Example 15 — Higher-order CFA

Description

sem can be used to estimate higher-order confirmatory factor analysis models.

. use https://www.stata-press.com/data/r16/sem_hcfa1
   (Higher-order CFA)
. ssd describe
   Summary statistics data from https://www.stata-press.com/data/r16/sem_hcfa1.dta
   obs: 251 Higher-order CFA
   vars: 16 25 May 2018 11:26
   (_dta has notes)

     variable name          variable label
    ---------               -------------------
     phyab1                Physical ability 1
     phyab2                Physical ability 2
     phyab3                Physical ability 3
     phyab4                Physical ability 4
     appear1               Appearance 1
     appear2               Appearance 2
     appear3               Appearance 3
     appear4               Appearance 4
     peerrel1              Relationship w/ peers 1
     peerrel2              Relationship w/ peers 2
     peerrel3              Relationship w/ peers 3
     peerrel4              Relationship w/ peers 4
     parrel1               Relationship w/ parent 1
     parrel2               Relationship w/ parent 2
     parrel3               Relationship w/ parent 3
     parrel4               Relationship w/ parent 4

. notes
   _dta:
   2. Summary statistics based on 251 students from Sydney, Australia in Grade 5.
   3. Data collected using the Self-Description Questionnaire and includes sixteen subscales designed to measure nonacademic traits: four intended to measure physical ability, four intended to measure physical appearance, four intended to measure relations with peers, and four intended to measure relations with parents.

See Higher-order CFA models in [SEM] Intro 5 for background.
Remarks and examples

Remarks are presented under the following headings:

- Fitting the model
- Fitting the model with the Builder

Fitting the model

We fit the following model:
Example 15 — Higher-order CFA 3

. sem (Phys -> phyab1 phyab2 phyab3 phyab4) > (Appear -> appear1 appear2 appear3 appear4) > (Peer -> peerrel1 peerrel2 peerrel3 peerrel4) > (Par -> parrel1 parrel2 parrel3 parrel4) > (Nonacad -> Phys Appear Peer Par)

Endogenous variables
Measurement: phyab1 phyab2 phyab3 phyab4 appear1 appear2 appear3 appear4 peerrel1 peerrel2 peerrel3 peerrel4 parrel1 parrel2 parrel3 parrel4
Latent: Phys Appear Peer Par
Exogenous variables
Latent: Nonacad

Fitting target model:
Iteration 0:  log likelihood = -7686.6699 (not concave)
Iteration 1:  log likelihood = -7643.7387 (not concave)
Iteration 2:  log likelihood = -7616.2966 (not concave)
Iteration 3:  log likelihood = -7597.6133
Iteration 4:  log likelihood = -7588.9515
Iteration 5:  log likelihood = -7585.3162
Iteration 6:  log likelihood = -7584.8125
Iteration 7:  log likelihood = -7584.7885
Iteration 8:  log likelihood = -7584.7881

Structural equation model
Number of obs = 251
Estimation method = ml
Log likelihood = -7584.7881

( 1) [phyab1]Phys = 1
( 2) [appear1]Appear = 1
( 3) [peerrel1]Peer = 1
( 4) [parrel1]Par = 1
( 5) [Phys]Nonacad = 1

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<tr>
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<th>OIM</th>
<th></th>
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<th>[95% Conf. Interval]</th>
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<td>Std. Err.</td>
<td>z</td>
<td>P&gt;</td>
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## Example 15 — Higher-order CFA

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### Example 15 — Higher-order CFA

<table>
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<th></th>
<th>var(e.appe-2)</th>
<th>var(e.appe-3)</th>
<th>var(e.appe-4)</th>
<th>var(e.peer-1)</th>
<th>var(e.peer-2)</th>
<th>var(e.peer-3)</th>
<th>var(e.peer-4)</th>
<th>var(e.parr-1)</th>
<th>var(e.parr-2)</th>
<th>var(e.parr-3)</th>
<th>var(e.parr-4)</th>
<th>var(e.Phys)</th>
<th>var(e.Appear)</th>
<th>var(e.Peer)</th>
<th>var(e.Par)</th>
<th>var(Nonacad)</th>
<th>LR test of model vs. saturated: chi2(100) = 219.48, Prob &gt; chi2 = 0.0000</th>
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<td>2.374508</td>
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<td>2.189162</td>
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</table>

#### Notes:

1. The idea behind this model is that physical ability, appearance, and relationships with peers and parents may be determined by a latent variable containing nonacademic traits. This model was suggested by Bollen (1989, 315).

2. `sem` automatically provided normalization constraints for the first-order factors Phys, Appear, Peer, and Par. Their path coefficients were set to 1.

3. `sem` automatically provided a normalization constraint for the second-order factor Nonacad. Its path coefficient was set to 1.

### Fitting the model with the Builder

Use the diagram above for reference.

1. Open the dataset.

   In the Command window, type

   ```stata
   . use https://www.stata-press.com/data/r16/sem_hcfa1
   ```

2. Open a new Builder diagram.

   Select menu item Statistics > SEM (structural equation modeling) > Model building and estimation.

3. Enlarge the size of the canvas to accommodate the length of the diagram.

   Click on the Adjust canvas size button, ▶️, in the Standard Toolbar, change the second size to 7 (inches), and then click on OK.

4. Change the size of the observed variables’ rectangles.
   a. In the SEM Builder menu, select Settings > Variables > All observed....
   b. In the resulting dialog box, change the second size to .25 and click on OK.

5. Create the measurement component for physical ability.

   Select the Add measurement component tool, ⬇️. Then using the darker one-inch grid lines in the background as a guide, click in the diagram about two inches in from the left and one inch down from the top.
In the resulting dialog box,

a. change the *Latent variable name* to *Phys*;

b. select *phyab1*, *phyab2*, *phyab3*, and *phyab4* by using the *Measurement variables* control;

c. select *Left* in the *Measurement direction* control;

d. click on *OK*.

If you wish, move the component by clicking on any variable and dragging it.

6. Create the remaining first-order measurement components.

   a. Repeat the process from item 5, but place the measurement component on the grid line two inches in from the left and about two and one-half inches down from the top. Label the latent variable *Appear*, and select measurement variables *appear1*, *appear2*, *appear3*, and *appear4*.

   b. Repeat the process from item 5, but place the measurement component on the grid line two inches in from the left and about four inches down from the top. Label the latent variable *Peer*, and select measurement variables *peerrel1*, *peerrel2*, *peerrel3*, and *peerrel4*.

   c. Repeat the process from item 5, but place the measurement component on the grid line two inches in from the left and about five and one-half inches down from the top. Label the latent variable *Par*, and select measurement variables *parrel1*, *parrel2*, *parrel3*, and *parrel4*.

7. Create the second-order latent variable.

   a. Select the Add latent variable tool, \( \circ \), and then click in the diagram about two inches in from the right and vertically centered between the *Appear* and *Peer* latent variables.

   b. In the Contextual Toolbar, type *Nonacad* in the *Name* control and press *Enter*.

8. Create paths from *Nonacad* to each of the first-order latent variables.

   a. Click in the Add path tool, \( \rightarrow \).

   b. Click in the upper-left quadrant of the *Nonacad* oval (it will highlight when you hover over it), and drag a path to the lower-left quadrant of the *Phys* oval (it will highlight when you can release to connect the path).

   c. Continuing with the \( \rightarrow \) tool, create the following paths by clicking first on the left side of the *Nonacad* variable and dragging to the right side of the first-order latent variable.

\[
\text{Nonacad} \rightarrow \text{Appear} \\
\text{Nonacad} \rightarrow \text{Peer} \\
\text{Nonacad} \rightarrow \text{Par}
\]

9. Clean up the direction of the errors.

   We want the errors for each of the latent variables to be below the latent variable. The errors for *Phys*, *Appear*, and *Peer* are likely to have been created in other directions.

   a. Choose the Select tool, \( \text{揵} \).

   b. Click in the *Phys* oval.

   c. Click on one of the *Error rotation* buttons, \( \leftrightarrow \), in the Contextual Toolbar until the error is below the latent variable.

Repeat this for all errors on latent variables that are not below the latent variable.
10. Clean up the paths.
   
   If you do not like where a path has been connected to its variable, use the Select tool, ‒, to click on the path, and then simply click on where it connects to an oval and drag the endpoint.

11. Estimate.

   Click on the Estimate button, ●, in the Standard Toolbar, and then click on OK in the resulting SEM estimation options dialog box.

   Tip: See the tips of [SEM] Example 9 to make creating paths somewhat easier than described above.

   You can open a completed diagram in the Builder by typing

   . webgetsem sem_hcfa1

Reference


Also see

[SEM] sem — Structural equation model estimation command