

[Description](#)[Options](#)[Acknowledgment](#)[Quick start](#)[Remarks and examples](#)[References](#)[Menu](#)[Stored results](#)[Also see](#)[Syntax](#)[Methods and formulas](#)

Description

`rreg` performs one version of robust regression of *depvar* on *indepvars*.

Also see [Robust standard errors](#) in [\[R\] regress](#) for standard regression with robust variance estimates and [\[R\] qreg](#) for quantile (including median) regression.

Quick start

Robust regression of `y` on `x`

```
rreg y x
```

Add a categorical covariate `a` using factor-variable syntax

```
rreg y x i.a
```

Same as above, but set the tuning parameter to 8

```
rreg y x i.a, tune(8)
```

Generate a new variable `wvar` containing the final weight for each observation

```
rreg y x i.a, genwt(wvar)
```

Set confidence level to 99%

```
rreg y x i.a, level(99)
```

Menu

Statistics > Linear models and related > Other > Robust regression

Syntax

```
rreg depvar [indepvars] [if] [in] [ , options ]
```

<i>options</i>	Description
Model	
<code>tune(#)</code>	use # as the biweight tuning constant; default is <code>tune(7)</code>
Reporting	
<code>level(#)</code>	set confidence level; default is <code>level(95)</code>
<code>genwt(<i>newvar</i>)</code>	create <i>newvar</i> containing the weights assigned to each observation
<code>display_options</code>	control columns and column formats, row spacing, line width, display of omitted variables and base and empty cells, and factor-variable labeling
Optimization	
<code>optimization_options</code>	control the optimization process; seldom used
<code>graph</code>	graph weights during convergence
<code>coeflegend</code>	display legend instead of statistics

indepvars may contain factor variables; see [U] 11.4.3 **Factor variables**.

depvar and *indepvars* may contain time-series operators; see [U] 11.4.4 **Time-series varlists**.

`by`, `collect`, `mfp`, `mi` `estimate`, `rolling`, and `statsby` are allowed; see [U] 11.1.10 **Prefix commands**.

`coeflegend` does not appear in the dialog box.

See [U] 20 **Estimation and postestimation commands** for more capabilities of estimation commands.

Options

Model

`tune(#)` is the biweight tuning constant. The default is `tune(7)`, meaning seven times the median absolute deviation from the median residual; see [Methods and formulas](#). Lower tuning constants downweight outliers rapidly but may lead to unstable estimates (less than 6 is not recommended). Higher tuning constants produce milder downweighting.

Reporting

`level(#)`; see [R] [Estimation options](#).

`genwt(newvar)` creates the new variable *newvar* containing the weights assigned to each observation.

`display_options`: `nocl`, `nopvalues`, `noomitted`, `vsquish`, `noemptycells`, `baselevels`, `allbaselevels`, `nofvlabel`, `fvwrap(#)`, `fvwrapon(style)`, `cformat(%fmt)`, `pformat(%fmt)`, `sformat(%fmt)`, and `no1stretch`; see [R] [Estimation options](#).

Optimization

`optimization_options`: `iterate(#)`, `tolerance(#)`, `[no]log`. `iterate()` specifies the maximum number of iterations; iterations stop when the maximum change in weights drops below `tolerance()`; and `log/nolog` specifies whether to show the iteration log (see `set iterlog` in [R] [set iter](#)). These options are seldom used.

graph allows you to graphically watch the convergence of the iterative technique. The weights obtained from the most recent round of estimation are graphed against the weights obtained from the previous round.

The following option is available with `rreg` but is not shown in the dialog box:

`coeflegend`; see [\[R\] Estimation options](#).

Remarks and examples

`rreg` first performs an initial screening based on Cook's distance > 1 to eliminate gross outliers before calculating starting values and then performs Huber iterations followed by biweight iterations, as suggested by [Li \(1985\)](#).

► Example 1

We wish to examine the relationship between mileage rating, weight, and location of manufacture for the 74 cars in the `auto.dta`. As a point of comparison, we begin by fitting an ordinary regression:

```
. use https://www.stata-press.com/data/r19/auto
(1978 automobile data)
```

```
. regress mpg weight foreign
```

Source	SS	df	MS	Number of obs	=	74
Model	1619.2877	2	809.643849	F(2, 71)	=	69.75
Residual	824.171761	71	11.608053	Prob > F	=	0.0000
				R-squared	=	0.6627
				Adj R-squared	=	0.6532
Total	2443.45946	73	33.4720474	Root MSE	=	3.4071

mpg	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
weight	-.0065879	.0006371	-10.34	0.000	-.0078583	-.0053175
foreign	-1.650029	1.075994	-1.53	0.130	-3.7955	.4954422
_cons	41.6797	2.165547	19.25	0.000	37.36172	45.99768

We now compare this with the results from `rreg`:

```
. rreg mpg weight foreign
```

```
Huber iteration 1: Maximum difference in weights = .80280176
Huber iteration 2: Maximum difference in weights = .2915438
Huber iteration 3: Maximum difference in weights = .08911171
Huber iteration 4: Maximum difference in weights = .02697328
Biweight iteration 5: Maximum difference in weights = .29186818
Biweight iteration 6: Maximum difference in weights = .11988101
Biweight iteration 7: Maximum difference in weights = .03315872
Biweight iteration 8: Maximum difference in weights = .00721325
```

```
Robust regression                                Number of obs    =      74
                                                F( 2,          71) =    168.32
                                                Prob > F          =      0.0000
```

mpg	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
weight	-.0063976	.0003718	-17.21	0.000	-.007139	-.0056562
foreign	-3.182639	.627964	-5.07	0.000	-4.434763	-1.930514
_cons	40.64022	1.263841	32.16	0.000	38.1202	43.16025

Note the large change in the foreign coefficient.



□ Technical note

It would have been better if we had fit the previous robust regression by typing `rreg mpg weight foreign, genwt(w)`. The new variable, `w`, would then contain the estimated weights. Let's pretend that we did this:

```
. rreg mpg weight foreign, genwt(w)
(output omitted)
. summarize w, detail
```

Robust Regression Weight				
	Percentiles	Smallest		
1%	0	0		
5%	.0442957	0		
10%	.4674935	0	Obs	74
25%	.8894815	.0442957	Sum of wgt.	74
50%	.9690193		Mean	.8509966
		Largest	Std. dev.	.2746451
75%	.9949395	.9996715		
90%	.9989245	.9996953	Variance	.0754299
95%	.9996715	.9997343	Skewness	-2.287952
99%	.9998585	.9998585	Kurtosis	6.874605

We discover that 3 observations in our data were dropped altogether (they have weight 0). We could further explore our data:

```
. sort w
. list make weight w if w < .467, sep(0)
```

	make	mpg	weight	w
1.	Datsun 210	35	2,020	0
2.	Subaru	35	2,050	0
3.	VW Diesel	41	2,040	0
4.	Plym. Arrow	28	3,260	.04429567
5.	Cad. Seville	21	4,290	.08241943
6.	Toyota Corolla	31	2,200	.10443129
7.	Olds 98	21	4,060	.28141296

Being familiar with the automobile data, we immediately spotted two things: the VW is the only diesel car in our data, and the weight recorded for the Plymouth Arrow is incorrect.



► Example 2

If we specify no explanatory variables, `rreg` produces a robust estimate of the mean:

```
. rreg mpg
      Huber iteration 1: Maximum difference in weights = .64471879
      Huber iteration 2: Maximum difference in weights = .05098336
      Huber iteration 3: Maximum difference in weights = .0099887
      Biweight iteration 4: Maximum difference in weights = .25197391
      Biweight iteration 5: Maximum difference in weights = .00358606
Robust regression                                Number of obs      =           74
                                                F(   0,           73) =           0.00
                                                Prob > F              =              .
```

mpg	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
_cons	20.68825	.641813	32.23	0.000	19.40912	21.96738

The estimate is given by the coefficient on `_cons`. The mean is 20.69 with an estimated standard error of 0.6418. The 95% confidence interval is [19.4, 22.0]. By comparison, `ci means` (see [\[R\] ci](#)) gives us the standard calculation:

```
. ci means mpg
```

Variable	Obs	Mean	Std. err.	[95% conf. interval]	
mpg	74	21.2973	.6725511	19.9569	22.63769

Stata has an active user community working in the area of robust statistics. You may also be interested in robust estimators and outlier detection tools from [Verardi and McCathie \(2012\)](#), [Verardi and Dehon \(2010\)](#), [Jann \(2010\)](#), and [Verardi and Croux \(2009\)](#), to name a few. See [\[R\] ssc](#) for how to install community-contributed packages.

Stored results

`rreg` stores the following in `e()`:

Scalars

<code>e(N)</code>	number of observations
<code>e(mss)</code>	model sum of squares
<code>e(df_m)</code>	model degrees of freedom
<code>e(rss)</code>	residual sum of squares
<code>e(df_r)</code>	residual degrees of freedom
<code>e(r2)</code>	R^2
<code>e(r2_a)</code>	adjusted R^2
<code>e(F)</code>	F statistic
<code>e(rmse)</code>	root mean squared error
<code>e(rank)</code>	rank of <code>e(V)</code>

Macros

<code>e(cmd)</code>	<code>rreg</code>
<code>e(cmdline)</code>	command as typed
<code>e(depvar)</code>	name of dependent variable
<code>e(genwt)</code>	variable containing the weights
<code>e(title)</code>	title in estimation output
<code>e(model)</code>	ols
<code>e(properties)</code>	b V
<code>e(predict)</code>	program used to implement predict
<code>e(marginsok)</code>	predictions allowed by margins
<code>e(asbalanced)</code>	factor variables <code>fvset</code> as <code>asbalanced</code>
<code>e(asobserved)</code>	factor variables <code>fvset</code> as <code>asobserved</code>

Matrices

<code>e(b)</code>	coefficient vector
<code>e(V)</code>	variance–covariance matrix of the estimators

Functions

<code>e(sample)</code>	marks estimation sample
------------------------	-------------------------

In addition to the above, the following is stored in `r()`:

Matrices

<code>r(table)</code>	matrix containing the coefficients with their standard errors, test statistics, p -values, and confidence intervals
-----------------------	---

Note that results stored in `r()` are updated when the command is replayed and will be replaced when any `r-class` command is run after the estimation command.

Methods and formulas

See [Berk \(1990\)](#), [Goodall \(1983\)](#), and [Rousseeuw and Leroy \(1987\)](#) for a general description of the issues and methods. [Hamilton \(1991a, 1992\)](#) provides a more detailed description of `rreg` and some Monte Carlo evaluations.

`rreg` begins by fitting the regression (see [\[R\] regress](#)), calculating Cook’s D (see [\[R\] predict](#) and [\[R\] regress postestimation](#)), and excluding any observation for which $D > 1$.

Thereafter, `rreg` works iteratively: it performs a regression, calculates case weights from absolute residuals, and regresses again using those weights. Iterations stop when the maximum change in weights drops below `tolerance()`. Weights derive from one of two weight functions, Huber weights and biweights. Huber weights ([Huber 1964](#)) are used until convergence, and then, from that result, biweights are used until convergence. The biweight was proposed by [Beaton and Tukey \(1974, 151–152\)](#) after

the Princeton robustness study (Andrews et al. 1972) had compared various estimators. Both weighting functions are used because Huber weights have problems dealing with severe outliers, whereas biweights sometimes fail to converge or have multiple solutions. The initial Huber weighting should improve the behavior of the biweight estimator.

In Huber weighting, cases with small residuals receive weights of 1; cases with larger residuals receive gradually smaller weights. Let $e_i = y_i - \mathbf{X}_i \mathbf{b}$ represent the i th-case residual. The i th scaled residual $u_i = e_i/s$ is calculated, where $s = M/0.6745$ is the residual scale estimate and $M = \text{med}(|e_i - \text{med}(e_i)|)$ is the median absolute deviation from the median residual. Huber estimation obtains case weights:

$$w_i = \begin{cases} 1 & \text{if } |u_i| \leq c_h \\ c_h/|u_i| & \text{otherwise} \end{cases}$$

`rreg` defines $c_h = 1.345$, so downweighting begins with cases whose absolute residual exceeds $(1.345/0.6745)M \approx 2M$.

With biweights, all cases with nonzero residuals receive some downweighting, according to the smoothly decreasing biweight function

$$w_i = \begin{cases} \{1 - (u_i/c_b)^2\}^2 & \text{if } |u_i| \leq c_b \\ 0 & \text{otherwise} \end{cases}$$

where $c_b = 4.685 \times \text{tune}()/7$. Thus when $\text{tune}() = 7$, cases with absolute residuals of $(4.685/0.6745)M \approx 7M$ or more are assigned 0 weight and thus are effectively dropped. Goodall (1983, 377) suggests using a value between 6 and 9, inclusive, for $\text{tune}()$ in the biweight case and states that performance is good between 6 and 12, inclusive.

The tuning constants $c_h = 1.345$ and $c_b = 4.685$ (assuming $\text{tune}()$ is set at the default 7) give `rreg` about 95% of the efficiency of OLS when applied to data with normally distributed errors (Hamilton 1991b). Lower tuning constants downweight outliers more drastically (but give up Gaussian efficiency); higher tuning constants make the estimator more like OLS.

Standard errors are calculated using the pseudovalues approach described in Street, Carroll, and Rupert (1988).

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References

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Also see

- [R] [rreg postestimation](#) — Postestimation tools for rreg
- [R] [qreg](#) — Quantile regression
- [R] [regress](#) — Linear regression
- [MI] [Estimation](#) — Estimation commands for use with mi estimate
- [U] [20 Estimation and postestimation commands](#)

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