sttocc — Convert survival-time data to case–control data

**Description**

sttocc generates a nested case–control study dataset from a cohort-study dataset by sampling controls from the risk sets. For each case, the controls are chosen randomly from those members of the cohort who are at risk at the failure time of the case. That is, the resulting case–control sample is matched with respect to analysis time—the time scale used to compute risk sets. The following variables are added to the dataset:

- **_case**: coded 0 for controls, 1 for cases
- **_set**: case–control ID; matches cases and controls that belong together
- **_time**: analysis time of the case’s failure

The names of these three variables can be changed by specifying the `generate()` option. `varlist` defines variables that, in addition to those used in the creation of the case–control study, will be retained in the final dataset. If `varlist` is not specified, all variables are carried over into the resulting dataset.

When the resulting dataset is analyzed as a matched case–control study, odds ratios will estimate corresponding rate-ratio parameters in the proportional hazards model for the cohort study.

Randomness in the matching is obtained using Stata’s `runiform()` function. To ensure that the sample truly is random, you should set the random-number seed; see [R] `set seed`.

**Quick start**

Create a nested case–control dataset from a cohort dataset that has been `stset`, matching cases to controls based on analysis time

```
sttocc
```

As above, but match on analysis time and categorical variable `catvar`

```
sttocc, match(catvar)
```

As above, but match 3 controls for each case

```
sttocc, match(catvar) number(3)
```

As above, and name the case indicator `case`, the matching identifier `mid`, and the case’s failure time `ftime`

```
sttocc, match(catvar) number(3) generate(case mid ftime)
```

**Menu**

Statistics > Survival analysis > Setup and utilities > Convert survival-time data to case-control data
Syntax

\texttt{sttocc [varlist] [ , options ]}

<table>
<thead>
<tr>
<th>options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{match(matchvarlist)}</td>
<td>match cases and controls on analysis time and specified categorical variables; default is to match on analysis time only</td>
</tr>
<tr>
<td>\texttt{number(#)}</td>
<td>use # controls for each case; default is \texttt{number(1)}</td>
</tr>
<tr>
<td>\texttt{nodots}</td>
<td>suppress displaying dots during calculation</td>
</tr>
</tbody>
</table>

Options

\texttt{generate(case set time)} | new variable names; default is \_case, \_set, and \_time |

You must \texttt{stset} your data before using \texttt{sttocc}; see \[ST\] \texttt{stset}.
\texttt{fweights}, \texttt{iweights}, and \texttt{pweights} may be specified using \texttt{stset}; see \[ST\] \texttt{stset}.

Remarks and examples

Nested case–control studies are an attractive alternative to full Cox regression analysis, particularly when time-varying explanatory variables are involved. They are also attractive when some explanatory variables involve laborious coding. For example, you can create a file with a subset of variables for all subjects in the cohort, generate a nested case–control study, and go on to code the remaining data only for those subjects selected.

In the same way as with Cox regression, the results of the analysis are critically dependent on the choice of analysis time (time scale). The choice of analysis time may be calendar time—so that controls would be chosen from subjects still being monitored on the date that the case fails—but other time scales, such as age or time in study, may be more appropriate in some studies. Remember that the analysis time set in selecting controls is implicitly included in the model in subsequent analysis.

\texttt{match()} requires that controls also be matched to the case with respect to other categorical variables, such as sex. This produces an analysis closely mirroring stratified Cox regression. If we wanted to match on calendar time and 5-year age bands, we could first type \texttt{stsplit ageband}...
to create the age bands and then specify `match(ageband)` on the `sttocc` command. Analyzing the resulting data as a matched case–control study would estimate rate ratios in the underlying cohort that are controlled for calendar time (very finely) and age (less finely). Such analysis could be carried out by Mantel–Haenszel (odds ratio) calculations, for example, using `mhodds`, or by conditional logistic regression using `clogit`.

When ties occur between entry times, censoring times, and failure times, the following convention is adopted:

\[
\text{Entry time} < \text{Failure time} < \text{Censoring time}
\]

Thus censored subjects and subjects entering at the failure time of the case are included in the risk set and are available for selection as controls. Tied failure times are broken at random.

### Example 1: Creating a nested case–control study

Using the `diet` data introduced in example 1 of [ST] `stsplit`, we will illustrate the use of `sttocc`, letting age be analysis time. Controls are chosen from subjects still being monitored at the age at which the case fails.

```
. use https://www.stata-press.com/data/r16/diet
   (Diet data with dates)
. stset dox, failure(fail) enter(time doe) id(id) origin(time dob) scale(365.25)
    id: id
    failure event: fail != 0 & fail < .
obs. time interval: (dox[_n-1], dox]
enter on or after: time doe
exit on or before: failure
   t for analysis: (time-origin)/365.25
    origin: time dob

  337  total observations
       0  exclusions

  337  observations remaining, representing
  337  subjects
     80  failures in single-failure-per-subject data
4,603.669  total analysis time at risk and under observation
   at risk from t =     0
      earliest observed entry t =  30.07529
      last observed exit t =  69.99863
. set seed 9123456
. sttocc, match(job) n(5) nodots
   failure _d: fail
   analysis time _t: (dox-origin)/365.25
    origin: time dob
enter on or after: time doe
    id: id
   matching for: job
There were 2 tied times involving failure(s)
 - failures assumed to precede censorings,
 - tied failure times split at random
There are 80 cases
Sampling 5 controls for each case
```

The above two commands create a new dataset in which there are five controls per case, matched on `job`, with the age of the subjects when the case failed recorded in the variable `time`. The case indicator is given in `_case` and the matched set number, in `_set`. Because we did not specify the optional `varlist`, all variables are carried over into the new dataset.
. describe
Contains data from https://www.stata-press.com/data/r16/diet.dta
obs: 480  Diet data with dates
vars: 14   1 May 2018 19:01

<table>
<thead>
<tr>
<th>variable name</th>
<th>type</th>
<th>format</th>
<th>label</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>int</td>
<td>%9.0g</td>
<td>Subject identity number</td>
</tr>
<tr>
<td>fail</td>
<td>byte</td>
<td>%8.0g</td>
<td>Outcome (CHD = 1 3 13)</td>
</tr>
<tr>
<td>job</td>
<td>byte</td>
<td>%8.0g</td>
<td>Occupation</td>
</tr>
<tr>
<td>month</td>
<td>byte</td>
<td>%8.0g</td>
<td>Month of survey</td>
</tr>
<tr>
<td>energy</td>
<td>float</td>
<td>%9.0g</td>
<td>Total energy (1000kcals/day)</td>
</tr>
<tr>
<td>height</td>
<td>float</td>
<td>%9.0g</td>
<td>Height (cm)</td>
</tr>
<tr>
<td>weight</td>
<td>float</td>
<td>%9.0g</td>
<td>Weight (kg)</td>
</tr>
<tr>
<td>hienergy</td>
<td>byte</td>
<td>%9.0g</td>
<td>Indicator for high energy</td>
</tr>
<tr>
<td>doe</td>
<td>int</td>
<td>%td</td>
<td>Date of entry</td>
</tr>
<tr>
<td>dox</td>
<td>int</td>
<td>%td</td>
<td>Date of exit</td>
</tr>
<tr>
<td>dob</td>
<td>int</td>
<td>%td</td>
<td>Date of birth</td>
</tr>
<tr>
<td>_case</td>
<td>byte</td>
<td>%8.0g</td>
<td>0 for controls; 1 for cases</td>
</tr>
<tr>
<td>_set</td>
<td>long</td>
<td>%12.0g</td>
<td>case-control ID</td>
</tr>
<tr>
<td>_time</td>
<td>double</td>
<td>%10.0g</td>
<td>analysis time of the case's failure</td>
</tr>
</tbody>
</table>

Sorted by: _set _case
Note: Dataset has changed since last saved.

We can verify that the controls were correctly selected:

. gen ageentry=(doe-dob)/365.25
. gen ageexit=(dox-dob)/365.25
. sort _set _case id
. list _set id _case _time ageentry ageexit job, sepby(_set)

<table>
<thead>
<tr>
<th>_set</th>
<th>id</th>
<th>_case</th>
<th>_time</th>
<th>ageentry</th>
<th>ageexit</th>
<th>job</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>42.57358</td>
<td>40.11225</td>
<td>56.82409</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
<td>42.57358</td>
<td>36.58043</td>
<td>52.70636</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>42.57358</td>
<td>37.09788</td>
<td>53.39083</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>42.57358</td>
<td>31.13484</td>
<td>47.26078</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>0</td>
<td>42.57358</td>
<td>31.4141</td>
<td>42.57358</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>42.57358</td>
<td>31.4141</td>
<td>42.57358</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>0</td>
<td>47.8987</td>
<td>41.26215</td>
<td>61.22108</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>0</td>
<td>47.8987</td>
<td>43.6386</td>
<td>63.51266</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>0</td>
<td>47.8987</td>
<td>45.30048</td>
<td>57.42368</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>0</td>
<td>47.8987</td>
<td>44.34223</td>
<td>61.54963</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>0</td>
<td>47.8987</td>
<td>46.37645</td>
<td>61.8371</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1</td>
<td>47.8987</td>
<td>45.46475</td>
<td>47.8987</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>0</td>
<td>47.96408</td>
<td>35.2115</td>
<td>52.67351</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>0</td>
<td>47.96408</td>
<td>40.9309</td>
<td>56.9692</td>
<td>0</td>
</tr>
<tr>
<td>479</td>
<td>80</td>
<td>0</td>
<td>68.596851</td>
<td>61.55784</td>
<td>69.99863</td>
<td>1</td>
</tr>
<tr>
<td>480</td>
<td>80</td>
<td>1</td>
<td>68.596851</td>
<td>55.72074</td>
<td>68.59686</td>
<td>1</td>
</tr>
</tbody>
</table>

The controls do indeed belong to the appropriate risk set. The controls in each set enter at an age that is less than the age of the case at failure, and they exit at an age that is greater than the age of the case at failure. To estimate the effect of high energy, use \texttt{clogit}, just as you would for any matched case–control study:
sttocc — Convert survival-time data to case–control data

. clogit _case hienergy, group(_set) or
Iteration 0:  log likelihood = -143.22071
Iteration 1:  log likelihood = -143.22071
Conditional (fixed-effects) logistic regression

Number of obs = 480
LR chi2(1) = 0.24
Prob > chi2 = 0.6241
Log likelihood = -143.22071 Pseudo R2 = 0.0008

|      | Odds Ratio | Std. Err. | z    | P>|z| | [95% Conf. Interval] |
|------|------------|-----------|------|------|----------------------|
| _case |            |           |      |      |                      |
| hienergy | 0.88683 | 0.217505 | -0.49 | 0.624 | 0.54837 1.434191 |

Acknowledgments

The original version of sttocc was written by David Clayton (retired) of the Cambridge Institute for Medical Research and Michael Hills (retired) of the London School of Hygiene and Tropical Medicine.

References


Also see

[ST] stbase — Form baseline dataset
[ST] stdescribe — Describe survival-time data
[ST] stset — Declare data to be survival-time data
[ST] stsplit — Split and join time-span records