



Path diagrams

Path diagrams are useful to present the basic conceptual ideas of a model, as seen in the examples discussed thus far. From these path diagrams, the relationships of the model can easily be written in the input file.

Path diagrams can also be obtained as output from LISREL. Several different path diagrams can be produced on the screen, and these path diagrams can be changed interactively to define a modified model, which in turn can be estimated directly without changing the input file. The path diagrams and how to change them are described and illustrated in this document, using data from some of the examples discussed previously.

To produce a path diagram of an estimated model, include a line

```
Path Diagram
```

in the input file. This line may be inserted anywhere after the line

```
Observed Variables
```

and before the line

```
End of Problem
```

In the examples that follows, we have inserted the line immediately before the line

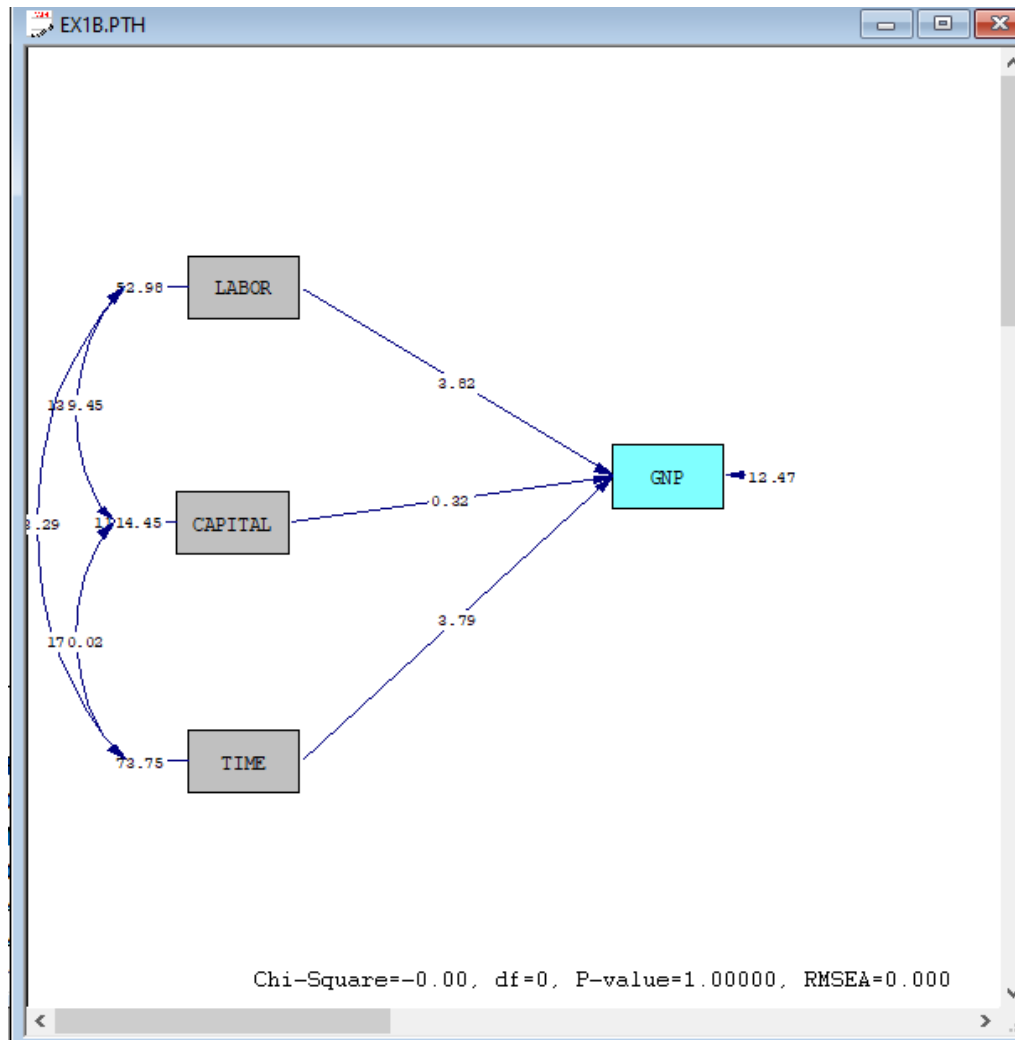
```
End of Problem
```

Parameter Estimates and *t*-values

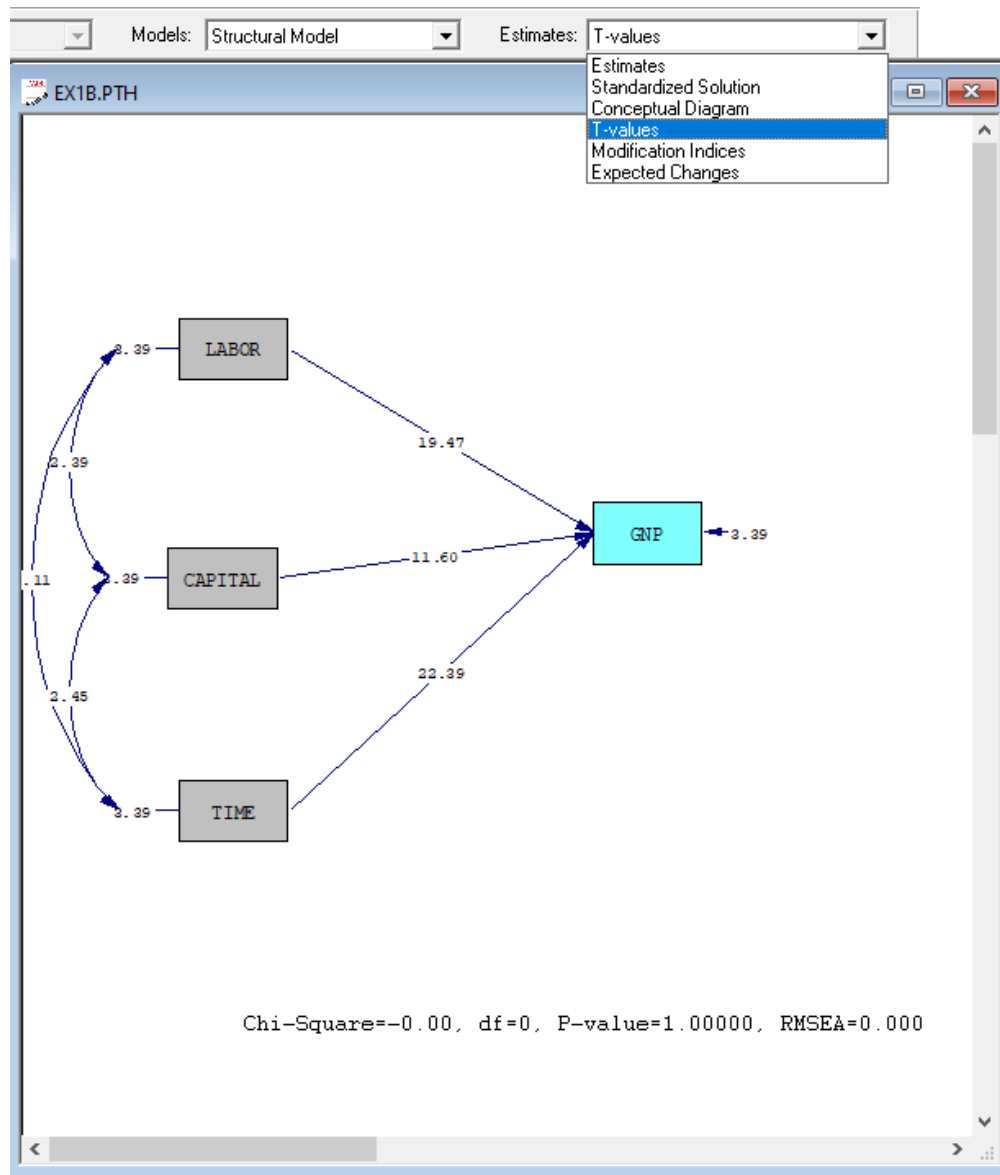
Consider the regression of GNP problem and the input file **EX1B.SPL** (see the **SIMPLIS Examples** folder). Insert the line

```
Path Diagram
```

and run the problem the path diagram depicted below appears as part of the output. This is the path diagram with parameter estimates.



To obtain t -values, select the **T-values** option from the **Estimates:** menu. A similar path diagram appears but with t -values instead of parameter estimates (see below). The non-significant t -values, if any, will appear in a different color.

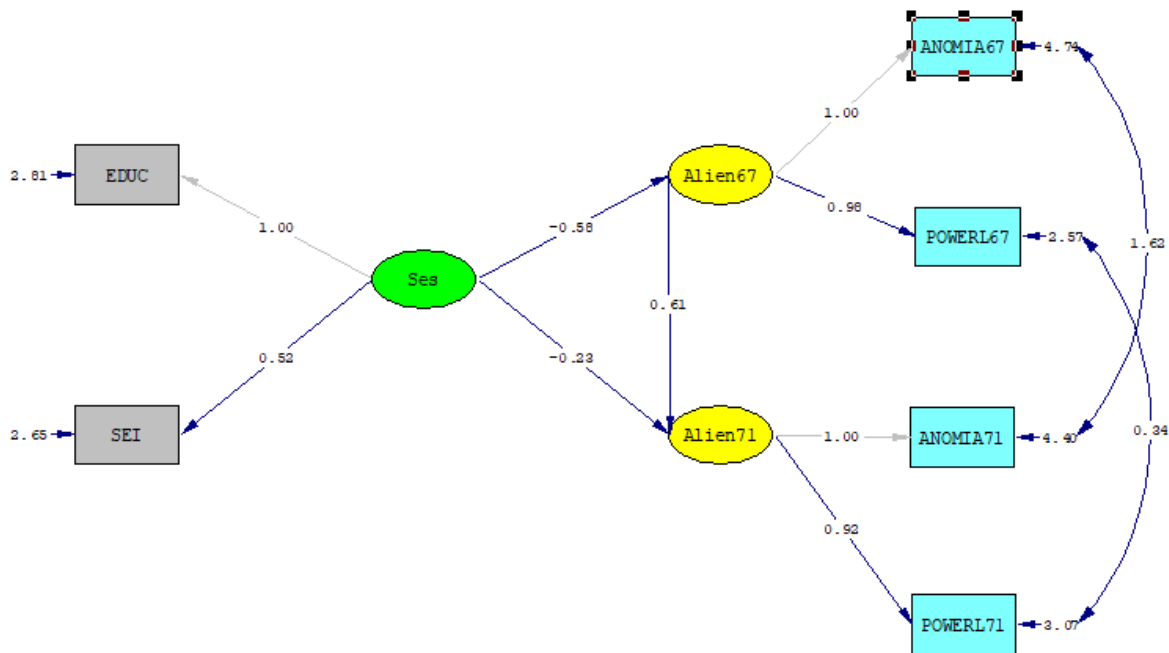


B-, X-, Y-, S-, and R-diagrams

Using the Stability of Alienation data considered in the sixth example and the input file **EX6B.SPL**, we insert the line

Path Diagram

and run the problem. The path diagram (see below) is the **B**-diagram with parameter estimates (**B** for Basic model).



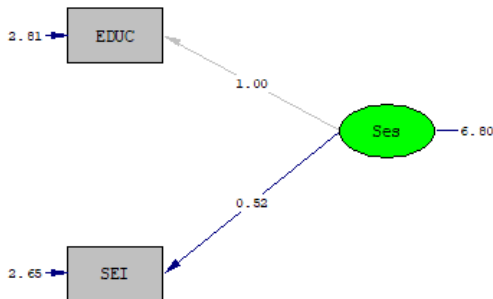
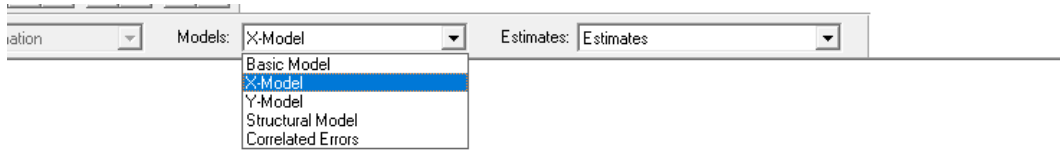
Chi-Square=4.74, df=4, P-value=0.31510, RMSEA=0.014

There are four additional path diagrams with estimates that are produced, but only one is visible at any time. The other four path diagrams are shown below, with the corresponding option on the **Models:** menu highlighted.

The latent variables are classified into dependent and independent latent variables. The dependent latent variables are those which depend on other latent variables. In the path diagram these have one or more one-way (undirected) arrows pointing towards them. Hence the dependent latent variables are Alien67 and Alien71 in this example. The independent latent variables are those which do not depend on other latent variables. In the path diagram they have no one-way arrows pointing to them. In this case there is one independent latent variable, namely Ses. In standard LISREL terminology, the dependent latent variables are called η -variables or ETA-variables, and the independent latent variables are called ξ -variables or KSI-variables.

Next, the observed variables are classified into two categories: y -variables and x -variables. The y -variables are those observed variables that depend on the dependent latent variables, and the x -variables are those that depend on the independent latent variables. In this case, the y -variables are ANOMIA67 ANOMIA71

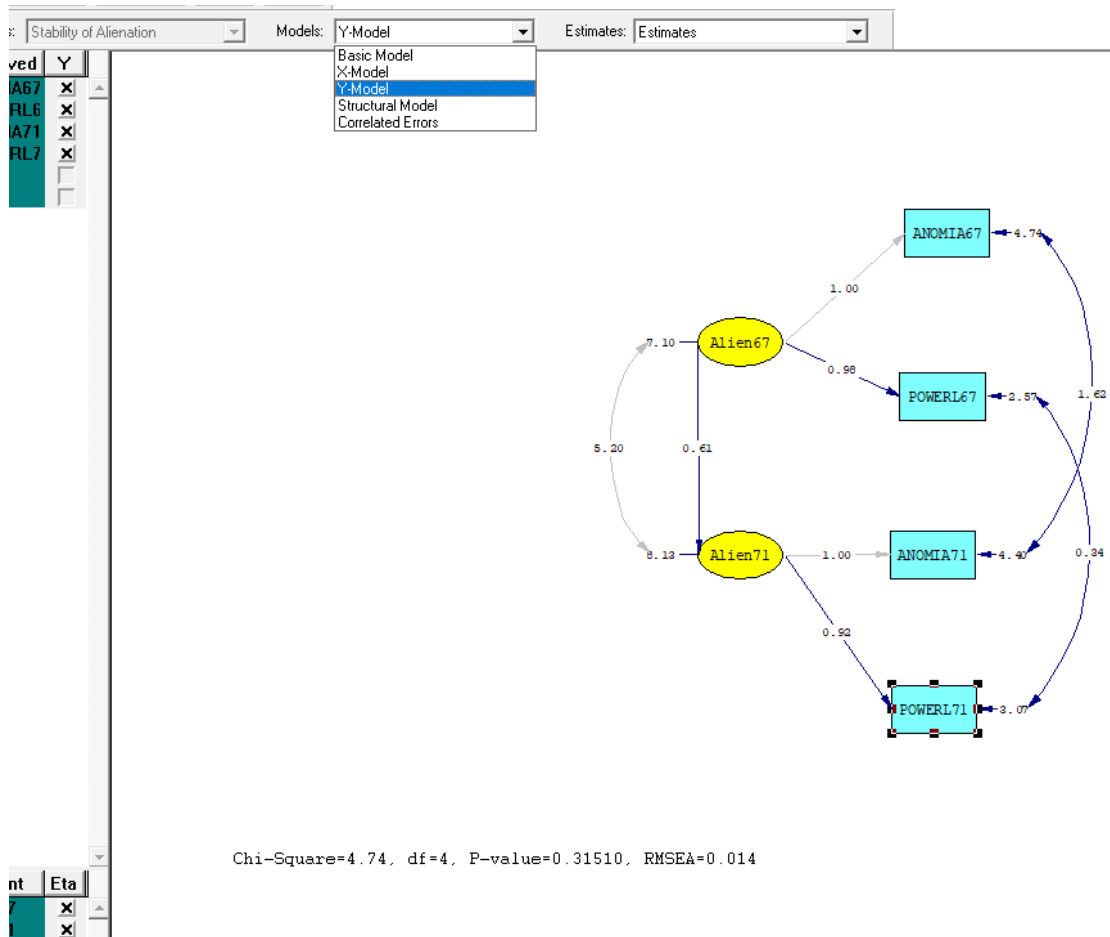
POWERL67 POWERL71, as these depend on the dependent latent variables Alien67 and Alien71; the x -variables are EDUC and SEI as they depend on the independent latent variable Ses.



Chi-Square=4.74, df=4, P-value=0.31510, RMSEA=0.014

The **X**-diagram shown above describes how the x -variables depend on the independent latent variables. This is the measurement model for the x -variables. The measurement errors of the x -variables and their variances are included in this path diagram. The variance of **Ses** is also shown in this path diagram.

The **Y**-diagram shown below describes how the y -variables depend on the dependent latent variables. This is the measurement model for the y -variables. The measurement errors of the y -variables and their variances are included in this path diagram as well as the variances and covariances of the latent dependent variables.



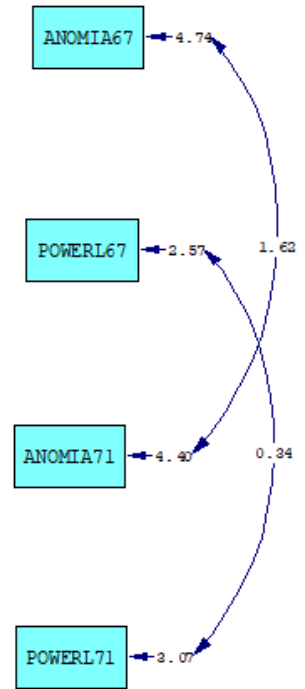
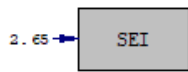
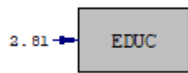
Although the measurement errors of the y-variables are shown in the **Y**-diagram, this diagram does not show that some of these errors are correlated, as was specified in the input file **EX6B.SPL**. To see the correlated error terms, select the **Correlated Error** option from the **Model**: menu.

This gives a path diagram as shown below, the **R**-diagram. Here a two-way arrow indicates that two error terms are correlated and the number attached to the line is the covariance between the two error terms. Note that it is the covariance of the error terms of the variables that are indicated in the path diagram, not the covariance between the observed variables.

The variances and covariances of the measurement errors of the y-variables can be seen in the **R**-diagram. For example, the measurement error variance of ANOMIA67 is 4.74 and that of ANOMIA71 is 4.40. The covariance of these two error terms is also seen in the **R**-diagram and is given as 1.62.

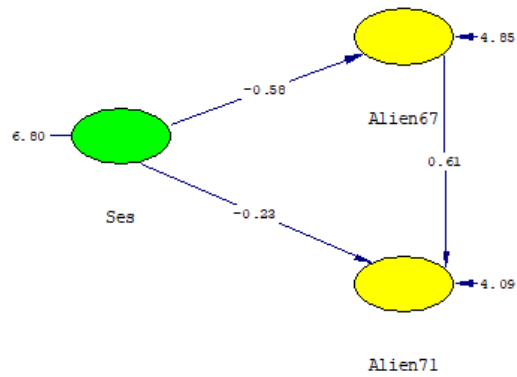
ion Models: **Correlated Errors** Estimates: Estimates

- Basic Model
- X-Model
- Y-Model
- Structural Model
- Correlated Errors**



Chi-Square=4.74, df=4, P-value=0.31510, RMSEA=0.014

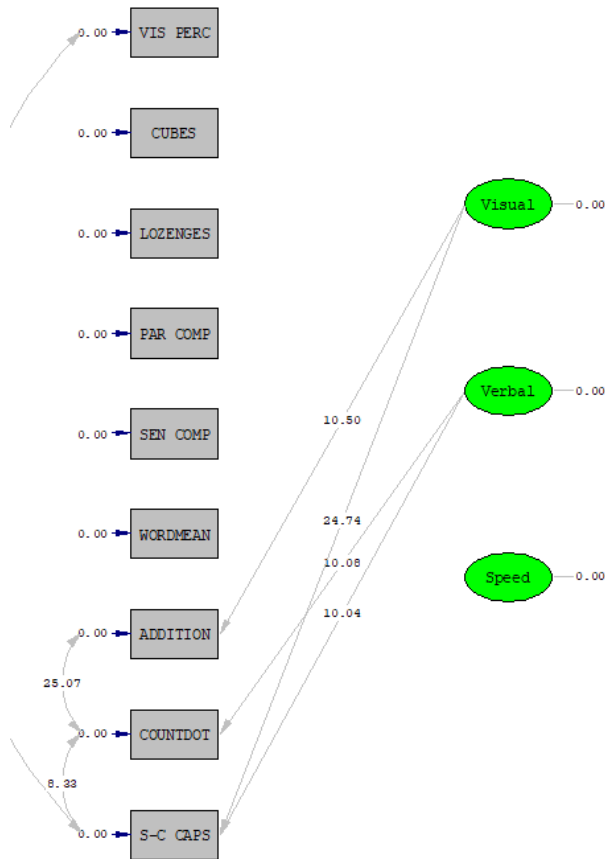
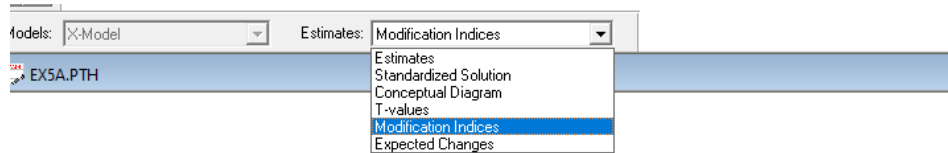
The next path diagram is the **S**-diagram (**S**tructural Relationships) which describes how the dependent latent variables depend on the independent latent variables. Note that there is an error term on each of the dependent latent variables and the variances of these appear in the path diagram. Also note that the variance of the latent independent variable appears at a line (not an arrow) attached to Ses. If there are several independent latent variables, all their variances and covariances will be indicated in the path diagram.



Chi-Square=4.74, df=4, P-value=0.31510, RMSEA=0.014

Modification Indices

To illustrate the modification indices available with the path diagram, we use the data previously used in the fifth example (Nine psychological variables – a confirmatory factor analysis) and the syntax file **EX5A.SPL**. After obtaining the path diagram by running the syntax, select **Modification Indices** from the **Estimates:** menu as shown below.



Chi-Square=52.99, df=24, P-value=0.00058, RMSEA=0.091

Recall that there is a modification index for each fixed parameter in the model and that the index estimates the decrease in chi-square that would occur if the parameter is set free to be estimated. This means that there is a modification index associated with every path missing in the original path diagram and that it measures the improvement in fit to be expected if a corresponding path is added to the model. Only larger modification indices are of interest, so LISREL only displays modification indices larger than 7.882, which is the 99.5 percentile of the chi-square distribution with one degree of freedom.

The largest modification index in the figure is 24.7 for the path from Visual to S-C CAPS. If it is difficult to see the value of the modification index or to determine which path it belongs to, several options are available:

- One can zoom and enlarge a smaller window of the path diagram by selecting the first tool on the path diagram toolbox



- One can temporarily delete some paths in the **M**-diagram above until the one associated with 24.7 is uniquely identified. In this case, it is sufficient to delete the path from Verbal to S-C CAPS to see that 24.7 is really associated with the path from Visual to S-C CAPS.
- While looking at a path diagram, one can display the output file and then go back to the path diagram.

To illustrate the third alternative above, switch to the output file. This output shows

The Modification Indices Suggest to Add the

Path to	from	Decrease in Chi-Square	New Estimate
ADDITION	Visual	10.5	-0.37
COUNTDOT	Verbal	10.1	-0.28
S-C CAPS	Visual	24.7	0.57
S-C CAPS	Verbal	10.0	0.26

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
COUNTDOT	ADDITION	25.1	0.62
S-C CAPS	VIS PERC	9.1	0.18
S-C CAPS	COUNTDOT	8.3	-0.38

The output also tells us that the parameter associated with this path from Visual to S-C CAPS should be expected to be in the vicinity of 0.57 if it is included in the model and estimated.