Package 'rdpower'

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Title Power Calculations for RD Designs

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Description The regression discontinuity (RD) design is a popular quasi-experimental design for causal inference and policy evaluation. The 'rdpower' package provides tools to perform power, sample size and MDE calculations in RD designs: rdpower() calculates the power of an RD design, rdsampsi() calculates the required sample size to achieve a desired power and rdmde() calculates minimum detectable effects. See Cattaneo, Titiunik and Vazquez-Bare (2019) <https://rdpackages.github.io/references/Cattaneo-Titiunik-VazquezBare_2019_Stata.pdf> for further methodological details.

Imports rdrobust

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rdpower-package *rdpower: Power and Sample Size Calculations for RD Designs*

Description

The regression discontinuity (RD) design is a popular quasi-experimental design for causal inference and policy evaluation. The 'rdpower' package provides tools to perform power, sample size and MDE calculations in RD designs: rdpower() calculates the power of an RD design, rdsampsi() calculates the required sample size to achieve a desired power and rdmde() calculates minimum detectable effects. This package relies on the rdrobust package. See Calonico, Cattaneo and Titiunik (2014, 2015) and Calonico, Cattaneo, Farrell and Titiunik (2017). For more details, and related Stata and R packages useful for analysis of RD designs, visit https://rdpackages.github.io/.

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References

Calonico, S., M. D. Cattaneo, M. Farrell and R. Titiunik. (2017).rdrobust: Software for Regression Discontinuity Designs. *Stata Journal* 17(2): 372-404.

Calonico, S., M. D. Cattaneo, and R. Titiunik. (2014). Robust Data-Driven Inference in the Regression-Discontinuity Design. *Stata Journal* 14(4): 909-946.

Calonico, S., M. D. Cattaneo, and R. Titiunik. (2015).rdrobust: An R Package for Robust Nonparametric Inference in Regression-Discontinuity Designs. *R Journal* 7(1): 38-51.

Cattaneo, M. D., R. Titiunik and G. Vazquez-Bare. (2019). Power Calculations for Regression Discontinuity Designs. *Stata Journal*, 19(1): 210-245.

rdmde *MDE Calculations for RD Designs*

Description

rdmde() performs MDE calculations for RD designs.

Usage

```
rdmde(
  data = NULL,
  cutoff = 0,
  alpha = 0.05,
  beta = 0.8,
  nsamples = NULL,
  sampsi = NULL,
  samph = NULL,
  all = FALSE,
  bias = NULL,
  variance = NULL,
  init.cond = NULL,
  covs = NULL,
  covs_drop = TRUE,
  deriv = 0,
  p = 1,
  q = NULL,
  h = NULL,
  b = NULL,
  rho = NULL,
  kernel = "triangular",
  bwselect = "mserd",
  vce = "nn",
  cluster = NULL,
  scalepar = 1,
  scaleregul = 1,
  fuzzy = NULL,
  level = 95,
  weights = NULL,
  masspoints = "adjust",
  bwcheck = NULL,
  bwrestrict = TRUE,
  stdvars = FALSE
)
```

Arguments

data	a matrix (Y,R) containing the outcome variable and the running variable (as column vectors).
cutoff	the RD cutoff (default is 0).
alpha	specifies the significance level for the power function. Default is 0.05.
beta	specifies the desired power. Default is 0.8.
nsamples	sets the total sample size to the left, sample size to the left inside the bandwidth, total sample size to the right and sample size to the right of the cutoff inside the bandwidth to calculate the variance when the running variable is not specified. When not specified, the values are calculated using the running variable.

sampsi	sets the sample size at each side of the cutoff for power calculation. The first number is the sample size to the left of the cutoff and the second number is the sample size to the right. Default values are the sample sizes inside the chosen bandwidth.
samph	sets the bandwidths at each side of the cutoff for power calculation. The first number is the bandwidth to the left of the cutoff and the second number is the bandwidth to the right. Default values are the bandwidths used by rdrobust.
all	displays the power using the conventional variance estimator, in addition to the robust bias corrected one.
bias	set bias to the left and right of the cutoff. If not specified, the biases are estimated using rdrobust.
variance	set variance to the left and right of the cutoff. If not specified, the variances are estimated using rdrobust.
init.cond	sets the initial condition for the Newton-Raphson algorithm that finds the MDE. Default is 0.2 times the standard deviation of the outcome below the cutoff.
covs	option for rdrobust(): specifies additional covariates to be used for estimation and inference.
covs_drop	option for rdrobust(): if TRUE, it checks for collinear additional covariates and drops them. Default is TRUE.
deriv	option for rdrobust(): specifies the order of the derivative of the regression functions to be estimated.
p	option for rdrobust(): specifies the order of the local-polynomial used to construct the point-estimator.
q	option for rdrobust(): specifies the order of the local-polynomial used to construct the bias-correction.
h	option for rdrobust(): specifies the values of the main bandwidth to be used on the left and on the right of the cutoff, respectively.
b	option for rdrobust(): specifies the values of the bias bandwidth b to be used on the left and on the right of the cutoff, respectively.
rho	option for rdrobust(): specifies the value of rho so that the bias bandwidth b equals b=h/rho.
kernel	option for rdrobust(): kernel function used to construct the local-polynomial estimators.
bwselect	option for rdrobust(): specifies the bandwidth selection procedure to be used.
vce	option for rdrobust(): specifies the procedure used to compute the variance-covariance matrix estimator.
cluster	option for rdrobust(): indicates the cluster ID variable used for the cluster-robust variance estimation with degrees-of-freedom weights.
scalepar	option for rdrobust(): specifies scaling factor for RD parameter of interest.
scaleregul	option for rdrobust(): specifies scaling factor for the regularization terms of bandwidth selectors.
fuzzy	option for rdrobust(): specifies the treatment status variable used to implement fuzzy RD estimation.

level	option for rdrobust(): sets the confidence level for confidence intervals.
weights	option for rdrobust(): is the variable used for optional weighting of the estimation procedure. The unit-specific weights multiply the kernel function.
masspoints	option for rdrobust(): checks and controls for repeated observations in tue running variable.
bwcheck	option for rdrobust(): if a positive integer is provided, the preliminary bandwidth used in the calculations is enlarged so that at least bwcheck unique observations are used.
bwrestrict	option for rdrobust(): if TRUE, computed bandwidths are restricted to lie withing the range of x. Default is bwrestrict=TRUE.
stdvars	option for rdrobust(): if TRUE, x and y are standardized before computing the bandwidths. Default is stdvars=TRUE.

Value

mde	MDE using robust bias corrected standard error
se.rbc	robust bias corrected standard error
sampsi.r	number of observations inside the window to the right of the cutoff
sampsi.l	number of observations inside the window to the left of the cutoff
samph.r	bandwidth to the right of the cutoff
samph.l	bandwidth to the left of the cutoff
alpha	significance level used in power function
bias.r	bias to the right of the cutoff
bias.l	bias to the left of the cutoff
Vr.rb	Robust bias corrected variance to the right of the cutoff
Vl.rb	Robust bias corrected variance to the left of the cutoff
N.r	Total sample size to the right of the cutoff
N.l	Total sample size to the left of the cutoff
mde.conv	MDE using conventional inference
se.conv	conventional standard error

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References

Cattaneo, M. D., R. Titiunik and G. Vazquez-Bare. (2019). Power Calculations for Regression Discontinuity Designs. *Stata Journal*, 19(1): 210-245.

Examples

```
# Toy dataset
X <- array(rnorm(2000),dim=c(1000,2))
R <- X[,1] + X[,2] + rnorm(1000)
Y <- 1 + R -.5*R^2 + .3*R^3 + (R>=0) + rnorm(1000)
# MDE calculation
tmp <- rdmde(data=cbind(Y,R),init.cond=0.5)
```

---

rdpower *Power Calculations for RD Designs*

Description

`rdpower()` performs power calculations for RD designs.

Usage

```
rdpower(
  data = NULL,
  cutoff = 0,
  tau = NULL,
  alpha = 0.05,
  nsamples = NULL,
  sampsi = NULL,
  samph = NULL,
  all = FALSE,
  bias = NULL,
  variance = NULL,
  plot = FALSE,
  graph.range = NULL,
  covs = NULL,
  covs_drop = TRUE,
  deriv = 0,
  p = 1,
  q = NULL,
  h = NULL,
  b = NULL,
  rho = NULL,
  kernel = "triangular",
  bwselect = "mserd",
  vce = "nn",
  cluster = NULL,
  scalepar = 1,
  scaleregul = 1,
  fuzzy = NULL,
```

```
  level = 95,
  weights = NULL,
  masspoints = "adjust",
  bwcheck = NULL,
  bwrestrict = TRUE,
  stdvars = FALSE
)
```

Arguments

data	a matrix (Y,R) containing the outcome variable and the running variable (as column vectors).
cutoff	the RD cutoff (default is 0).
tau	specifies the treatment effect under the alternative at which the power function is evaluated. The default is half the standard deviation of the outcome for the untreated group.
alpha	specifies the significance level for the power function. Default is 0.05.
nsamples	sets the total sample size to the left, sample size to the left inside the bandwidth, total sample size to the right and sample size to the right of the cutoff inside the bandwidth to calculate the variance when the running variable is not specified. When not specified, the values are calculated using the running variable.
sampsi	sets the sample size at each side of the cutoff for power calculation. The first number is the sample size to the left of the cutoff and the second number is the sample size to the right. Default values are the sample sizes inside the chosen bandwidth.
samph	sets the bandwidths at each side of the cutoff for power calculation. The first number is the bandwidth to the left of the cutoff and the second number is the bandwidth to the right. Default values are the bandwidths used by `rdrobust`.
all	displays the power using the conventional variance estimator, in addition to the robust bias corrected one.
bias	set bias to the left and right of the cutoff. If not specified, the biases are estimated using `rdrobust`.
variance	set variance to the left and right of the cutoff. If not specified, the variances are estimated using `rdrobust`.
plot	plots the power function using the conventional and robust bias corrected standard errors from `rdrobust`.
graph.range	range of the plot.
covs	option for `rdrobust()`: specifies additional covariates to be used for estimation and inference.
covs_drop	option for `rdrobust()`: if TRUE, it checks for collinear additional covariates and drops them. Default is TRUE.
deriv	option for `rdrobust()`: specifies the order of the derivative of the regression functions to be estimated.
p	option for `rdrobust()`: specifies the order of the local-polynomial used to construct the point-estimator.

q	option for rdrobust(): specifies the order of the local-polynomial used to construct the bias-correction.
h	option for rdrobust(): specifies the values of the main bandwidth to be used on the left and on the right of the cutoff, respectively.
b	option for rdrobust(): specifies the values of the bias bandwidth b to be used on the left and on the right of the cutoff, respectively.
rho	option for rdrobust(): specifies the value of rho so that the bias bandwidth b equals b=h/rho.
kernel	option for rdrobust(): kernel function used to construct the local-polynomial estimators.
bwselect	option for rdrobust(): specifies the bandwidth selection procedure to be used.
vce	option for rdrobust(): specifies the procedure used to compute the variance-covariance matrix estimator.
cluster	option for rdrobust(): indicates the cluster ID variable used for the cluster-robust variance estimation with degrees-of-freedom weights.
scalepar	option for rdrobust(): specifies scaling factor for RD parameter of interest.
scaleregul	option for rdrobust(): specifies scaling factor for the regularization terms of bandwidth selectors.
fuzzy	option for rdrobust(): specifies the treatment status variable used to implement fuzzy RD estimation.
level	option for rdrobust(): sets the confidence level for confidence intervals.
weights	option for rdrobust(): is the variable used for optional weighting of the estimation procedure. The unit-specific weights multiply the kernel function.
masspoints	option for rdrobust(): checks and controls for repeated observations in tue running variable.
bwcheck	option for rdrobust(): if a positive integer is provided, the preliminary bandwidth used in the calculations is enlarged so that at least bwcheck unique observations are used.
bwrestrict	option for rdrobust(): if TRUE, computed bandwidths are restricted to lie withing the range of x. Default is bwrestrict=TRUE.
stdvars	option for rdrobust(): if TRUE, x and y are standardized before computing the bandwidths. Default is stdvars=TRUE.

Value

power.rbc	power against tau using robust bias corrected standard error
se.rbc	robust bias corrected standard error
sampsi.r	number of observations inside the window to the right of the cutoff
sampsi.l	number of observations inside the window to the left of the cutoff
samph.r	bandwidth to the right of the cutoff
samph.l	bandwidth to the left of the cutoff
alpha	significance level used in power function

tau	treatment effect under alternative hypothesis
bias.r	bias to the right of the cutoff
bias.l	bias to the left of the cutoff
Vr.rb	Robust bias corrected variance to the right of the cutoff
Vl.rb	Robust bias corrected variance to the left of the cutoff
N.r	Total sample size to the right of the cutoff
N.l	Total sample size to the left of the cutoff
power.conv	power against tau using conventional inference
se.conv	conventional standard error

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References

Cattaneo, M. D., R. Titiunik and G. Vazquez-Bare. (2019). Power Calculations for Regression Discontinuity Designs. *Stata Journal*, 19(1): 210-245.

Examples

```
# Toy dataset
X <- array(rnorm(2000),dim=c(1000,2))
R <- X[,1] + X[,2] + rnorm(1000)
Y <- 1 + R -.5*R^2 + .3*R^3 + (R>=0) + rnorm(1000)
# Power against tau = 1
tmp <- rdpower(data=cbind(Y,R),tau=1)
# Power against tau = 1 including covariates
tmp <- rdpower(data=cbind(Y,R),tau=1,covs=X)
```

---

rdsampsi *Sample Size Calculations for RD Designs*

Description

`rdsampsi()` performs sample size calculations for RD designs.

Usage

```
rdsampsi(
  data = NULL,
  cutoff = 0,
  tau = NULL,
  alpha = 0.05,
  beta = 0.8,
  samph = NULL,
  nsamples = NULL,
  all = FALSE,
  bias = NULL,
  variance = NULL,
  nratio = NULL,
  init.cond = NULL,
  plot = FALSE,
  graph.range = NULL,
  covs = NULL,
  covs_drop = TRUE,
  deriv = 0,
  p = 1,
  q = NULL,
  h = NULL,
  b = NULL,
  rho = NULL,
  kernel = "triangular",
  bwselect = "mserd",
  vce = "nn",
  cluster = NULL,
  scalepar = 1,
  scaleregul = 1,
  fuzzy = NULL,
  level = 95,
  weights = NULL,
  masspoints = "adjust",
  bwcheck = NULL,
  bwrestrict = TRUE,
  stdvars = FALSE
)
```

Arguments

data	a matrix (Y,R) containing the outcome variable and the running variable (as column vectors).
cutoff	the RD cutoff (default is 0).
tau	specifies the treatment effect under the alternative at which the power function is evaluated. The default is half the standard deviation of the outcome for the untreated group.

alpha	specifies the significance level for the power function. Default is 0.05.
beta	specifies the desired power. Default is 0.8.
samph	sets the bandwidths at each side of the cutoff for power calculation. The first number is the bandwidth to the left of the cutoff and the second number is the bandwidth to the right. Default values are the bandwidths used by rdrobust.
nsamples	sets the total sample size to the left, sample size to the left inside the bandwidth, total sample size to the right and sample size to the right of the cutoff inside the bandwidth to calculate the variance when the running variable is not specified. When not specified, the values are calculated using the running variable.
all	displays the power using the conventional variance estimator, in addition to the robust bias corrected one.
bias	set bias to the left and right of the cutoff. If not specified, the biases are estimated using rdrobust.
variance	set variance to the left and right of the cutoff. If not specified, the variances are estimated using rdrobust.
nratio	specifies the proportion of treated units in the window. Default is the ratio of the standard deviation of the treated to the sum of the standard deviations for treated and controls.
init.cond	sets the initial condition for the Newton-Raphson algorithm that finds the sample size. Default is the number of observations in the sample with non-missing values of the outcome and running variable.
plot	plots the power function using the conventional and robust bias corrected standard errors from rdrobust.
graph.range	range of the plot.
covs	option for rdrobust(): specifies additional covariates to be used for estimation and inference.
covs_drop	option for rdrobust(): if TRUE, it checks for collinear additional covariates and drops them. Default is TRUE.
deriv	option for rdrobust(): specifies the order of the derivative of the regression functions to be estimated.
p	option for rdrobust(): specifies the order of the local-polynomial used to construct the point-estimator.
q	option for rdrobust(): specifies the order of the local-polynomial used to construct the bias-correction.
h	option for rdrobust(): specifies the values of the main bandwidth to be used on the left and on the right of the cutoff, respectively.
b	option for rdrobust(): specifies the values of the bias bandwidth b to be used on the left and on the right of the cutoff, respectively.
rho	option for rdrobust(): specifies the value of rho so that the bias bandwidth b equals b=h/rho.
kernel	option for rdrobust(): kernel function used to construct the local-polynomial estimators.

bwselect	option for rdrobust(): specifies the bandwidth selection procedure to be used.
vce	option for rdrobust(): specifies the procedure used to compute the variance-covariance matrix estimator.
cluster	option for rdrobust(): indicates the cluster ID variable used for the cluster-robust variance estimation with degrees-of-freedom weights.
scalepar	option for rdrobust(): specifies scaling factor for RD parameter of interest.
scaleregul	option for rdrobust(): specifies scaling factor for the regularization terms of bandwidth selectors.
fuzzy	option for rdrobust(): specifies the treatment status variable used to implement fuzzy RD estimation.
level	option for rdrobust(): sets the confidence level for confidence intervals.
weights	option for rdrobust(): is the variable used for optional weighting of the estimation procedure. The unit-specific weights multiply the kernel function.
masspoints	option for rdrobust(): checks and controls for repeated observations in tue running variable.
bwcheck	option for rdrobust(): if a positive integer is provided, the preliminary bandwidth used in the calculations is enlarged so that at least bwcheck unique observations are used.
bwrestrict	option for rdrobust(): if TRUE, computed bandwidths are restricted to lie withing the range of x. Default is bwrestrict=TRUE.
stdvars	option for rdrobust(): if TRUE, x and y are standardized before computing the bandwidths. Default is stdvars=TRUE.

Value

alpha	significance level
beta	desired power
tau	treatment effect under alternative hypothesis
sampsi.h.tot	total number of observations inside the window
sampsi.h.r	number of observations inside the window to the right of the cutoff
sampsi.h.l	number of observations inside the window to the left of the cutoff
N.r	Total sample size to the right of the cutoff
N.l	Total sample size to the left of the cutoff
samph.r	bandwidth to the right of the cutoff
samph.l	bandwidth to the left of the cutoff
var.r	Robust bias corrected variance to the right of the cutoff
Var.l	Robust bias corrected variance to the left of the cutoff
sampsi.h.tot.cl	implied total number of observations inside the window using conventional s.e.
sampsi.h.r.cl	number of observations inside the window to the right of the cutoff using conventional s.e.

`sampsi.h.l.cl`	number of observations inside the window to the left of the cutoff using conventional s.e.
`no.iter`	number of iterations until convergence of the Newton-Raphson algorithm
`init.cond`	initial condition of the Newton-Raphson algorithm

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References

Cattaneo, M. D., R. Titiunik and G. Vazquez-Bare. (2019). Power Calculations for Regression Discontinuity Designs. *Stata Journal*, 19(1): 210-245.

Examples

```
# Toy dataset
X <- array(rnorm(2000),dim=c(1000,2))
R <- X[,1] + X[,2] + rnorm(1000)
Y <- 1 + R -.5*R^2 + .3*R^3 + (R>=0) + rnorm(1000)
# Sample size to achieve power of 0.8 against tau = 1
tmp <- rdsampsi(data=cbind(Y,R),tau=1)
# Sample size against tau = 1 including covariates
tmp <- rdsampsi(data=cbind(Y,R),tau=1,covs=X)
```

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