Package 'fwildclusterboot'

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Title Fast Wild Cluster Bootstrap Inference for Linear Regression Models

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Description Implementation of the fast algorithm for wild cluster bootstrap inference developed in Roodman et al (2019, STATA Journal) for linear regression models <https://journals.sagepub.com/doi/full/10.1177/1536867X19830877>, which makes it feasible to quickly calculate bootstrap test statistics based on a large number of bootstrap draws even for large samples - as long as the number of bootstrapping clusters is not too large. Multiway clustering, regression weights, bootstrap weights, fixed effects and subcluster bootstrapping are supported. Further, both restricted (WCR) and unrestricted (WCU) bootstrap are supported. Methods are provided for a variety of fitted models, including 'lm()', 'feols()' (from package 'fixest') and 'felm()' (from package 'lfe').

URL https://s3alfisc.github.io/fwildclusterboot/

BugReports https://github.com/s3alfisc/fwildclusterboot/issues/

License GPL-3

Imports collapse, Formula, Rcpp, dreamerr, Matrix, Matrix.utils, generics, gtools

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R topics documented:

.onLoad *setting options for nthreads when package is loaded*

Description

setting options for nthreads when package is loaded

Usage

```
.onLoad(libname, pkgname)
```

Arguments

libname	library name
pkgname	package name

Value

Changes number of threads used.

boottest *Fast wild cluster bootstrap inference*

Description

boottest is a S3 method that allows for fast wild cluster bootstrap inference for objects of class lm, fixest and felm by implementing the fast wild bootstrap algorithm developed in Roodman et al., 2019.

Usage

```
boottest(object, ...)
```

Arguments

object	An object of type lm, fixest of felm
...	other arguments

Value

An object of class boottest.

See Also

boottest.lm, boottest.fixest and boottest.felm

`boottest.felm` *Fast wild cluster bootstrap inference for object of class felm*

Description

`boottest.felm` is a S3 method that allows for fast wild cluster bootstrap inference for objects of class felm by implementing the fast wild bootstrap algorithm developed in Roodman et al., 2019.

Usage

```
## S3 method for class 'felm'
boottest(
  object,
  param,
  B,
  clustid,
  bootcluster = "max",
  fe = NULL,
  conf_int = NULL,
  seed = NULL,
  beta0 = 0,
  sign_level = NULL,
  type = "rademacher",
  impose_null = TRUE,
  p_val_type = "two-tailed",
  tol = 1e-06,
  maxiter = 10,
  na_omit = TRUE,
  nthreads = getBoottest_nthreads(),
  ...
)
```

Arguments

`object`	An object of class felm
`param`	A character vector of length one. The name of the regression coefficient for which the hypothesis is to be tested
`B`	Integer. The number of bootstrap iterations. When the number of clusters is low, increasing B adds little additional runtime.
`clustid`	A character vector containing the names of the cluster variables
`bootcluster`	A character vector. Specifies the bootstrap clustering variable or variables. If more than one variable is specified, then bootstrapping is clustered by the intersections of clustering implied by the listed variables. To mimic the behavior of stata's boottest command, the default is to cluster by the intersection of all the variables specified via the `clustid` argument, even though that is not necessarily recommended (see the paper by Roodman et al cited below, section 4.2). Other

	options include "min", where bootstrapping is clustered by the cluster variable with the fewest clusters.
fe	A character vector of length one which contains the name of the fixed effect to be projected out in the bootstrap. Note: if regression weights are used, fe needs to be NULL.
conf_int	A logical vector. If TRUE, boottest computes confidence intervals by p-value inversion. If FALSE, only the p-value is returned.
seed	An integer. Allows the user to set a random seed. If NULL, `boottest()` sets an internal seed. Hence by default, calling `boottest()` multiple times on the same object will produce the same test statistics.
beta0	A numeric. Shifts the null hypothesis H0: param = beta0 vs H1: param != beta0
sign_level	A numeric between 0 and 1 which sets the significance level of the inference procedure. E.g. sign_level = 0.05 returns 0.95% confidence intervals. By default, sign_level = 0.05.
type	character or function. The character string specifies the type of boostrap to use: One of "rademacher", "mammen", "norm" and "webb". Alternatively, type can be a function(n) for drawing wild bootstrap factors. "rademacher" by default. For the Rademacher and Mammen distribution, if the number of replications B exceeds the number of possible draw ombinations, 2^(#number of clusters), then `boottest()` will use each possible combination once (enumeration).
impose_null	Logical. Controls if the null hypothesis is imposed on the bootstrap dgp or not. Null imposed (`WCR`) by default. If FALSE, the null is not imposed (`WCU`)
p_val_type	Character vector of length 1. Type of p-value. By default "two-tailed".
tol	Numeric vector of length 1. The desired accuracy (convergence tolerance) used in the root finding procedure to find the confidence interval. 1e-6 by default.
maxiter	Integer. Maximum number of iterations used in the root finding procedure to find the confidence interval. 10 by default.
na_omit	Logical. If TRUE, `boottest()` omits rows with missing variables in the cluster variable that have not previously been deleted when fitting the regression object (e.g. if the cluster variable was not used when fitting the regression model).
nthreads	The number of threads. Can be: a) an integer lower than, or equal to, the maximum number of threads; b) 0: meaning all available threads will be used; c) a number strictly between 0 and 1 which represents the fraction of all threads to use. The default is to use 1 core.
...	Further arguments passed to or from other methods.

Value

An object of class `boottest`

p_val	The bootstrap p-value.
t_stat	The bootstrap t-statistic.
conf_int	The bootstrap confidence interval.
param	The tested parameter.

N	Sample size. Might differ from the regression sample size if the cluster variables contain NA values.
B	Number of Bootstrap Iterations.
clustid	Names of the cluster Variables.
N_G	Dimension of the cluster variables as used in boottest.
sign_level	Significance level used in boottest.
type	Distribution of the bootstrap weights.
p_test_vals	All p-values calculated while calculating the confidence interval.
test_vals	All t-statistics calculated while calculating the confidence interval.
regression	The regression object used in boottest.
call	Function call of boottest.

Confidence Intervals

boottest computes confidence intervals by inverting p-values. In practice, the following procedure is used:

- Based on an initial guess for starting values, calculate p-values for 26 equal spaced points between the starting values.
- Out of the 26 calculated p-values, find the two pairs of values x for which the corresponding p-values px cross the significance level sign_level.
- Feed the two pairs of x into an numerical root finding procedure and solve for the root. boottest currently relies on stats::uniroot and sets an absolute tolerance of 1e-06 and stops the procedure after 10 iterations.

Standard Errors

boottest does not calculate standard errors.

References

Roodman et al., 2019, "Fast and wild: Bootstrap inference in STATA using boottest", The STATA Journal. (https://journals.sagepub.com/doi/full/10.1177/1536867X19830877)

Examples

```
library(fwildclusterboot)
library(lfe)
data(voters)
felm_fit <- felm(proposition_vote ~ treatment + ideology1 + log_income
           | Q1_immigration,
           data = voters)
boot1 <- boottest(felm_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = "group_id1")
boot2 <- boottest(felm_fit,
```

```
                  B = 9999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"))
boot3 <- boottest(felm_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"),
                  fe = "Q1_immigration")
boot4 <- boottest(felm_fit,
                  B = 999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"),
                  fe = "Q1_immigration",
                  sign_level = 0.2,
                  seed = 8,
                  beta0 = 2)
summary(boot1)
plot(boot1)
```

`boottest.fixest` *Fast wild cluster bootstrap inference for object of class fixest*

Description

`boottest.fixest` is a S3 method that allows for fast wild cluster bootstrap inference for objects of class fixest by implementing the fast wild bootstrap algorithm developed in Roodman et al., 2019.

Usage

```
## S3 method for class 'fixest'
boottest(
  object,
  clustid,
  param,
  B,
  bootcluster = "max",
  fe = NULL,
  sign_level = NULL,
  conf_int = NULL,
  seed = NULL,
  beta0 = 0,
  type = "rademacher",
  impose_null = TRUE,
  p_val_type = "two-tailed",
  tol = 1e-06,
  maxiter = 10,
  na_omit = TRUE,
  nthreads = getBoottest_nthreads(),
  ...
)
```

Arguments

object	An object of class fixest
clustid	A character vector containing the names of the cluster variables
param	A character vector of length one. The name of the regression coefficient for which the hypothesis is to be tested
B	Integer. The number of bootstrap iterations. When the number of clusters is low, increasing B adds little additional runtime.
bootcluster	A character vector. Specifies the bootstrap clustering variable or variables. If more than one variable is specified, then bootstrapping is clustered by the intersections of clustering implied by the listed variables. To mimic the behavior of stata's boottest command, the default is to cluster by the intersection of all the variables specified via the clustid argument, even though that is not necessarily recommended (see the paper by Roodman et al cited below, section 4.2). Other options include "min", where bootstrapping is clustered by the cluster variable with the fewest clusters.
fe	A character vector of length one which contains the name of the fixed effect to be projected out in the bootstrap. Note: if regression weights are used, fe needs to be NULL.
sign_level	A numeric between 0 and 1 which sets the significance level of the inference procedure. E.g. sign_level = 0.05 returns 0.95% confidence intervals. By default, sign_level = 0.05.
conf_int	A logical vector. If TRUE, boottest computes confidence intervals by p-value inversion. If FALSE, only the p-value is returned.
seed	An integer. Allows the user to set a random seed. If NULL, boottest() sets an internal seed. Hence by default, calling boottest() multiple times on the same object will produce the same test statistics.
beta0	A numeric. Shifts the null hypothesis H0: param = beta0 vs H1: param != beta0
type	character or function. The character string specifies the type of boostrap to use: One of "rademacher", "mammen", "norm" and "webb". Alternatively, type can be a function(n) for drawing wild bootstrap factors. "rademacher" by default. For the Rademacher and Mammen distribution, if the number of replications B exceeds the number of possible draw ombinations, 2^(#number of clusters), then boottest() will use each possible combination once (enumeration).
impose_null	Logical. Controls if the null hypothesis is imposed on the bootstrap dgp or not. Null imposed (WCR) by default. If FALSE, the null is not imposed (WCU)
p_val_type	Character vector of length 1. Type of p-value. By default "two-tailed".
tol	Numeric vector of length 1. The desired accuracy (convergence tolerance) used in the root finding procedure to find the confidence interval. 1e-6 by default.
maxiter	Integer. Maximum number of iterations used in the root finding procedure to find the confidence interval. 10 by default.
na_omit	Logical. If TRUE, boottest() omits rows with missing variables in the cluster variable that have not previously been deleted when fitting the regression object (e.g. if the cluster variable was not used when fitting the regression model).

nthreads	The number of threads. Can be: a) an integer lower than, or equal to, the maximum number of threads; b) 0: meaning all available threads will be used; c) a number strictly between 0 and 1 which represents the fraction of all threads to use. The default is to use 1 core.
...	Further arguments passed to or from other methods.

Value

An object of class `boottest`

p_val	The bootstrap p-value.
t_stat	The bootstrap t-statistic.
conf_int	The bootstrap confidence interval.
param	The tested parameter.
N	Sample size. Might differ from the regression sample size if the cluster variables contain NA values.
B	Number of Bootstrap Iterations.
clustid	Names of the cluster Variables.
N_G	Dimension of the cluster variables as used in boottest.
sign_level	Significance sign_level used in boottest.
type	Distribution of the bootstrap weights.
p_test_vals	All p-values calculated while calculating the confidence interval.
test_vals	All t-statistics calculated while calculating the confidence interval.
regression	The regression object used in boottest.
call	Function call of boottest.

Confidence Intervals

`boottest` computes confidence intervals by inverting p-values. In practice, the following procedure is used:

- Based on an initial guess for starting values, calculate p-values for 26 equal spaced points between the starting values.
- Out of the 26 calculated p-values, find the two pairs of values x for which the corresponding p-values px cross the significance sign_level sign_level.
- Feed the two pairs of x into an numerical root finding procedure and solve for the root. boottest currently relies on `stats::uniroot` and sets an absolute tolerance of 1e-06 and stops the procedure after 10 iterations.

Standard Errors

`boottest` does not calculate standard errors.

References

Roodman et al., 2019, "Fast and wild: Bootstrap inference in STATA using boottest", The STATA Journal. (https://journals.sagepub.com/doi/full/10.1177/1536867X19830877)

Examples

```
library(fwildclusterboot)
library(fixest)
data(voters)
feols_fit <-feols(proposition_vote ~ treatment + ideology1 + log_income,
           fixef =  "Q1_immigration",
           data = voters)
boot1 <- boottest(feols_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = "group_id1")
boot2 <- boottest(feols_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"))
boot3 <- boottest(feols_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"),
                  fe = "Q1_immigration")
boot4 <- boottest(feols_fit,
                  B = 10000,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"),
                  fe = "Q1_immigration",
                  sign_level = 0.2,
                  seed = 8,
                  beta0 = 2)
summary(boot1)
plot(boot1)
```

`boottest.lm` *Fast wild cluster bootstrap inference for object of class lm*

Description

`boottest.lm` is a S3 method that allows for fast wild cluster bootstrap inference for objects of class lm by implementing the fast wild bootstrap algorithm developed in Roodman et al., 2019.

Usage

```
## S3 method for class 'lm'
boottest(
  object,
```

```
  clustid,
  param,
  B,
  bootcluster = "max",
  conf_int = NULL,
  seed = NULL,
  beta0 = NULL,
  sign_level = NULL,
  type = "rademacher",
  impose_null = TRUE,
  p_val_type = "two-tailed",
  tol = 1e-06,
  maxiter = 10,
  na_omit = TRUE,
  nthreads = getBoottest_nthreads(),
  ...
)
```

Arguments

`object`	An object of class lm
`clustid`	A character vector containing the names of the cluster variables
`param`	A character vector of length one. The name of the regression coefficient for which the hypothesis is to be tested
`B`	Integer. The number of bootstrap iterations. When the number of clusters is low, increasing B adds little additional runtime.
`bootcluster`	A character vector. Specifies the bootstrap clustering variable or variables. If more than one variable is specified, then bootstrapping is clustered by the intersections of clustering implied by the listed variables. To mimic the behavior of stata's boottest command, the default is to cluster by the intersection of all the variables specified via the `clustid` argument, even though that is not necessarily recommended (see the paper by Roodman et al cited below, section 4.2). Other options include "min", where bootstrapping is clustered by the cluster variable with the fewest clusters.
`conf_int`	A logical vector. If TRUE, boottest computes confidence intervals by p-value inversion. If FALSE, only the p-value is returned.
`seed`	An integer. Allows the user to set a random seed. If NULL, `boottest()` sets an internal seed. Hence by default, calling `boottest()` multiple times on the same object will produce the same test statistics.
`beta0`	A numeric. Shifts the null hypothesis H0: param = beta0 vs H1: param != beta0
`sign_level`	A numeric between 0 and 1 which sets the significance level of the inference procedure. E.g. sign_level = 0.05 returns 0.95% confidence intervals. By default, sign_level = 0.05.
`type`	character or function. The character string specifies the type of boostrap to use: One of "rademacher", "mammen", "norm" and "webb". Alternatively, type can be a function(n) for drawing wild bootstrap factors. "rademacher" by default.

	For the Rademacher and Mammen distribution, if the number of replications B exceeds the number of possible draw ombinations, 2^(#number of clusters), then `boottest()` will use each possible combination once (enumeration).
`impose_null`	Logical. Controls if the null hypothesis is imposed on the bootstrap dgp or not. Null imposed (`WCR`) by default. If FALSE, the null is not imposed (`WCU`)
`p_val_type`	Character vector of length 1. Type of p-value. By default "two-tailed".
`tol`	Numeric vector of length 1. The desired accuracy (convergence tolerance) used in the root finding procedure to find the confidence interval. 1e-6 by default.
`maxiter`	Integer. Maximum number of iterations used in the root finding procedure to find the confidence interval. 10 by default.
`na_omit`	Logical. If TRUE, `boottest()` omits rows with missing variables in the cluster variable that have not previously been deleted when fitting the regression object (e.g. if the cluster variable was not used when fitting the regression model).
`nthreads`	The number of threads. Can be: a) an integer lower than, or equal to, the maximum number of threads; b) 0: meaning all available threads will be used; c) a number strictly between 0 and 1 which represents the fraction of all threads to use. The default is to use 1 core.
`...`	Further arguments passed to or from other methods.

Value

An object of class `boottest`

`p_val`	The bootstrap p-value.
`t_stat`	The bootstrap t-statistic.
`conf_int`	The bootstrap confidence interval.
`param`	The tested parameter.
`N`	Sample size. Might differ from the regression sample size if the cluster variables contain NA values.
`B`	Number of Bootstrap Iterations.
`clustid`	Names of the cluster Variables.
`N_G`	Dimension of the cluster variables as used in boottest.
`sign_level`	Significance level used in boottest.
`type`	Distribution of the bootstrap weights.
`p_test_vals`	All p-values calculated while calculating the confidence interval.
`test_vals`	All t-statistics calculated while calculating the confidence interval.
`regression`	The regression object used in boottest.
`call`	Function call of boottest.

Confidence Intervals

boottest computes confidence intervals by inverting p-values. In practice, the following procedure is used:

- Based on an initial guess for starting values, calculate p-values for 26 equal spaced points between the starting values.
- Out of the 26 calculated p-values, find the two pairs of values x for which the corresponding p-values px cross the significance level sign_level.
- Feed the two pairs of x into an numerical root finding procedure and solve for the root. boottest currently relies on stats::uniroot and sets an absolute tolerance of 1e-06 and stops the procedure after 10 iterations.

Standard Errors

boottest does not calculate standard errors.

References

Roodman et al., 2019, "Fast and wild: Bootstrap inference in STATA using boottest", The STATA Journal. (https://journals.sagepub.com/doi/full/10.1177/1536867X19830877)

Examples

```
library(fwildclusterboot)
data(voters)
lm_fit <-lm(proposition_vote ~ treatment + ideology1 + log_income + Q1_immigration,
         data = voters)
boot1 <- boottest(lm_fit,
                  B = 9999,
                  param = "treatment",
                   clustid = "group_id1")
boot2 <- boottest(lm_fit,
                  B = 9999,
                  param = "treatment",
                 clustid = c("group_id1", "group_id2"))
boot3 <- boottest(lm_fit,
                  B = 9999,
                  param = "treatment",
                  clustid = c("group_id1", "group_id2"),
                  sign_level = 0.2,
                  seed = 8,
                  beta0 = 2)
summary(boot1)
plot(boot1)
```

boot_algo2 *Fast wild cluster bootstrap algorithm*

Description

function that implements the fast bootstrap algorithm as described in Roodman et al (2019)

Usage

```
boot_algo2(
  preprocessed_object,
  boot_iter,
  point_estimate,
  impose_null,
  beta0,
  sign_level,
  param,
  seed,
  p_val_type,
  nthreads,
  type,
  full_enumeration
)
```

Arguments

preprocessed_object	A list: output of the preprocess2 function.
boot_iter	number of bootstrap iterations
point_estimate	The point estimate of the test parameter from the regression model.
impose_null	If TRUE, the null is not imposed on the bootstrap distribution. This is what Roodman et al call the "WCU" bootstrap. With impose_null = FALSE, the null is imposed ("WCR").
beta0	Shifts the null hypothesis.
sign_level	The significance level.
param	name of the test parameter.
seed	the random seed. controls draw of bootstrap weights.
p_val_type	type Type of p-value. By default "two-tailed". Other options: "equal-tailed", ">", "<"
nthreads	The number of threads. Can be: a) an integer lower than, or equal to, the maximum number of threads; b) 0: meaning all available threads will be used; c) a number strictly between 0 and 1 which represents the fraction of all threads to use. The default is to use 50\ set permanently the number of threads used within this package using the function ...

type character or function. The character string specifies the type of boostrap to use: One of "rademacher", "mammen", "norm" and "webb". Alternatively, type can be a function(n) for drawing wild bootstrap factors. "rademacher" by default.

full_enumeration
Is full enumeration employed? Full enum. is used if N_G^2 < boot_iter for Mammen and Rademacher weights

Value

A list of ...

`check_set_nthreads` *Simple function that checks that the nber of threads is valid*

Description

Simple function that checks that the nber of threads is valid

Usage

```
check_set_nthreads(nthreads)
```

Arguments

nthreads Integer. Number of threads to be used

Value

Integer. The number of threads to be used.

`cpp_get_nb_threads` *Get maximum number of threads on hardware for open mp support*

Description

Get maximum number of threads on hardware for open mp support

Usage

```
cpp_get_nb_threads()
```

Value

The maximum number of threads supported.

create_data *Simulate Data*

Description

Function simulates data for tests and examples with clustering variables and fixed-effects.

Usage

```
create_data(N, N_G1, icc1, N_G2, icc2, numb_fe1, numb_fe2, seed, weights)
```

Arguments

N	number of observations
N_G1	A scalar. number of clusters for clustering variable 1
icc1	A scalar between 0 and 1. intra-cluster correlation for clustering variable 1
N_G2	A scalar. number of clusters for clustering variable 2
icc2	A scalar between 0 and 1. intra-cluster correlation for clustering variable 2
numb_fe1	A scalar. Number of fixed effect for first factor variable
numb_fe2	A scalar. Number of fixed effect for second factor variable
seed	An integer. Set the random seed
weights	Possible regression weights to be used in estimation

Value

A simulated `data.frame` with specified numbers of clusters, intra-cluster correlations and dimensionality of fixed effects.

crosstab *optimized collapse way to calculate crosstabs*

Description

optimized collapse way to calculate crosstabs

Usage

```
crosstab(data, var1, var2)
```

Arguments

data	A matrix to collapse by two dimensions var1 var2
var1	a data.frame containing a single variable
var2	a data.frame containing a single variable

Value

A collapsed matrix of dimension length(unique(var1)) x length(unique(var2)). If...

`crosstab3` *collapse way to calculate crosstabs*

Description

collapse way to calculate crosstabs

Usage

```
crosstab3(data, var1, var2)
```

Arguments

`data`	A matrix to collapse by two dimensions var1 var2
`var1`	a data.frame containing a single variable
`var2`	a data.frame containing a single variable

Value

A collapsed matrix of dimension length(unique(var1)) x length(unique(var2)). If...

`crosstab4` *Function 4 to calculate crosstabs*

Description

Function 4 to calculate crosstabs

Usage

```
crosstab4(data, var1, var2)
```

Arguments

`data`	A matrix to collapse by two dimensions var1 var2
`var1`	a data.frame containing a single variable
`var2`	a data.frame containing a single variable

Value

A collapsed matrix of dimension length(unique(var1)) x length(unique(var2)). If...

eigenMapMatMult *Matrix Multiplication via Eigen*

Description

Matrix Multiplication via Eigen

Usage

```
eigenMapMatMult(A, B, nthreads)
```

Arguments

A	A matrix.
B	A matrix.
nthreads	Integer. Number of threads to use for matrix multiplication.

Value

A matrix

eigenMatMult *Matrix Multiplication via Eigen*

Description

Matrix Multiplication via Eigen

Usage

```
eigenMatMult(A, B, nthreads)
```

Arguments

A	A matrix.
B	A matrix.
nthreads	Integer. Number of threads to use for matrix multiplication.

Value

A matrix

getBoottest_nthreads *get the number of threads for use with open mp*

Description

get the number of threads for use with open mp

Usage

```
getBoottest_nthreads()
```

Value

The number of threads currently used by boottest as set in options

glance.boottest *S3 method to glance at objects of class boottest*

Description

S3 method to glance at objects of class boottest

Usage

```
## S3 method for class 'boottest'
glance(x, ...)
```

Arguments

x	object of type boottest
...	Further arguments passed to or from other methods.

Value

A single row summary "glance" of an object of type boottest - lists characteristics of the input regression model

`invert_p_val2` *Calculation of Confidence Sets*

Description

Inverts the bootstrap p-value and calculates confidence sets

Usage

```
invert_p_val2(
  object,
  boot_iter,
  point_estimate,
  se_guess,
  clustid,
  sign_level,
  vcov_sign,
  impose_null,
  p_val_type,
  tol,
  maxiter
)
```

Arguments

`object`	A object of type boottest
`boot_iter`	An integer. Number of bootstrap iterations
`point_estimate`	A scalar. Point estimate of the coefficient of interest from the regression model
`se_guess`	A scalar vector of dimension 2. A guess of the standard error that initiates the p-value inversion.
`clustid`	A vector with the clusters
`sign_level`	A numeric between 0 and 1. Sets to confidence level: sign_level = 0.05 returns 0.95% confidence intervals
`vcov_sign`	Controls addition / substraction of individual covariance matrices for multiway clustering
`impose_null`	Logical. Controls if the null hypothesis is imposed on the bootstrap dgp or not. Null imposed - WCR - by default. If FALSE, unrestricted WCU
`p_val_type`	type Type of p-value. By default "two-tailed". Other options: "equal-tailed", ">", "<"
`tol`	the desired accuracy (convergence tolerance) for confidence interval inversion. 1e-6 by default.
`maxiter`	maximum number of iterations for confidence interval inversion. 10 by default.

Value

A list containing the calculated confidence interval, the t-statistics and corresponding p-values used in the grid search.

`plot.boottest` *Plot the bootstrap distribution of t-statistics*

Description

Plot the bootstrap distribution of t-statistics

Usage

```
## S3 method for class 'boottest'
plot(x, ...)
```

Arguments

`x`	An object of type boottest
`...`	Further arguments passed to or from other methods.

Value

A plot of bootstrap t-statistics under different null hypotheses

---

`preprocess2` *function that pre-processes regression objects of type lm, fixest and feols*

Description

function that pre-processes regression objects of type lm, fixest and feols

Usage

```
preprocess2(object, cluster, fe, param, bootcluster, na_omit)
```

Arguments

`object`	An object of class lm, fixest or felm
`cluster`	A vector with the names of the clusters
`fe`	A character scalar - fixed effect to be projected out, or NULL
`param`	The univariate coefficients for which a hypothesis is to be tested
`bootcluster`	The bootstrap sampling cluster.
`na_omit`	Logical. If TRUE, `boottest()` omits rows with missing variables that are added to the model via the `cluster` argument in `boottest()`

Value

List containing preprocessed data for boottest estimation

`p_val_null2` *Calculate p-values based on A, B, CC, CD, DD and other inputs*

Description

Calculate p-values based on A, B, CC, CD, DD and other inputs

Usage

```
p_val_null2(
  beta0,
  A,
  B,
  CC,
  CD,
  DD,
  clustid,
  boot_iter,
  small_sample_correction,
  impose_null,
  point_estimate,
  p_val_type
)
```

Arguments

`beta0`	Scalar. Shifts the null hypothesis.
`A`	A list.
`B`	A list.
`CC`	A list.
`CD`	A list.
`DD`	A list.
`clustid`	A data.frame containing the cluster variables.
`boot_iter`	An integer. Number of bootstrap iterations.
`small_sample_correction`	A vector of the dimension of ncol(clustid)
`impose_null`	If TRUE, no null hypothesis if imposed on the bootstrap
`point_estimate`	The point estimate of the test parameter from the regression model.
`p_val_type`	type Type of p-value. By default "two-tailed". Other options: "equal-tailed", ">", "<"

Value

A list containing the bootstrapped p-value, the bootstrapped t-statistics, and the number of invalid test statistics.

`setBoottest_nthreads` *Set the number of threads for use with open mp via options By default, only one thread is used*

Description

Set the number of threads for use with open mp via options By default, only one thread is used

Usage

```
setBoottest_nthreads(nthreads)
```

Arguments

`nthreads`	Integer. Number of threads to be used

Value

No return value

`summary.boottest` *S3 method to summarize objects of class boottest*

Description

S3 method to summarize objects of class boottest

Usage

```
## S3 method for class 'boottest'
summary(object, digits = 3, ...)
```

Arguments

`object`	object of type boottest
`digits`	rounding of output. 3 by default
`...`	Further arguments passed to or from other methods.

Value

Returns result summaries for objects of type boottest

tidy.boottest *S3 method to summarize objects of class boottest into tidy data.frame*

Description

S3 method to summarize objects of class boottest into tidy data.frame

Usage

```
## S3 method for class 'boottest'
tidy(object, ...)
```

Arguments

object	object of type boottest
...	Further arguments passed to or from other methods.

Value

A tidy data.frame with estimation results for objects of type boottest

voters *Random example data set*

Description

Random example data set

Usage

```
data(voters)
```

Format

An object of class `data.frame` with 300 rows and 13 columns.

Examples

```
data(voters)
```

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