Example 8 — Testing that coefficients are equal, and constraining them

Description Remarks and examples Also see

Description

This example continues where [SEM] **Example 7** left off, where we typed

```
. use https://www.stata-press.com/data/r19/sem_sm1
. ssd describe
. notes
. sem (r_occasp <- f_occasp r_intel r_ses f_ses)  ///
      (f_occasp <- r_occasp f_intel f_ses r_ses), ///
                  cov(e.r_occasp*e.f_occasp) standardized
. estat stable
. estat teffects
```

Remarks and examples

Remarks are presented under the following headings:

We want to show you how to evaluate potential constraints after estimation, how to fit a model with constraints, and how to evaluate enforced constraints after estimation.

Obviously, in a real analysis, if you evaluated potential constraints after estimation, there would be no reason to evaluate enforced constraints after estimation, and vice versa.

Using test to evaluate adding constraints

In this model of respondents and corresponding friends, it would be surprising if the coefficients relating friends' characteristics to respondents' occupational aspirations and vice versa were not equal. It would also be surprising if coefficients relating a respondent's characteristics to his occupational aspirations were not equal to those of his friends' characteristics to his occupational aspirations. The paths that we suspect should be equal are

```
r_intel -> r_occasp     f_intel -> f_occasp
r_ses   -> r_occasp     f_ses   -> f_occasp
f_ses   -> r_occasp     r_ses   -> f_occasp
f_occasp -> r_occasp     r_occasp -> f_occasp
```

You are about to learn that to test whether those paths have equal coefficients, you type

```
. test (_b[r_occasp:r_intel ]==_b[f_occasp:f_intel ])   ///
       (_b[r_occasp:r_ses   ]==_b[f_occasp:f_ses   ])   ///
       (_b[r_occasp:f_ses   ]==_b[f_occasp:r_ses   ])   ///
       (_b[r_occasp:f_occasp]==_b[f_occasp:r_occasp])
```

In Stata, _b[] is how one accesses the estimated parameters. It is difficult to remember what the names are. To determine the names of the parameters, replay the sem results with the coeflegend option:

```
. sem, coeflegend
Structural equation model                                   Number of obs = 329
Estimation method: ml
Log likelihood = -2617.0489
```

	Coefficient	Legend
Structural		
r_occasp		
f_occasp	.2773441	_b[r_occasp:f_occasp]
r_intel	.2854766	_b[r_occasp:r_intel]
r_ses	.1570082	_b[r_occasp:r_ses]
f_ses	.0973327	_b[r_occasp:f_ses]
f_occasp		
r_occasp	.2118102	_b[f_occasp:r_occasp]
r_ses	.0794194	_b[f_occasp:r_ses]
f_ses	.1681772	_b[f_occasp:f_ses]
f_intel	.3693682	_b[f_occasp:f_intel]
var(e.r_oc~p)	.6868304	_b[/var(e.r_occasp)]
var(e.f_oc~p)	.6359151	_b[/var(e.f_occasp)]
cov(e.r_oc~p, e.f_occasp)	-.1536992	_b[/cov(e.r_occasp,e.f_occasp)]

```
LR test of model vs. saturated: chi2(0) = 0.00                Prob > chi2 = .
```

With the parameter names at hand, to perform the test, we can type

```
. test (_b[r_occasp:r_intel ]==_b[f_occasp:f_intel ])
>      (_b[r_occasp:r_ses   ]==_b[f_occasp:f_ses   ])
>      (_b[r_occasp:f_ses   ]==_b[f_occasp:r_ses   ])
>      (_b[r_occasp:f_occasp]==_b[f_occasp:r_occasp])
 ( 1)  [r_occasp]r_intel - [f_occasp]f_intel = 0
 ( 2)  [r_occasp]r_ses - [f_occasp]f_ses = 0
 ( 3)  [r_occasp]f_ses - [f_occasp]r_ses = 0
 ( 4)  [r_occasp]f_occasp - [f_occasp]r_occasp = 0

           chi2(  4) =    1.61
         Prob > chi2 =    0.8062
```

We cannot reject the constraint, just as we expected.

Refitting the model with added constraints

We could refit the model with these constraints by typing

```
. sem (r_occasp <- f_occasp@b1  r_intel@b2  r_ses@b3  f_ses@b4)
>     (f_occasp <- r_occasp@b1  f_intel@b2  f_ses@b3  r_ses@b4),
>                             cov(e.r_occasp*e.f_occasp)

Endogenous variables
  Observed: r_occasp f_occasp

Exogenous variables
  Observed: r_intel r_ses f_ses f_intel

Fitting target model:
Iteration 0:  Log likelihood = -2617.8735
Iteration 1:  Log likelihood = -2617.8705
Iteration 2:  Log likelihood = -2617.8705

Structural equation model                                Number of obs = 329
Estimation method: ml

Log likelihood = -2617.8705

 ( 1)  [r_occasp]f_occasp - [f_occasp]r_occasp = 0
 ( 2)  [r_occasp]r_intel - [f_occasp]f_intel = 0
 ( 3)  [r_occasp]r_ses - [f_occasp]f_ses = 0
 ( 4)  [r_occasp]f_ses - [f_occasp]r_ses = 0
```

	Coefficient	OIM std. err.	z	P>|z|	[95% conf.	interval]
Structural						
r_occasp						
f_occasp	.2471578	.1024504	2.41	0.016	.0463588	.4479568
r_intel	.3271847	.0407973	8.02	0.000	.2472234	.4071459
r_ses	.1635056	.0380582	4.30	0.000	.0889129	.2380984
f_ses	.088364	.0427106	2.07	0.039	.0046529	.1720752
f_occasp						
r_occasp	.2471578	.1024504	2.41	0.016	.0463588	.4479568
r_ses	.088364	.0427106	2.07	0.039	.0046529	.1720752
f_ses	.1635056	.0380582	4.30	0.000	.0889129	.2380984
f_intel	.3271847	.0407973	8.02	0.000	.2472234	.4071459
var(e.r_oc~p)	.6884513	.0538641			.5905757	.8025477
var(e.f_oc~p)	.6364713	.0496867			.5461715	.7417005
cov(e.r_oc~p, e.f_occasp)	-.1582175	.1410111	-1.12	0.262	-.4345942	.1181592

```
LR test of model vs. saturated: chi2(4) = 1.64            Prob > chi2 = 0.8010
```

Using estat scoretests to test whether constraints can be relaxed

```
. estat scoretests
(no score tests to report; all chi2 values less than 3.841458820694123)
```

No tests were reported because no tests were individually significant at the 5% level. We can obtain all the individual tests by adding the `minchi2(0)` option, which we can abbreviate to `min(0)`:

```
. estat scoretests, min(0)
Score tests for linear constraints
  ( 1)  [r_occasp]f_occasp - [f_occasp]r_occasp = 0
  ( 2)  [r_occasp]r_intel - [f_occasp]f_intel = 0
  ( 3)  [r_occasp]r_ses - [f_occasp]f_ses = 0
  ( 4)  [r_occasp]f_ses - [f_occasp]r_ses = 0
```

	chi2	df	P>chi2
(1)	0.014	1	0.91
(2)	1.225	1	0.27
(3)	0.055	1	0.81
(4)	0.136	1	0.71

Notes:

1. When we began this example, we used `test` to evaluate potential constraints that we were considering. We obtained an overall $\chi^2(4)$ statistic of 1.61 and thus could not reject the constraints at any reasonable level.
2. We then refit the model with those constraints.
3. For pedantic reasons, now we use `estat scoretests` to evaluate relaxing constraints included in the model. `estat scoretests` does not report a joint test. You cannot sum the χ^2 values to obtain a joint test statistic. Thus we learn only that the individual constraints should not be relaxed at reasonable confidence levels.
4. Thus when evaluating multiple constraints, it is better to fit the model without the constraints and use `test` to evaluate them jointly.

Also see

[SEM] **Example 7** — Nonrecursive structural model

[SEM] **sem** — Structural equation model estimation command

[SEM] **sem and gsem path notation** — Command syntax for path diagrams

[SEM] **estat scoretests** — Score tests

[SEM] **test** — Wald test of linear hypotheses