

Package ‘qte’

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Title Quantile Treatment Effects

Version 1.3.1

Description Provides several methods for computing the Quantile Treatment Effect (QTE) and Quantile Treatment Effect on the Treated (QTT). The main cases covered are (i) Treatment is randomly assigned, (ii) Treatment is as good as randomly assigned after conditioning on some covariates (also called conditional independence or selection on observables) using the methods developed in Firpo (2007) <[doi:10.1111/j.1468-0262.2007.00738.x](https://doi.org/10.1111/j.1468-0262.2007.00738.x)>, (iii) Identification is based on a Difference in Differences assumption (several varieties are available in the package e.g. Athey and Imbens (2006) <[doi:10.1111/j.1468-0262.2006.00668.x](https://doi.org/10.1111/j.1468-0262.2006.00668.x)> Callaway and Li (2019) <[doi:10.3982/QE935](https://doi.org/10.3982/QE935)>, Callaway, Li, and Oka (2018) <[doi:10.1016/j.jeconom.2018.06.008](https://doi.org/10.1016/j.jeconom.2018.06.008)>).

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bounds	<i>bounds</i>
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Description

bounds estimates bounds for the Quantile Treatment Effect on the Treated (QTET) using the method of Fan and Yu (2012).

Usage

```
bounds(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tname,
```

```

    data,
    idname,
    probs = seq(0.05, 0.95, 0.05)
  )

```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g \sim age + education. Additional covariates can also be passed by name using the x parameter.
t	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the panel.qtet method.
tmin1	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.
tname	The name of the column containing the time periods
data	A data.frame containing all the variables used
idname	The individual (cross-sectional unit) id name
probs	A vector of values between 0 and 1 to compute the QTET at

Value

A BoundsObj object

References

Fan, Yanqin and Zhengfei Yu. "Partial Identification of Distributional and Quantile Treatment Effects in Difference-in-Differences Models." *Economics Letters* 115.3, pp.511-515, 2012.

Examples

```

## load the data
data(lalonde)

## Run the bounds method with no covariates
b1 <- bounds(re ~ treat, t=1978, tmin1=1975, data=lalonde.psid.panel,
  idname="id", tname="year")
summary(b1)

```

 ci.qte

ci.qte

Description

The `ci.qtet` method implements estimates the Quantile Treatment Effect (QTE) under a Conditional Independence Assumption (sometimes this is called Selection on Observables) developed in Firpo (2007). This method using propensity score re-weighting and minimizes a check function to compute the QTET. Standard errors (if requested) are computed using the bootstrap.

Usage

```
ci.qte(
  formula,
  xformula = NULL,
  x = NULL,
  data,
  w = NULL,
  probs = seq(0.05, 0.95, 0.05),
  se = TRUE,
  iters = 100,
  alp = 0.05,
  method = "logit",
  retEachIter = FALSE,
  printIter = FALSE,
  pl = FALSE,
  cores = 2
)
```

Arguments

<code>formula</code>	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
<code>xformula</code>	A optional one sided formula for additional covariates that will be adjusted for. E.g \sim age + education. Additional covariates can also be passed by name using the <code>x</code> paramater.
<code>x</code>	Vector of covariates. Default is no covariates
<code>data</code>	A <code>data.frame</code> containing all the variables used
<code>w</code>	an additional vector of sampling weights
<code>probs</code>	A vector of values between 0 and 1 to compute the QTET at
<code>se</code>	Boolean whether or not to compute standard errors
<code>iters</code>	The number of iterations to compute bootstrap standard errors. This is only used if <code>se=TRUE</code>
<code>alp</code>	The significance level used for constructing bootstrap confidence intervals

method	Method to compute propensity score. Default is logit; other option is probit.
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is FALSE). This is potentially useful for debugging but can cause errors due to running out of memory.
printIter	For debugging only; should leave at default FALSE unless you want to see a lot of output
p1	boolean for whether or not to compute bootstrap error in parallel. Note that computing standard errors in parallel is a new feature and may not work at all on Windows.
cores	the number of cores to use if bootstrap standard errors are computed in parallel

Value

QTE object

References

Firpo, Sergio. "Efficient Semiparametric Estimation of Quantile Treatment Effects." *Econometrica* 75.1, pp. 259-276, 2015.

Examples

```
## Load the data
data(lalonde)

##Estimate the QTET of participating in the job training program;
##This is the no covariate case. Note: Because individuals that participate
## in the job training program are likely to be much different than
## individuals that do not (e.g. less experience and less education), this
## method is likely to perform poorly at estimating the true QTET
q1 <- ci.qte(re78 ~ treat, x=NULL, data=lalonde.psid, se=FALSE,
  probs=seq(0.05,0.95,0.05))
summary(q1)

##This estimation controls for all the available background characteristics.
q2 <- ci.qte(re78 ~ treat,
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid, se=FALSE, probs=seq(0.05, 0.95, 0.05))
summary(q2)
```

ci.qtet

ci.qtet

Description

The `ci.qtet` method implements estimates the Quantile Treatment Effect on the Treated (QTET) under a Conditional Independence Assumption (sometimes this is called Selection on Observables) developed in Firpo (2007). This method using propensity score re-weighting and minimizes a check function to compute the QTET. Standard errors (if requested) are computed using the bootstrap.

Usage

```

ci.qtet(
  formula,
  xformula = NULL,
  w = NULL,
  data,
  probs = seq(0.05, 0.95, 0.05),
  se = TRUE,
  iters = 100,
  alp = 0.05,
  method = "logit",
  retEachIter = FALSE,
  indsample = TRUE,
  printIter = FALSE,
  pl = FALSE,
  cores = 2
)

```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the x paramater.
w	an additional vector of sampling weights
data	A data.frame containing all the variables used
probs	A vector of values between 0 and 1 to compute the QTET at
se	Boolean whether or not to compute standard errors
iters	The number of iterations to compute bootstrap standard errors. This is only used if $se=TRUE$
alp	The significance level used for constructing bootstrap confidence intervals
method	Method to compute propensity score. Default is logit; other option is probit.
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is FALSE). This is potentially useful for debugging but can cause errors due to running out of memory.
indsample	Binary variable for whether to treat the samples as independent or dependent. This affects bootstrap standard errors. In the job training example, the samples are independent because they are two samples collected independently and then merged. If the data is from the same source, usually should set this option to be FALSE.
printIter	For debugging only; should leave at default FALSE unless you want to see a lot of output
pl	Whether or not to compute standard errors in parallel
cores	Number of cores to use if computing in parallel

Value

QTE object

References

Firpo, Sergio. "Efficient Semiparametric Estimation of Quantile Treatment Effects." *Econometrica* 75.1, pp. 259-276, 2015.

Examples

```
## Load the data
data(lalonde)

##Estimate the QTET of participating in the job training program;
##This is the no covariate case. Note: Because individuals that participate
## in the job training program are likely to be much different than
## individuals that do not (e.g. less experience and less education), this
## method is likely to perform poorly at estimating the true QTET
q1 <- ci.qtet(re78 ~ treat, x=NULL, data=lalonde.psid, se=FALSE,
  probs=seq(0.05,0.95,0.05))
summary(q1)

##This estimation controls for all the available background characteristics.
q2 <- ci.qtet(re78 ~ treat,
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid, se=FALSE, probs=seq(0.05, 0.95, 0.05))
summary(q2)
```

CiC

Change in Changes

Description

CiC computes the Quantile Treatment Effect on the Treated (QTET) using the method of Athey and Imbens (2006). CiC is a Difference in Differences type method. It requires having two periods of data that can be either repeated cross sections or panel data.

The method can accommodate conditioning on covariates though it does so in a restrictive way: It specifies a linear model for outcomes conditional on group-time dummies and covariates. Then, after residualizing (see details in Athey and Imbens (2006)), it computes the Change in Changes model based on these quasi-residuals.

Usage

```
CiC(
  formula,
  xformula = NULL,
  t,
```

```

    tmin1,
    tname,
    data,
    panel = FALSE,
    se = TRUE,
    idname = NULL,
    alp = 0.05,
    probs = seq(0.05, 0.95, 0.05),
    iters = 100,
    pl = FALSE,
    cores = 2,
    retEachIter = FALSE
  )

```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the x parameter.
t	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the <code>panel.qtet</code> method.
tmin1	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.
tname	The name of the column containing the time periods
data	A <code>data.frame</code> containing all the variables used
panel	Binary variable indicating whether or not the dataset is panel. This is used for computing bootstrap standard errors correctly.
se	Boolean whether or not to compute standard errors
idname	The individual (cross-sectional unit) id name
alp	The significance level used for constructing bootstrap confidence intervals
probs	A vector of values between 0 and 1 to compute the QTET at
iters	The number of iterations to compute bootstrap standard errors. This is only used if <code>se=TRUE</code>
pl	Whether or not to compute standard errors in parallel
cores	Number of cores to use if computing in parallel
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is <code>FALSE</code>). This is potentially useful for debugging but can cause errors due to running out of memory.

Value

QTE Object

References

Athey, Susan and Guido Imbens. "Identification and Inference in Nonlinear Difference-in-Differences Models." *Econometrica* 74.2, pp. 431-497, 2006.

Examples

```
## load the data
data(lalonde)
## Run the Change in Changes model conditioning on age, education,
## black, hispanic, married, and nodegree
c1 <- CiC(re ~ treat, t=1978, tmin1=1975, tname="year",
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(c1)
```

`compute.panel.qtet` *compute.panel.qtet*

Description

`compute.panel.qtet` uses third period of data, combined with Distributional Difference in Differences assumption (Fan and Yu, 2012) to point identify QTET.

Usage

```
compute.panel.qtet(qp)
```

Arguments

qp QTEparams object containing the parameters passed to `ciqte`

Value

QTE object

computeDiffSE	<i>computeDiffSE</i>
---------------	----------------------

Description

Takes two sets of initial estimates and bootstrap estimations (they need to have the same number of iterations) and determines whether or not the estimates are statistically different from each other. It can be used to compare any sets of estimates, but it is particularly used here to compare estimates from observational methods with observations from the experimental data (which also have standard errors because, even though the estimates are cleanly identified, they are still estimated).

Usage

```
computeDiffSE(est1, bootIters1, est2, bootIters2, alp = 0.05)
```

Arguments

est1	A QTE object containing the first set of estimates
bootIters1	A List of QTE objects that have been bootstrapped
est2	A QTE object containing a second set of estimates
bootIters2	A List of QTE objects that have been bootstrapped using the second method
alp	The significance level used for constructing bootstrap confidence intervals

ddid2	<i>ddid2</i>
-------	--------------

Description

ddid2 computes the Quantile Treatment Effect on the Treated (QTET) using the method of Callaway, Li, and Oka (2015).

Usage

```
ddid2(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tname,
  data,
  panel = TRUE,
  dropalwaystreated = TRUE,
  idname = NULL,
  probs = seq(0.05, 0.95, 0.05),
```

```

    iters = 100,
    alp = 0.05,
    method = "logit",
    se = TRUE,
    retEachIter = FALSE,
    seedvec = NULL,
    pl = FALSE,
    cores = NULL
)

```

Arguments

formla	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary)
xformla	A optional one sided formula for additional covariates that will be adjusted for. E.g \sim age + education. Additional covariates can also be passed by name using the x paramater.
t	The 3rd time period in the sample (this is the name of the column)
tmin1	The 2nd time period in the sample (this is the name of the column)
tname	The name of the column containing the time periods
data	The name of the data.frame that contains the data
panel	Boolean indicating whether the data is panel or repeated cross sections
dropalwaystreated	How to handle always treated observations in panel data case (not currently used)
idname	The individual (cross-sectional unit) id name
probs	A vector of values between 0 and 1 to compute the QTET at
iters	The number of iterations to compute bootstrap standard errors. This is only used if $se=TRUE$
alp	The significance level used for constructing bootstrap confidence intervals
method	The method for estimating the propensity score when covariates are included
se	Boolean whether or not to compute standard errors
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure
seedvec	Optional value to set random seed; can possibly be used in conjunction with bootstrapping standard errors.
pl	boolean for whether or not to compute bootstrap error in parallel. Note that computing standard errors in parallel is a new feature and may not work at all on Windows.
cores	the number of cores to use if bootstrap standard errors are computed in parallel

Value

QTE object

References

Callaway, Brantly, Tong Li, and Tatsushi Oka. "Quantile Treatment Effects in Difference in Differences Models under Dependence Restrictions and with Only Two Time Periods." Working Paper, 2015.

Examples

```
##load the data
data(lalonde)

## Run the ddid2 method on the observational data with no covariates
d1 <- ddid2(re ~ treat, t=1978, tmin1=1975, tname="year",
  data=lalonde.psid.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(d1)

## Run the ddid2 method on the observational data with covariates
d2 <- ddid2(re ~ treat, t=1978, tmin1=1975, tname="year",
  data=lalonde.psid.panel, idname="id", se=FALSE,
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  probs=seq(0.05, 0.95, 0.05))
summary(d2)
```

diffQ

diffQ

Description

takes a single set of quantiles:

(not qtes as in diffquantiles) and returns the difference between particular ones

Usage

```
diffQ(qvec, tauvec, hightau, lowtau)
```

Arguments

qvec	vector of quantiles
tauvec	vector of tau (should be same length as qvec)
hightau	upper quantile
lowtau	lower quantile

Value

scalar difference between quantiles

DR	<i>DR</i>
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Description

A distribution regression object

Usage

```
DR(yvals, drlist)
```

Arguments

<code>yvals</code>	A vector of values that y can take
<code>drlist</code>	A list where for each value of y, a distribution regression

<code>ggqte</code>	<i>ggqte</i>
--------------------	--------------

Description

Makes somewhat nicer plots of quantile treatment effects by using ggplot

Usage

```
ggqte(
  qteobj,
  main = "",
  ylab = "QTE",
  ylim = NULL,
  ybreaks = NULL,
  xbreaks = c(0.1, 0.3, 0.5, 0.7, 0.9),
  setype = "pointwise"
)
```

Arguments

<code>qteobj</code>	a QTE object
<code>main</code>	optional title
<code>ylab</code>	optional y axis label
<code>ylim</code>	optional limits of y axis
<code>ybreaks</code>	optional breaks in y axis
<code>xbreaks</code>	optional breaks in x axis

setype options are "pointwise", "uniform" or both; pointwise confidence intervals cover the QTE at each particular point with a fixed probability, uniform confidence bands cover the entire curve with a fixed probability. Uniform confidence bands will tend to be wider. The option "both" will plot both types of confidence intervals

Value

a ggplot object

lalonge	<i>Lalonde (1986)'s NSW Dataset</i>
---------	-------------------------------------

Description

lalonge contains data from the National Supported Work Demonstration. This program randomly assigned applicants to the job training program (or out of the job training program). The dataset is discussed in Lalonde (1986). The experimental part of the dataset is combined with an observational dataset from the Panel Study of Income Dynamics (PSID). Lalonde (1986) and many subsequent papers (e.g. Heckman and Hotz (1989), Dehejia and Wahba (1999), Smith and Todd (2005), and Firpo (2007) have used this combination to study the effectiveness of various ‘observational’ methods (e.g. regression, Heckman selection, Difference in Differences, and propensity score matching) of estimating the Average Treatment Effect (ATE) of participating in the job training program. The idea is that the results from the observational method can be compared to results that can be easily obtained from the experimental portion of the dataset.

To be clear, the observational data combines the observations that are treated from the experimental portion of the data with untreated observations from the PSID.

Usage

```
data(lalonge)
```

Format

Four data.frames: (i) lalonge.exp contains a cross sectional version of the experimental data, (ii) lalonge.psid contains a cross sectional version of the observational data, (iii) lalonge.exp.panel contains a panel version of the experimental data, and (iv) lalonge.psid.panel contains a panel version of the observational data. Note: the cross sectional and panel versions of each dataset are identical up to their shape; in demonstrating each of the methods, it is sometimes convenient to have one form of the data or the other.

References

LaLonde, Robert. “Evaluating the Econometric Evaluations of Training Programs with Experimental Data.” *The American Economics Review*, pp. 604-620, 1986. @source The dataset comes from Lalonde (1986) and has been studied in much subsequent work. The qte package uses a version from the causalsens package (<https://CRAN.R-project.org/package=causalsens>)

lalonge.exp	<i>Lalonge's Experimental Dataset</i>
-------------	---------------------------------------

Description

The cross sectional verion of the experimental part of the lalonge dataset. It is loaded with all the datasets with the command `data(lalonge)`

lalonge.exp.panel	<i>Lalonge's Panel Experimental Dataset</i>
-------------------	---

Description

The panel verion of the experimental part of the lalonge dataset. It is loaded with all the datasets with the command `data(lalonge)`

lalonge.psid	<i>Lalonge's Observational Dataset</i>
--------------	--

Description

The cross sectional verion of the observational part of the lalonge dataset. It is loaded with all the datasets with the command `data(lalonge)`

lalonge.psid.panel	<i>Lalonge's Experimental Dataset</i>
--------------------	---------------------------------------

Description

The panel verion of the observational part of the lalonge dataset. It is loaded with all the datasets with the command `data(lalonge)`

MDiD

*Mean Difference in Differences***Description**

MDiD is a Difference in Differences type method for computing the QTET.

The method can accommodate conditioning on covariates though it does so in a restrictive way: It specifies a linear model for outcomes conditional on group-time dummies and covariates. Then, after residualizing (see details in Athey and Imbens (2006)), it computes the Change in Changes model based on these quasi-residuals.

Usage

```
MDiD(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tname,
  data,
  panel = FALSE,
  se = TRUE,
  idname = NULL,
  alp = 0.05,
  probs = seq(0.05, 0.95, 0.05),
  iters = 100,
  retEachIter = FALSE
)
```

Arguments

<code>formula</code>	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
<code>xformula</code>	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the <code>x</code> paramater.
<code>t</code>	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the <code>panel.qtet</code> method.
<code>tmin1</code>	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.
<code>tname</code>	The name of the column containing the time periods
<code>data</code>	A data.frame containing all the variables used

panel	Binary variable indicating whether or not the dataset is panel. This is used for computing bootstrap standard errors correctly.
se	Boolean whether or not to compute standard errors
idname	The individual (cross-sectional unit) id name
alp	The significance level used for constructing bootstrap confidence intervals
probs	A vector of values between 0 and 1 to compute the QTET at
iters	The number of iterations to compute bootstrap standard errors. This is only used if se=TRUE
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is FALSE). This is potentially useful for debugging but can cause errors due to running out of memory.

Value

A QTE object

References

Athey, Susan and Guido Imbens. "Identification and Inference in Nonlinear Difference-in-Differences Models." *Econometrica* 74.2, pp. 431-497, 2006.

Thuysbaert, Bram. "Distributional Comparisons in Difference in Differences Models." Working Paper, 2007.

Examples

```
## load the data
data(lalonde)

## Run the Mean Difference in Differences method conditioning on
## age, education, black, hispanic, married, and nodegree
md1 <- MDiD(re ~ treat, t=1978, tmin1=1975, tname="year",
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(md1)
```

panel.checks

panel.checks

Description

Does some checking that data setup is valid for using methods in qte package

Usage

```
panel.checks(qp)
```

Arguments

qp QTEparams object containing the parameters passed to ciqte

panel.qtet *panel.qtet*

Description

panel.qtet computes the Quantile Treatment Effect on the Treated (QTET) using the method of Callaway and Li (2015). This method should be used when the researcher wants to invoke a Difference in Differences assumption to identify the QTET. Relative to the other Difference in Differences methods available in the qte package, this method's assumptions are more intuitively similar to the identifying assumptions used in identifying the Average Treatment Effect on the Treated (ATT).

Additionally, this method can accommodate covariates in a more flexible way than the other Difference in Differences methods available. In order to accommodate covariates, the user should specify a vector *x* of covariate names. The user also may specify a method for estimating the propensity score. The default is logit.

panel.qtet can only be used in some situations, however. The method requires three periods of panel data where individuals are not treated until the last period. The data should be formatted as a panel; the names of columns containing time periods and ids for each cross sectional unit need to be passed to the method.

Usage

```
panel.qtet(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tmin2,
  tname,
  data,
  idname,
  probs = seq(0.05, 0.95, 0.05),
  iters = 100,
  alp = 0.05,
  method = c("qr", "pscore"),
  se = TRUE,
  retEachIter = FALSE,
  pl = FALSE,
  cores = NULL
)
```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the <code>x</code> parameter.
t	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the <code>panel.qtet</code> method.
tmin1	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.
tmin2	The 1st time period in the sample. This should be a pre-treatment period for all individuals in the sample.
tname	The name of the column containing the time periods
data	A <code>data.frame</code> containing all the variables used
idname	The individual (cross-sectional unit) id name
probs	A vector of values between 0 and 1 to compute the QTET at
iters	The number of iterations to compute bootstrap standard errors. This is only used if <code>se=TRUE</code>
alp	The significance level used for constructing bootstrap confidence intervals
method	The method for including covariates, should either be "QR" for quantile regression or "pscore" for propensity score
se	Boolean whether or not to compute standard errors
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is FALSE). This is potentially useful for debugging but can cause errors due to running out of memory.
pl	Whether or not to compute standard errors in parallel
cores	Number of cores to use if computing in parallel

Value

QTE object

References

Callaway, Brantly and Tong Li. "Quantile Treatment Effects in Difference in Differences Models with Panel Data." Working Paper, 2019.

Examples

```
##load the data
data(lalonde)

## Run the panel.qtet method on the experimental data with no covariates
pq1 <- panel.qtet(re ~ treat, t=1978, tmin1=1975, tmin2=1974, tname="year",
  data=lalonde.exp.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(pq1)

## Run the panel.qtet method on the observational data with no covariates
pq2 <- panel.qtet(re ~ treat, t=1978, tmin1=1975, tmin2=1974, tname="year",
  data=lalonde.psid.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(pq2)

## Run the panel.qtet method on the observational data conditioning on
## age, education, black, hispanic, married, and nodegree.
## The propensity score will be estimated using the default logit method.
pq3 <- panel.qtet(re ~ treat, t=1978, tmin1=1975, tmin2=1974, tname="year",
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid.panel, idname="id", se=FALSE, method="pscore",
  probs=seq(0.05, 0.95, 0.05))
summary(pq3)

pq4 <- panel.qtet(re ~ treat, t=1978, tmin1=1975, tmin2=1974, tname="year",
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid.panel, idname="id", se=FALSE, method="qr",
  probs=seq(0.05, 0.95, 0.05))
summary(pq4)
```

panelize.data

panelize.data

Description

get data in correct format for using panel methods in qte package

Usage

```
panelize.data(data, idname, tname, t, tmin1, tmin2 = NULL)
```

Arguments

data	A data.frame containing all the variables used
idname	The individual (cross-sectional unit) id name
tname	The name of the column containing the time periods

t	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the panel.qtet method.
tmin1	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.
tmin2	The 1st time period in the sample. This should be a pre-treatment period for all individuals in the sample.

Value

data.frame

plot.BoundsObj *Plot Bounds*

Description

Plots a BoundObj Object

Usage

```
## S3 method for class 'BoundsObj'
plot(
  x,
  plotate = FALSE,
  plot0 = FALSE,
  qtecol = "black",
  atecol = "black",
  col0 = "black",
  ylim = NULL,
  uselegend = FALSE,
  legloc = "topright",
  ...
)
```

Arguments

x	A BoundsObj Object
plotate	Boolean whether or not to plot the ATE
plot0	Boolean whether to plot a line at 0
qtecol	Color for qte plot. Default "black"
atecol	Color for ate plot. Default "black"
col0	Color for 0 plot. Default "black"

ylim	The ylim for the plot; if not passed, it will be automatically set based on the values that the QTE takes
uselegend	Boolean whether or not to print a legend
legloc	String location for the legend. Default "topright"
...	Other parameters to be passed to plot (e.g lwd)

plot.QTE

plot.QTE

Description

Plots a QTE Object

Usage

```
## S3 method for class 'QTE'
plot(
  x,
  plotate = FALSE,
  plot0 = FALSE,
  qtecol = "black",
  atecol = "black",
  col0 = "black",
  xlab = "tau",
  ylab = "QTE",
  legend = NULL,
  ontreated = FALSE,
  ylim = NULL,
  uselegend = FALSE,
  legendcol = NULL,
  legloc = "topright",
  ...
)
```

Arguments

x	a QTE Object
plotate	Boolean whether or not to plot the ATE
plot0	Boolean whether to plot a line at 0
qtecol	Color for qte plot. Default "black"
atecol	Color for ate plot. Default "black"
col0	Color for 0 plot. Default "black"
xlab	Custom label for x-axis. Default "tau"
ylab	Custom label for y-axis. Default "QTE"

legend	Vector of strings to add to legend
ontreated	Boolean whether parameters are "on the treated group"
ylim	The ylim for the plot; if not passed, it will be automatically set based on the values that the QTE takes
uselegend	Boolean whether or not to print a legend
legendcol	Legend Colors for plotting
legloc	String location for the legend. Default "topright"
...	Other parameters to be passed to plot (e.g lwd)

```
print.summary.BoundsObj
```

Print a summary.BoundsObj

Description

Prints a Summary QTE Object

Usage

```
## S3 method for class 'summary.BoundsObj'
print(x, ...)
```

Arguments

x	A summary.BoundsObj
...	Other objects to pass (not used)

```
print.summary.QTE
```

Print

Description

Prints a Summary QTE Object

Usage

```
## S3 method for class 'summary.QTE'
print(x, ...)
```

Arguments

x	A summary.QTE object
...	Other params (required as generic function, but not used)

QDiD

*Quantile Difference in Differences***Description**

QDiD is a Difference in Differences type method for computing the QTET.

The method can accommodate conditioning on covariates though it does so in a restrictive way: It specifies a linear model for outcomes conditional on group-time dummies and covariates. Then, after residualizing (see details in Athey and Imbens (2006)), it computes the Change in Changes model based on these quasi-residuals.

Usage

```
QDiD(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tname,
  data,
  panel = FALSE,
  se = TRUE,
  idname = NULL,
  alp = 0.05,
  probs = seq(0.05, 0.95, 0.05),
  iters = 100,
  retEachIter = FALSE,
  pl = FALSE,
  cores = NULL
)
```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary), d should be equal to one in all time periods for individuals that are eventually treated
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the x paramater.
t	The 3rd time period in the sample. Treated individuals should be treated in this time period and untreated individuals should not be treated. The code attempts to enforce this condition, but it is good try to handle this outside the panel.qtet method.
tmin1	The 2nd time period in the sample. This should be a pre-treatment period for all individuals in the sample.

tname	The name of the column containing the time periods
data	A data.frame containing all the variables used
panel	Binary variable indicating whether or not the dataset is panel. This is used for computing bootstrap standard errors correctly.
se	Boolean whether or not to compute standard errors
idname	The individual (cross-sectional unit) id name
alp	The significance level used for constructing bootstrap confidence intervals
probs	A vector of values between 0 and 1 to compute the QTET at
iters	The number of iterations to compute bootstrap standard errors. This is only used if se=TRUE
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure (default is FALSE). This is potentially useful for debugging but can cause errors due to running out of memory.
pl	Whether or not to compute standard errors in parallel
cores	Number of cores to use if computing in parallel

Value

QTE Object

References

Athey, Susan and Guido Imbens. "Identification and Inference in Nonlinear Difference-in-Differences Models." *Econometrica* 74.2, pp. 431-497, 2006.

Examples

```
## load the data
data(lalonde)

## Run the Quantile Difference in Differences method conditioning on
## age, education, black, hispanic, married, and nodegree
qd1 <- QDiD(re ~ treat, t=1978, tmin1=1975, tname="year",
  xformula=~age + I(age^2) + education + black + hispanic + married + nodegree,
  data=lalonde.psid.panel, idname="id", se=FALSE,
  probs=seq(0.05, 0.95, 0.05))
summary(qd1)
```

 QTE

qte: A package for computing quantile treatment effects

Description

Main class of objects. A QTE object is returned by all of the methods that compute the QTE or QTET.

Usage

```

QTE(
  qte,
  ate = NULL,
  qte.se = NULL,
  qte.lower = NULL,
  qte.upper = NULL,
  ate.se = NULL,
  ate.lower = NULL,
  ate.upper = NULL,
  c = NULL,
  pscore.reg = NULL,
  probs,
  type = "On the Treated",
  F.treated.t = NULL,
  F.untreated.t = NULL,
  F.treated.t.cf = NULL,
  F.treated.tmin1 = NULL,
  F.treated.tmin2 = NULL,
  F.treated.change.tmin1 = NULL,
  F.untreated.change.t = NULL,
  F.untreated.change.tmin1 = NULL,
  F.untreated.tmin1 = NULL,
  F.untreated.tmin2 = NULL,
  condQ.treated.t = NULL,
  condQ.treated.t.cf = NULL,
  eachIterList = NULL,
  inffunct = NULL,
  inffuncu = NULL
)

```

Arguments

<code>qte</code>	The Quantile Treatment Effect at each value of <code>probs</code>
<code>ate</code>	The Average Treatment Effect (or Average Treatment Effect on the Treated)
<code>qte.se</code>	A vector of standard errors for each <code>qte</code>

<code>qte.lower</code>	A vector of lower confidence intervals for each <code>qte</code> (it is based on the bootstrap confidence interval – not the <code>se</code> – so it may not be symmetric about the <code>qte</code>)
<code>qte.upper</code>	A vector of upper confidence intervals for each <code>qte</code> (it is based on the bootstrap confidence interval – not the <code>se</code> – so it may not be symmetric about the <code>qte</code>)
<code>ate.se</code>	The standard error for the ATE
<code>ate.lower</code>	Lower confidence interval for the ATE (it is based on the bootstrap confidence interval – not the <code>se</code> – so it may not be symmetric about the ATE)
<code>ate.upper</code>	Upper confidence interval for the ATE (it is based on the bootstrap confidence interval – not the <code>se</code> – so it may not be symmetric about the ATE)
<code>c</code>	The critical value from a KS-type statistic used for creating uniform confidence bands
<code>pscore.reg</code>	The results of propensity score regression, if specified
<code>probs</code>	The values for which the <code>qte</code> is computed
<code>type</code>	Takes the values "On the Treated" or "Population" to indicate whether the estimated QTE is for the treated group or for the entire population
<code>F.treated.t</code>	Distribution of treated outcomes for the treated group at period <code>t</code>
<code>F.untreated.t</code>	Distribution of untreated potential outcomes for the untreated group at period <code>t</code>
<code>F.treated.t.cf</code>	Counterfactual distribution of untreated potential outcomes for the treated group at period <code>t</code>
<code>F.treated.tmin1</code>	Distribution of treated outcomes for the treated group at period <code>tmin1</code>
<code>F.treated.tmin2</code>	Distribution of treated outcomes for the treated group at period <code>tmin2</code>
<code>F.treated.change.tmin1</code>	Distribution of the change in outcomes for the treated group between periods <code>tmin1</code> and <code>tmin2</code>
<code>F.untreated.change.t</code>	Distribution of the change in outcomes for the untreated group between periods <code>t</code> and <code>tmin1</code>
<code>F.untreated.change.tmin1</code>	Distribution of the change in outcomes for the untreated group between periods <code>tmin1</code> and <code>tmin2</code>
<code>F.untreated.tmin1</code>	Distribution of outcomes for the untreated group in period <code>tmin1</code>
<code>F.untreated.tmin2</code>	Distribution of outcomes for the untreated group in period <code>tmin2</code>
<code>condQ.treated.t</code>	Conditional quantiles for the treated group in period <code>t</code>
<code>condQ.treated.t.cf</code>	Counterfactual conditional quantiles for the treated group in period <code>t</code>
<code>eachIterList</code>	An optional list of the outcome of each bootstrap iteration
<code>inffunct</code>	The influence function for the treated group; used for inference when there are multiple periods and in the case with panel data. It is needed for computing covariance terms in the variance-covariance matrix.
<code>inffuncu</code>	The influence function for the untreated group

 QTEparams

QTEparams

Description

QTEparams is an object that contains all the parameters passed to QTE methods

Usage

```
QTEparams(
  formula,
  xformula = NULL,
  t = NULL,
  tmin1 = NULL,
  tmin2 = NULL,
  tname = NULL,
  data,
  panel = FALSE,
  w = NULL,
  idname = NULL,
  probs,
  alp = NULL,
  method = NULL,
  plot = NULL,
  se = NULL,
  iters = NULL,
  retEachIter = NULL,
  bootstrapiter = NULL,
  seedvec = NULL,
  pl = NULL,
  cores = NULL
)
```

Arguments

formula	Should be some y on treatment variable
xformula	a formula for the other covariates such as $\sim x_1 + x_2$
t	The last period (not always used)
tmin1	The last pre-treatment period (not always used)
tmin2	The 2nd to last pre-treatment period (not always used)
tname	The name of the column containing time periods (not always used)
data	The name of the data frame
panel	Whether or not the data is panel
w	Additional (usually sampling) weights

idname	The name of the id column used with panel data (not always used)
probs	Which quantiles to produce quantile treatment effects for
alp	The significance level
method	The method to compute the propensity score
plot	boolean for whether or not to plot qtes
se	boolean whether or not to compute standard errors
iters	The number of bootstrap iterations to use to compute standard errors
retEachIter	boolean whether or not to return the full results from each bootstrap iteration
bootstrapiter	Used internally for determining whether or not a call is part of computing standard errors via the bootstrap
seedvec	A seed to compute the same bootstrap standard errors each time the method is called (not always used)
p1	Boolean for whether or not computing bootstrap standard errors in parallel
cores	The number of cores to use if computing standard errors in in parallel

qtes2mat

qtes2mat

Description

Turn multiple qtes into a matrix for printing

Usage

```
qtes2mat(qteList, sset = NULL, se = TRUE, rnd = 3)
```

Arguments

qteList	a list of qte objects
sset	subset of qtes to keep
se	whether or not to include standard errors in the resulting matrix
rnd	how many digits to round to

Value

matrix

qteToTexreg	<i>diffQ</i>
-------------	--------------

Description

takes a single set of quantiles:

(not qtes as in diffquantiles) and returns the difference between particular ones

Usage

```
qteToTexreg(qteobj, tau = NULL, reportAte = T)
```

Arguments

qteobj	A QTE object
tau	Optional vector of taus to texreg results for
reportAte	Whether or not texreg the ATE (or ATT) as well

setupData	<i>setupData</i>
-----------	------------------

Description

setupData sets up the data to use in each compute method in the QTE package

Usage

```
setupData(qteParams)
```

Arguments

qteParams	object holding the function parameters
-----------	--

Value

qteData object holding data to be used in QTE functions

 spatt

spatt

Description

spatt computes the Average Treatment Effect on the Treated (ATT) using the method of Abadie (2005)

Usage

```
spatt(
  formula,
  xformula = NULL,
  t,
  tmin1,
  tname,
  data,
  w = NULL,
  panel = FALSE,
  idname = NULL,
  iters = 100,
  alp = 0.05,
  method = "logit",
  plot = FALSE,
  se = TRUE,
  retEachIter = FALSE,
  seedvec = NULL,
  pl = FALSE,
  cores = 2
)
```

Arguments

formula	The formula $y \sim d$ where y is the outcome and d is the treatment indicator (d should be binary)
xformula	A optional one sided formula for additional covariates that will be adjusted for. E.g $\sim \text{age} + \text{education}$. Additional covariates can also be passed by name using the x paramater.
t	The 3rd time period in the sample (this is the name of the column)
tmin1	The 2nd time period in the sample (this is the name of the column)
tname	The name of the column containing the time periods
data	The name of the data.frame that contains the data
w	an additional vector of sampling weights
panel	Boolean indicating whether the data is panel or repeated cross sections
idname	The individual (cross-sectional unit) id name

iters	The number of iterations to compute bootstrap standard errors. This is only used if se=TRUE
alp	The significance level used for constructing bootstrap confidence intervals
method	The method for estimating the propensity score when covariates are included
plot	Boolean whether or not the estimated QTET should be plotted
se	Boolean whether or not to compute standard errors
retEachIter	Boolean whether or not to return list of results from each iteration of the bootstrap procedure
seedvec	Optional value to set random seed; can possibly be used in conjunction with bootstrapping standard errors.
pl	boolean for whether or not to compute bootstrap error in parallel. Note that computing standard errors in parallel is a new feature and may not work at all on Windows.
cores	the number of cores to use if bootstrap standard errors are computed in parallel

Value

QTE object

References

Abadie (2005)

Examples

```
##load the data
data(lalonde)

## Run the panel.qtet method on the experimental data with no covariates
att1 <- spatt(re ~ treat, t=1978, tmin1=1975, tname="year",
  x=NULL, data=lalonde.psid.panel, idname="id", se=FALSE)
summary(att1)

## Run the panel.qtet method on the observational data with no covariates
```

summary.BoundsObj

Summary of BoundsObj

Description

summary.BoundsObj is an object for holding bounds results

Usage

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

Arguments

```
object      A BoundsObj Object
...         Other params (for consistency as generic S3 method, but not used)
```

Value

```
summary.BoundsObj Object
```

summary.QTE	<i>Summary</i>
-------------	----------------

Description

```
summary.QTE summarizes QTE objects
```

Usage

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

Arguments

```
object      A QTE Object
...         Other params (to work as generic method, but not used)
```

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