Example 36g — MIMIC model (generalized response)

Description

To demonstrate a multiple-indicators multiple-causes (MIMIC) model with generalized indicators, we use the same data used in [SEM] Example 35g:

```
use https://www.stata-press.com/data/r16/gsem_issp93
(Selection from ISSP 1993)
```

```
describe
Contains data from https://www.stata-press.com/data/r16/gsem_issp93.dta
obs: 871 Selection for ISSP 1993
vars: 8 21 Mar 2018 16:03
(_dta has notes)
```

<table>
<thead>
<tr>
<th>variable name</th>
<th>type</th>
<th>format</th>
<th>value label</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int</td>
<td>%9.0g</td>
<td>respondent identifier</td>
</tr>
<tr>
<td>y1</td>
<td>byte</td>
<td>%26.0g</td>
<td>agree5 too much science, not enough feelings &amp; faith</td>
</tr>
<tr>
<td>y2</td>
<td>byte</td>
<td>%26.0g</td>
<td>agree5 science does more harm than good</td>
</tr>
<tr>
<td>y3</td>
<td>byte</td>
<td>%26.0g</td>
<td>agree5 any change makes nature worse</td>
</tr>
<tr>
<td>y4</td>
<td>byte</td>
<td>%26.0g</td>
<td>agree5 science will solve environmental problems</td>
</tr>
<tr>
<td>sex</td>
<td>byte</td>
<td>%9.0g</td>
<td>sex</td>
</tr>
<tr>
<td>age</td>
<td>byte</td>
<td>%9.0g</td>
<td>age (6 categories)</td>
</tr>
<tr>
<td>edu</td>
<td>byte</td>
<td>%20.0g</td>
<td>education (6 categories)</td>
</tr>
</tbody>
</table>

Sorted by: _dta:

2. Full text of y1: We believe too often in science, and not enough in feelings and faith.
3. Full text of y2: Overall, modern science does more harm than good.
4. Full text of y3: Any change humans cause in nature, no matter how scientific, is likely to make things worse.
5. Full text of y4: Modern science will solve our environmental problems with little change to our way of life.

See _Structural models 10: MIMIC models_ in [SEM] Intro 5 for background.

Remarks and examples

Remarks are presented under the following headings:

- Fitting the MIMIC model
- Fitting the model with the Builder
Fitting the MIMIC model

For a refresher on MIMIC models, see [SEM] Example 10. In the data above, we have ordered categorical indicators. For an explanation on how we are about to treat these indicators with ordered probit, see [SEM] Example 35g.

We wish to fit the following model:

![Diagram of the MIMIC model](image)

We fit the model in the command language by typing

```
.gsem (y1 y2 y3 y4 <- SciAtt) (SciAtt <- sex), oprobit
```

Fitting fixed-effects model:
Iteration 0:  log likelihood = -5227.8743
Iteration 1:  log likelihood = -5227.8743

Refining starting values:
Grid node 0:  log likelihood = -5230.8106

Fitting full model:
Iteration 0:  log likelihood = -5230.8106  (not concave)
Iteration 1:  log likelihood = -5132.1065  (not concave)
Iteration 2:  log likelihood = -5066.8481
Iteration 3:  log likelihood = -5033.2807
Iteration 4:  log likelihood = -5032.7884
Iteration 5:  log likelihood = -5032.3837
Iteration 6:  log likelihood = -5032.3778
Iteration 7:  log likelihood = -5032.3778
<table>
<thead>
<tr>
<th>Response</th>
<th>Family</th>
<th>Link</th>
<th>Response</th>
<th>Family</th>
<th>Link</th>
<th>Response</th>
<th>Family</th>
<th>Link</th>
<th>Response</th>
<th>Family</th>
<th>Link</th>
<th>Response</th>
<th>Family</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>y1</td>
<td>ordinal</td>
<td>probit</td>
<td>y2</td>
<td>ordinal</td>
<td>probit</td>
<td>y3</td>
<td>ordinal</td>
<td>probit</td>
<td>y4</td>
<td>ordinal</td>
<td>probit</td>
<td>y1</td>
<td>ordinal</td>
<td>probit</td>
</tr>
<tr>
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</tr>
<tr>
<td>Log likelihood = -5032.3778</td>
<td>(1) [y1]\text{SciAtt} = 1</td>
<td></td>
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</tr>
</tbody>
</table>

| y1 | SciAtt | Coef. | Std. Err. | z | P>|z| | [95% Conf. Interval] |
|----|--------|-------|-----------|---|------|----------------------|
| y1 | SciAtt | 1 (constrained) | | | | |
| y2 | SciAtt | 1.405732 | 0.2089672 | 6.73 | 0.000 | 0.9961641 | 1.8153 |
| y3 | SciAtt | 1.246449 | 0.1710771 | 7.29 | 0.000 | 0.911144 | 1.581754 |
| y4 | SciAtt | -0.0345517 | 0.0602017 | -0.57 | 0.566 | -0.1525449 | 0.0834415 |
|     | SciAtt | -0.2337427 | 0.0644245 | -3.63 | 0.000 | -0.3600124 | -0.1074729 |
|     | cut1  | -1.469615 | 0.0855651 | -1.63732 | -1.301911 |
|     | cut2  | -1.09992 | 0.0615897 | -2.306336 | -0.107937 |
|     | cut3  | 0.679334 | 0.0644695 | 0.5465755 | 0.7992914 |
|     | cut4  | 1.879901 | 0.0996675 | 1.684557 | 2.075246 |
|     | cut1  | -2.16739 | 0.1480596 | -1.457582 | -1.877199 |
|     | cut2  | -0.9912152 | 0.0943091 | -1.176058 | -0.8063727 |
|     | cut3  | -0.111914 | 0.075311 | -0.259482 | 0.0357154 |
|     | cut4  | 1.252164 | 0.0983918 | 1.05932 | 1.445008 |
|     | cut1  | -1.412372 | 0.0977772 | -1.604012 | -1.220733 |
|     | cut2  | -0.0230879 | 0.1480596 | -0.1578221 | 0.1116464 |
|     | cut3  | 0.820522 | 0.071653 | 0.6697109 | 0.9721935 |
|     | cut4  | 1.966042 | 0.1196586 | 1.731515 | 2.200568 |
|     | cut1  | -1.47999 | 0.0650596 | -1.607505 | -1.352476 |
|     | cut2  | -0.4218768 | 0.0443504 | -0.508802 | -0.3349516 |
|     | cut3  | -0.172995 | 0.0432394 | 0.0882473 | 0.2577427 |
|     | cut4  | 0.9454906 | 0.0507422 | 0.8460376 | 1.044944 |
|     | var(e.SciAtt) | 0.5283629 | 0.0978703 | 0.3675036 | 0.7596315 |
Notes:

1. Our latent variable measures a negative attitude toward science, just as it did in [SEM] Example 35g.

2. In this MIMIC model, we allow males and females to have different underlying attitudes toward science.

3. The coefficient for $\text{SciAtt} \leftarrow \text{sex}$ is $-0.234$. Variable $\text{sex}$ is equal to 1 for females, thus females have a lower mean value for $\text{SciAtt}$ by 0.234. Because our $\text{SciAtt}$ measure is reversed, this means that females have a more positive attitude toward science. The effect is significant at better than the 1% level.

4. The difference between males and females in $\text{SciAtt}$ is $-0.234$. Is that big or small, practically speaking?

   In the ordered probit specification, predicted agreement with questions is determined by an index into a $N(0, 1)$ distribution. The value of the index is then compared with the cutpoints to determine the probability that the response is 1, 2, 3, 4, or 5.

   For statement 1, the loading on $\text{SciAtt}$ is 1, and therefore the average difference in the probit index for males and females is $-0.234 \times 1 = -0.234$ standard deviation units. Females are 0.234 standard deviations to the left of males on average.

   For statement 2, the loading on $\text{SciAtt}$ is 1.41, and therefore the average difference in the probit index is $-0.234 \times 1.41 = -0.33$ standard deviation units.

   You can work out the effect size for the other statements. We would say that the effect is medium sized.

**Fitting the model with the Builder**

   Use the diagram in *Fitting the MIMIC model* above for reference.

1. Open the dataset.

   In the Command window, type
   
   `. use https://www.stata-press.com/data/r16/gsem_issp93`

2. Open a new Builder diagram.

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

3. Put the Builder in `gsem` mode by clicking on the $\mathbb{G}$ button.

4. Create the measurement component for $\text{SciAtt}$.

   Select the Add measurement component tool, $\mathbb{M}$, and then click in the diagram halfway down and slightly left of the center.

   In the resulting dialog box,
   
   a. change the Latent variable name to $\text{SciAtt}$;
   b. select $y_1$, $y_2$, $y_3$, and $y_4$ by using the Measurement variables control;
   c. check Make measurements generalized;
   d. select Ordinal, Probit in the Family/Link control;
   e. select Down in the Measurement direction control;
   f. click on OK.

   If you wish, move the component by clicking on any variable and dragging it.
5. Create the variable for the formative indicator of SciAtt.
   a. Select the Add observed variable tool, \( \square \), and then click in the diagram directly above the oval for SciAtt and about one-fourth of the way down from the top. After adding it, you can click inside the rectangle to move the variable if you wish.
   b. In the Contextual Toolbar, select sex with the Variable control.

6. Create the path from the formative indicator to SciAtt.
   a. Select the Add path tool, \( \rightarrow \).
   b. Click in the bottom of the sex rectangle (it will highlight when you hover over it), and drag a path to the top of the SciAtt oval (it will highlight when you can release to connect the path).

7. Clean up the direction of the error.
   The error on SciAtt is likely to have been created below the oval for SciAtt. Choose the Select tool, \( \checkmark \), and then click in the SciAtt oval. Click on one of the Error rotation buttons, \( \leftrightarrow \), in the Contextual Toolbar until the error is where you want it.

8. Clean up the location of the path.
   If you do not like where the path between sex and SciAtt has been connected to its variables, use the Select tool, \( \checkmark \), to click on the path, and then simply click on where it connects to a rectangle or oval and drag the endpoint.

   Click on the Estimate button, \( \mathbb{E} \), in the Standard Toolbar, and then click on OK in the resulting GSEM estimation options dialog box.

   You can open a completed diagram in the Builder by typing \( \texttt{. weblogtsem gsem_mimic} \)

Reference

Also see
[SEM] Example 10 — MIMIC model
[SEM] Example 35g — Ordered probit and ordered logit
[SEM] Intro 5 — Tour of models
[SEM] gsem — Generalized structural equation model estimation command