

# Package ‘did’

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**Title** Treatment Effects with Multiple Periods and Groups

**Version** 2.3.0

**URL** <https://bcallaway11.github.io/did/>,  
<https://github.com/bcallaway11/did/>

**Description** The standard Difference-in-Differences (DID) setup involves two periods and two groups -- a treated group and untreated group. Many applications of DID methods involve more than two periods and have individuals that are treated at different points in time. This package contains tools for computing average treatment effect parameters in Difference in Differences setups with more than two periods and with variation in treatment timing using the methods developed in Callaway and Sant'Anna (2021) <[doi:10.1016/j.jeconom.2020.12.001](https://doi.org/10.1016/j.jeconom.2020.12.001)>. The main parameters are group-time average treatment effects which are the average treatment effect for a particular group at a particular time. These can be aggregated into a fewer number of treatment effect parameters, and the package deals with the cases where there is selective treatment timing, dynamic treatment effects, calendar time effects, or combinations of these. There are also functions for testing the Difference in Differences assumption, and plotting group-time average treatment effects.

**Depends** R (>= 4.1.0),

**License** GPL-2

**Encoding** UTF-8

**LazyData** true

**Imports** BMisc (>= 1.4.4), Matrix, pbapply, ggplot2, DRDID (>= 1.1.0),  
generics, methods, tidyr, fastglm, data.table (>= 1.15.4),  
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aggte

*Aggregate Group-Time Average Treatment Effects*

---

## Description

A function to take group-time average treatment effects and aggregate them into a smaller number of parameters. There are several possible aggregations including "simple", "dynamic", "group", and "calendar."

**Usage**

```

aggte(
  MP,
  type = "group",
  balance_e = NULL,
  min_e = -Inf,
  max_e = Inf,
  na.rm = FALSE,
  bstrap = NULL,
  biters = NULL,
  cband = NULL,
  alp = NULL,
  clustervars = NULL
)

```

**Arguments**

MP	an MP object (i.e., the results of the <code>att_gt()</code> method)
type	Which type of aggregated treatment effect parameter to compute. One option is "simple" (this just computes a weighted average of all group-time average treatment effects with weights proportional to group size). Other options are "dynamic" (this computes average effects across different lengths of exposure to the treatment and is similar to an "event study"; here the overall effect averages the effect of the treatment across all positive lengths of exposure); "group" (this is the default option and computes average treatment effects across different groups; here the overall effect averages the effect across different groups); and "calendar" (this computes average treatment effects across different time periods; here the overall effect averages the effect across each time period).
balance_e	If set (and if one computes dynamic effects), it balances the sample with respect to event time. For example, if <code>balance_e=2</code> , <code>aggte</code> will drop groups that are not exposed to treatment for at least three periods. (the initial period when <code>e=0</code> as well as the next two periods when <code>e=1</code> and the <code>e=2</code> ). This ensures that the composition of groups does not change when event time changes.
min_e	For event studies, this is the smallest event time to compute dynamic effects for. By default, <code>min_e = -Inf</code> so that effects at all lengths of exposure are computed.
max_e	For event studies, this is the largest event time to compute dynamic effects for. By default, <code>max_e = Inf</code> so that effects at all lengths of exposure are computed.
na.rm	Logical value if we are to remove missing Values from analyses. Defaults is FALSE.
bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set <code>bstrap=TRUE</code> . Default is value set in the MP object. If <code>bstrap</code> is FALSE, then analytical standard errors are reported.
biters	The number of bootstrap iterations to use. The default is the value set in the MP object, and this is only applicable if <code>bstrap=TRUE</code> .

<code>cband</code>	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\alpha$ . In order to compute uniform confidence bands, <code>bstrap</code> must also be set to <code>TRUE</code> . The default is the value set in the MP object
<code>alp</code>	the significance level, default is value set in the MP object.
<code>clustervars</code>	A vector of variables to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as <code>idname</code> which allows for clustering at the individual level. Default is the variables set in the MP object

### Value

An `AGGTEobj` object that holds the results from the aggregation

### Examples

Initial ATT(g,t) estimates from `att_gt()`

```
data(mpdta)
set.seed(09152024)
out <- att_gt(yname="lemp",
              tname="year",
              idname="countyreal",
              gname="first.treat",
              xformula=NULL,
              data=mpdta)
```

You can aggregate the ATT(g,t) in many ways.

#### Overall ATT:

```
aggte(out, type = "simple")
#>
#> Call:
#> aggte(MP = out, type = "simple")
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#>
#>   ATT      Std. Error    [ 95% Conf. Int.]
#> -0.04      0.0119    -0.0633    -0.0166 *
#>
#>
#> ---
#> Signif. codes:  `*' confidence band does not cover 0
#>
#> Control Group:  Never Treated,  Anticipation Periods:  0
#> Estimation Method:  Doubly Robust
```

**Dynamic ATT (Event-Study):**

```
aggte(out, type = "dynamic")
#>
#> Call:
#> aggte(MP = out, type = "dynamic")
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#>
#> Overall summary of ATT's based on event-study/dynamic aggregation:
#>      ATT      Std. Error      [ 95% Conf. Int.]
#> -0.0772      0.0208      -0.118      -0.0365 *
#>
#>
#> Dynamic Effects:
#> Event time Estimate Std. Error [95% Simult. Conf. Band]
#>      -3  0.0305  0.0154  -0.0101  0.0711
#>      -2 -0.0006  0.0129  -0.0346  0.0334
#>      -1 -0.0245  0.0145  -0.0628  0.0139
#>       0 -0.0199  0.0119  -0.0513  0.0114
#>       1 -0.0510  0.0160  -0.0934 -0.0085 *
#>       2 -0.1373  0.0393  -0.2412 -0.0333 *
#>       3 -0.1008  0.0356  -0.1949 -0.0067 *
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
#> Control Group: Never Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust
```

**ATT for each group:**

```
aggte(out, type = "group")
#>
#> Call:
#> aggte(MP = out, type = "group")
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#>
#> Overall summary of ATT's based on group/cohort aggregation:
#>      ATT      Std. Error      [ 95% Conf. Int.]
#> -0.031      0.0126      -0.0558      -0.0063 *
#>
#>
#> Group Effects:
#> Group Estimate Std. Error [95% Simult. Conf. Band]
#> 2004 -0.0797  0.0300  -0.1445  -0.0150 *
```

```
#> 2006 -0.0229 0.0163 -0.0582 0.0123
#> 2007 -0.0261 0.0167 -0.0622 0.0101
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
#> Control Group: Never Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust
```

### ATT for each calendar year:

```
aggte(out, type = "calendar")
#>
#> Call:
#> aggte(MP = out, type = "calendar")
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#>
#> Overall summary of ATT's based on calendar time aggregation:
#>      ATT      Std. Error    [ 95% Conf. Int.]
#> -0.0417      0.0175    -0.0759    -0.0075 *
#>
#>
#> Time Effects:
#> Time Estimate Std. Error [95% Simult. Conf. Band]
#> 2004 -0.0105 0.0242 -0.0685 0.0475
#> 2005 -0.0704 0.0319 -0.1467 0.0059
#> 2006 -0.0488 0.0206 -0.0980 0.0004
#> 2007 -0.0371 0.0133 -0.0689 -0.0052 *
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
#> Control Group: Never Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust
```

---

AGGTEobj

AGGTEobj

---

### Description

Objects of this class hold results on aggregated group-time average treatment effects

An object for holding aggregated treatment effect parameters.

**Usage**

```

AGGTEobj(
  overall.att = NULL,
  overall.se = NULL,
  type = "simple",
  egt = NULL,
  att.egt = NULL,
  se.egt = NULL,
  crit.val.egt = NULL,
  inf.function = NULL,
  min_e = NULL,
  max_e = NULL,
  balance_e = NULL,
  call = NULL,
  DIDparams = NULL
)

```

**Arguments**

<code>overall.att</code>	The estimated overall ATT
<code>overall.se</code>	Standard error for overall ATT
<code>type</code>	Which type of aggregated treatment effect parameter to compute. One option is "simple" (this just computes a weighted average of all group-time average treatment effects with weights proportional to group size). Other options are "dynamic" (this computes average effects across different lengths of exposure to the treatment and is similar to an "event study"; here the overall effect averages the effect of the treatment across all positive lengths of exposure); "group" (this is the default option and computes average treatment effects across different groups; here the overall effect averages the effect across different groups); and "calendar" (this computes average treatment effects across different time periods; here the overall effect averages the effect across each time period).
<code>egt</code>	Holds the length of exposure (for dynamic effects), the group (for selective treatment timing), or the time period (for calendar time effects)
<code>att.egt</code>	The ATT specific to egt
<code>se.egt</code>	The standard error specific to egt
<code>crit.val.egt</code>	A critical value for computing uniform confidence bands for dynamic effects, selective treatment timing, or time period effects.
<code>inf.function</code>	The influence function of the chosen aggregated parameters
<code>min_e</code>	For event studies, this is the smallest event time to compute dynamic effects for. By default, <code>min_e = -Inf</code> so that effects at all lengths of exposure are computed.
<code>max_e</code>	For event studies, this is the largest event time to compute dynamic effects for. By default, <code>max_e = Inf</code> so that effects at all lengths of exposure are computed.
<code>balance_e</code>	If set (and if one computes dynamic effects), it balances the sample with respect to event time. For example, if <code>balance.e=2</code> , <code>aggte</code> will drop groups that are not exposed to treatment for at least three periods. (the initial period when <code>e=0</code> )



**Arguments**

yname	The name of the outcome variable
tname	The name of the column containing the time periods
idname	The individual (cross-sectional unit) id name
gname	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
xformula	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <code>xformula=~1</code>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{post}</math> conditional on <math>X_{post}</math> minus <math>Y_{pre}</math> conditional on <math>X_{pre}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
data	The name of the data.frame that contains the data
panel	Whether or not the data is a panel dataset. The panel dataset should be provided in long format – that is, where each row corresponds to a unit observed at a particular point in time. The default is <code>TRUE</code> . When is using a panel dataset, the variable <code>idname</code> must be set. When <code>panel=FALSE</code> , the data is treated as repeated cross sections.
allow_unbalanced_panel	Whether or not function should "balance" the panel with respect to time and id. The default values if <code>FALSE</code> which means that <code>att_gt()</code> will drop all units where data is not observed in all periods. The advantage of this is that the computations are faster (sometimes substantially).
control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set <code>group="notyettreated"</code> . In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.
anticipation	The number of time periods before participating in the treatment where units can anticipate participating in the treatment and therefore it can affect their untreated potential outcomes
weightsname	The name of the column containing the sampling weights. If not set, all observations have same weight.
alp	the significance level, default is 0.05

bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set bstrap=TRUE. Default is TRUE (in addition, cband is also by default TRUE indicating that uniform confidence bands will be returned. If bstrap is FALSE, then analytical standard errors are reported).
cband	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\alpha$ . In order to compute uniform confidence bands, bstrap must also be set to TRUE. The default is TRUE.
biters	The number of bootstrap iterations to use. The default is 1000, and this is only applicable if bstrap=TRUE.
clustervars	A vector of variables names to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as idname which allows for clustering at the individual level. By default, we cluster at individual level (when bstrap=TRUE).
est_method	the method to compute group-time average treatment effects. The default is "dr" which uses the doubly robust approach in the DRDID package. Other built-in methods include "ipw" for inverse probability weighting and "reg" for first step regression estimators. The user can also pass their own function for estimating group time average treatment effects. This should be a function $f(Y1, Y0, treat, covariates)$ where $Y1$ is an $n \times 1$ vector of outcomes in the post-treatment outcomes, $Y0$ is an $n \times 1$ vector of pre-treatment outcomes, $treat$ is a vector indicating whether or not an individual participates in the treatment, and $covariates$ is an $n \times k$ matrix of covariates. The function should return a list that includes ATT (an estimated average treatment effect), and $inf.func$ (an $n \times 1$ influence function). The function can return other things as well, but these are the only two that are required. <code>est_method</code> is only used if <code>covariates</code> are included.
base_period	Whether to use a "varying" base period or a "universal" base period. Either choice results in the same post-treatment estimates of $ATT(g,t)$ 's. In pre-treatment periods, using a varying base period amounts to computing a pseudo-ATT in each treatment period by comparing the change in outcomes for a particular group relative to its comparison group in the pre-treatment periods (i.e., in pre-treatment periods this setting computes changes from period $t-1$ to period $t$ , but repeatedly changes the value of $t$ ) A universal base period fixes the base period to always be $(g-anticipation-1)$ . This does not compute pseudo- $ATT(g,t)$ 's in pre-treatment periods, but rather reports average changes in outcomes from period $t$ to $(g-anticipation-1)$ for a particular group relative to its comparison group. This is analogous to what is often reported in event study regressions. Using a varying base period results in an estimate of $ATT(g,t)$ being reported in the period immediately before treatment. Using a universal base period normalizes the estimate in the period right before treatment (or earlier when the user allows for anticipation) to be equal to 0, but one extra estimate in an earlier period.
faster_mode	This option enables a faster version of did, optimizing computation time for large datasets by improving data management within the package. The default

is set to FALSE. While the difference is minimal for small datasets, it is recommended for use with large datasets.

print\_details Whether or not to show details/progress of computations. Default is FALSE.  
 pl Whether or not to use parallel processing  
 cores The number of cores to use for parallel processing

### Value

an MP object containing all the results for group-time average treatment effects

### Examples:

#### Basic att\_gt() call:

```
# Example data
data(mpdata)
set.seed(09152024)
out1 <- att_gt(yname="lemp",
              tname="year",
              idname="countyreal",
              gname="first.treat",
              xformula=NULL,
              data=mpdta)

summary(out1)
#>
#> Call:
#> att_gt(yname = "lemp", tname = "year", idname = "countyreal",
#>       gname = "first.treat", xformula = NULL, data = mpdta)
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#> Group-Time Average Treatment Effects:
#> Group Time ATT(g,t) Std. Error [95% Simult. Conf. Band]
#> 2004 2004 -0.0105 0.0258 -0.0809 0.0599
#> 2004 2005 -0.0704 0.0341 -0.1635 0.0227
#> 2004 2006 -0.1373 0.0384 -0.2423 -0.0322 *
#> 2004 2007 -0.1008 0.0354 -0.1976 -0.0040 *
#> 2006 2004 0.0065 0.0235 -0.0578 0.0708
#> 2006 2005 -0.0028 0.0192 -0.0554 0.0499
#> 2006 2006 -0.0046 0.0184 -0.0548 0.0456
#> 2006 2007 -0.0412 0.0207 -0.0977 0.0153
#> 2007 2004 0.0305 0.0161 -0.0135 0.0746
#> 2007 2005 -0.0027 0.0157 -0.0456 0.0401
#> 2007 2006 -0.0311 0.0184 -0.0815 0.0193
#> 2007 2007 -0.0261 0.0176 -0.0741 0.0220
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
```

```
#> P-value for pre-test of parallel trends assumption: 0.16812
#> Control Group: Never Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust
```

### Using covariates:

```
out2 <- att_gt(yname="lemp",
              tname="year",
              idname="countyreal",
              gname="first.treat",
              xformula=~lpop,
              data=mpdta)

summary(out2)
#>
#> Call:
#> att_gt(yname = "lemp", tname = "year", idname = "countyreal",
#>        gname = "first.treat", xformula = ~lpop, data = mpdta)
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Tim
#>
#> Group-Time Average Treatment Effects:
#> Group Time ATT(g,t) Std. Error [95% Simult. Conf. Band]
#> 2004 2004 -0.0145 0.0222 -0.0737 0.0446
#> 2004 2005 -0.0764 0.0303 -0.1570 0.0041
#> 2004 2006 -0.1404 0.0382 -0.2421 -0.0388 *
#> 2004 2007 -0.1069 0.0358 -0.2021 -0.0117 *
#> 2006 2004 -0.0005 0.0231 -0.0618 0.0609
#> 2006 2005 -0.0062 0.0188 -0.0561 0.0437
#> 2006 2006 0.0010 0.0204 -0.0534 0.0553
#> 2006 2007 -0.0413 0.0210 -0.0971 0.0145
#> 2007 2004 0.0267 0.0140 -0.0104 0.0639
#> 2007 2005 -0.0046 0.0170 -0.0498 0.0407
#> 2007 2006 -0.0284 0.0187 -0.0782 0.0213
#> 2007 2007 -0.0288 0.0161 -0.0715 0.0140
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
#> P-value for pre-test of parallel trends assumption: 0.23267
#> Control Group: Never Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust
```

### Specify comparison units:

```
out3 <- att_gt(yname="lemp",
              tname="year",
              idname="countyreal",
              gname="first.treat",
              xformula=~lpop,
```

```

control_group = "notyettreated",
data=mpdta)
summary(out3)
#>
#> Call:
#> att_gt(ymame = "lemp", tname = "year", idname = "countyreal",
#>   gname = "first.treat", xformula = ~lpop, data = mpdta, control_group = "notyettreated")
#>
#> Reference: Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Time
#>
#> Group-Time Average Treatment Effects:
#> Group Time ATT(g,t) Std. Error [95% Simult. Conf. Band]
#> 2004 2004 -0.0212 0.0217 -0.0788 0.0365
#> 2004 2005 -0.0816 0.0324 -0.1676 0.0044
#> 2004 2006 -0.1382 0.0368 -0.2361 -0.0403 *
#> 2004 2007 -0.1069 0.0344 -0.1984 -0.0154 *
#> 2006 2004 -0.0075 0.0233 -0.0693 0.0544
#> 2006 2005 -0.0046 0.0184 -0.0533 0.0442
#> 2006 2006 0.0087 0.0182 -0.0397 0.0570
#> 2006 2007 -0.0413 0.0205 -0.0956 0.0130
#> 2007 2004 0.0269 0.0136 -0.0091 0.0630
#> 2007 2005 -0.0042 0.0153 -0.0448 0.0364
#> 2007 2006 -0.0284 0.0191 -0.0792 0.0223
#> 2007 2007 -0.0288 0.0167 -0.0732 0.0157
#> ---
#> Signif. codes: `*' confidence band does not cover 0
#>
#> P-value for pre-test of parallel trends assumption: 0.23326
#> Control Group: Not Yet Treated, Anticipation Periods: 0
#> Estimation Method: Doubly Robust

```

## References

Callaway, Brantly and Pedro H.C. Sant'Anna. "Difference-in-Differences with Multiple Time Periods." *Journal of Econometrics*, Vol. 225, No. 2, pp. 200-230, 2021. [doi:10.1016/j.jeconom.2020.12.001](https://doi.org/10.1016/j.jeconom.2020.12.001), <https://arxiv.org/abs/1803.09015>

---

build\_sim\_dataset      *build\_sim\_dataset*

---

## Description

A function for building simulated data

## Usage

```
build_sim_dataset(sp_list, panel = TRUE)
```

**Arguments**

sp_list	A list of simulation parameters. See <code>reset.sim</code> to generate some default values for parameters
panel	whether to construct panel data (the default) or repeated cross sections data

**Value**

a data.frame with the following columns

- G observations group
- X value of covariate
- id observation's id
- cluster observation's cluster (by construction there is no within-cluster correlation)
- period time period for current observation
- Y outcome
- treat whether or not this unit is ever treated

---

conditional\_did\_pretest

*Pre-Test of Conditional Parallel Trends Assumption*

---

**Description**

An integrated moments test for the conditional parallel trends assumption holding in all pre-treatment time periods for all groups

**Usage**

```
conditional_did_pretest(
  yname,
  tname,
  idname = NULL,
  gname,
  xformula = NULL,
  data,
  panel = TRUE,
  allow_unbalanced_panel = FALSE,
  control_group = c("nevertreated", "notyettreated"),
  weightsname = NULL,
  alp = 0.05,
  bstrap = TRUE,
  cband = TRUE,
  biters = 1000,
  clustervars = NULL,
  est_method = "ipw",
```

```

    print_details = FALSE,
    pl = FALSE,
    cores = 1
)

```

### Arguments

yname	The name of the outcome variable
tname	The name of the column containing the time periods
idname	The individual (cross-sectional unit) id name
gname	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
xformula	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <code>xformula=<math>\sim</math>1</code>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{\text{post}}</math> conditional on <math>X_{\text{post}}</math> minus <math>Y_{\text{pre}}</math> conditional on <math>X_{\text{pre}}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
data	The name of the data.frame that contains the data
panel	Whether or not the data is a panel dataset. The panel dataset should be provided in long format – that is, where each row corresponds to a unit observed at a particular point in time. The default is TRUE. When using a panel dataset, the variable <code>idname</code> must be set. When <code>panel=FALSE</code> , the data is treated as repeated cross sections.
allow_unbalanced_panel	Whether or not function should "balance" the panel with respect to time and id. The default values if FALSE which means that <code>att_gt()</code> will drop all units where data is not observed in all periods. The advantage of this is that the computations are faster (sometimes substantially).
control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set <code>group="notyettreated"</code> . In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.
weightsname	The name of the column containing the sampling weights. If not set, all observations have same weight.

alp	the significance level, default is 0.05
bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set bstrap=TRUE. Default is TRUE (in addition, cband is also by default TRUE indicating that uniform confidence bands will be returned. If bstrap is FALSE, then analytical standard errors are reported).
cband	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\text{alp}$ . In order to compute uniform confidence bands, bstrap must also be set to TRUE. The default is TRUE.
biters	The number of bootstrap iterations to use. The default is 1000, and this is only applicable if bstrap=TRUE.
clustervars	A vector of variables names to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as idname which allows for clustering at the individual level. By default, we cluster at individual level (when bstrap=TRUE).
est_method	the method to compute group-time average treatment effects. The default is "dr" which uses the doubly robust approach in the DRDID package. Other built-in methods include "ipw" for inverse probability weighting and "reg" for first step regression estimators. The user can also pass their own function for estimating group time average treatment effects. This should be a function $f(Y1, Y0, \text{treat}, \text{covariates})$ where $Y1$ is an $n \times 1$ vector of outcomes in the post-treatment outcomes, $Y0$ is an $n \times 1$ vector of pre-treatment outcomes, $\text{treat}$ is a vector indicating whether or not an individual participates in the treatment, and $\text{covariates}$ is an $n \times k$ matrix of covariates. The function should return a list that includes ATT (an estimated average treatment effect), and $\text{inf.func}$ (an $n \times 1$ influence function). The function can return other things as well, but these are the only two that are required. <code>est_method</code> is only used if <code>covariates</code> are included.
print_details	Whether or not to show details/progress of computations. Default is FALSE.
pl	Whether or not to use parallel processing
cores	The number of cores to use for parallel processing

### Value

an `MP.TEST` object

### References

Callaway, Brantly and Sant'Anna, Pedro H. C. "Difference-in-Differences with Multiple Time Periods and an Application on the Minimum Wage and Employment." Working Paper <https://arxiv.org/abs/1803.09015v2> (2018).

### Examples

```
## Not run:
data(mpdata)
pre.test <- conditional_did_pretest(yname="lemp",
```

```

tname="year",
idname="countyreal",
gname="first.treat",
xformula=~lpop,
data=mpdta)

summary(pre.test)

## End(Not run)

```

---

DIDparams

*DIDparams*


---

## Description

Object to hold did parameters that are passed across functions

## Usage

```

DIDparams(
  yname,
  tname,
  idname = NULL,
  gname,
  xformula = NULL,
  data,
  control_group,
  anticipation = 0,
  weightsname = NULL,
  alp = 0.05,
  bstrap = TRUE,
  biters = 1000,
  clustervars = NULL,
  cband = TRUE,
  print_details = TRUE,
  faster_mode = FALSE,
  pl = FALSE,
  cores = 1,
  est_method = "dr",
  base_period = "varying",
  panel = TRUE,
  true_repeated_cross_sections,
  n = NULL,
  nG = NULL,
  nT = NULL,
  tlist = NULL,
  glist = NULL,
  call = NULL
)

```

**Arguments**

yname	The name of the outcome variable
tname	The name of the column containing the time periods
idname	The individual (cross-sectional unit) id name
gname	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
xformula	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <math>xformula \sim 1</math>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{post}</math> conditional on <math>X_{post}</math> minus <math>Y_{pre}</math> conditional on <math>X_{pre}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
data	The name of the data.frame that contains the data
control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set <code>group="notyettreated"</code> . In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.
anticipation	The number of time periods before participating in the treatment where units can anticipate participating in the treatment and therefore it can affect their untreated potential outcomes
weightsname	The name of the column containing the sampling weights. If not set, all observations have same weight.
alp	the significance level, default is 0.05
bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set <code>bstrap=TRUE</code> . Default is TRUE (in addition, <code>cband</code> is also by default TRUE indicating that uniform confidence bands will be returned. If <code>bstrap</code> is FALSE, then analytical standard errors are reported.
biters	The number of bootstrap iterations to use. The default is 1000, and this is only applicable if <code>bstrap=TRUE</code> .
clustervars	A vector of variables names to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as <code>idname</code>

	which allows for clustering at the individual level. By default, we cluster at individual level (when <code>bstrap=TRUE</code> ).
<code>cband</code>	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\alpha$ . In order to compute uniform confidence bands, <code>bstrap</code> must also be set to <code>TRUE</code> . The default is <code>TRUE</code> .
<code>print_details</code>	Whether or not to show details/progress of computations. Default is <code>FALSE</code> .
<code>faster_mode</code>	This option enables a faster version of <code>did</code> , optimizing computation time for large datasets by improving data management within the package. The default is set to <code>FALSE</code> . While the difference is minimal for small datasets, it is recommended for use with large datasets.
<code>p1</code>	Whether or not to use parallel processing
<code>cores</code>	The number of cores to use for parallel processing
<code>est_method</code>	the method to compute group-time average treatment effects. The default is "dr" which uses the doubly robust approach in the DRDID package. Other built-in methods include "ipw" for inverse probability weighting and "reg" for first step regression estimators. The user can also pass their own function for estimating group time average treatment effects. This should be a function $f(Y1, Y0, treat, covariates)$ where $Y1$ is an $n \times 1$ vector of outcomes in the post-treatment outcomes, $Y0$ is an $n \times 1$ vector of pre-treatment outcomes, <code>treat</code> is a vector indicating whether or not an individual participates in the treatment, and <code>covariates</code> is an $n \times k$ matrix of covariates. The function should return a list that includes <code>ATT</code> (an estimated average treatment effect), and <code>inf.func</code> (an $n \times 1$ influence function). The function can return other things as well, but these are the only two that are required. <code>est_method</code> is only used if <code>covariates</code> are included.
<code>base_period</code>	Whether to use a "varying" base period or a "universal" base period. Either choice results in the same post-treatment estimates of <code>ATT(g,t)</code> 's. In pre-treatment periods, using a varying base period amounts to computing a pseudo- <code>ATT</code> in each treatment period by comparing the change in outcomes for a particular group relative to its comparison group in the pre-treatment periods (i.e., in pre-treatment periods this setting computes changes from period $t-1$ to period $t$ , but repeatedly changes the value of $t$ ) A universal base period fixes the base period to always be $(g-anticipation-1)$ . This does not compute pseudo- <code>ATT(g,t)</code> 's in pre-treatment periods, but rather reports average changes in outcomes from period $t$ to $(g-anticipation-1)$ for a particular group relative to its comparison group. This is analogous to what is often reported in event study regressions. Using a varying base period results in an estimate of <code>ATT(g,t)</code> being reported in the period immediately before treatment. Using a universal base period normalizes the estimate in the period right before treatment (or earlier when the user allows for anticipation) to be equal to 0, but one extra estimate in an earlier period.
<code>panel</code>	Whether or not the data is a panel dataset. The panel dataset should be provided in long format – that is, where each row corresponds to a unit observed at a particular point in time. The default is <code>TRUE</code> . When is using a panel dataset, the variable <code>idname</code> must be set. When <code>panel=FALSE</code> , the data is treated as repeated cross sections.

true_repeated_cross_sections	Whether or not the data really is repeated cross sections. (We include this because unbalanced panel code runs through the repeated cross sections code)
n	The number of observations. This is equal to the number of units (which may be different from the number of rows in a panel dataset).
nG	The number of groups
nT	The number of time periods
tlist	a vector containing each time period
glist	a vector containing each group
call	Function call to att_gt

---

ggdid	<i>Plot did objects using ggplot2</i>
-------	---------------------------------------

---

### Description

Function to plot objects from the did package

### Usage

```
ggdid(object, ...)
```

### Arguments

object	either a MP object or AGGTEobj object. See <code>help(ggdid.MP)</code> and <code>help(ggdid.AGGTEobj)</code> .
...	other arguments

---

ggdid.AGGTEobj	<i>Plot AGGTEobj objects</i>
----------------	------------------------------

---

### Description

A function to plot AGGTEobj objects

### Usage

```
## S3 method for class 'AGGTEobj'
ggdid(
  object,
  ylim = NULL,
  xlab = NULL,
  ylab = NULL,
  title = "",
  xgap = 1,
```

```

    legend = TRUE,
    ref_line = 0,
    theming = TRUE,
    ...
)

```

### Arguments

object	either a MP object or AGGTEobj object. See <code>help(ggdid.MP)</code> and <code>help(ggdid.AGGTEobj)</code> .
ylim	optional y limits for the plot; setting here makes the y limits the same across different plots
xlab	optional x-axis label
ylab	optional y-axis label
title	optional plot title
xgap	optional gap between the labels on the x-axis. For example, <code>xgap=3</code> indicates that the labels should show up for every third value on the x-axis. The default is 1.
legend	Whether or not to include a legend (which will indicate color of pre- and post-treatment estimates). Default is TRUE.
ref_line	A reference line at this value, usually to compare confidence intervals to 0. Set to NULL to omit.
theming	Set to FALSE to skip all theming so you can do it yourself.
...	other arguments

---

ggdid.MP

*Plot MP objects using ggplot2*


---

### Description

A function to plot MP objects

### Usage

```

## S3 method for class 'MP'
ggdid(
  object,
  ylim = NULL,
  xlab = NULL,
  ylab = NULL,
  title = "Group",
  xgap = 1,
  ncol = 1,
  legend = TRUE,
  group = NULL,
)

```

```

    ref_line = 0,
    theming = TRUE,
    grtitle = "Group",
    ...
)

```

### Arguments

object	either a MP object or AGGTEobj object. See <code>help(ggdid.MP)</code> and <code>help(ggdid.AGGTEobj)</code> .
ylim	optional y limits for the plot; setting here makes the y limits the same across different plots
xlab	optional x-axis label
ylab	optional y-axis label
title	optional plot title
xgap	optional gap between the labels on the x-axis. For example, <code>xgap=3</code> indicates that the labels should show up for every third value on the x-axis. The default is 1.
ncol	The number of columns to include in the resulting plot. The default is 1.
legend	Whether or not to include a legend (which will indicate color of pre- and post-treatment estimates). Default is TRUE.
group	Vector for which groups to include in the plots of <code>ATT(g,t)</code> . Default is NULL, and, in this case, plots for all groups will be included ( <code>ggdid.MP</code> only).
ref_line	A reference line at this value, usually to compare confidence intervals to 0. Set to NULL to omit.
theming	Set to FALSE to skip all theming so you can do it yourself.
grtitle	Title to append before each group name ( <code>ggdid.MP</code> only).
...	other arguments

---

glance.AGGTEobj

*glance model characteristics from AGGTEobj objects*

---

### Description

glance model characteristics from AGGTEobj objects

### Usage

```

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

```

### Arguments

x	a model of class AGGTEobj produced by the <code>aggte()</code> function
...	other arguments passed to methods

---

glance.MP	<i>glance model characteristics from MP objects</i>
-----------	---

---

**Description**

glance model characteristics from MP objects

**Usage**

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

**Arguments**

x	a model of class MP produced by the <code>att_gt()</code> function
...	other arguments passed to methods

---

indicator	<i>indicator</i>
-----------	------------------

---

**Description**

indicator weighting function

**Usage**

```
indicator(X, u)
```

**Arguments**

X	matrix of X's from the data
u	a particular value to compare X's to

**Value**

numeric vector

**Examples**

```
data(mpdt)
dta <- subset(mpdt, year==2007)
X <- model.matrix(~lpop, data=dta)
X <- indicator(X, X[1,])
```

---

<code>mboot</code>	<i>Multiplier Bootstrap</i>
--------------------	-----------------------------

---

**Description**

A function to take an influence function and use the multiplier bootstrap to compute standard errors and critical values for uniform confidence bands.

**Usage**

```
mboot(inf.func, DIDparams, pl = FALSE, cores = 1)
```

**Arguments**

<code>inf.func</code>	an influence function
<code>DIDparams</code>	DIDparams object
<code>pl</code>	whether or not to use parallel processing in the multiplier bootstrap, default=FALSE
<code>cores</code>	the number of cores to use with parallel processing, default=1

**Value**

<code>list</code>	list with elements
<code>bres</code>	results from each bootstrap iteration
<code>V</code>	variance matrix
<code>se</code>	standard errors
<code>crit.val</code>	a critical value for computing uniform confidence bands

---

<code>MP</code>	<i>MP</i>
-----------------	-----------

---

**Description**

Multi-period objects that hold results for group-time average treatment effects

**Usage**

```
MP(
  group,
  t,
  att,
  V_analytical,
  se,
  c,
```

```

    inffunc,
    n = NULL,
    W = NULL,
    Wpval = NULL,
    aggte = NULL,
    alp = 0.05,
    DIDparams = NULL
)

```

### Arguments

group	which group (defined by period first treated) an group-time average treatment effect is for
t	which time period a group-time average treatment effect is for
att	the group-average treatment effect for group group and time period t
V_analytical	Analytical estimator for the asymptotic variance-covariance matrix for group-time average treatment effects
se	standard errors for group-time average treatment effects. If bootstrap is set to TRUE, this provides bootstrap-based se.
c	simultaneous critical value if one is obtaining simultaneous confidence bands. Otherwise it reports the critical value based on pointwise normal approximation.
inffunc	the influence function for estimating group-time average treatment effects
n	the number of unique cross-sectional units (unique values of idname)
W	the Wald statistic for pre-testing the common trends assumption
Wpval	the p-value of the Wald statistic for pre-testing the common trends assumption
aggte	an aggregate treatment effects object
alp	the significance level, default is 0.05
DIDparams	a <code>DIDparams</code> object. A way to optionally return the parameters of the call to <code>att_gt()</code> or <code>conditional_did_pretest()</code> .

### Value

MP object

---

MP.TEST

*MP.TEST*

---

### Description

An object that holds results from computing pre-test of the conditional parallel trends assumption

**Usage**

```

MP.TEST(
  CvM = NULL,
  CvMb = NULL,
  CvMcval = NULL,
  CvMpval = NULL,
  KS = NULL,
  KSb = NULL,
  KScval = NULL,
  KSpval = NULL,
  clustervars = NULL,
  xformula = NULL
)

```

**Arguments**

CvM	Cramer von Mises test statistic
CvMb	a vector of bootstrapped Cramer von Mises test statistics
CvMcval	CvM critical value
CvMpval	p-value for CvM test
KS	Kolmogorov-Smirnov test statistic
KSb	a vector of bootstrapped KS test statistics
KScval	KS critical value
KSpval	p-value for KS test
clustervars	vector of which variables were clustered on for the test
xformula	formula for the X variables used in the test

---

mpdta

*County Teen Employment Dataset*


---

**Description**

A dataset containing (the log of) teen employment in 500 counties in the U.S. from 2004 to 2007. This is a subset of the dataset used in Callaway and Sant'Anna (2021). See that paper for additional descriptions.

**Usage**

mpdta

**Format**

A data frame with 2000 rows and 5 variables:

**year** the year of the observation

**countyreal** a unique identifier for a particular county

**lpop** the log of 1000s of population for the county

**lemp** the log of teen employment in the county

**first.treat** the year that the state where the county is located raised its minimum wage, it is set equal to 0 for counties that have minimum wages equal to the federal minimum wage over the entire period.

**treat** whether or not a particular county is treated in that year

**Source**

Callaway and Sant'Anna (2020)

---

pre_process_did	<i>Process did Function Arguments</i>
-----------------	---------------------------------------

---

**Description**

Function to process arguments passed to the main methods in the did package as well as conducting some tests to make sure data is in proper format / try to throw helpful error messages.

**Usage**

```
pre_process_did(
  yname,
  tname,
  idname,
  gname,
  xformula = NULL,
  data,
  panel = TRUE,
  allow_unbalanced_panel,
  control_group = c("nevertreated", "notyettreated"),
  anticipation = 0,
  weightsname = NULL,
  alp = 0.05,
  bstrap = FALSE,
  cband = FALSE,
  biters = 1000,
  clustervars = NULL,
  est_method = "dr",
  base_period = "varying",
```

```

print_details = TRUE,
faster_mode = FALSE,
pl = FALSE,
cores = 1,
call = NULL
)

```

## Arguments

yname	The name of the outcome variable
tname	The name of the column containing the time periods
idname	The individual (cross-sectional unit) id name
gname	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
xformula	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <code>xformula=<math>\sim 1</math></code>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{\text{post}}</math> conditional on <math>X_{\text{post}}</math> minus <math>Y_{\text{pre}}</math> conditional on <math>X_{\text{pre}}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
data	The name of the data.frame that contains the data
panel	Whether or not the data is a panel dataset. The panel dataset should be provided in long format – that is, where each row corresponds to a unit observed at a particular point in time. The default is TRUE. When is using a panel dataset, the variable <code>idname</code> must be set. When <code>panel=FALSE</code> , the data is treated as repeated cross sections.
allow_unbalanced_panel	Whether or not function should "balance" the panel with respect to time and id. The default values if FALSE which means that <code>att_gt()</code> will drop all units where data is not observed in all periods. The advantage of this is that the computations are faster (sometimes substantially).
control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set <code>group="notyettreated"</code> . In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.

anticipation	The number of time periods before participating in the treatment where units can anticipate participating in the treatment and therefore it can affect their untreated potential outcomes
weightsname	The name of the column containing the sampling weights. If not set, all observations have same weight.
alp	the significance level, default is 0.05
bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set bstrap=TRUE. Default is TRUE (in addition, cband is also by default TRUE indicating that uniform confidence bands will be returned. If bstrap is FALSE, then analytical standard errors are reported.
cband	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\alpha p$ . In order to compute uniform confidence bands, bstrap must also be set to TRUE. The default is TRUE.
biters	The number of bootstrap iterations to use. The default is 1000, and this is only applicable if bstrap=TRUE.
clustervars	A vector of variables names to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as idname which allows for clustering at the individual level. By default, we cluster at individual level (when bstrap=TRUE).
est_method	the method to compute group-time average treatment effects. The default is "dr" which uses the doubly robust approach in the DRDID package. Other built-in methods include "ipw" for inverse probability weighting and "reg" for first step regression estimators. The user can also pass their own function for estimating group time average treatment effects. This should be a function $f(Y1, Y0, treat, covariates)$ where $Y1$ is an $n \times 1$ vector of outcomes in the post-treatment outcomes, $Y0$ is an $n \times 1$ vector of pre-treatment outcomes, $treat$ is a vector indicating whether or not an individual participates in the treatment, and $covariates$ is an $n \times k$ matrix of covariates. The function should return a list that includes ATT (an estimated average treatment effect), and $inf.func$ (an $n \times 1$ influence function). The function can return other things as well, but these are the only two that are required. <code>est_method</code> is only used if covariates are included.
base_period	Whether to use a "varying" base period or a "universal" base period. Either choice results in the same post-treatment estimates of $ATT(g,t)$ 's. In pre-treatment periods, using a varying base period amounts to computing a pseudo-ATT in each treatment period by comparing the change in outcomes for a particular group relative to its comparison group in the pre-treatment periods (i.e., in pre-treatment periods this setting computes changes from period $t-1$ to period $t$ , but repeatedly changes the value of $t$ )  A universal base period fixes the base period to always be $(g-anticipation-1)$ . This does not compute pseudo- $ATT(g,t)$ 's in pre-treatment periods, but rather reports average changes in outcomes from period $t$ to $(g-anticipation-1)$ for a particular group relative to its comparison group. This is analogous to what is often reported in event study regressions.

Using a varying base period results in an estimate of ATT(g,t) being reported in the period immediately before treatment. Using a universal base period normalizes the estimate in the period right before treatment (or earlier when the user allows for anticipation) to be equal to 0, but one extra estimate in an earlier period.

print_details	Whether or not to show details/progress of computations. Default is FALSE.
faster_mode	This option enables a faster version of did, optimizing computation time for large datasets by improving data management within the package. The default is set to FALSE. While the difference is minimal for small datasets, it is recommended for use with large datasets.
pl	Whether or not to use parallel processing
cores	The number of cores to use for parallel processing
call	Function call to att_gt

**Value**

a [DIDparams](#) object

---

pre\_process\_did2      *Process did Function Arguments*

---

**Description**

Function to process arguments passed to the main methods in the did package as well as conducting some tests to make sure data is in proper format / try to throw helpful error messages.

**Usage**

```
pre_process_did2(
  yname,
  tname,
  idname,
  gname,
  xformula = NULL,
  data,
  panel = TRUE,
  allow_unbalanced_panel,
  control_group = c("nevertreated", "notyettreated"),
  anticipation = 0,
  weightsname = NULL,
  alp = 0.05,
  bstrap = FALSE,
  cband = FALSE,
  biters = 1000,
  clustervars = NULL,
  est_method = "dr",
```

```

    base_period = "varying",
    print_details = TRUE,
    faster_mode = FALSE,
    pl = FALSE,
    cores = 1,
    call = NULL
  )

```

## Arguments

yname	The name of the outcome variable
tname	The name of the column containing the time periods
idname	The individual (cross-sectional unit) id name
gname	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
xformula	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <code>xformula=<math>\sim 1</math></code>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{\text{post}}</math> conditional on <math>X_{\text{post}}</math> minus <math>Y_{\text{pre}}</math> conditional on <math>X_{\text{pre}}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
data	The name of the data.frame that contains the data
panel	Whether or not the data is a panel dataset. The panel dataset should be provided in long format – that is, where each row corresponds to a unit observed at a particular point in time. The default is TRUE. When using a panel dataset, the variable <code>idname</code> must be set. When <code>panel=FALSE</code> , the data is treated as repeated cross sections.
allow_unbalanced_panel	Whether or not function should "balance" the panel with respect to time and id. The default values if FALSE which means that <code>att_gt()</code> will drop all units where data is not observed in all periods. The advantage of this is that the computations are faster (sometimes substantially).
control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set <code>group="notyettreated"</code> . In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This

	includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.
anticipation	The number of time periods before participating in the treatment where units can anticipate participating in the treatment and therefore it can affect their untreated potential outcomes
weightsname	The name of the column containing the sampling weights. If not set, all observations have same weight.
alp	the significance level, default is 0.05
bstrap	Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set bstrap=TRUE. Default is TRUE (in addition, cband is also by default TRUE indicating that uniform confidence bands will be returned. If bstrap is FALSE, then analytical standard errors are reported.
cband	Boolean for whether or not to compute a uniform confidence band that covers all of the group-time average treatment effects with fixed probability $1-\alpha$ . In order to compute uniform confidence bands, bstrap must also be set to TRUE. The default is TRUE.
biters	The number of bootstrap iterations to use. The default is 1000, and this is only applicable if bstrap=TRUE.
clustervars	A vector of variables names to cluster on. At most, there can be two variables (otherwise will throw an error) and one of these must be the same as idname which allows for clustering at the individual level. By default, we cluster at individual level (when bstrap=TRUE).
est_method	the method to compute group-time average treatment effects. The default is "dr" which uses the doubly robust approach in the DRDID package. Other built-in methods include "ipw" for inverse probability weighting and "reg" for first step regression estimators. The user can also pass their own function for estimating group time average treatment effects. This should be a function $f(Y1, Y0, treat, covariates)$ where $Y1$ is an $n \times 1$ vector of outcomes in the post-treatment outcomes, $Y0$ is an $n \times 1$ vector of pre-treatment outcomes, $treat$ is a vector indicating whether or not an individual participates in the treatment, and $covariates$ is an $n \times k$ matrix of covariates. The function should return a list that includes ATT (an estimated average treatment effect), and $inf.func$ (an $n \times 1$ influence function). The function can return other things as well, but these are the only two that are required. <code>est_method</code> is only used if <code>covariates</code> are included.
base_period	Whether to use a "varying" base period or a "universal" base period. Either choice results in the same post-treatment estimates of $ATT(g,t)$ 's. In pre-treatment periods, using a varying base period amounts to computing a pseudo-ATT in each treatment period by comparing the change in outcomes for a particular group relative to its comparison group in the pre-treatment periods (i.e., in pre-treatment periods this setting computes changes from period $t-1$ to period $t$ , but repeatedly changes the value of $t$ )  A universal base period fixes the base period to always be $(g-anticipation-1)$ . This does not compute pseudo- $ATT(g,t)$ 's in pre-treatment periods, but rather reports average changes in outcomes from period $t$ to $(g-anticipation-1)$ for a

particular group relative to its comparison group. This is analogous to what is often reported in event study regressions.

Using a varying base period results in an estimate of  $ATT(g,t)$  being reported in the period immediately before treatment. Using a universal base period normalizes the estimate in the period right before treatment (or earlier when the user allows for anticipation) to be equal to 0, but one extra estimate in an earlier period.

print_details	Whether or not to show details/progress of computations. Default is FALSE.
faster_mode	This option enables a faster version of did, optimizing computation time for large datasets by improving data management within the package. The default is set to FALSE. While the difference is minimal for small datasets, it is recommended for use with large datasets.
pl	Whether or not to use parallel processing
cores	The number of cores to use for parallel processing
call	Function call to att_gt

### Value

a [DIDparams](#) object

---

print.AGGTEobj	<i>print.AGGTEobj</i>
----------------	-----------------------

---

### Description

prints value of a AGGTEobj object

### Usage

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

### Arguments

x	a AGGTEobj object
...	extra arguments

---

print.MP	<i>print.MP</i>
----------	-----------------

---

**Description**

prints value of a MP object

**Usage**

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

**Arguments**

x	a MP object
...	extra arguments

---

process_attgt	<i>Process Results from <a href="#">compute.att_gt()</a></i>
---------------	--

---

**Description**

Process Results from [compute.att\\_gt\(\)](#)

**Usage**

```
process_attgt(attgt.list)
```

**Arguments**

attgt.list	list of results from <a href="#">compute.att_gt()</a>
------------	---

**Value**

list with elements:

group	which group a set of results belongs to
tt	which time period a set of results belongs to
att	the group time average treatment effect

---

 reset.sim

*reset.sim*


---

### Description

a function to create a "reasonable" set of parameters to create simulated panel data that obeys a parallel trends assumption. In particular, it provides parameters where the the effect of participating in the treatment is equal to one in all post-treatment time periods.

After calling this function, the user can change particular values of the parameters in order to generate dynamics, heterogeneous effects across groups, etc.

### Usage

```
reset.sim(time.periods = 4, n = 5000, ipw = TRUE, reg = TRUE)
```

### Arguments

time.periods	The number of time periods to include
n	The total number of observations
ipw	If TRUE, sets parameters so that DGP is compatible with recovering $ATT(g,t)$ 's using IPW (i.e., where logit that just includes a linear term in X works). If FALSE, sets parameters that will be incompatible with IPW. Either way, these parameters can be specified by the user if so desired.
reg	If TRUE, sets parameters so that DGP is compatible with recovering $ATT(g,t)$ 's using regressions on untreated untreated potential outcomes. If FALSE, sets parameters that will be incompatible with using regressions (i.e., regressions that include only linear term in X). Either way, these parameters can be specified by the user if so desired.

### Value

list of simulation parameters

---

 sim

*sim*


---

### Description

An internal function that builds simulated data, computes  $ATT(g,t)$ 's and some aggregations. It is useful for testing the inference procedures in the did function.

**Usage**

```

sim(
  sp_list,
  ret = NULL,
  bstrap = TRUE,
  cband = TRUE,
  control_group = "nevertreated",
  xformula = ~X,
  est_method = "dr",
  clustervars = NULL,
  panel = TRUE
)

```

**Arguments**

<code>sp_list</code>	A list of simulation parameters. See <code>reset.sim</code> to generate some default values for parameters
<code>ret</code>	which type of results to return. The options are <code>Wpval</code> (returns 1 if the p-value from a Wald test that all pre-treatment $ATT(g,t)$ 's are equal is less than .05), <code>cband</code> (returns 1 if a uniform confidence band covers 0 for groups and times), <code>simple</code> (returns 1 if, using the simple treatment effect aggregation results in rejecting that this aggregated treatment effect parameter is equal to 0), <code>dynamic</code> (returns 1 if the uniform confidence band from the dynamic treatment effect aggregation covers 0 in all pre- and post-treatment periods). The default value is <code>NULL</code> , and in this case the function will just return the results from the call to <code>att_gt</code> .
<code>bstrap</code>	whether or not to use the bootstrap to conduct inference (default is <code>TRUE</code> )
<code>cband</code>	whether or not to compute uniform confidence bands in the call to <code>att_gt</code> (the default is <code>TRUE</code> )
<code>control_group</code>	Whether to use the "nevertreated" comparison group (the default) or the "notyet-treated" as the comparison group
<code>xformula</code>	Formula for covariates in <code>att_gt</code> (default is <code>~X</code> )
<code>est_method</code>	Which estimation method to use in <code>att_gt</code> (default is "dr")
<code>clustervars</code>	Any additional variables which should be clustered on
<code>panel</code>	whether to simulate panel data (the default) or otherwise repeated cross sections data

**Value**

When `ret=NULL`, returns the results of the call to `att_gt`, otherwise returns 1 if the specified test rejects or 0 if not.

---

summary.AGGTEobj	<i>Summary Aggregate Treatment Effect Parameter Objects</i>
------------------	---

---

**Description**

A function to summarize aggregated treatment effect parameters.

**Usage**

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

**Arguments**

object	an AGGTEobj object
...	other arguments

---

summary.MP	<i>summary.MP</i>
------------	-------------------

---

**Description**

prints a summary of a MP object

**Usage**

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

**Arguments**

object	an MP object
...	extra arguments

---

summary.MP.TEST	<i>summary.MP.TEST</i>
-----------------	------------------------

---

**Description**

print a summary of test results

**Usage**

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

**Arguments**

object	an MP.TEST object
...	other variables

---

test.mboot	<i>Multiplier Bootstrap for Conditional Moment Test</i>
------------	---

---

**Description**

A slightly modified multiplier bootstrap procedure for the pre-test of the conditional parallel trends assumption

**Usage**

```
test.mboot(inf.func, DIDparams, cores = 1)
```

**Arguments**

inf.func	an influence function
DIDparams	DIDparams object
cores	The number of cores to use to bootstrap the test statistic in parallel. Default is cores=1 which corresponds to not running parallel.

**Value**

list	
bres	CvM test statistics for each bootstrap iteration
crit.val	critical value for CvM test statistic



---

trimmer	<i>trimmer</i>
---------	----------------

---

## Description

A utility function to find observations that appear to violate support conditions. This function is not called anywhere in the code, but it is just useful for debugging some common issues that users run into.

## Usage

```
trimmer(
  g,
  tname,
  idname,
  gname,
  xformula,
  data,
  control_group = "notyettreated",
  threshold = 0.999
)
```

## Arguments

<code>g</code>	is a particular group (below I pass in 2009)
<code>tname</code>	The name of the column containing the time periods
<code>idname</code>	The individual (cross-sectional unit) id name
<code>gname</code>	The name of the variable in data that contains the first period when a particular observation is treated. This should be a positive number for all observations in treated groups. It defines which "group" a unit belongs to. It should be 0 for units in the untreated group.
<code>xformula</code>	<p>A formula for the covariates to include in the model. It should be of the form <math>\sim X1 + X2</math>. Default is NULL which is equivalent to <code>xformula=<math>\sim</math>1</code>. This is used to create a matrix of covariates which is then passed to the 2x2 DID estimator chosen in <code>est_method</code>.</p> <p>For time-varying covariates: (1) With balanced panel data, in each 2x2 comparison, the covariates are taken to be the value of the covariates in the earlier time period, and all of the underlying computation involve change in Y as a function of those values of covariates. (2) With repeated cross sections data and unbalanced panel data, the covariates are taken from each time period and computations involve <math>Y_{post}</math> conditional on <math>X_{post}</math> minus <math>Y_{pre}</math> conditional on <math>X_{pre}</math>. A byproduct of this is that, with balanced panel data and in the presence of time-varying covariates, it is possible to get different numerical results according to whether or not <code>allow_unbalanced_panel=TRUE</code> or <code>FALSE</code>.</p>
<code>data</code>	The name of the data.frame that contains the data

control_group	Which units to use the control group. The default is "nevertreated" which sets the control group to be the group of units that never participate in the treatment. This group does not change across groups or time periods. The other option is to set group="notyettreated". In this case, the control group is set to the group of units that have not yet participated in the treatment in that time period. This includes all never treated units, but it includes additional units that eventually participate in the treatment, but have not participated yet.
threshold	the cutoff for which observations are flagged as likely violators of the support condition.

**Value**

list of ids of observations that likely violate support conditions

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