

# REGRM: Robust estimator for a generalized ratio model

## REGRM

The goal of REGRM is to provide convenient tools for robust estimation of a generalized ratio model,  $y_i = \beta x_i + x_i^\gamma \varepsilon_i$ , where  $\varepsilon$  is a homoscedastic error term.

The conventional ratio model  $y_i = \beta x_i + \epsilon_i$  has the heteroscedastic error term  $\epsilon$  and this is the obstacle to have robust estimation by means of M-estimator.

The ratio model is re-defined with homoscedastic error term  $\varepsilon$ , generalized with the power  $\gamma$  to  $\varepsilon$ , and robustified by means of M-estimation. The algorithm used is the iteratively re-weighted least squares (IRLS).

The corresponding estimator is shown as follows:

$$\hat{\beta}_{rob} = \frac{\sum_{i=1}^n w_i y_i x_i^{1-2\gamma}}{\sum_{i=1}^n w_i x_i^{2(1-\gamma)}},$$

where  $w_i$  is obtained by a weight function. The conventional ratio model is obtained when  $\gamma = 1/2$ .

Two different weight functions, two different scale parameters, and three choices of the gamma value can be used. There are 12 functions according to these settings.

## Functions included

An integrated function REGRM calls an appropriate child function shown in the table internally. REGRM only accepts the tuning parameter c2=4, 6 or 8 and the value will be automatically converted according to the internal 12 functions.

Weight function	$\gamma = 1$	$\gamma = 1/2$	$\gamma = 0$
Tukey's biweight function & AAD scale	RrTa.aad	RrTb.aad	RrTc.aad
Tukey's biweight function & MAD scale	RrTa.mad	RrTb.mad	RrTc.mad
Huber's weight function & AAD scale	RrHa.aad	RrTb.aad	RrTc.aad
Hukey's weight function & MAD scale	RrHa.mad	RrHb.mad	RrHc.mad

If a user wish to select other values of the tuning parameter, any child functions can be called directly. In this case, the tuning parameter c1 should be selected appropriately according to the list below.

- List of the recommended tuning parameter for REGRM and the 12 functions

function	Very robust	...	Less robust	Default
REGRM	4	6	8	8
Tukey AAD	4	6	8	8
Tukey MAD(SD)	5.01	7.52	10.03	10.03
Huber AAD	1.15	1.72	2.30	2.30
Huber MAD(SD)	1.44	2.16	2.88	2.88

## Installation

You can install the development version from GitHub with:

```
# install.packages("devtools")
devtools::install_github("kazwd2008/REGRM")
```

## Sample code

```
require(REGRM)

x <- seq(1, 10, by=0.1)
#e <- rnorm(length(x))
e <- rt(length(x), df=3) # error term following t distribution

b <- 2 # true value of slope

y1 <- b*x + x*e # example 1: gamma=1
y2 <- b*x + sqrt(x)*e # example 2: gamma=1/2

o1 <- REGRM(x, y1, gm="a")
o2 <- REGRM(x, y2, gm="b")

o1$par; o2$par # estimated slope

require(RColorBrewer)
cols = brewer.pal(11, "PiYG")
cl1 <- round((o1$wt)*10+1)
cl2 <- round((o2$wt)*10+1)

par(mfrow=c(1,2))
plot(x, y1, col=cols[cl1], pch=20)
plot(x, y2, col=cols[cl2], pch=20)
```