cusum — Cusum plots and tests for binary variables

Description

`cusum` graphs the cumulative sum (cusum) of a binary (0/1) variable, *yvar*, against a (usually) continuous variable, *xvar*.

Quick start

Cusum statistics for binary variable `y` and graph of cumulative sum against values of `x`

```
cusum y x
```

Also generate `cs` to store the cumulative sum

```
cusum y x, generate(cs)
```

Set the seed first for reproducible results

```
set seed 87534690
cusum y x, generate(cs)
```

Cumulative sum of `y` against a variable containing fitted values `yhat`

```
cusum y x, yfit(yhat)
```

Menu

Statistics > Other > Quality control > Cusum plots and tests for binary variables

Syntax

```
cusum yvar xvar [ if ] [ in ] [ , options ]
```

options	Description
Main	
generate(*newvar*)	save cumulative sum in *newvar*
yfit(*fitvar*)	calculate cumulative sum against *fitvar*
nograph	suppress the plot
nocalc	suppress cusum test statistics
Cusum plot	
connect_options	affect the rendition of the plotted line
Add plots	
addplot(*plot*)	add plots to the generated graph
Y axis, X axis, Titles, Legend, Overall	
twoway_options	any options other than by() documented in [G-3] ***twoway_options***

collect is allowed; see **[U] 11.1.10 Prefix commands**.

Options

Main

generate(*newvar*) saves the cusum in *newvar*.

yfit(*fitvar*) calculates a cusum against *fitvar*, that is, the running sums of the "residuals" *fitvar* minus *yvar*. Typically, *fitvar* is the predicted probability of a positive outcome obtained from a logistic regression analysis.

nograph suppresses the plot.

nocalc suppresses calculation of the cusum test statistics.

Cusum plot

connect_options affect the rendition of the plotted line; see [G-3] ***connect_options***.

Add plots

addplot(*plot*) provides a way to add other plots to the generated graph. See [G-3] ***addplot_option***.

Y axis, X axis, Titles, Legend, Overall

twoway_options are any of the options documented in [G-3] ***twoway_options***, excluding by(). These include options for titling the graph (see [G-3] ***title_options***) and for saving the graph to disk (see [G-3] ***saving_option***).

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Remarks and examples

The cusum is the running sum of the proportion of ones in the sample, a constant number, minus *yvar*,

$$c_j = \sum_{k=1}^{j} f - yvar_{(k)}, \qquad 1 \le j \le N$$

where $f = (\sum yvar)/N$ and $yvar_{(k)}$ refers to the corresponding value of *yvar* when *xvar* is placed in ascending order: $xvar_{(k+1)} \ge xvar_{(k)}$. Tied values of *xvar* are broken at random. If you want them broken the same way in two runs, you must set the random-number seed to the same value before giving the `cusum` command; see [R] **set seed**.

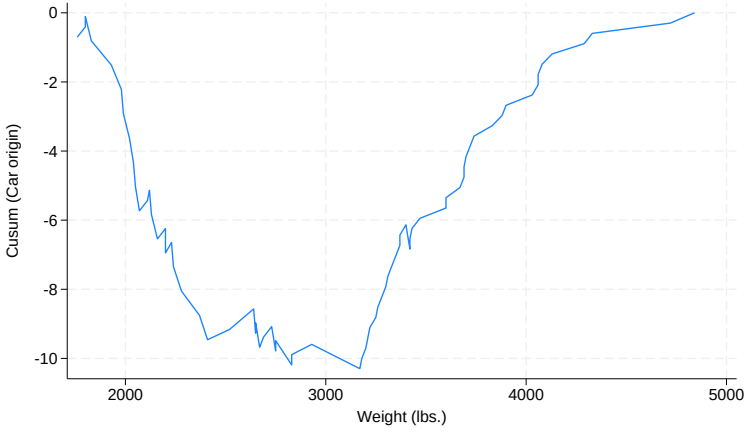
A U-shaped or inverted U-shaped cusum indicates, respectively, a negative or a positive trend of *yvar* with *xvar*. A sinusoidal shape is evidence of a nonmonotonic (for example, quadratic) trend. `cusum` displays the maximum absolute cusum for monotonic and nonmonotonic trends of *yvar* on *xvar*. These are nonparametric tests of departure from randomness of *yvar* with respect to *xvar*. Approximate values for the tests are given.

Example 1

For the automobile dataset, `auto.dta`, we wish to investigate the relationship between `foreign` (0 = domestic, 1 = foreign) and car weight as follows:

```
. use https://www.stata-press.com/data/r18/auto
(1978 automobile data)
. cusum foreign weight
```

Variable	Obs	Pr(1)	CusumL	zL	Pr>zL	CusumQ	zQ	Pr>zQ
foreign	74	0.2973	10.30	3.963	0.000	2.92	0.064	0.475

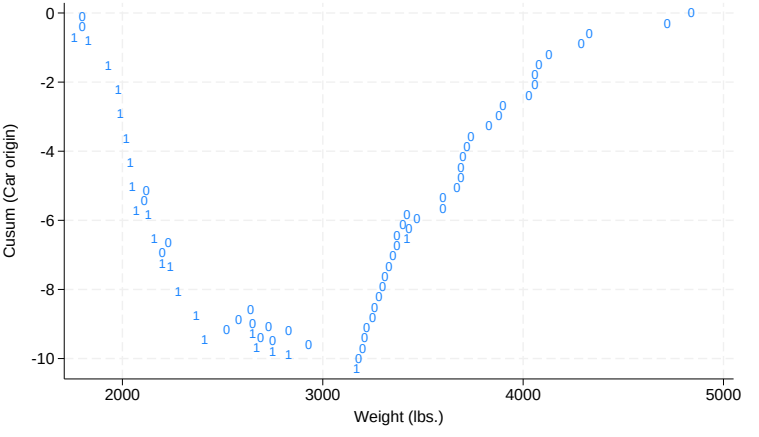


The resulting plot, which is U-shaped, suggests a negative monotonic relationship. The trend is confirmed by a highly significant linear cusum statistic, labeled `CusumL` in the output above.

Some 29.73% of the cars are foreign (coded 1). The proportion of foreign cars diminishes with increasing weight. The domestic cars are crudely heavier than the foreign ones. We could have discovered that by typing `table foreign, statistics(mean weight)`, but such an approach does not give the full picture of the relationship. The quadratic cusum (`CusumQ`) is not significant, so we do not suspect any tendency for the very heavy cars to be foreign rather than domestic. A slightly enhanced version of the plot shows the preponderance of domestic (coded 0) cars at the heavy end of the weight axis:

```
. label values foreign
. cusum foreign weight, s(none) recast(scatter) mlabel(foreign) mlabp(0)
```

Variable	Obs	Pr(1)	CusumL	zL	Pr>zL	CusumQ	zQ	Pr>zQ
foreign	74	0.2973	10.30	3.963	0.000	3.32	0.469	0.320



The example is, of course, artificial, because we would not really try to model the probability of a car being foreign given its weight.

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Stored results

`cusum` stores the following in `r()`:

Scalars

`r(N)`	number of observations	`r(P_zl)`	p-value for test (linear)
`r(prop1)`	proportion of positive outcomes	`r(cusumq)`	quadratic cusum
`r(cusuml)`	cusum	`r(zq)`	test (quadratic)
`r(zl)`	test (linear)	`r(P_zq)`	p-value for test (quadratic)

Acknowledgment

`cusum` was written by Patrick Royston of the MRC Clinical Trials Unit, London, and coauthor of the Stata Press book *Flexible Parametric Survival Analysis Using Stata: Beyond the Cox Model*.

Reference

Royston, P. 1992. The use of cusums and other techniques in modelling continuous covariates in logistic regression. *Statistics in Medicine* 11: 1115–1129. https://doi.org/10.1002/sim.4780110813.

Also see

[R] **logistic** — Logistic regression, reporting odds ratios

[R] **logit** — Logistic regression, reporting coefficients

[R] **probit** — Probit regression