

Example 47g — Exponential survival model
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Description

In this example, we demonstrate how to fit parametric survival models with `gsem`. Specifically, in this example, we fit an exponential model, but much of the discussion applies to Weibull, gamma, loglogistic, and lognormal models as well.

```
. use https://www.stata-press.com/data/r17/gsem_kva
(Generator experiment)
. describe
```

```
Contains data from https://www.stata-press.com/data/r17/gsem_kva.dta
Observations:      12      Generator experiment
Variables:         3       23 Jan 2021 21:41
                        (_dta has notes)
```

Variable name	Storage type	Display format	Value label	Variable label
failtime	int	%9.0g		Time until failure (hrs.)
load	byte	%9.0g		Overload (kVA)
bearings	byte	%9.0g		Has new bearings

Sorted by:

```
. notes
```

```
_dta:
```

1. Artificial experimental data on two types of bearings in emergency generators.
2. The purpose is to compare the ability to withstand overloads of new-style bearings to old-style bearings.
3. All generators are run until failure.
4. Experiments were performed under overloads of 20, 25, 30, 35, and 40 kVA.

See *Structural models 7: Survival models* in [SEM] **Intro 5** for background.

Remarks and examples

Remarks are presented under the following headings:

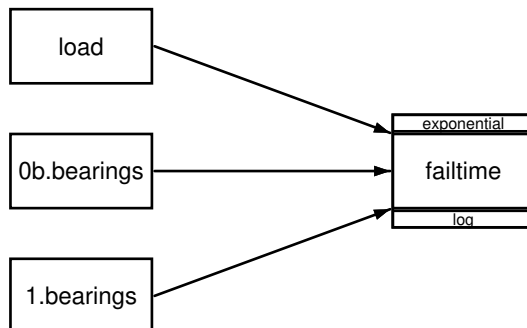
Fitting the exponential model

Obtaining hazard ratios

Fitting the model with the Builder

Fitting the exponential model

We wish to fit the following model:



That is, we wish to fit an exponential model in which the failure time of bearings (`failtime`) depends on the amount of overload (`load`) and whether the bearings are the new style (`bearings = 1`) or the old style (`bearings = 0`).

To fit this model, we use the `gsem` command with the `exponential` option.

```

. gsem (failtime <- load i.bearings), exponential
Iteration 0:  log likelihood = -84108.99
Iteration 1:  log likelihood = -67.363768
Iteration 2:  log likelihood = -66.855013
Iteration 3:  log likelihood = -62.300033
Iteration 4:  log likelihood = -62.227842
Iteration 5:  log likelihood = -62.227568
Iteration 6:  log likelihood = -62.227568

Generalized structural equation model                Number of obs =    12
Response: failtime                                No. of failures =    12
Family: Exponential                               Time at risk = 896.00
Form: Proportional hazards
Link: Log
Log likelihood = -62.227568
  
```

	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
failtime						
load	.0611166	.0354318	1.72	0.085	-.0083284	.1305616
1.bearings	-.2194825	.5773503	-0.38	0.704	-1.351068	.9121033
_cons	-5.756595	1.056403	-5.45	0.000	-7.827106	-3.686084

Notes:

1. By default, exponential models are fit in the proportional-hazards metric. The `exponential` option can be replaced with `family(exponential, aft)` if you want to fit the model in the accelerated failure-time metric.
2. `gsem` reports coefficients. These coefficients match those reported by the equivalent `streg` command,


```

. stset failtime
. streg load bearings, distribution(exponential) nohr
      
```
3. Without the `nohr` option, `streg` reports hazard ratios, which are the exponentiated coefficients.

Obtaining hazard ratios

The `estat eform` command reports exponentiated coefficients for models fit with `gsem`, so we can obtain hazard ratios as follows.

```
. estat eform
```

	exp(b)	Std. err.	z	P> z	[95% conf. interval]	
failtime						
load	1.063023	.0376648	1.72	0.085	.9917062	1.139468
1.bearings	.8029342	.4635743	-0.38	0.704	.2589635	2.489553
_cons	.0031619	.0033402	-5.45	0.000	.0003988	.02507

The hazard ratio of 0.80 for `bearings = 1` indicates that the predicted hazard of failure for the new style of bearing is 80% of the hazard for a bearing of the old type, provided that they have the same loading.

Fitting the model with the Builder

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

1. Open the dataset.


In the Command window, type

```
. use https://www.stata-press.com/data/r17/gsem_kv
```


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 $\overset{G}{SEM}$ button.
4. Create the exponential regression component for `failtime`.


Select the Add regression component tool, , and then click in the diagram about one-third of the way in from the left and halfway down.

In the resulting dialog box,


- a. select `failtime` in the *Dependent variable* control;
- b. check *Make response generalized*;
- c. select **Exponential**, **Log** in the *Family/Link* control;
- d. select the *Select variables* radio button (it may already be selected);
- e. use the *Independent variables* control to select the variable `load`;
- f. include the levels of the factor variable `bearings` by clicking on the  button next to the *Independent variables* control. In the resulting dialog box, select the *Factor variable* radio button, select **Main effect** in the *Specification* control, and select `bearings` in the *Variables* control for *Variable 1*. Click on **Add to varlist**, and then click on **OK**;
- g. select **Left** in the *Independent variables' direction* control;
- h. click on **OK**.

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

5. Clean up.

The box for `failtime` is created closer to the independent variables than it is in the example diagram. Use the Select tool, , and click on the box for `failtime`. Drag it to the right to allow more space for results along the paths.

6. Estimate.

Click on the **Estimate** button, , 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

```
. webgetsem gsem_exp
```

Also see

[SEM] [Example 48g](#) — Loglogistic survival model with censored and truncated data

[SEM] [Example 49g](#) — Multiple-group Weibull survival model

[SEM] [Intro 5](#) — Tour of models

[SEM] [gsem](#) — Generalized structural equation model estimation command

[SEM] [estat eform](#) — Display exponentiated coefficients