

Package ‘ssmrob’

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Description Package provides a set of tools for robust estimation and inference for models with sample selectivity.

License GPL-2

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 ssmrob-package

Robust Estimation and Inference in Sample Selection Models

Description

Package provides a set of tools for robust estimation and inference for models with sample selectivity.

Details

Package: ssmrob
 Type: Package
 Version: 0.7
 Date: 2019-07-16
 License: GPL-2

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti
 Maintainer: Mikhail Zhelonkin <Mikhail.Zhelonkin@gmail.com>

References

Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.
 Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

See Also

ssmrob, etregrob, heckitrob, heckit5rob, selection

Examples

```
# Zhelonkin, Genton, Ronchetti (2016): page 823
data(MEPS2001)
attach(MEPS2001)
selectEq <- dambexp ~ age + female + educ + blhisp + totchr + ins
outcomeEq <- lnambx ~ age + female + educ + blhisp + totchr + ins
meps.fit <- ssmrob(selectEq, outcomeEq, control = heckitrob.control(tcc = 3.2))
summary(meps.fit)
```

 coef.etregrob

Extract Coefficients from Robust Endogenous Treatment Model Fit

Description

Returns the coefficients of the robust two-stage estimator for endogenous treatment model.

Usage

```
## S3 method for class 'etregrob'
coef(object, ...)
```

Arguments

object	object of class "etregrob"
...	currently not used

Value

Returns a list of two vectors of parameters of two stages.

S	coefficients of the selection equation.
O	coefficients of the outcome equation.

Author(s)

Mikhail Zhelonkin

 coef.heckit5rob *Extract Coefficients from Robust Sample Selection Model Fit*

Description

Returns the coefficients of the robust two-stage estimator for simple Heckman's selection model or switching regression model.

Usage

```
## S3 method for class 'heckit5rob'
coef(object, ...)
```

Arguments

object	object of class "heckitrob" or "heckit5rob"
...	currently not used

Value

Returns a list of two (censored) or three (switching) vectors of parameters of two stages.

S	coefficients of the selection equation.
O	coefficients of the outcome equation(s).

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

 coef.heckitrob *Extract Coefficients from Robust Sample Selection Model Fit*

Description

Returns the coefficients of the robust two-stage estimator for simple Heckman's selection model or switching regression model.

Usage

```
## S3 method for class 'heckitrob'
coef(object, ...)
```

Arguments

object	object of class "heckitrob" or "heckit5rob"
...	currently not used

Value

Returns a list of two (censored) or three (switching) vectors of parameters of two stages.

S	coefficients of the selection equation.
O	coefficients of the outcome equation(s).

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

dLambdadSM	<i>Inverse Mills Ratio Derivative</i>
------------	---------------------------------------

Description

Computes a derivative of the inverse Mills ratio with respect to the parameter vector.

Usage

```
dLambdadSM(x, beta)
```

Arguments

x	vector of exogenous variables
beta	vector of parameters

Details

This function is necessary for computation of the asymptotic variance. In case of switching regressions the inverse Mills ratio term is different, and its derivative is computed in function `dLambdadSM5`. It can be also used to compute the influence function of the two-stage estimator.

Value

The gradient of the inverse Mills ratio is returned as a vector

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

dLambdadSM5 *Inverse Mills Ratio Derivative*

Description

Computes a derivative of the inverse Mills ratio with respect to the parameter vector.

Usage

```
dLambdadSM5(x, beta)
```

Arguments

x	vector of exogenous variables
beta	vector of parameters

Details

This function is necessary for computation of the asymptotic variance. In case of switching regressions the inverse Mills ratio term is different, and its derivative is computed in function `dLambdadSM5`. It can also be used to compute the influence function of the two-stage estimator.

Value

The gradient of the inverse Mills ratio is returned as a vector

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

etreg2steprobVcov *Variance Covariance Matrix*

Description

Computation of the asymptotic variance matrix of the robust Heckman's two-stage estimator for endogenous treatment model.

Usage

```
etreg2steprobVcov(y1vec, y2vec, x1Matr, x2Matr, eststage1, eststage2, eststage2sign,
weights = rep(1, nrow(y1vec)), t.c = 1.345)
```

Arguments

<code>y1vec</code>	vector of endogenous variables of the selection stage
<code>y2vec</code>	vector of endogenous variables of the outcome stage
<code>x1Matr</code>	matrix of exogenous variables of the selection stage
<code>x2Matr</code>	matrix of exogenous variables of the outcome stage
<code>eststage1</code>	object of class "glmrob", corresponding to the robust probit fit
<code>eststage2</code>	vector of the coefficients of the outcome stage
<code>eststage2sigma</code>	the robust scale estimate of the second stage regression
<code>weights</code>	robustness weights
<code>t.c</code>	tuning constant of the second stage

Details

The computation is made using the Huber (1967) - White (1980) sandwich estimator. In the computation of leverage weights the lambda's are assumed to be fixed.

Value

Variance covariance matrix of the second stage estimator

Author(s)

Mikhail Zhelonkin

References

Huber, P.J. (1967) The Behavior of Maximum Likelihood Estimates under Nonstandard Conditions. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*; L.M. LeCam, J. Neyman (Eds.), Berkeley: University of California Press, p. 221-233.

White, H.J. (1980) A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48, p. 817-838.

etregrob

Robust Fit of Endogenous Treatment Model

Description

Fits the endogenous treatment model using a robust two-stage estimator

Usage

```
etregrob(selection, outcome, control = heckitrob.control())
```

Arguments

<code>selection</code>	formula, the selection equation
<code>outcome</code>	formula, the outcome equation
<code>control</code>	a list of parameters for controlling the fitting process. The same list as for sample selection model

Details

Compute robust two-step estimates of the Endogenous Treatment Model. The robust probit is fitted in the first stage. In the second stage the Mallows type M-estimator is used instead of traditional OLS. The correction for endogeneity is made by means of control function, which is the inverse Mills ratio for a complete sample (see Maddala, 1983, p. 120-122). The values of the tuning constants and the robustness weights can be modified in `heckitrob.control`.

Value

Object of class "etregrob".

<code>coefficients</code>	a named vector of coefficients
<code>stage1</code>	object of class <code>glmrob</code> that contains robust probit fit
<code>stage2</code>	object of class <code>rlm</code> that contains second stage robust fit. Note that the standard errors in this object are biased, since they are not corrected for the uncertainty in the first estimation step. Use <code>vcov</code> below
<code>vcov</code>	variance matrix of the second stage
<code>sigma</code>	the standard error of the error term of the outcome equation
<code>CIMR</code>	inverse Mills ratio for the complete sample
<code>call</code>	the matched call
<code>method</code>	method of estimation, currently only "robust two-stage" is implemented
<code>converged</code>	logical. Did all the estimators converge?
<code>iterations</code>	list containing the numbers of iterations

Note

The treatment variable is automatically included in the formula for the second estimation step, i.e. one should not add the dependent variable from the selection equation in the formula of the outcome equation.

Author(s)

Mikhail Zhelonkin

References

Maddala G.S. (1983) Limited-Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press.

See Also

glmrob, rlm, ssmrob, heckitrob.control

Examples

```
library(mvtnorm)
set.seed(2)
N <- 3000
beta1 <- c(1.0, 1.0, 0.75)
beta2 <- c(1.5, 1.0, 0.5)
alpha <- 1.25
x1 <- rmvnorm(N, mean = c(0, -1, 1), sigma = diag(c(1, 0.5, 1)))
x2 <- x1
x2[, 3] <- rnorm(N, 1, 1)
eps <- rmvnorm(N, mean = rep(0, 2), sigma = matrix(c(1, -0.7, -0.7, 1), 2, 2))
x1beta1 <- x1[, 1]*beta1[1] + x1[, 2]*beta1[2] + x1[, 3]*beta1[3]
x2beta2 <- x2[, 1]*beta2[1] + x2[, 2]*beta2[2] + x2[, 3]*beta2[3]
y1 <- ifelse(x1beta1 + eps[, 1] > 0, 1, 0)
y2 <- x2beta2 + alpha*y1 + eps[, 2]
etm.ctrl <- heckitrob.control(weights.x1 = "hat", weights.x2 = "covMcd")
etmsim.fit <- etregrob(y1 ~ x1, y2 ~ x2, control = etm.ctrl)
summary(etmsim.fit)
```

fitted.etregrob *Fitted values of endogenous treatment model*

Description

Calculate the fitted values of the endogenous treatment model using robust fit.

Usage

```
## S3 method for class 'etregrob'
fitted(object, ...)
```

Arguments

object	object of class "etregrob"
...	currently not used

Value

vector of fitted values

Author(s)

Mikhail Zhelonkin

fitted.heckit5rob *Fitted values of robust sample selection model*

Description

Calculate the fitted values of the sample selection model using robust fit.

Usage

```
## S3 method for class 'heckit5rob'  
fitted(object, ...)
```

Arguments

object	object of class "heckitrob" or object of class "heckit5rob"
...	currently not used

Details

In case of truncated selection model one vector of fitted values is returned. In case of switching regression model a list, that contains two vectors corresponding to two regimes, is returned.

Value

vector of fitted values or a list that contains two vectors of fitted values

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

fitted.heckitrob *Fitted values of robust sample selection model*

Description

Calculate the fitted values of the sample selection model using robust fit.

Usage

```
## S3 method for class 'heckitrob'  
fitted(object, ...)
```

Arguments

object object of class "heckitrob" or object of class "heckit5rob"
 ... currently not used

Details

In case of truncated selection model one vector of fitted values is returned. In case of switching regression model a list, that contains two vectors corresponding to two regimes, is returned.

Value

vector of fitted values or a list that contains two vectors of fitted values

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

heck2steprobVcov *Variance Covariance Matrix*

Description

Computation of the asymptotic variance matrix of the robust Heckman's two-stage estimator for truncated selection model.

Usage

```
heck2steprobVcov(y1vec, y2vec, x1Matr, x2Matr, eststage1, eststage2,
                 eststage2sigma, weights = rep(1,nrow(y1vec)), t.c = 1.345)
```

Arguments

y1vec vector of endogenous variables of the selection stage
 y2vec vector of endogenous variables of the outcome stage
 x1Matr matrix of exogenous variables of the selection stage
 x2Matr matrix of exogenous variables of the outcome stage
 eststage1 object of class "glmrob", corresponding to the robust probit fit
 eststage2 vector of the coefficients of the outcome stage
 eststage2sigma the robust scale estimate of the second stage regression
 weights vector of robustness weights
 t.c tuning constant of the second stage

Details

The computation is made using the Huber (1967) - White (1980) sandwich estimator with Heckman (1979) correction. In the computation of leverage weights the lambda's are assumed to be fixed.

Value

Variance covariance matrix of the second stage estimator

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.

Huber, P.J. (1967) The Behavior of Maximum Likelihood Estimates under Nonstandard Conditions. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability; L.M. LeCam, J. Neyman (Eds.), Berkeley: University of California Press*, p. 221-233.

White, H.J. (1980) A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48, p. 817-838.

See Also

glmrob

heck5twosteprobVcov

Variance Covariance Matrix

Description

Computation of the asymptotic variance matrix of the robust Heckman's two-stage estimator for the second regime of switching regression model, i.e. when $y_1 = 0$.

Usage

```
heck5twosteprobVcov(y1vec, y2vec, x1Matr, x2Matr, eststage1, eststage2,  
                    eststage2sigma, weights = rep(1, nrow(y1vec)), t.c = 1.345)
```

Arguments

<code>y1vec</code>	vector of endogenous variables of the selection stage
<code>y2vec</code>	vector of endogenous variables of the outcome stage
<code>x1Matr</code>	matrix of exogenous variables of the selection stage
<code>x2Matr</code>	matrix of exogenous variables of the outcome stage
<code>eststage1</code>	object of class "glmrob", corresponding to the robust probit fit
<code>eststage2</code>	vector of the coefficients of the outcome stage
<code>eststage2sigma</code>	the robust scale estimate of the second stage regression
<code>weights</code>	vector of robustness weights
<code>t.c</code>	tuning constant of the second stage

Details

The computation is made using the Huber (1967) - White (1980) sandwich estimator with Heckman (1979) correction. In the computation of leverage weights the λ 's are assumed to be fixed.

Value

Variance covariance matrix of the second stage estimator

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

- Amemiya, T. (1984) Tobit Models: a Survey. *Journal of Econometrics*, 24, p. 3-61.
- Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.
- Huber, P.J. (1967) The Behavior of Maximum Likelihood Estimates under Nonstandard Conditions. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability; L.M. LeCam, J. Neyman (Eds.), Berkeley: University of California Press*, p. 221-233.
- White, H.J. (1980) A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48, p. 817-838.

 heckit5rob

Robust Heckit Fit: Switching Regressions

Description

Fits the switching regression model with probit selection using a robust two-stage estimator

Usage

```
heckit5rob(selection, outcome1, outcome2, control = heckitrob.control())
```

Arguments

<code>selection</code>	formula, the selection equation
<code>outcome1</code>	formula, first outcome equation
<code>outcome2</code>	formula, second outcome equation
<code>control</code>	a list of parameters for controlling the fitting process

Details

Compute robust two-stage estimates of the switching regression model with probit selection. The robust probit is fitted in the first stage. In the second stage the Mallows type M-estimators are used. The values of the tuning constants and the robustness weights can be modified in `heckitrob.control`.

Value

Object of class "heckit5rob".

<code>coefficients</code>	a named vector of coefficients
<code>stage1</code>	object of class <code>glmrob</code> that contains (first stage) robust probit fit
<code>stage21</code>	object of class <code>rlm</code> that contains second stage first regime robust fit. Note that the standard errors in this object are biased, since they are not corrected for the uncertainty in the first estimation step. Use <code>vcov1</code> below
<code>stage22</code>	object of class <code>rlm</code> that contains second stage second regime robust fit. Note that the standard errors in this object are biased, since they are not corrected for the uncertainty in the first estimation step. Use <code>vcov2</code> below
<code>vcov1</code>	variance matrix of the second stage first regime
<code>vcov2</code>	variance matrix of the second stage second regime
<code>sigma1</code>	the standard error of the error term of the outcome equation when $y_1=1$
<code>sigma2</code>	the standard error of the error term of the outcome equation when $y_1=0$
<code>IMR1</code>	inverse Mills ratio for the case when $y_1=1$
<code>IMR2</code>	inverse Mills ratio for the case when $y_1=0$
<code>call</code>	the matched call
<code>method</code>	method of estimation, currently only "robust two-stage" is implemented
<code>converged</code>	logical. Did all the estimators converge?
<code>iterations</code>	list containing the numbers of iterations

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.

Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

See Also

glmrob, rlm, ssmrob, heckitrob, heckitrob.control

Examples

```
## Not run:
library(mvtnorm)
set.seed(2)
N <- 5000
beta1 <- c(0, 1.0, 1.0, 0.75)
beta21 <- c(0, 1.5, 1.0, 0.5)
beta22 <- c(1, -1.5, 1.0, 0.5)
covm <- diag(3)
covm[lower.tri(covm)] <- c(0.75, 0.5, 0.25)
covm[upper.tri(covm)] <- covm[lower.tri(covm)]
eps <- rmvnorm(N, rep(0, 3), covm)
x1 <- rmvnorm(N, mean=c(0, -1, 1), sigma=diag(c(1, 0.5, 1)))
x21 <- x1
x22 <- x1
x21[, 3] <- rnorm(N, 1, 1)
x22[, 3] <- rnorm(N, 1, 1)
x1beta1 <- beta1[1] + x1[, 1]*beta1[2] + x1[, 2]*beta1[3] + x1[, 3]*beta1[4]
x21beta21 <- beta21[1] + x21[, 1]*beta21[2] + x21[, 2]*beta21[3] + x21[, 3]*beta21[4]
x22beta22 <- beta22[1] + x22[, 1]*beta22[2] + x22[, 2]*beta22[3] + x22[, 3]*beta22[4]
y1 <- ifelse(x1beta1 + eps[, 1] > 0, 1, 0)
y2 <- ifelse(y1 > 0.5, x21beta21 + eps[, 2],
x22beta22 + eps[, 3])
srsim.fit <- ssmrob(y1 ~ x1, list(y2 ~ x21, y2 ~ x22),
control = heckitrob.control(weights.x1 = "hat", weights.x2 = "covMcd"))
summary(srsim.fit)

## End(Not run)
```

heckitrob

Robust Heckit Fit

Description

Fits the sample selection model using a robust two-stage estimator

Usage

```
heckitrob(selection, outcome, control = heckitrob.control())
```

Arguments

<code>selection</code>	formula, the selection equation
<code>outcome</code>	formula, the outcome equation
<code>control</code>	a list of parameters for controlling the fitting process

Details

Compute robust two-stage estimates of the Heckman's selection model. The robust probit is fitted in the first stage. In the second stage the Mallows type M-estimator is used. The values of the tuning constants and the robustness weights can be modified in `heckitrob.control`.

Value

Object of class "heckitrob".

<code>coefficients</code>	a named vector of coefficients
<code>stage1</code>	object of class <code>glmrob</code> that contains robust probit fit
<code>stage2</code>	object of class <code>rlm</code> that contains second stage robust fit. Note that the standard errors in this object are biased, since they are not corrected for the uncertainty in the first estimation step. Use <code>vcov</code> below
<code>vcov</code>	variance matrix of the second stage
<code>sigma</code>	the standard error of the error term of the outcome equation
<code>IMR1</code>	inverse Mills ratio for the case when $y_1=1$
<code>call</code>	the matched call
<code>method</code>	method of estimation, currently only "robust two-stage" is implemented
<code>converged</code>	logical. Did all the estimators converge?
<code>iterations</code>	list containing the numbers of iterations

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

- Cameron, C.A., Trivedi, P.K. (2009) *Microeconometrics Using Stata*. College Station, TX: Stata Press.
- Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.
- Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

See Also

glmrob, rlm, ssmrob, heckitrob.control, heckit5rob, etregrob

Examples

```
# Zhelonkin, Genton, Ronchetti (2016): page 823
data(MEPS2001)
attach(MEPS2001)
selectEq <- dambexp ~ age + female + educ + blhisp + totchr + ins
outcomeEq <- lnambx ~ age + female + educ + blhisp + totchr + ins
meps.fit <- ssmrob(selectEq, outcomeEq, control = heckitrob.control(tcc = 3.2))
summary(meps.fit)
```

heckitrob.control *Auxiliary for Controlling Robust Fitting*

Description

Auxiliary function used for fitting the sample selection models. Contains control sequences, tuning constants and robustness weight functions.

Usage

```
heckitrob.control(acc = 1e-04, test.acc = "coef", maxit = 50, maxitO = 50,
                 weights.x1 = c("none", "hat", "robCov", "covMcd"),
                 weights.x2 = c("none", "hat", "robCov", "covMcd"),
                 tcc = 1.345, t.c = 1.345)
```

Arguments

acc	positive convergence level
test.acc	only "coef" is currently implemented
maxit	integer giving the maximum number of iterations: selection equation
maxitO	integer giving the maximum number of iterations: outcome equation
weights.x1	vector of robustness weights controlling for the leverage effect in the selection equation
weights.x2	vector of robustness weights controlling for the leverage effect in the outcome equation
tcc	tuning constant c for Huber's psi-function for the selection stage
t.c	tuning constant c for Huber's psi-function for the outcome stage

Value

A list with the arguments as components.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

 MEPS2001

Ambulatory Expenditures Data

Description

Sample of 3328 observations, with 526 zero expenditures.

Usage

`data (MEPS2001)`

Format

A data frame with 3328 observations on the following 22 variables.

`educ` education status
`age` age
`income` income
`female` gender
`vgood` a numeric vector
`good` a numeric vector
`hospexp` a numeric vector
`totchr` number of chronic diseases
`ffs` a numeric vector
`dhospexp` a numeric vector
`age2` a numeric vector
`agefem` a numeric vector
`fairpoor` a numeric vector
`year01` a numeric vector
`instype` a numeric vector
`ambexp` ambulatory expenditures
`lambexp` log ambulatory expenditures
`blhisp` ethnicity
`instype_s1` a numeric vector
`dambexp` dummy variable, ambulatory expenditures
`lnambx` a numeric vector
`ins` insurance status

Source

2001 Medical Expenditure Panel Survey by the Agency for Healthcare Research and Quality.

References

Cameron, C.A. and Trivedi, P.K. (2009) *Microeconometrics Using Stata*, College Station, TX: Stata Press.

Examples

```
data (MEPS2001)
attach (MEPS2001)
hist (lnambx)
```

MmatrM

M Matrix

Description

M matrix of a linear regression M-estimator of Mallows type.

Usage

```
MmatrM(x, y, beta, sigma, t.c = 1.345, weights = 1)
```

Arguments

x	matrix of explanatory variables
y	vector of dependent variables
beta	vector of parameters
sigma	robust scale estimate
t.c	tuning constant c for Huber's psi-function
weights	vector of robustness weights controlling for the leverage effects

Details

Computes the M matrix of the M-estimator of Mallows type. In current implementation only the Huber score function is available.

Value

M matrix for the sandwich formula.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

```
model.matrix.etregrob
```

Design Matrix of Endogenous Treatment Model

Description

Create design matrix of endogenous treatment model

Usage

```
## S3 method for class 'etregrob'  
model.matrix(object, part = "outcome", ...)
```

Arguments

object	object of class etregrob
part	character string indicating which matrix to extract: "outcome" for the outcome equation, "selection" for the selection equation.
...	currently not used

Value

If argument part is "outcome", the design matrix of the outcome equation is returned.

If argument part is "selection", the design matrix of the selection equation is returned.

Author(s)

Mikhail Zhelonkin

```
model.matrix.heckit5rob
```

Design Matrix of Switching Regression Model

Description

Create design matrix of switching regression model

Usage

```
## S3 method for class 'heckit5rob'  
model.matrix(object, part = "outcome", ...)
```

Arguments

object	object of class heckit5rob
part	character string indicating which matrix to extract: "outcome" for the outcome equations, "selection" for the selection equation.
...	currently not used

Value

If argument `part` is "outcome", the list containing design matrices of the outcome equations is returned.

stage21	design matrix for the first regime
stage22	design matrix for the second regime

If argument `part` is "selection", the design matrix of the selection equation is returned.

Author(s)

Mikhail Zhelonkin

model.matrix.heckitrob

Design Matrix of Sample Selection Model

Description

Create design matrix of sample selection model

Usage

```
## S3 method for class 'heckitrob'
model.matrix(object, part = "outcome", ...)
```

Arguments

object	object of class heckitrob
part	character string indicating which matrix to extract: "outcome" for the outcome equation, "selection" for the selection equation.
...	currently not used

Value

If argument `part` is "outcome", the design matrix of the outcome equation is returned.

If argument `part` is "selection", the design matrix of the selection equation is returned.

Author(s)

Mikhail Zhelonkin

MROZ .RAW

Wage Offer Data

Description

Sample of 753 observations, with 325 truncated observations.

Usage

data (MROZ .RAW)

Format

A data frame with 753 observations on the following 22 variables.

inlf in labor force (binary)

hours hours worked

kidslt6 number of young children

kidsge6 number of children greater than 6 years of age

age age

educ education status

wage wage

repwage a numeric vector

hushrs a numeric vector

husage husband's age

huseduc husband's education

huswage husband's wage

faminc family income

mtr a numeric vector

motheduc mother's education

fatheduc a numeric vector

unem a numeric vector

city a numeric vector

exper experience

nwifeinc non-wife income

lwage log-wage

expersq squared experience

References

Mroz , T.A. (1987) The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions. *Econometrica*, 55, p. 765-799.

Wooldridge, J.M. (2002) *Econometric Analysis of Cross Section and Panel Data*, Cambridge MA: MIT Press.

Examples

```
data (MROZ.RAW)
attach (MROZ.RAW)
hist (lwage)
```

nobs.heckitrob	<i>Number of Observations</i>
----------------	-------------------------------

Description

Number of observations

Usage

```
## S3 method for class 'heckitrob'
nobs(object, ...)
```

Arguments

object	object of class heckitrob, or heckit5rob or etregrob
...	currently not used

Author(s)

Mikhail Zhelonkin

print.etregrob	<i>Print a etregrob Object</i>
----------------	--------------------------------

Description

Print an object generated by etregrob

Usage

```
## S3 method for class 'etregrob'
print(x, digits = 4, ...)
```

Arguments

<code>x</code>	object of <code>etregrob</code> class
<code>digits</code>	number of significant digits to be printed
<code>...</code>	currently not used

Author(s)

Mikhail Zhelonkin

See Also

`etregrob`

`print.heckit5rob` *Print a heckit5rob Object*

Description

Print an object generated by `ssmrob`

Usage

```
## S3 method for class 'heckit5rob'  
print(x, digits = 4, ...)
```

Arguments

<code>x</code>	object returned from the <code>heckit5rob</code> representing the fit of the model
<code>digits</code>	number of significant digits to be printed
<code>...</code>	currently not used

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

`ssmrob`

print.heckitrob *Print a heckitrob Object*

Description

Print an object generated by `ssmrob`

Usage

```
## S3 method for class 'heckitrob'  
print(x, digits = 4, ...)
```

Arguments

<code>x</code>	object returned from the <code>heckitrob</code> representing the fit of the model
<code>digits</code>	number of significant digits to be printed
<code>...</code>	currently not used

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

`ssmrob`

print.summary.etregrob
Print Function for summary.etregrob

Description

Print a `summary.etregrob` object

Usage

```
## S3 method for class 'summary.etregrob'  
print(x, digits = 4, ...)
```

Arguments

<code>x</code>	Object of class <code>summary.etregrob</code> returned by a summary function
<code>digits</code>	number of nonzero digits after comma
<code>...</code>	currently not used

Author(s)

Mikhail Zhelonkin

```
print.summary.heckit5rob
```

Print Function for summary.heckit5rob

Description

Print a summary.heckit5rob object

Usage

```
## S3 method for class 'summary.heckit5rob'  
print(x, digits = 4, ...)
```

Arguments

x	Object of class summary.heckit5rob returned by a summary function
digits	number of nonzero digits after comma
...	currently not used

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

```
print.summary.heckitrob
```

Print Function for summary.heckitrob

Description

Print a summary.heckitrob object

Usage

```
## S3 method for class 'summary.heckitrob'  
print(x, digits = 4, ...)
```

Arguments

x	Object of class summary.heckitrob returned by a summary function
digits	number of nonzero digits after comma
...	currently not used

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

PsiMest

Score Function of the Mallows M-Estimator

Description

Score function of the Mallows-type M-estimator.

Usage

```
PsiMest(x, y, beta, sigma, t.c, weight)
```

Arguments

x	vector of exogenous variables
y	scalar endogenous variable
beta	parameter vector
sigma	std.error
t.c	tuning constant of Huber Psi-function
weight	scalar weight on the exogenous variables

Details

Can be used to compute the influence function of the estimator. Also can be used to approximate the bias of the estimator.

Value

score of the Psi-function

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

Hampel, Ronchetti, Rousseeuw, Stahel (1986). Robust Statistics: The Approach Based on Influence Functions. New York: Wiley.

residuals.etregrob *Residuals of Robust Endogenous Treatment Model Fit*

Description

Calculate the residuals of the endogenous treatment model using robust fit.

Usage

```
## S3 method for class 'etregrob'  
residuals(object, ...)
```

Arguments

object	object of class "etregrob"
...	currently not used

Value

numeric vector of residuals.

Author(s)

Mikhail Zhelonkin

See Also

etregrob

residuals.heckit5rob
Residuals of Robust Sample Selection Model Fit

Description

Calculate the residuals of the sample selection model using robust fit.

Usage

```
## S3 method for class 'heckit5rob'  
residuals(object, ...)
```

Arguments

object	object of class "heckitrob" or object of class "heckit5rob"
...	currently not used

Details

In case of truncated selection model one vector of residuals is returned. In case of switching regression model a list containing two vectors corresponding to two regimes is returned.

Value

The numeric vector(s) of the residuals.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

heckitrob; heckit5rob

residuals.heckitrob

Residuals of Robust Sample Selection Model Fit

Description

Calculate the residuals of the sample selection model using robust fit.

Usage

```
## S3 method for class 'heckitrob'  
residuals(object, ...)
```

Arguments

object	object of class "heckitrob" or object of class "heckit5rob"
...	currently not used

Details

In case of truncated selection model one vector of residuals is returned. In case of switching regression model a list containing two vectors corresponding to two regimes is returned.

Value

vector(s) of residuals.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

heckitrob; heckit5rob

ssmrob

Robust Sample Selection Model

Description

Compute robust two-stage estimates of truncated selection model (Tobit-2) and switching regression model (Tobit-5).

Usage

```
ssmrob(selection, outcome, control = heckitrob.control())
```

Arguments

selection	formula, the selection equation
outcome	formula(s), the outcome equation(s)
control	a list of parameters for controlling the fitting process

Details

Outcome equation may be a simple formula for the case of Heckman selection model, or a list of two formulas for the case of switching regressions.

Value

Object of class "heckitrob" or object of class "heckit5rob".

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

References

- Amemiya, T. (1984) Tobit Models: a Survey. *Journal of Econometrics*, 24, p. 3-61.
- Heckman, J.J. (1979) Sample Selection Bias as a Specification Error. *Econometrica*, 47, p. 153-161.
- Zhelonkin, M., Genton M.G., and Ronchetti, E. (2016) Robust Inference in Sample Selection Models. *Journal of the Royal Statistical Society, Series B*, 78, p. 805-827.

See Also

heckitrob; heckit5rob

Examples

```

# sample selection model (Tobit-2)
# Zhelonkin, Genton, Ronchetti (2016): page 823
data(MEPS2001)
attach(MEPS2001)
selectEq <- dambexp ~ age + female + educ + blhisp + totchr + ins
outcomeEq <- lnambx ~ age + female + educ + blhisp + totchr + ins
meps.fit <- ssmrob(selectEq, outcomeEq, control = heckitrob.control(tcc = 3.2))
summary(meps.fit)

# switching regressions example (Tobit-5)
## Not run:
library(mvtnorm)
set.seed(2)
N <- 5000
beta1 <- c(0, 1.0, 1.0, 0.75)
beta21 <- c(0, 1.5, 1.0, 0.5)
beta22 <- c(1, -1.5, 1.0, 0.5)
covm <- diag(3)
covm[lower.tri(covm)] <- c(0.75, 0.5, 0.25)
covm[upper.tri(covm)] <- covm[lower.tri(covm)]
eps <- rmvnorm(N, rep(0, 3), covm)
x1 <- rmvnorm(N, mean=c(0, -1, 1), sigma=diag(c(1, 0.5, 1)))
x21 <- x1
x22 <- x1
x21[, 3] <- rnorm(N, 1, 1)
x22[, 3] <- rnorm(N, 1, 1)
x1beta1 <- beta1[1] + x1[, 1]*beta1[2] + x1[, 2]*beta1[3] + x1[, 3]*beta1[4]
x21beta21 <- beta21[1] + x21[, 1]*beta21[2] + x21[, 2]*beta21[3] + x21[, 3]*beta21[4]
x22beta22 <- beta22[1] + x22[, 1]*beta22[2] + x22[, 2]*beta22[3] + x22[, 3]*beta22[4]
y1 <- ifelse(x1beta1 + eps[, 1] > 0, 1, 0)
y2 <- ifelse(y1 > 0.5, x21beta21 + eps[, 2],
x22beta22 + eps[, 3])
srsim.fit <- ssmrob(y1 ~ x1, list(y2 ~ x21, y2 ~ x22),
control = heckitrob.control(weights.x1 = "hat", weights.x2 = "covMcd"))
summary(srsim.fit)

## End(Not run)

```

summary.etregrob *Summarizing Robust Fits of Endogenous Treatment Models*

Description

Summarizes robust fit of endogenous treatment models.

Usage

```

## S3 method for class 'etregrob'
summary(object, ...)

```

Arguments

object object of class "etregrob"
 ... currently not used

Value

object of class "summary.etregrob"

Author(s)

Mikhail Zhelonkin

See Also

etregrob

summary.heckit5rob *Summarizing Robust Fits of Sample Selection Models*

Description

Summarize robust fit of Heckman selection model.

Usage

```
## S3 method for class 'heckit5rob'
summary(object, ...)
```

Arguments

object object of class "heckitrob" or "heckit5rob"
 ... currently not used

Value

object of class "summary.heckitrob" or object of class "summary.heckit5rob"

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

heckitrob; heckit5rob; heck2steprobVcov; heck5twosteprobVcov

summary.heckitrob *Summarizing Robust Fits of Sample Selection Models*

Description

Summarize robust fit of Heckman selection model.

Usage

```
## S3 method for class 'heckitrob'
summary(object, ...)
```

Arguments

object	object of class "heckitrob" or "heckit5rob"
...	currently not used

Value

object of class "summary.heckitrob" or object of class "summary.heckit5rob"

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

heckitrob; heckit5rob; heck2steprobVcov; heck5twosteprobVcov

vcov.etregrob *Extract Asymptotic Variance Covariance Matrix*

Description

Extracts the variance covariance matrix of the robust endogenous treatment model fit

Usage

```
## S3 method for class 'etregrob'
vcov(object, ...)
```

Arguments

object	object of class "etregrob"
...	currently not used

Value

Variance covariance matrix of the second stage. Variance covariance matrix of the selection stage can be extracted using the `vcov` function for the probit estimator, e.g. `vcov(etregrob.object$stage1)`.

Author(s)

Mikhail Zhelonkin

See Also

`etreg2steprobVcov`

`vcov.heckit5rob` *Extract Asymptotic Variance Covariance Matrix*

Description

Extract the variance covariance matrix of the robust sample selection model fit

Usage

```
## S3 method for class 'heckit5rob'
vcov(object, ...)
```

Arguments

<code>object</code>	object of class "heckitrob" or object of class "heckit5rob"
<code>...</code>	currently not used

Value

Variance covariance matrix of the second stage. Variance covariance matrix of the selection stage can be extracted using the `vcov` function for the probit estimator, e.g. `vcov(heckitrob.object$stage1)`.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

`heck2steprobVcov`

vcov.heckitrob *Extract Asymptotic Variance Covariance Matrix*

Description

Extract the variance covariance matrix of the robust sample selection model fit

Usage

```
## S3 method for class 'heckitrob'
vcov(object, ...)
```

Arguments

object	object of class "heckitrob" or object of class "heckit5rob"
...	currently not used

Value

Variance covariance matrix of the second stage. Variance covariance matrix of the selection stage can be extracted using the `vcov` function for the probit estimator, e.g. `vcov(heckitrob.object$stage1)`.

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

heck2steprobVcov

x2weight.covMcd *Robustness Weights*

Description

Auxiliary function. Computation of the leverage weights based on robust Mahalanobis distance. For computation of location and scatter the MCD method is used.

Usage

```
x2weight.covMcd(xMat)
```

Arguments

xMat	matrix of explanatory variables
------	---------------------------------

Value

vector of weights

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

cov.rob

x2weight.robCov *Robustness Weights*

Description

Auxiliary function. Computation of the leverage weights based on robust Mahalanobis distance. For computation of location and scatter the MVE method is used.

Usage

```
x2weight.robCov(xMat)
```

Arguments

xMat matrix of explanatory variables

Value

vector of weights

Author(s)

Mikhail Zhelonkin, Marc G. Genton, Elvezio Ronchetti

See Also

cov.rob