.14	0.14	0.15	0.06	0.09	0.42	1		
VOCABU_A	3.05	-.04	0.03	0.09	0.16	0.06	0.09	0.19	0.21	1	
VOCABU_B	2.25	0.02	0.02	0.10	0.23	0.024	0.07	0.09	0.21	0.72	1

We shall examine the hypothesis that the two forms of each test are tau-equivalent, except for the two-word fluency tests Things Round and Things Blue that are only assumed to be congeneric. The five true scores are

postulated to depend on two factors, the first, Speed Closure, being measured by the first three tests and the second, Vocabulary, being measured by the last two tests. The model specification is:

$$\Lambda_y = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & * & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}, \quad \Gamma = \begin{pmatrix} * & 0 \\ * & 0 \\ * & 0 \\ 0 & * \\ 0 & * \end{pmatrix}, \quad \Phi = \begin{pmatrix} 1 & \\ * & 1 \end{pmatrix}$$

Here * denotes parameters to be estimated and "0" and "1" are fixed parameters. The LISREL syntax file for this model is as follows:

```
Second order factor analysis
DA NI=10 NO=267
LA FI=EX62.DAT
KM FI=EX62.DAT
SD FI=EX62.DAT
MO NY=10 NE=5 NK=2 GA=FI PH=ST PS=DI
LE
GESCOM CONWOR HIDPAT THINGS VOCABU
LK
SPEEDCLO VOCABUL
VA 1 LY 1 1 LY 2 1 LY 3 2 LY 4 2 LY 5 3 LY 6 3 LY 7 4 LY 9 5 LY 10 5
FR LY 8 4 GA 1 1 GA 2 1 GA 3 1 GA 4 2 GA 5 2
ST 1 ALL
OU SE TV SS NS
```

The goodness-of-fit statistic χ^2 is 53.06 with 33 degrees of freedom.

2 Building the LISREL Syntax

From the **File** menu, select **New** to obtain the **New** dialog box. Select **LISREL Project** and click **OK** to obtain the **Save As** dialog box.
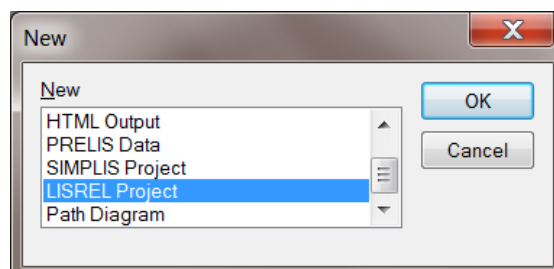
Select the filename **sofa.lpj**. When done, click **Save**.

The following step is to provide information regarding the title, additional comments to be included in the syntax file, the data file and the variables in it. This is accomplished by selecting the **Title and Comments** option from the **Setup** menu. The **Title and Comments** dialog box appears. Enter a title and (optional) comments in the **Title** string field and the **Comments** text box.
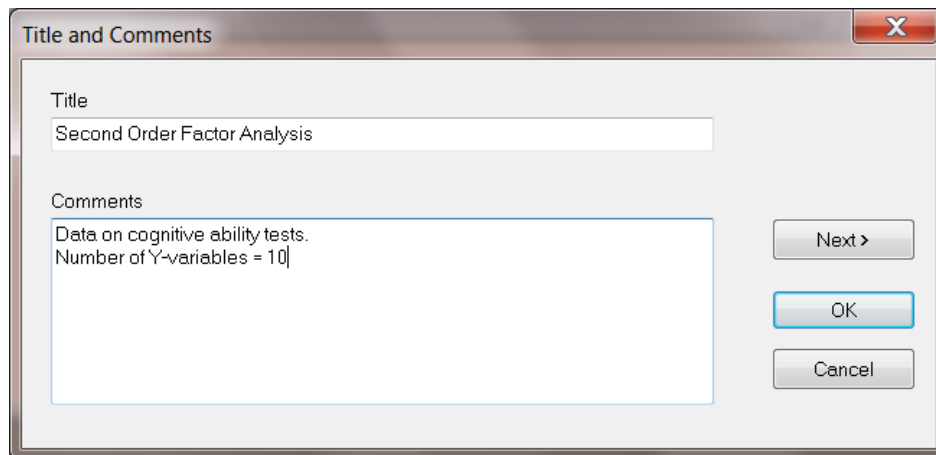

Since the present example is based on the analysis of a single group, nothing is entered in the space allowed for **Group Labels**, and **Next** is clicked to go to the **Labels** dialog box.

The default number of variables on the **Labels** dialog box is 2, these being VAR 1 and VAR 2. Since the present analysis calls for 10 variables, the mouse cursor is moved to the **Observed Variables** box. By pressing the **Insert** key on the computer keyboard eight times, provision is made for eight additional observed variables, and therefore the total number becomes ten. Alternatively, the **Add List** option may be used and var3-var10 entered (or, for example, X3-X10). If the **Add List** option was used, click **OK** to return to the **Labels** dialog box. Variable labels can alternatively be read in from an existing *.**lsf** or *.**dsf** file. See the section on LISREL system files for more information on this option.

A label may be assigned to each of the 10 variables by clicking on the corresponding button (numbered 1,2,3, …, under the **Observed Variables** column). The background color of the space allowed for entering the variable name will change and one can go ahead and type the appropriate label. For the present example, the labels are GESCOM A, GESCOM B, CONWOR A, CONWOR B, HIDPAT A, HIDPAT B, THIROUND, THIBLUE, VOCABU A and VOCABU B respectively. Note that a label name, which may include blanks, may not exceed 8 characters. Note also that the labels for the variables may instead be entered by, for example, clicking on VAR 1. Type in GESCOM A and use the down arrow on the keyboard to create the next space. Type GESCOM B and continue in a similar fashion until all the labels are typed in.

Since we have 7 latent variables, Gescom, Conwor, Hidpat, Things, Vocabu, Speedclo and Vocabu1, the procedure outlined above for the observed variables is repeated by selecting **Add List** on the **Latent Variables** portion of the **Labels** dialog box. Add var1-var7 and click on **OK** (alternatively the keyboard down arrow may be used). Assign labels to these latent variables by clicking on the number of each variable. Finally, click **Next** to go to the **Data** dialog box.
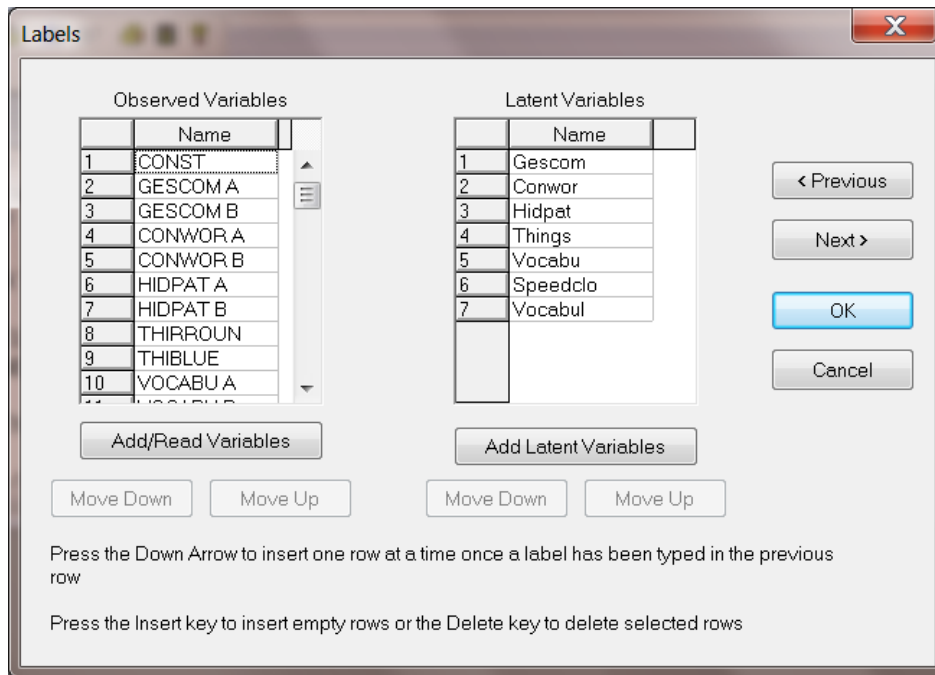
From the **Data** dialog box, select **Covariances** from the **Statistics from:** drop-down list box and also **Covariances** from the **Matrix to be analyzed** drop-down list box. Type 267 in the **Number of Observations** string field. For **File type**, select **External ASCII Data** and then click **Browse** to go to the **Browse** dialog box.
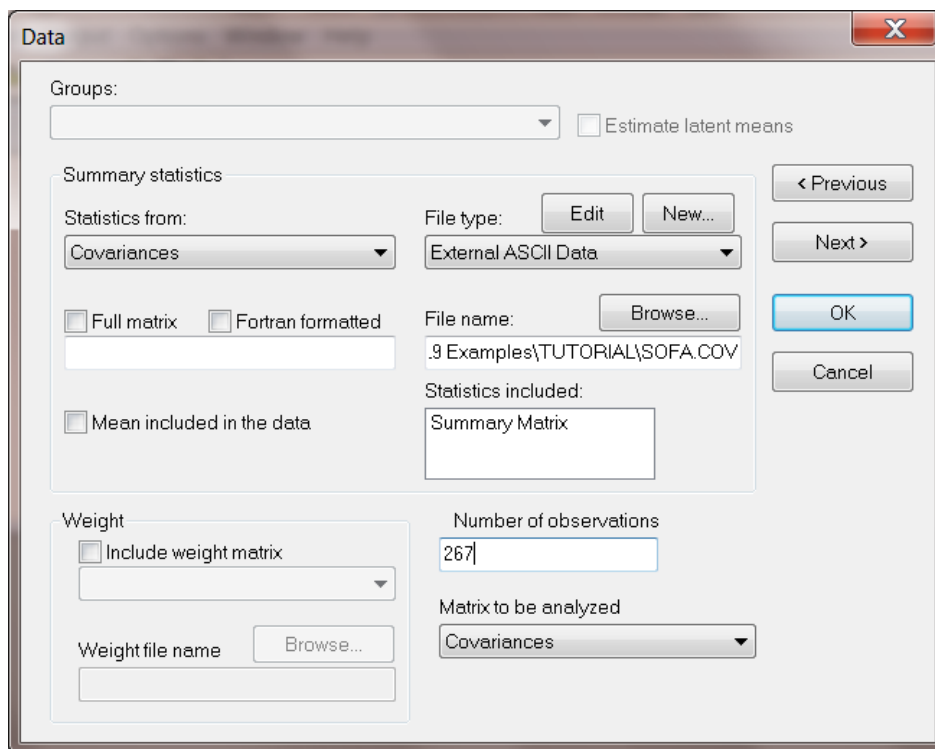
Select the ASCII file **sofa.cov**. Click **Open** to return to the **Data** dialog box, and then select **Next** to go to the **Define Observed Variables** dialog box.

The program will now produce the **Define Observed Variables** dialog box, on which the user may select **Y-variables** and **X-variables** from the list of **Variable Names**. Since the present application calls for Y-variables only, all of the variable names are selected as Y-variables. This is achieved by sequentially clicking on each variable number box

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and then on the **Select as Y** option. Alternatively, with the left mouse button down, drag from variable number 1 to number 10, release the mouse button and click on the **Select as Y** button.
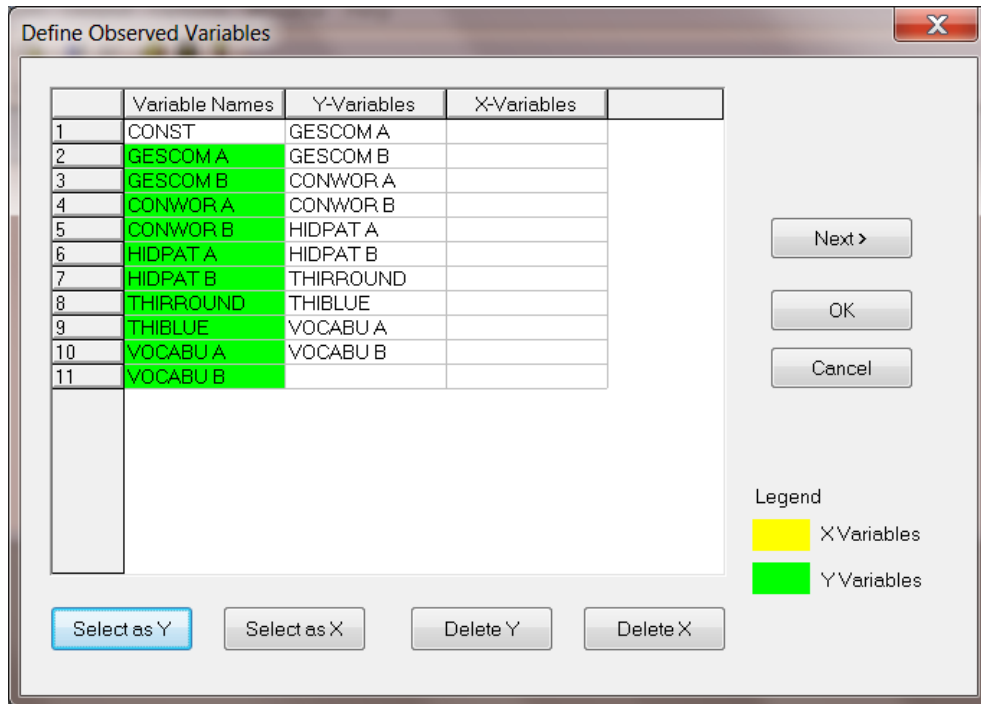

Click **Next** to go to the **Define Latent Variables** dialog box.

The latent variables consist of 5 Eta-variables and 2 Ksi-variables. Click on the appropriate square under **Variable Names** and then choose **Select Eta** for the Eta-variables (the first 5) or **Select Ksi** for the Ksi-variables (the last 2 variables). Once this is done, click **Next** to go to the **Model Parameters** dialog box.
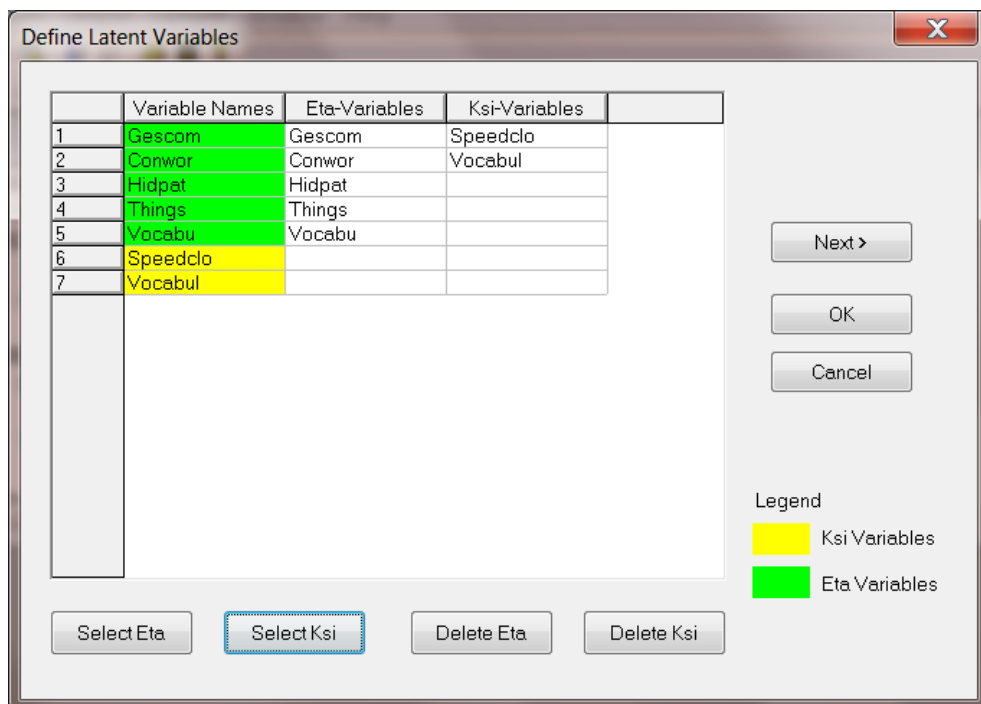

The **Model Parameters** dialog box shown below allows the user to:

- specify the form and mode of the matrices listed,
- specify which elements are fixed and which are free, and
- assign values to the elements of each of the matrices.
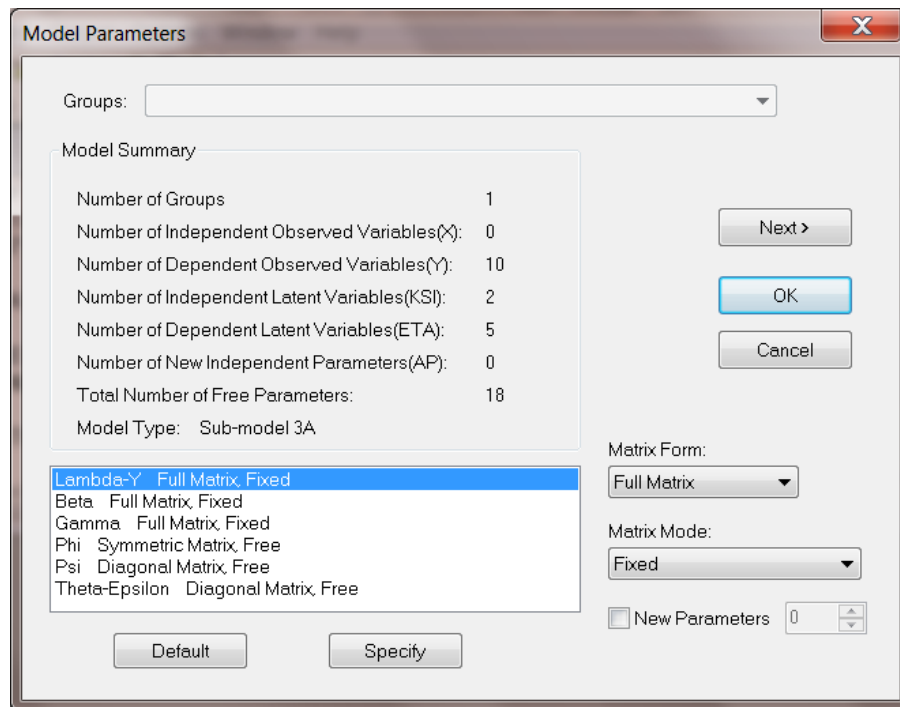
Since some changes need to be made to the default specifications for the Lambda-Y matrix, highlight the **Lambda-Y Full Matrix, Fixed** option by clicking on it. This action will cause the words Full Matrix and Fixed to appear in the **Matrix From** and **Matrix Mode** fields respectively. Proceed by clicking **Specify** to obtain the dialog shown below.
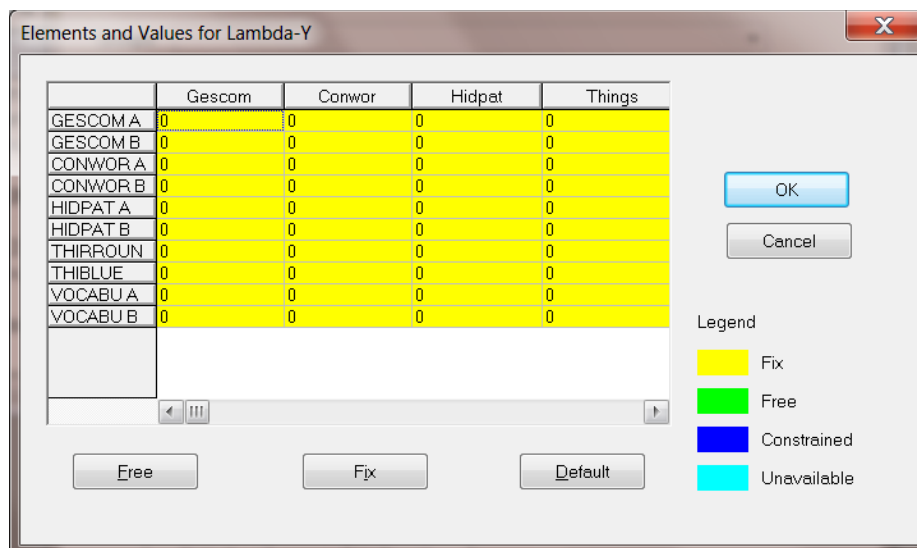

The initial dialog box will indicate that all the elements of Lambda-Y are fixed and equal to zero. The steps required to obtain the pattern shown in the dialog box below corresponding to the statements is given next.

VA 1.0 LY(1,1) LY(2,1) LY(3,2) LY(4,2) LY(5,2) LY(6,3) LY(7,4) LY(9,5) LY(10,5)
FR LY(8,4),

- o Click on the first rectangle next to the variable description button (that is under the heading Gescom) and use the computer keyboard to type in the value of 1, then press the keyboard Enter button.
- o Proceed in a similar fashion to enter 1 in the second row, and finally a 1 in the rectangle corresponding to the row VOCABU B and column Vocabu.
- o By clicking on the rectangle in the row THIBLUE and column Things and then on the **Free** button, the color of the rectangle will change to indicate that LY(8,4) is free.

Note that one may move the mouse pointer to a vertical divider line on the dialog box below. Column widths can subsequently be adjusted by clicking the left button and dragging the vertical line to the left or the right of its present position.
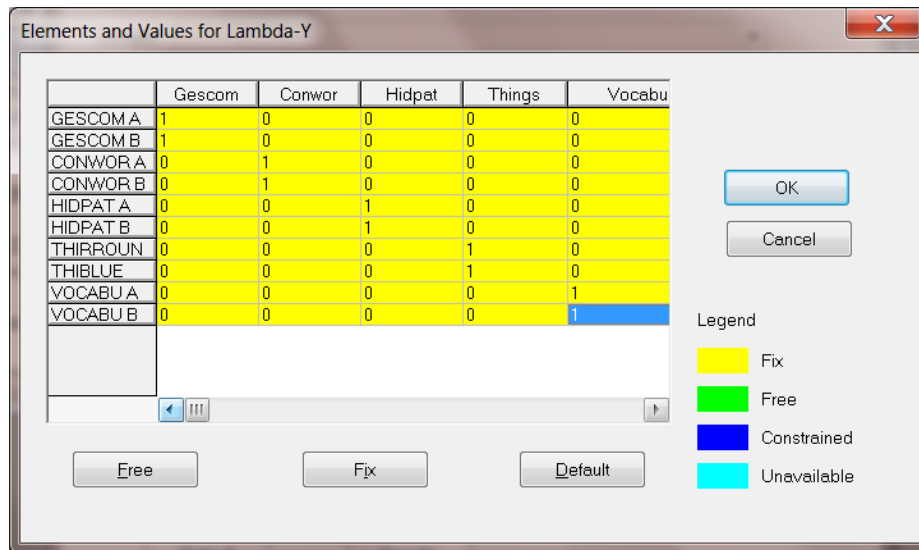
The input specifications require BETA to be a full matrix with all elements fixed at a value of 0. Since this is the default, one can proceed to specify the pattern and values for the GAMMA matrix.
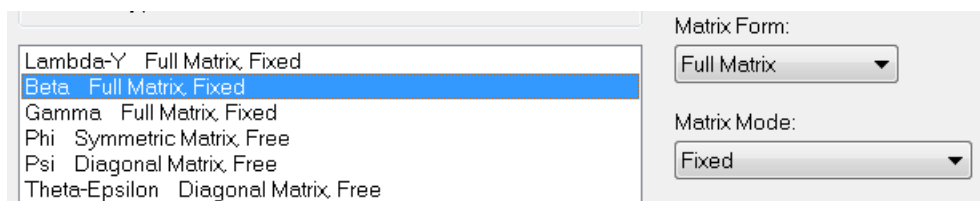
Highlight the **Gamma Full Matrix, Fixed** option and click on **Specify**.
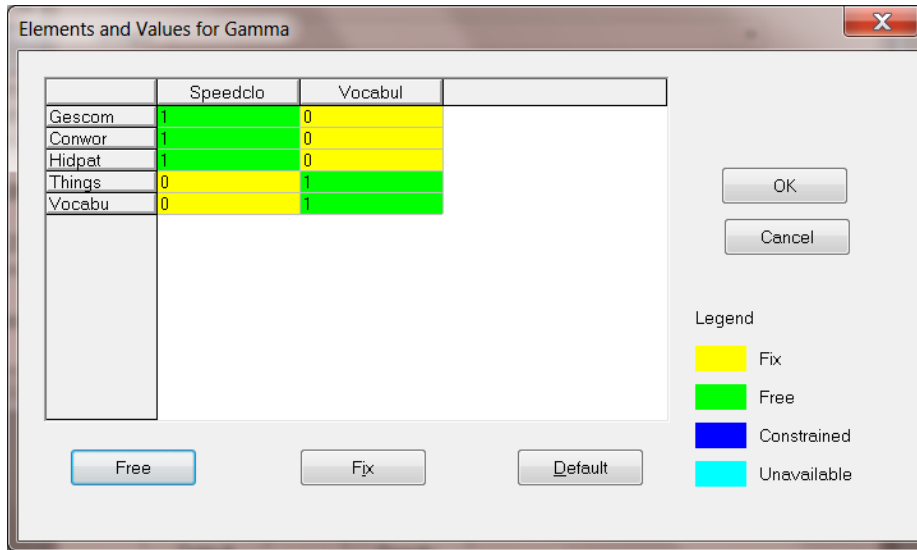
Use the dialog box shown above to specify the following statements

FR GA(1,1) GA(2,1) GA(3,1) GA(4,2) GA(5,2)
VA 1.0 GA(1,1) GA(2,1) GA(3,1) GA(4,2) GA(5,2)

This is accomplished by clicking on the rectangle that corresponds to the Eta-variable Gescom and the Ksi-variable Speedclo. Use the computer keyboard to type in 1 and click again to activate this rectangle. Then select the **Free** button to change the status of the GA(1,1) parameter to free. Continue in a similar fashion to obtain the pattern shown above.

Since the default settings for the parameter matrices Psi and Theta-Epsilon are correctly set at the default values (see dialog box below), click on **Next** to go to the **Constraints** dialog box.
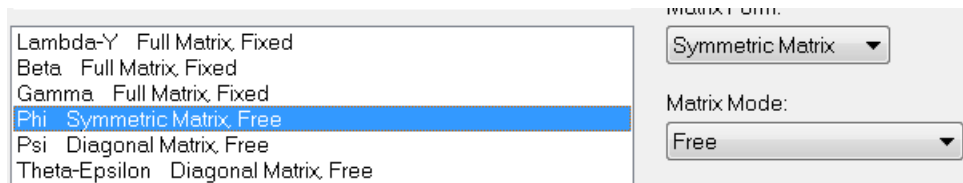

In the present example, no constraints are imposed on the elements of the parameter matrices and therefore the **Next** button is clicked to go to the **Output Selections** dialog box.
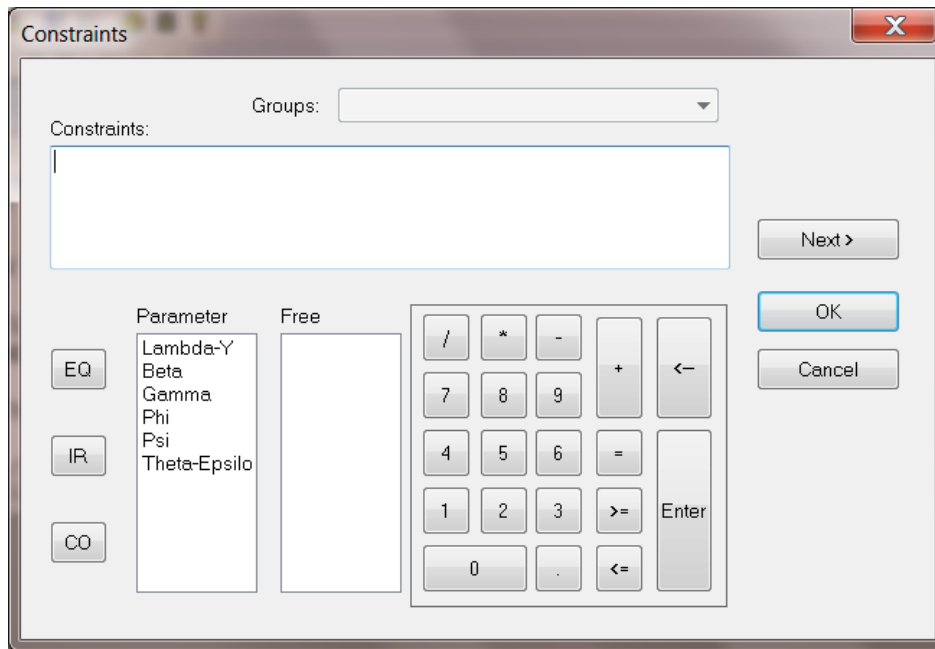
The **Output Selections** dialog box enables the user to create an output file that contains selected parts of the LISREL printout. Make the appropriate selections by clicking on the boxes at the left of the different options. Once this is done, click **Next** to go to the final dialog box, which is the **Save Matrices** dialog box.
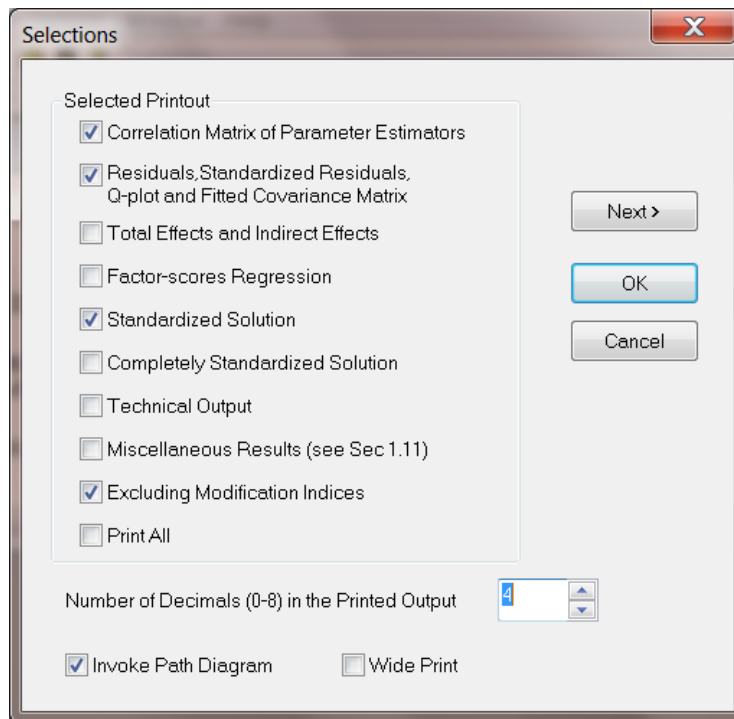
Any of the matrices or statistics shown on the dialog box illustration below may be selected by clicking on the boxes.
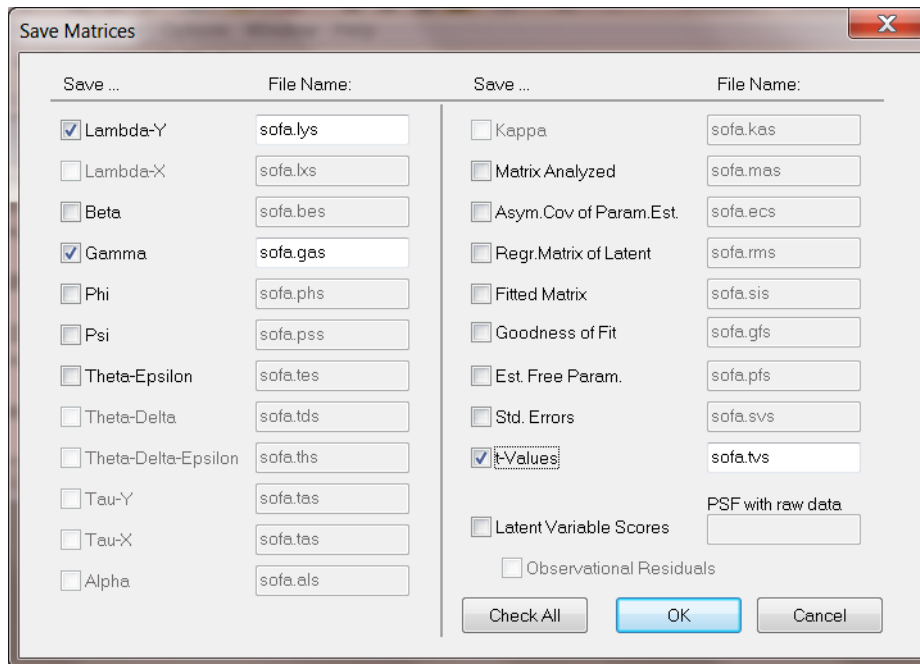
As an example, we selected **Lambda-Y**, **Gamma** and **t-values**. These files will have the same filename as the LISREL project file but with different file extensions, these being *.**lys**, *.**gas**, and *.**tvs** respectively.

Click **OK** to return to the LISREL project (LPJ) window. The LISREL syntax, saved in the file **sofa.lpj**, is shown below:



```
TI Second Order Factor Analysis
!Data on cognitive ability tests. Number of Y-variables = 10
DA NI=10 NO=267 MA=CM
LA
CONST 'GESCOM A' 'GESCOM B' 'CONWOR A' 'CONWOR B' 'HIDPAT A' 'HIDPAT B' THIRROUN THIBLUE 'VOCABU A' 'VOCABU B'
CM FI='C:\LISREL9 Examples\TUTORIAL\SOFA.COV' SY
MO NY=10 NK=2 NE=5 BE=FU GA=FI PS=SY TE=SY
LE
Gescom Conwor Hidpat Things Vocabu
LK
Speedclo Vocabul
FR LY(8,4) GA(1,1) GA(2,1) GA(3,1) GA(4,2) GA(5,2)
VA 1 LY(1,1)
VA 1 LY(2,1)
VA 1 LY(3,2)
VA 1 LY(4,2)
VA 1 LY(5,3)
VA 1 LY(6,3)
VA 1 LY(7,4)
VA 1 LY(8,4)
VA 1 LY(9,5)
VA 1 LY(10,5)
PD
OU PC RS SS XM ND=4  LY=sofa.lys GA=sofa.gas TV=sofa.tvs
```

Click the **Run LISREL** icon button on the main menu bar to run the problem.

The path diagram for this example is shown below and the output is saved to the file **sofa.out**.

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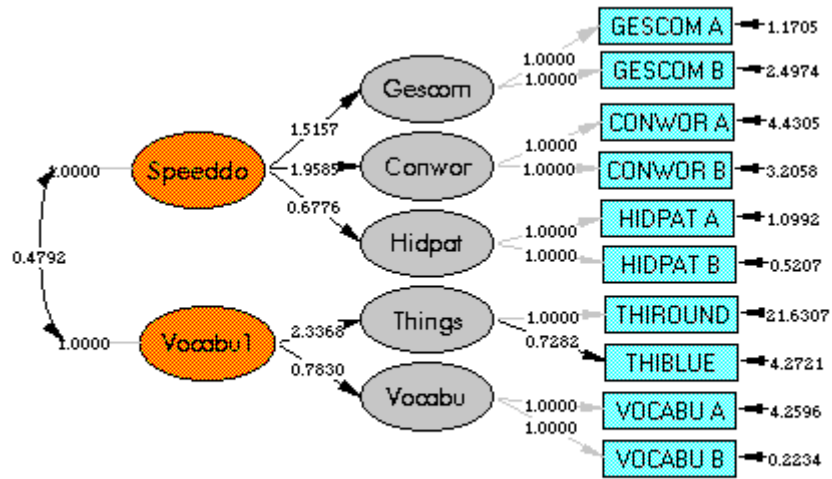
Chi-Square=53.67, df=33, P-value=0.01294, RMSEA=0.049

One may modify the path diagram by deleting, fixing or adding paths.