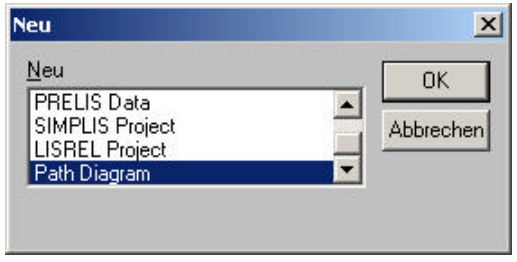
Using LISREL: SIMPLIS and LISREL Language

There are different methods to specify and estimate a structural equation model using Interactive LISREL

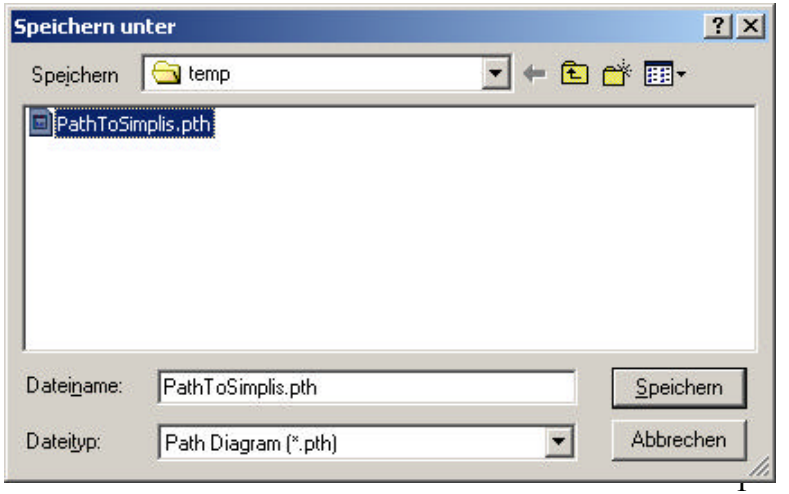
- Writing a text file with SIMPLIS commands (*.spl)
- Writing a text file with LISREL commands (*.ls8)
- generating a texte file with SIMPLIS commands using the menu (*.spj)
- generating a text file with LISREL commands using the menu (*.lpj)
- generating SIMPLIS or LISREL commands from a path diagram (*.pth)

Example: Generating SIMPLIS-commands by drawing a path diagram:

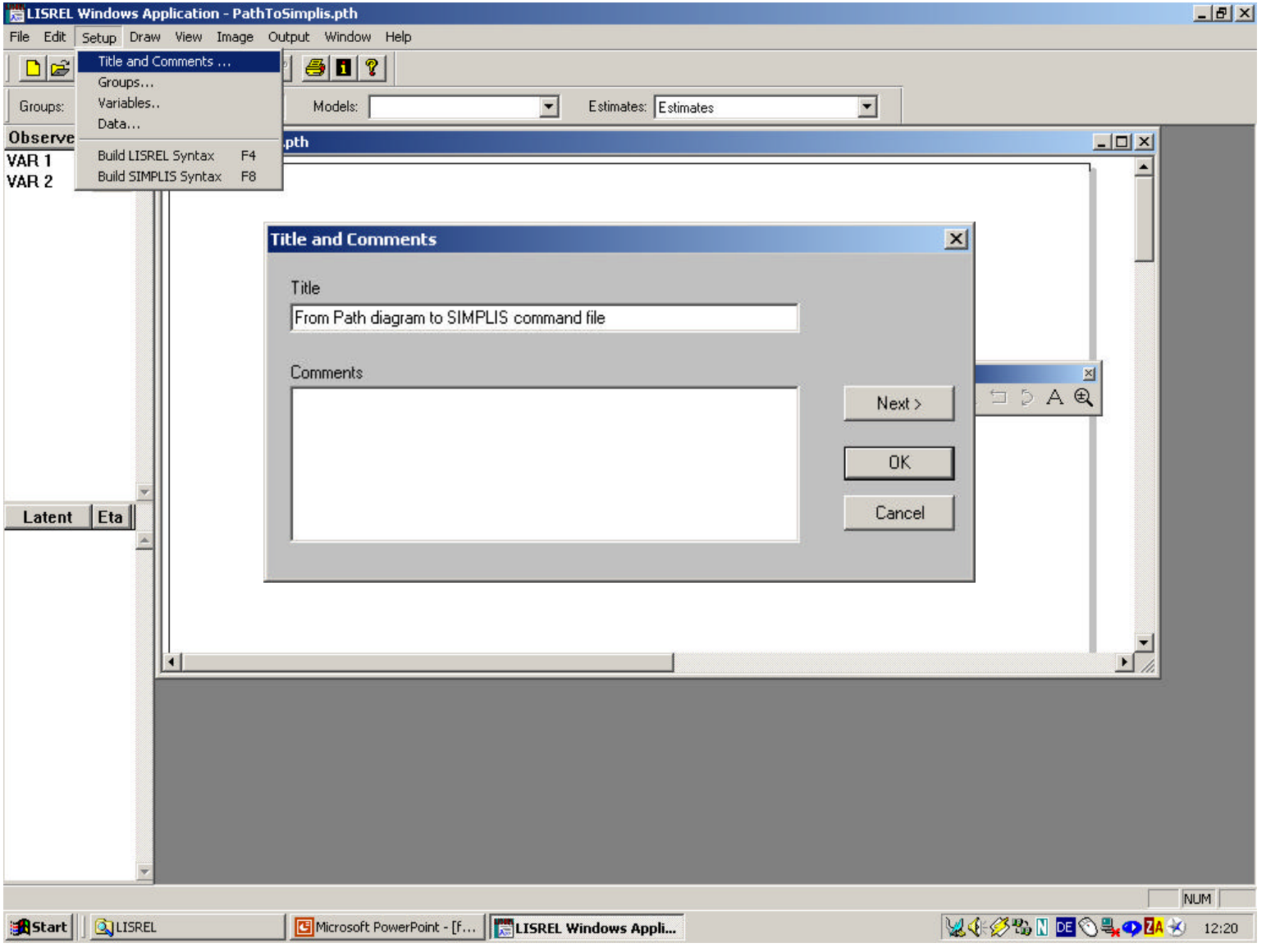
Step 1: Open the New-menue and chose “Path diagram”



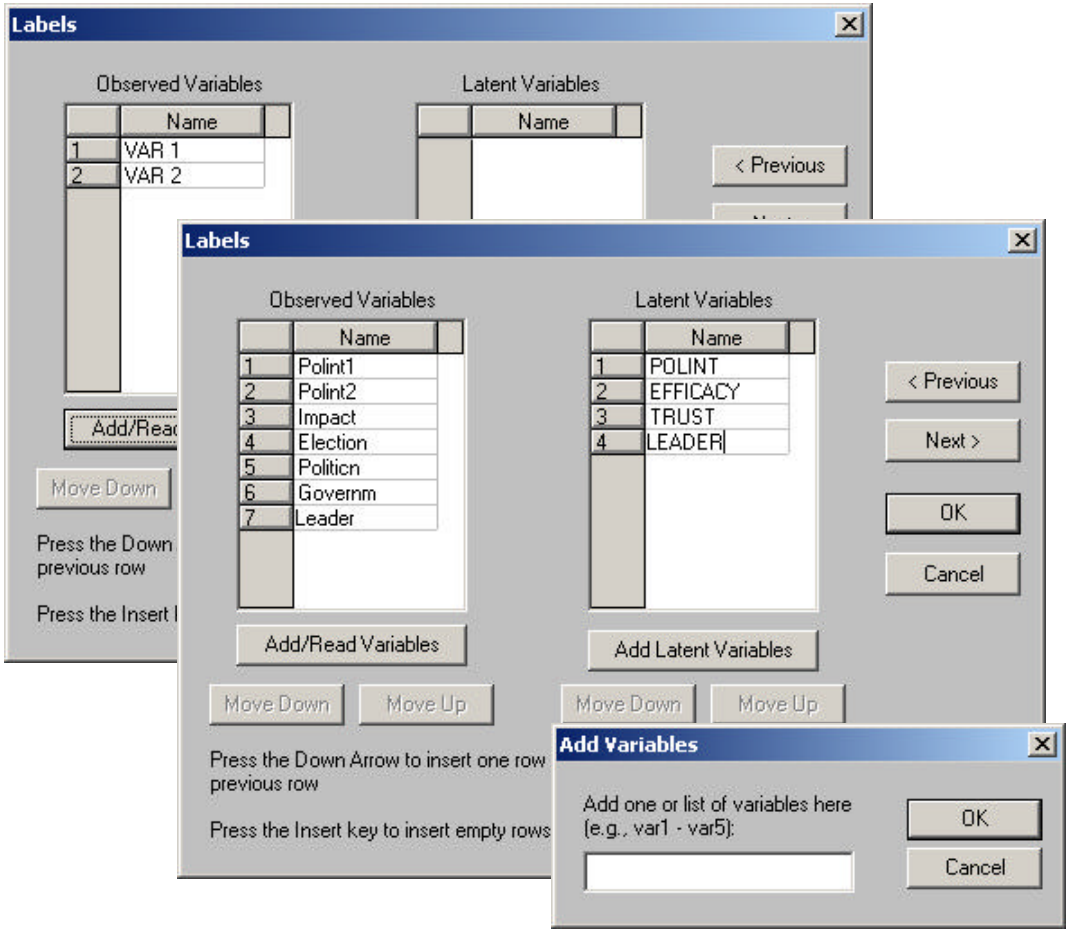
a filename have to be specified:



Step 2: Specifying Title line



Step 3: Specifying observed and latent variables

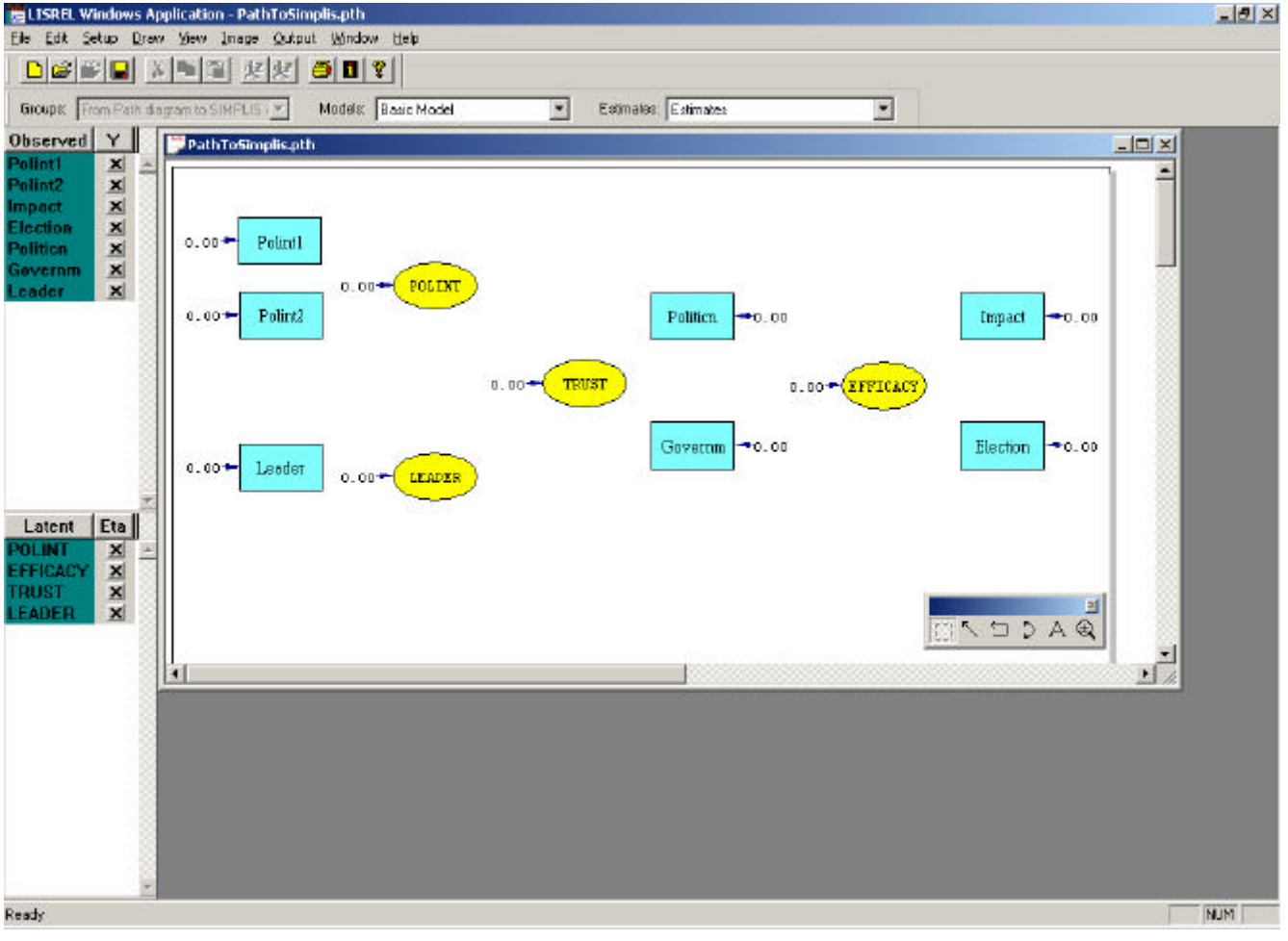


Overwrite given names,
↓ changed to line below;
if there is no one a further line will be generated.
<enter> finished last line

<Add latent variables> will open a field for the first latent variable

Step 4: Placing the variables

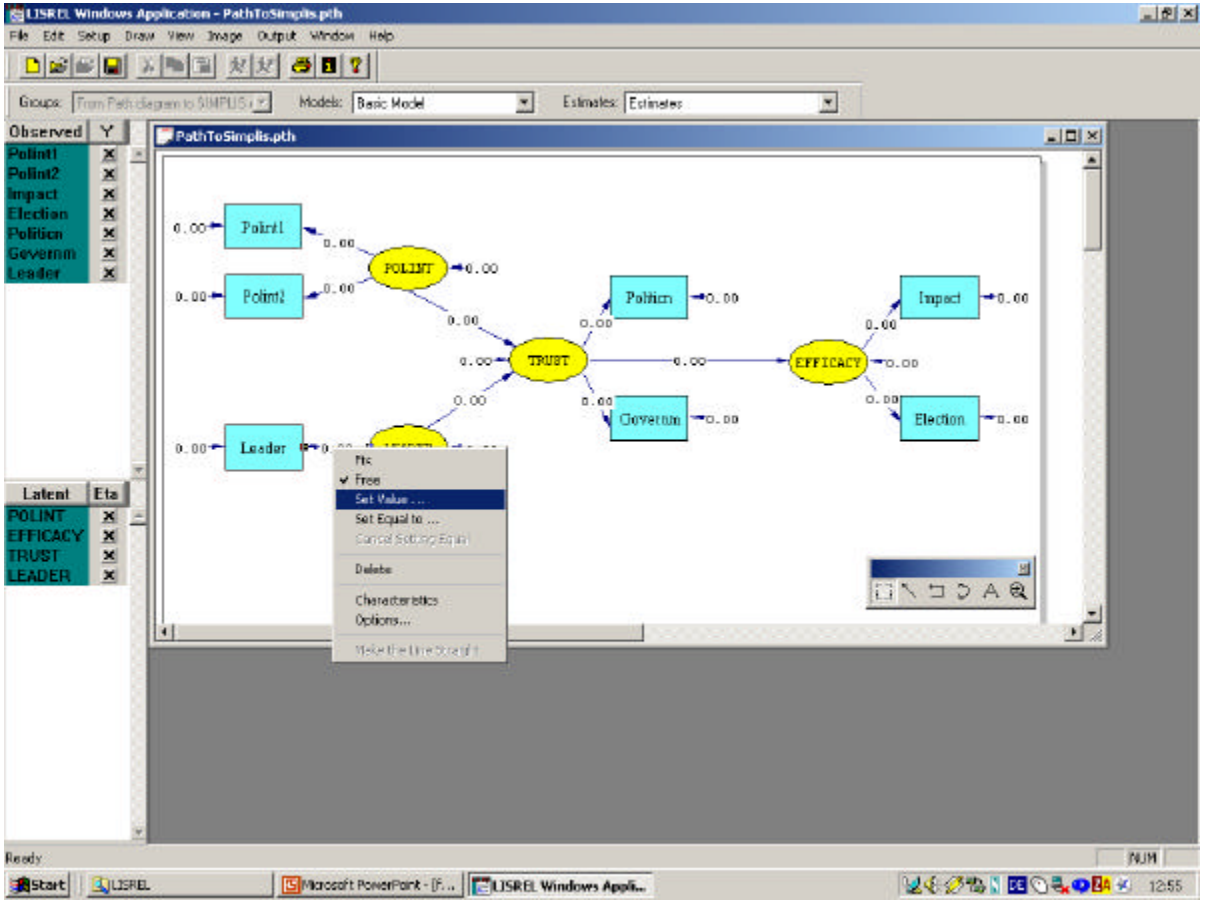
After declaring Observed variables from X (default) to Y, and latent from ξ to η, any variable can be placed by drawing it from the name to the drawing field.



Using the „Image“ menu objects can be aligned, rotated or flipped.

Step 5: Drawing paths and covariances

Relations between variables are set after pressing the arrow-symbol in the bar and pressing first the independent variable and than the dependent variables.

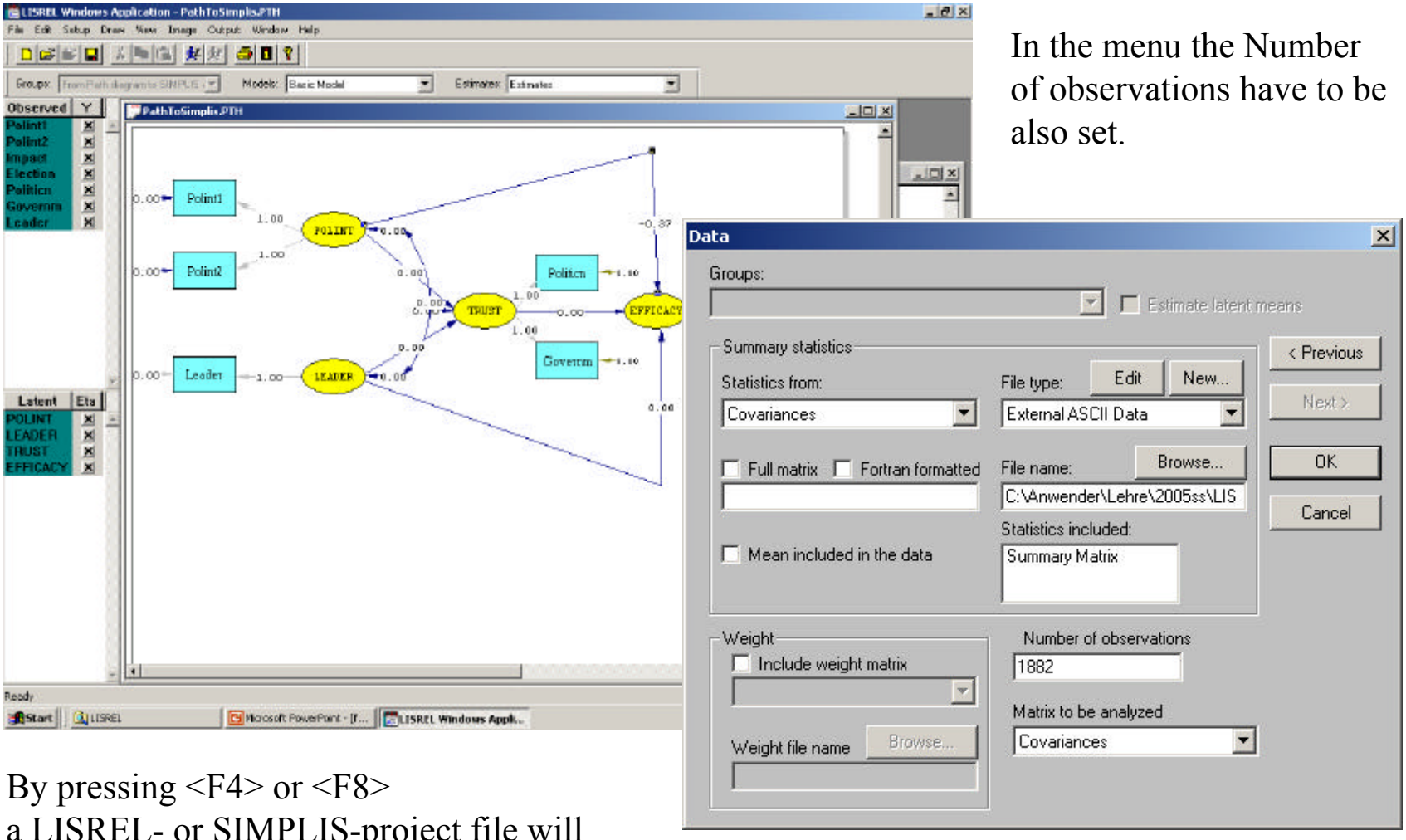


Similarly a covariance can be specified after pressing the double arrowed line.

By default all parameter are free.
Setting values, freeing or restricting parameters can be done after marking a path and pressing the right mouse key.

Step 6: Specifying the input data

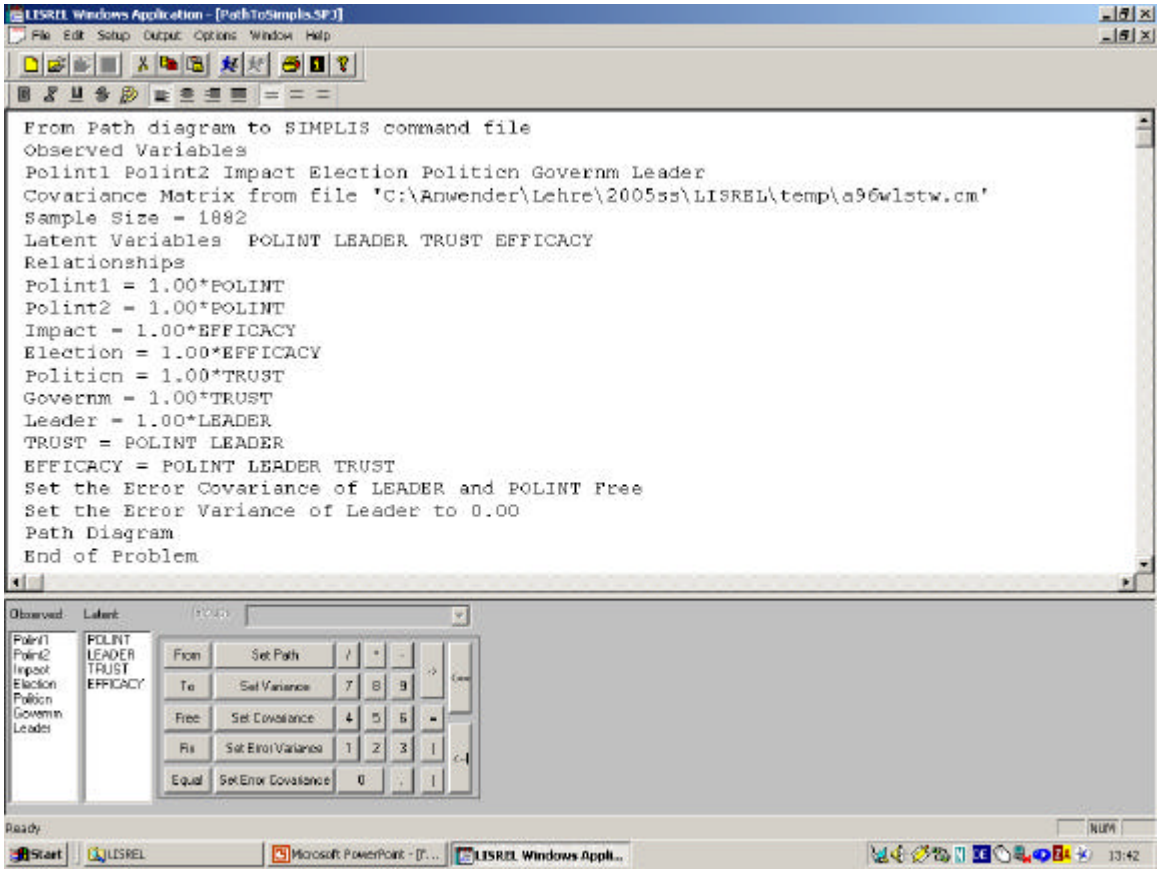
The input data information can be specified using the menu Setup -> Data



In the menu the Number of observations have to be also set.

By pressing <F4> or <F8>
a LISREL- or SIMPLIS-project file will be generated from the path diagram.

Step 7: Run LISREL



Before running LISREL it is possible to change the syntax.
For example it may be possibe to add the “no x-variables”-command.

Lastly the LISREL program will be run by pressing the LISREL-bottom.

The SIMPLIS command language

1) Title

It is useful if the model specification starts with informative title line(s)

```
Efficacy model using data from ALLBUS 96 West miss listw del
```

Title lines should not start with the not case-sensitive strings “DA”, “Observed”, “Labels”.
The number of title lines is arbitrary. If there is one or more title lines, only the first line will be reprinted on each page of the output.

2) Defining the observed variables

```
Observed Variables
Polint1 Polint2 Impact Election Politicn Governm Leader
```

After the key-words “observed variables” the variables in the data to be analyzed will be defined by their names (labels) . There should be defined as many names as there are variables in the data set to be analyzed. The order is given by the order in the input data.
A label should have no more than 8 characters. If there are blanks within a name the name must be specified in single quotation marks (e.g. ‘Pol 1’). Note, that Variable names are case sensitive. Further, names have to be different from SIMPLIS key words.
Alternatively variable names can be read in from a file by the keyword:

```
Observed Variables from file filename
```

A synonym of the keyword “observed variables “ are they shortcut “labels”.

3) Reading in Data to be analyzed

a) Covariance matrix and number of cases in ASCII format

After defining the observed variables input data can be read in. Most often this will be sufficient statistics as a variance-covariance matrix. Then the number of cases on which the statistics are based have to given too.

```
Covariance Matrix from file 'a96wlstw.cm'
Sample Size = 1882
```

A Covariance matrix can be read also from the next lines:

```
Covariance Matrix
0.951
0.827  0.895
...
```

Covariances will be read in in free format as a lower triangular matrix.
Sample size have to be specified if sufficient statistics will be read in

b) Reading Correlations, Standard Deviations and/or Means

It is also possible to read in Correlations Standard deviations and means from a file or directly after the corresponding keyword “correlation matrix”, “Standard deviations”, “Means”.

```
Correlation matrix from file a96wlstw.km
Standard deviations from file a96wlstw.sd
Means from file a96wlstw.me
Sample Size 1882
```

c) Reading row data

Instead of Statistics raw data can be read in:

```
Raw data from file a96wlstw.raw
```

Raw data can be given also in the lines following they key word “raw data”.
As all other input information (moments, variable names) raw data have to be given in free format (items separated by blanks) or using a FORTRAN format in the first row of the data.
If raw data are read in “sample size” should not be specified.
One (and only one) missing value can be defined if raw data are read in:

```
Missing value code 9
Raw data from file a96wall.raw
```

If missing data are present LISREL uses the FIML-algorithm with coping for missing data for the estimation of free parameters

d) Reading raw data from a psf-file

```
Raw data from file allb96sub.psf
```

The raw data can be read in also from a PRELIS system file. Then the “observed variables” should not be given and will be ignored otherwise.

e) Reading in a DSF-file

Both PRELIS and LISREL will generate with each run a "data system file" which has the same name as the file with PRELIS-, SIMPLIS- or LISREL-commands but the extension ".dsf".
In the dsf-file variable names, number of cases and sufficient statistics will be stored. Therefore, Instead of defining observed variables and read in raw data or sufficient statistics the dsf-file can be read in also.

```
System file from file Simplis1.dsf
```

Note, that all information are used from the dsf-file. Therefore, if in a PRELIS-job not only the covariance matrix will be produced but also the asymptotic covariance matrix, this matrix will be used to. Therefore, robust estimators will be invoked automatically.
The asymptotic covariances will be stored in an binary file defined on the ou-command in PRELIS. If this file will be deleted or moved in another directory LISREL stops with an error if the dsf-file is read in.

4) Defining latent variables

If a SEM with latent variables should be estimated, the latent variables have to be defines using the key words "Latent variables":

```
Latent Variables POLINT LEADER TRUST EFFICACY
```

As observed variables the variable names can be read in also from an external ASCII-file.
The order of the latent variables is arbitrary.

5) specification of linear equations

a) Writing equations

The linear relations between the variables can be specified as symbolic relations.

```
Relationships
Polint1  Polint2  = POLINT
Impact   Election = EFFICACY
Politicn Governm  = TRUST
Leader            = 1*LEADER
TRUST    EFFICACY = POLINT LEADER
         EFFICACY = TRUST
```

The variables at the left hand side are the dependent variables that will be explained by the independent variable in the right hand side.

By default the linear weights are free parameter.

Linear weights can be fixed to given numbers by specifying the fixed number and a multiplication symbol ("*") before the independent variable.

Similarly to specify a starting value, the number should be given in brackets.

Note that SIMPLIS will standardize latent variables if no unit is imposed by fixing the variance of an exogenous factor to 1 and fixing the first loading of an endogenous factor such that the variance becomes 1 too. To avoid one loading of each latent variable should be fixed to one.

b) Writing Paths

Instead of writing equations relations can be also specified as paths, where the characters "->" symbolized an effect.

```
PATHS
POLINT -> Polint1 Polint2
EFFICACY -> Impact Election
TRUST -> Politicn Governm
LEADER -> Leader
POLINT LEADER -> TRUST EFFICACY
TRUST -> EFFICACY
```

Then variables at the left hand side are the independent variables that will be explain the dependent variable in the right hand side.

The keyword "relationships" or "paths" to indicate the start of the model specification are optional and can be omitted without any consequence.

Note that starting values and fixed weights cannot be specified within a path definition. If necessary the have to be specified by following SIMPLIS commands.

A factor becomes a ξ-variable if it is not dependent. Their indicators becomes x-variables. Using the command

```
no x-variables
```

alls indicators will be specified as y-variables and all factors as η-variables

6) Change of default (pre-defined) restrictions

```
Set the Error Covariance of LEADER and POLINT free
Set the Error Variance of Leader equal to 0
Set error variances Impact and Election equal
```

Fixed parameter can be freed by the command "Set ... free",
free parameters can be fixed to a number by the command "set .. equal to z", where z is a number,
two parameters can be set equal by the command "set ... and ... equal".
Parameters are:
a) (error) variance of variable
b) (error) covariance of variable1 and variable2
c) path variable1 -> variable 2
In freeing or setting a restriction a path between any two variables var1 and var2 have to be specified either by "path var1 -> var 2" or by "path from var1 to var 2".
parameters can be set also by

`Set ... to z` if the parameter should be fixed to a value
or `Set ... to(z)` if the parameter should be free with a starting value

The SIMPLIS command language

7) Specification of output:

```
Path Diagram
Options ND=3 MI RS SC
LISREL output
```

The command "path diagram" forces LISREL to produce a path diagram.
The options command allows to set the estimation method and print options:

ND=m	forces m significant digits after the decimal point
MI	prints modification indices and expected changes for all restricted parameters
RS	print fitted moment, residuals, and standardized residuaös
SC	prints standardized solution (SS) and full standardized solution
PC	print covariances and correlations of estimators
AD=n	test regularity of covariance matrices of exogenous variables after n iterations AD=off no admissability test
SO	no test of identification of units of latent variables
ML	maximum likelihood estimation; GL GLS-estimation; UL ULS-estimation; WL WLS-estimation (asymptotic covariances matrix have to be read in).
LISREL output	instead of equation output output is presented as matrices; additionally the model specification is given. If the "LISREL output" command is specified all options may be given on this line.

8) Denoting the end of model specification

```
end of problem
```

to signal the end of the model specification.

General rules for PRELIS-, SIMPLIS- and LISREL- commands

- SIMPLIS- (and LISREL-) command lines have a maximum length of 128 characters.
- Two or more command can be given in one line if they are separated by a colon (;).
- The exclamation mark (!) is used as a comment sign. Every text after a explamation mark until the end of a line will be ignored.

The LISREL command language

Using LISREL a SEM can be also specified and estimated using the LISREL command language. Some specifications can be done onyl using LISREl commands and not using SIMPLIS commands.

As with PRELIS the LISREL command language is based on key-words where only the first two characters will be recognized by the program.

As using SIMPLIS input data information will be given first and model specification second.

From the LISREL path diagram output a command file with LISREL syntax can be generated by pressing <F4>. for example the first SIMPLIS specification (Simplis1.spl) will generate the LISREL commands shown at the following sheet.

The LISREL command language

```
TI Efficacy model using data from ALLBUS 96 West miss listw del
!DA NI=7 NO=1882 MA=CM
SY='C:\Anwender\Lehre\2005ss\LISREL\temp\Simplis1.DSF'
SE
 3 4 5 6 1 2 7 /
MO NX=3 NY=4 NK=2 NE=2 BE=FU GA=FI PS=SY TE=SY TD=SY
LE
TRUST EFFICACY
LK
POLINT LEADER
FI TD(3,3)
FR BE(2,1) GA(1,1) GA(1,2) GA(2,1) GA(2,2)
VA 1 LY(1,2)
VA 1 LY(2,2)
VA 1 LY(3,1)
VA 1 LY(4,1)
VA 1 LX(1,1)
VA 1 LX(2,1)
VA 1 LX(3,2)
EQ TE(2,2) TE(1,1)
PD
OU
```

The LISREL command language

1) Title

No difference to SIMPLIS

2) Defining input data

The LISREL command interpreter will be invoked by the DA-command which defines the input data.

```
DA NI=7 NO=1882 MA=CM MI=9
```

After the command "DA" the number of input variables and the number of cases have to be set:

`NI=k`	k observed variables will be in the input date
`NO=n`	The sufficient statistics are based on n cases
`MA=type`	gives the matrix to be analyzed, where "type" ist
`CM`	for covariance matrix
`KM`	for correlation matrix (PM polychoric correlation matrix)
`AM`	for augmented raw moment matrix.

Note that LISREL will recompute matrices, if a different type of input material is read.

If raw raw data will be read, missing values can be specified by the option MI

`MI=z`	where z denote the number used for missing values.

3) Defining labels for observed variables

By default the variable labels are “VAR1”, “VAR2” ...
It is possible to specify labels in the line following the LA-command or read in labels from an externals file.

```
LA
Polint1 Polint2 Impact Election Politicn Governm Leader /
```

or `LA=filename`

The order of the labels should follow the order in the input data.
It is not necessary to define labels for all variables. Then a slash (/) should given after the last label. Otherwise LISREL try to read as many labels as observed variables are defined, which will result in an error because the next commands will be interpreted as labels.
Note that different to SIMPLIS data input (labels, covariances ...) must be start on the next line if it is not read from an external file but within the command input stream.

The LISREL command language

4) Read data

As SIMPLIS also LISREL can read in sufficient statistics or raw data. Each type of data will be forced to read in by a different command:

`RAW=filename`	to read in raw data from an external file
`CM=filename`	to read in covariances
`KM=filename`	to read in correlations (PM for polychoric correlations)
`SD=filename`	to read in standard deviations
`ME=filename`	to read in means
`AC=filename`	to read a (binary) file of asymptotic variances and covariances

By default the input data will be read in free format (data are separated by blanks). It is possible to read in formatted input if a FORTRAN format is given in the first line of the data or if the Option "FO " follows the command. Then the format should be given in the next line:

```
RAW=allb96sub.dat FO
(8F1.0)
```

Moment matrices are lower triangular by definition. A full squared matrix can be read in using the option "FU". For example a 3 by 3 correlation matrix may be read in by:

```
KM FU
1.0 0.2 0.3
0.2 1.0 0.1
0.3 0.1 1.0 /
```

The LISREL command language

If data are read from an external file, the file can be read in again later, if the option "RE"(for rewind) is specified, for example

```
LA=labels.lab RE
```

With exception of the asymptotic covariance matrix all input data can be read in either by a file or in the next line(s) following the command that forces to read in information.

.

If raw data are read in, it is not necessary to specify the number of cases.
Instead of an external ASCII-file also a PRESLIS-system file can be read in. Then it is not necessary to specify labels:

```
RA=filename.psf
```

It is also possible to read in a data system file using the command

```
SY=filename.dsf
```

If a dsf-file is read the DA-command should be omitted.

The LISREL command language

5) Selection and Reorder of the input variables

The order of the input variables is given by the external files. But specifying a SEM with x- and y-variables using LISREL-commands the data information of the y-variables must be come before that of the x-variables. If the input variables do not follow this rule, they can be reordered by the SE-command:

```
SE
Impact Election Politicn Governm Polint1 Polint2 Leader /
```

Instead of variable names also numbers can be specified:

```
SE
3 4 5 6 1 2 7/
```

By this command a subset of input variables can be selected for an SEM. Then a slash should follow the last label or number.

This is not necessary if the labels or numbers are read from an external file:

```
SE=filename
```

The LISREL command language

6) Specification of the basic structure

The basic structure of an SEM ist specified with the MO-command, where MO means model specification:

```
MO NX=n NY=m NK=p NE=q C
   LX=type LY=type BE=type GA=type C
   TD=type TE=TYPE PH=type PS=type
```

The keywords NX and NK specify the number of x-variables and y-variables,
the keywords NK and NE the number of ξ-variables and η-variables.
Note that by this numbers the order of the parametrer matrixes are also given.

The keyword "C" is used to continue the command on the next lines.

Then the parameter matrices are specified:

LX	defines the loadings of x on ξ (lambda-x)
LY	defines the loadings of y on η (lambda-y)
BE	defines the effects between the η-variables (beta)
GA	defines the effects of ξ on η (gamma)
TD	defines the covariances of the δ-variables (theta-delta)
TE	defines the covariances of the ε-variables (theta-epsilon)
PH	defines the covariances of the ξ-variables (phi) and
PS	defines the covariacnes of the ζ-variables (psi)

The LISREL command language

After the keyword follows the type, which has the form "form,mode" where form is:

- FU for a full matrix
- SY for a symmetric matrix
- DI for a diagonal matrix
- ID for a identity-matrix
- ZE for a zero-matrix (parameters do not exist)

The mode can be either

- FI for all elements fixed (to zero by default) or
- FR for all elements free to be estimated

There are two specific types:

- PH=ST denote a symmetric phi-matrix which fixed ones in the diagonal and free off-diagonals (that is a correlation matrix)
- ma=SY denotes a symmetric matrix with free diagonal elements and off-diagonals fixed ma have to be a covariance matrix (PH, PS, TD, TE)

7) Giving labels for latent variables

Variable names (labels) for ξ-variables and η-variables may be specified after the MO-command is given.

`LK` forces LISREL to read in labels for the ξ-variables
`LE` forces LISREL to read in labels for the η-variables

The syntax is the same as the syntax of the LA-command. Most often follows the labels on the next lines in free format.
Then if not for all ξ- or η-variables labels are specified, a slash (/) should follow the last label. This is not necessary if the labels are read in from an external file by
`LK=filename` or `LE=filename`.

8) Changing the basic structure

As an example the basic specification for the efficacy model may be:

```
MO NX=3 NY=4 NK=2 NE=2 LX=FU,FI LY=FU,FI BE=FU,FI GA=FU,FR C
   PH=SY,FR PS=SY TD=SY TE=SY
```

Then lambda-x is a 3 by 2 matrix with 0 in all cells, lambda-y is a 4 by 2 matrix with 0 in all cells, beta is a 2 by 2 matrix with 0 in all cells, gamma is a 2 by 2 matrix where all 4 elements are free to be estimated, phi is a symmetric 2 by 2 matrix where all elements are free to be estimated and psi, theta-delat and theta-epsilon are symmetric matrices with free elements in the diagonals but fixed 0 in the off-diagonals.

Usually a basic structure have to be changed; some fixed elements should become free, some free elements should become fixed to a known number and other parameters may be set equal. To specify this the following LISREL-commands can be used

- `FR` to free parameters
- `FI` to fix parameters
- `EQ` to set parameters equal
- `VA` to set values different from 0 to fixed elements or starting values for free elements.

The LISREL command language

On the FR- FI-, EQ-, and the VA-command parameter are named by its matrix.name and their position in the matrix.

For example

`BE(2,1)` denotes the element in the second row and first column of the beta-matrix, that is the effect of η_1 on η_2 (β_{21})

Similarly all other parameters can be named. The brackets and the comma can be substituted by a blank, that is instead of "BE(2,1)" "BE 2 1 " can be written.

All parameters named on a FR-command becomes free elements, all parameters named on a FI command becomes free elements. It is possible to free a parameter on a FR-command and fix them later on a FI-command and vice versa.

All elements named on the same EQ-command are restricted to be equal.
Note that only free elements should be specified on a EQ-command.

Before parameters are named on the VA-command the value for the fixed parameter should be stated, for example

`VA 1 LX(1,1) LX(3,2)` set the fixed parameter λ^x_{11} and λ^x_{32} from 0 to 1.

The LISREL command language

An alternative for freeing and fixing parameters using FI- and FR commands is the specification of a pattern matrix:

`PA ma` where "ma" denote any parameter matrix.

After the command a pattern of free and fixed elements are given, symbolized by a "0" for a fixed and a "1" for a free element.

For example the lines:

```
PA BE
0 0
1 0
```

specified β_{11}, β_{12} and β_{22} as fixed parameters but β_{21} as free parameter.

As other input data the pattern can be read in from a file:

```
PA=filenmae ma
```

Values for all parameters of a matrix can be also specified by MA-commands:

`MA=filename ma` or `MA ma.`

For example starting values for Beta may be given by

```
MA BE
0.0 0.0
0.2 0.0
```

The LISREL command language

9) Specifying estimations method and output options

To force LISREL to draw a path diagram the command

`PD` has to be specified without further options.

The last command of each specification must be the OU-command:

```
OU options
```

There are the same options than in the options-command of SIMPLIS.

The LISREL command language

An example:

```
LISREL command language example
DA NI=7 NO=1882 MA=CM
LA=labels.lab
CM=a96wlstw.cm
SE=SE.lab
MO NX=3 NY=4 NK=2 NE=2 C
   LX=FU,FI LY=FU,FI BE=FU,FI C
   GA=FU,FR PH=SY,FR PS=SY C
   TE=SY TD=SY
LE
TRUST EFFICACY
LK
POLINT LEADER
FI TD(3,3)
VA 1 LX(1,1) LX(2,1) LX(3,2) C
   LY(1,1) LY(2,1) LY(3,2) LY(4,2)
FR BE(2,1)
EQ TE(3,3) TE(4,4)
PD
OU ND=3
```

DA-command defining 7 input variables
Labels, covariances and the order of the variables is read from externalö files.

Specification of a full LISREL model

Labels for latent variables follows in the input stream

θ^{δ}_{33} is fixed (to default value 0).
The default value 0 is changed for some loadings to the value 1
β_{21} becomes a free element
$\theta^{\varepsilon}_{33}$ and $\theta^{\varepsilon}_{44}$ are restricted to be equal