# Title

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**example 47g —** Exponential survival model

Description Remarks and examples Also see

## 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 http://www.stata-press.com/data/r15/gsem_kva
(Generator experiment)
. describe
Contains data from http://www.stata-press.com/data/r15/gsem_kva.dta
  obs:            12                          Generator experiment
 vars:             3                          23 Jan 2017 21:41
 size:            48                          (_dta has notes)
-------------------------------------------------------------------------------
              storage   display    value
variable name   type    format     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

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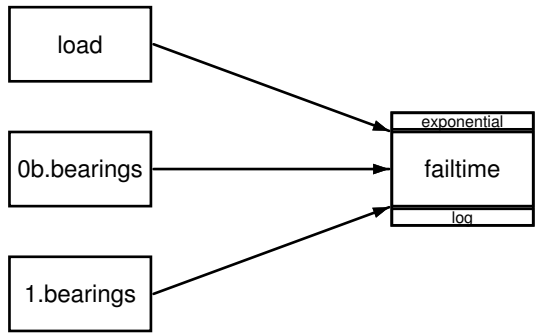
Remarks are presented under the following headings:

## 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
Form           : proportional hazards
Link           : log
Log likelihood = -62.227568
```

| | Coef. | 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 http://www.stata-press.com/data/r15/gsem_kva
   ```

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 GSEM 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] **gsem** — Generalized structural equation model estimation command

[SEM] **intro 5** — Tour of models

[SEM] **estat eform** — Display exponentiated coefficients