

Example 6 — Linear regression

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Description

Linear regression is demonstrated using `auto.dta`:

```
. sysuse auto  
(1978 automobile data)
```

See *Structural models 1: Linear regression* in [SEM] **Intro 5** for background.

Remarks and examples

Remarks are presented under the following headings:

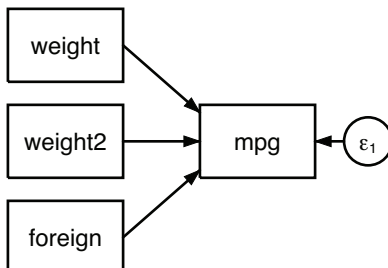
Fitting linear regression models
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Fitting linear regression models

The first two examples in [R] **regress** are

```
. regress mpg weight c.weight#c.weight foreign  
. regress, beta
```

This model corresponds to



To fit this model with `sem`, we type

```
. generate weight2 = weight^2
. sem (mpg <- weight weight2 foreign)
Endogenous variables
  Observed: mpg
Exogenous variables
  Observed: weight weight2 foreign
Fitting target model:
Iteration 0:  Log likelihood = -1909.8206
Iteration 1:  Log likelihood = -1909.8206
Structural equation model
Estimation method: ml
Log likelihood = -1909.8206
Number of obs = 74
```

	OIM					
	Coefficient	std. err.	z	P> z	[95% conf. interval]	
Structural						
mpg						
weight	-.0165729	.0038604	-4.29	0.000	-.0241392	-.0090067
weight2	1.59e-06	6.08e-07	2.62	0.009	4.00e-07	2.78e-06
foreign	-2.2035	1.03022	-2.14	0.032	-4.222695	-.1843056
_cons	56.53884	6.027559	9.38	0.000	44.72504	68.35264
var(e.mpg)	10.19332	1.675772			7.385485	14.06865

Warning: The LR test of model vs. saturated is not reported because the fitted model is not full rank. There appears to be 1 more fitted parameter than the data can support.

Notes:

1. We wished to include variable weight^2 in our model. Because `sem` does not allow Stata's factor-variable notation, we first had to generate new variable `weight2`.
2. Reported coefficients match those reported by `regress`.
3. Reported standard errors (SEs) differ slightly from those reported by `regress`. For instance, the SE for `foreign` is reported here as 1.03, whereas `regress` reported 1.06. SEM is an asymptotic estimator, and `sem` divides variances and covariances by $N = 74$, the number of observations. `regress` provides unbiased finite-sample estimates and divides by $N - k - 1 = 74 - 3 - 1 = 70$. Note that $1.03\sqrt{74/70} = 1.06$.
4. `sem` reports z statistics whereas `regress` reports t statistics.
5. Reported confidence intervals differ slightly between `sem` and `regress` because of the $(N - k - 1)/N$ issue.
6. `sem` reports the point estimate of `e.mpg` as 10.19332. `regress` reports the root MSE as 3.2827. And $\sqrt{10.19332 \times 74/70} = 3.2827$.
7. The warning at the bottom of the output indicates that the fitted model is not of full rank. Although this model is theoretically identified, the scale of variable `weight` causes the model to be less than full rank. If we rescale `weight`, say, by dividing by 100, we will not receive this warning.

Displaying standardized results

To obtain standardized coefficients from `regress`, you specify the `beta` option. To obtain standardized coefficients from `sem`, you specify the `standardized` option.

```
. sem, standardized
Structural equation model                      Number of obs = 74
Estimation method: ml
Log likelihood = -1909.8206
```

Standardized	OIM					[95% conf. interval]	
	Coefficient	std. err.	z	P> z			
Structural							
mpg							
weight	-2.226321	.4950378	-4.50	0.000	-3.196577	-1.256064	
weight2	1.32654	.498261	2.66	0.008	.3499662	2.303113	
foreign	-.17527	.0810378	-2.16	0.031	-.3341011	-.0164389	
_cons	9.839209	.9686872	10.16	0.000	7.940617	11.7378	
var(e.mpg)	.308704	.0482719			.2272168	.4194152	

Warning: The LR test of model vs. saturated is not reported because the fitted model is not full rank. There appears to be 1 more fitted parameter than the data can support.

`regress` simply reports standardized coefficients in an extra column. All other results are reported in unstandardized form. `sem` updates the entire output with the standardized values.

Fitting the model with the Builder

Use the diagram above for reference.

1. Open the dataset and create the additional variable `weight2`.

In the Command window, type

```
. use https://www.stata-press.com/data/r19/auto
. generate weight2 = weight^2
```

2. Open a new Builder diagram.

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

3. Create the regression component for the `mpg` outcome.


Select the Add regression component tool, , and then click in the center of the diagram.

In the resulting dialog box,

- a. select `mpg` in the *Dependent variable* control;
- b. select `weight`, `weight2`, and `foreign` by using the *Independent variables* control;
- c. select **Left** in the *Independent variables' direction* control;
- d. click on **OK**.

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

4. Estimate.

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

5. Show standardized estimates.

From the SEM Builder menu, select **View > Standardized estimates**.

You can open a completed diagram in the Builder by typing

```
. webgetsem sem_regress
```

Also see

[SEM] [Example 12](#) — Seemingly unrelated regression

[SEM] [Example 38g](#) — Random-intercept and random-slope models (multilevel)

[SEM] [Example 43g](#) — Tobit regression

[SEM] [Example 44g](#) — Interval regression

[SEM] [sem](#) — Structural equation model estimation command

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