Package ‘fastqrs’

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Title Fast Algorithms for Quantile Regression with Selection

Version 1.0.0

Description Fast estimation algorithms to implement the Quantile Regression with Selection estimator and the multiplicative Bootstrap for inference. This estimator can be used to estimate models that feature sample selection and heterogeneous effects in cross-sectional data. For more details, see Arellano and Bonhomme (2017) <doi:10.3982/ECTA14030> and Pereda-Fernández (2024) <doi:10.48550/arXiv.2402.16693>.

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Imports quantreg, copula, stats

Suggests knitr, rmarkdown, sampleSelection, ggplot2

Depends R (>= 2.10)

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`.bt.results` *bt.results*

Description

Collects the bootstrap results and yields the bootstrapped mean, standard error, and confidence intervals

Usage

```
.bt.results(x, alpha)
```

Arguments

`x`	= Vector with the bootstrap repetitions of an estimator
`alpha`	= Set of significance levels to be returned

Value

m = Bootstrapped mean

se = Bootstrapped standard error

ub = Upper bound of the bootstrapped confidence interval

lb = Lower bound of the bootstrapped confidence interval

`.qrs.prop.fast` *qrs.prop.fast*

Description

Algorithm 3: algorithm with preprocessing and quantile grid reduction for Quantile Regression with Selection (QRS); propensity score estimated previously.

Usage

```
.qrs.prop.fast(y, x, prop, w = NULL, Q1, Q2, P = 10, family, gridtheta, m)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`prop`	= Propensity score (N x 1)
`w`	= Sample weights (N x 1)
`Q1`	= Number of quantiles in reduced grid
`Q2`	= Number of quantiles in large grid
`P`	= Number of evaluated values of parameter with large quantile grid
`family`	= Parametric copula family
`gridtheta`	= Grid of values for copula parameter (T x 1)
`m`	= Parameter to select interval of observations in top and bottom groups

Value

beta = Estimated beta coefficients (K x Q2)

theta = Estimated copula parameter

objf_min = Value of objective function at the optimum

b1 = Estimated beta coefficients for the grid of values of the copula parameter with the reduced quantile grid (K x Q1 x T)

objf1 = Value of objective function for the grid of values of the copula parameter with the reduced quantile grid

gridtheta2 = Grid of values for copula parameter selected during the first part of the algorithm (P x 1)

b2 = Estimated beta coefficients for the grid of values of the copula parameter with large quantile grid (K x Q2 x P)

objf2 = Value of objective function for the grid of values of the copula parameter with large quantile grid (P x 1)

`.rqr.fast` *rqr.fast*

Description

Algorithm 2: algorithm with preprocessing for Rotated Quantile Regression (RQR) for a grid of quantiles and the rotation obtained with a copula.

Usage

```
.rqr.fast(y, x, w = NULL, G, zeta, m, initq)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`w`	= Sample weights (N x 1)
`G`	= Copula conditional on participation (N x Q)
`zeta`	= Conservative estimate of standard error of residuals (N x 1)
`m`	= Parameter to select interval of observations in top and bottom groups
`initq`	= Initial quantile to estimate regularly and obtain preliminary values for remaining quantiles

Value

b = Estimated beta coefficients (K x Q)

`.rqrb0.fast` *rqrb0.fast*

Description

Algorithm with preprocessing for Rotated Quantile Regression (RQR) for a grid of quantiles, the rotation obtained with a copula and initial values of the beta coefficients (used by Algorithms 3-4).

Usage

```
.rqrb0.fast(y, x, w = NULL, G, zeta, m, b0)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`w`	= Sample weights
`G`	= Copula conditional on participation (N x Q)
`zeta`	= Conservative estimate of standard error of residuals
`m`	= Parameter to select interval of observations in top and bottom groups
`b0`	= Initial values of the beta coefficients for all quantiles (K x Q)

Value

b = Estimated beta coefficients (K x Q)

`.rqrtau.fast` *rqrtau.fast*

Description

Algorithm 1: algorithm with preprocessing for Rotated Quantile Regression (RQR) with initial values of the beta coefficients for a single quantile tau

Usage

```
.rqrtau.fast(y, x, w = NULL, tau, zeta, m, b0)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`w`	= Sample weights (N x 1)
`tau`	= Quantile indexes rotated at individual level (N x 1)
`zeta`	= Conservative estimate of standard error of residuals (N x 1)
`m`	= Parameter to select interval of observations in top and bottom groups
`b0`	= Initial values of the beta coefficients (K x 1)

Value

b = Estimated beta coefficients (K x 1)

`Mroz87` *Mroz87: U.S. Women's Labor Force Participation (Example dataset)*

Description

The Mroz87 data frame contains data about 753 married women. These data are collected within the "Panel Study of Income Dynamics" (PSID). Of the 753 observations, the first 428 are for women with positive hours worked in 1975, while the remaining 325 observations are for women who did not work for pay in 1975. A more complete discussion of the data is found in Mroz (1987), Appendix 1.

Usage

```
Mroz87
```

Format

A data frame with 753 observations on the following variables:

lfp Dummy variable for labor-force participation.

hours Wife's hours of work in 1975.

kids5 Number of children 5 years old or younger.

kids618 Number of children 6 to 18 years old.

age Wife's age.

educ Wife's educational attainment, in years.

wage Wife's average hourly earnings, in 1975 dollars.

repwage Wife's wage reported at the time of the 1976 interview.

hushrs Husband's hours worked in 1975.

husage Husband's age.

huseduc Husband's educational attainment, in years.

huswage Husband's wage, in 1975 dollars.

faminc Family income, in 1975 dollars.

mtr Marginal tax rate facing the wife.

motheduc Wife's mother's educational attainment, in years.

fatheduc Wife's father's educational attainment, in years.

unem Unemployment rate in county of residence, in percentage points.

city Dummy variable = 1 if live in large city, else 0.

exper Actual years of wife's previous labor market experience.

nwifeinc Non-wife income.

wifecoll Dummy variable for wife's college attendance.

huscoll Dummy variable for husband's college attendance.

Source

Mroz, T. A. (1987) "The sensitivity of an empirical model of married women's hours of work to economic and statistical assumptions." *Econometrica* **55**, 765–799. PSID Staff, The Panel Study of Income Dynamics, Institute for Social ResearchPanel Study of Income Dynamics, University of Michigan, (For more information, visit the PSID website.).

qrs.fast *qrs.fast*

Description

Estimation of Quantile Regression with Selection (QRS) using Algorithm 3 for the estimation of the quantile and copula coefficients.

Usage

```
qrs.fast(y, x, d, z, w = NULL, Q1, Q2, P = 10, link, family, gridtheta, m = 1)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`d`	= Participation variable (N x 1)
`z`	= Regressors and instruments matrix for the propensity score (N x Kz)
`w`	= Sample weights (N x 1)
`Q1`	= Number of quantiles in reduced grid
`Q2`	= Number of quantiles in large grid
`P`	= Number of evaluated values of parameter with large quantile grid
`link`	= Link function to compute the propensity score
`family`	= Parametric copula family
`gridtheta`	= Grid of values for copula parameter (T x 1)
`m`	= Parameter to select interval of observations in top and bottom groups

Value

gamma = Estimated gamma coefficients (Kz x 1)

beta = Estimated beta coefficients (K x Q2)

theta = Estimated copula parameter

objf = Value of objective function at the optimum

b1 = Estimated beta coefficients for the grid of values of the copula parameter with the reduced quantile grid (K x Q1 x T)

Examples

```
set.seed(1)

N <- 100
x <- cbind(1, 2 + runif(N))
z <- cbind(x, runif(N))
cop <- copula::normalCopula(param = -0.5, dim = 2)
copu <- copula::rCopula(N, cop)
v <- copu[,1]
u <- copu[,2]
gamma <- c(-1.5, 0.05, 2)
beta <- cbind(qnorm(u), u^0.5)
prop <- exp(z %*% gamma) / (1 + exp(z %*% gamma))
d <- as.numeric(v <= prop)
y <- d * rowSums(x * beta)
w <- matrix(1, nrow = N, ncol = 1)

Q1 <- 9
Q2 <- 19
P <- 2
m <- 1
gridtheta <- seq(from = -1, to = 0, by = .1)
link <- "probit"
family <- "Gaussian"

result <- qrs.fast(y, x[,-1], d, z[,-1], w, Q1, Q2, P, link, family, gridtheta, m)
summary(result)
```

`qrs.fast.bt` *qrs.fast.bt*

Description

Algorithm 4: bootstrap algorithm with preprocessing and quantile grid reduction for Quantile Regression with Selection (QRS).

Usage

```
qrs.fast.bt(
  y,
  x,
  d,
  z,
  w0 = NULL,
  Q1,
  Q2,
  P = 10,
  link,
```

```
  family,
  gridtheta,
  m,
  b0,
  reps,
  alpha
)
```

Arguments

`y`	= Dependent variable (N x 1)
`x`	= Regressors matrix (N x K)
`d`	= Participation variable (N x 1)
`z`	= Regressors and instruments matrix for the propensity score (N x Kz)
`w0`	= Sample weights (N x 1)
`Q1`	= Number of quantiles in reduced grid
`Q2`	= Number of quantiles in large grid
`P`	= Number of evaluated values of parameter with large quantile grid
`link`	= Link function to compute the propensity score
`family`	= Parametric copula family
`gridtheta`	= Grid of values for copula parameter (T x 1)
`m`	= Parameter to select interval of observations in top and bottom groups
`b0`	= Initial values of the beta coefficients for all quantiles in the reduced quantile grid (K x Q1)
`reps`	= Number of bootstrap repetitions
`alpha`	= Significance level

Value

gammase = Bootstrapped standard error of gamma coefficients (Kz x 1)

gammaub = Bootstrapped upper bound of confidence interval of gamma coefficients (Kz x 1)

gammalb = Bootstrapped lower bound of confidence interval of gamma coefficients (Kz x 1)

betase = Bootstrapped standard error of beta coefficients (K x Q)

betaub = Bootstrapped upper bound of confidence interval of beta coefficients (K x Q)

betalb = Bootstrapped lower bound of confidence interval of beta coefficients (K x Q)

thetase = Bootstrapped standard error of theta coefficients (1 x 1)

thetaub = Bootstrapped upper bound of confidence interval of theta coefficients (1 x 1)

thetalb = Bootstrapped lower bound of confidence interval of theta coefficients (1 x 1)

gamma = Bootstrapped estimated theta coefficients (Kz x reps)

beta = Bootstrapped estimated beta coefficients (K x Q2 x reps)

theta = Bootstrapped estimated copula parameter (1 x reps)

objf = Bootstrapped value of objective function at the optimum (1 x reps)

Examples

```
set.seed(1)
N <- 100
x <- cbind(1, 2 + runif(N))
z <- cbind(x, runif(N))
cop <- copula::normalCopula(param = -0.5, dim = 2)
copu <- copula::rCopula(N, cop)
v <- copu[,1]
u <- copu[,2]
gamma <- c(-1.5, 0.05, 2)
beta <- cbind(qnorm(u), u^0.5)
prop <- exp(z %*% gamma) / (1 + exp(z %*% gamma))
d <- as.numeric(v <= prop)
y <- d * rowSums(x * beta)
w <- matrix(1, nrow = N, ncol = 1)

Q1 <- 9
Q2 <- 19
P <- 2
m <- 1
gridtheta <- seq(-1, 0, by = 0.1)
link <- "probit"
family <- "Gaussian"
reps <- 10
alpha <- 0.05

est <- qrs.fast(y, x[,-1], d, z[,-1], w, Q1, Q2, P, link, family, gridtheta, m)
bt <- qrs.fast.bt(y, x[,-1], d, z[,-1], w, Q1, Q2, P, link, family,
                  gridtheta, m, est$b1, reps, alpha)
summary(bt)
```

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