

Package: triplediff (via r-universe)

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Title Triple-Difference Estimators

Version 0.2.0

Description Implements triple-difference (DDD) estimators for both average treatment effects and event-study parameters. Methods include regression adjustment, inverse-probability weighting, and doubly-robust estimators, all of which rely on a conditional DDD parallel-trends assumption and allow covariate adjustment across multiple pre- and post-treatment periods. The methodology is detailed in Ortiz-Villavicencio and Sant'Anna (2025) <[doi:10.48550/arXiv.2505.09942](https://doi.org/10.48550/arXiv.2505.09942)>.

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| agg_ddd | <i>Aggregate Group-Time Average Treatment Effects in Staggered Triple-Differences Designs.</i> |
|---------|--|

Description

agg_ddd is a function that take group-time average treatment effects and aggregate them into a smaller number of summary parameters in staggered triple differences designs. There are several possible aggregations including "simple", "eventstudy", "group", and "calendar". Default is "eventstudy".

Usage

```
agg_ddd(
  ddd_obj,
  type = "eventstudy",
  balance_e = NULL,
  min_e = -Inf,
  max_e = Inf,
  na.rm = FALSE,
  boot = NULL,
  nboot = NULL,
  cband = NULL,
  alpha = 0.05
)
```

Arguments

| | |
|---------|---|
| ddd_obj | a ddd object (i.e., the results of the <code>ddd()</code> function) |
| type | Which type of aggregated treatment effect parameter to compute. "simple" just computes a weighted average of all group-time average treatment effects with weights proportional to group size. "eventstudy" computes average effects across different lengths of exposure to the treatment (event times). Here the overall effect averages the effect of the treatment across the positive lengths of exposure. This is the default option; "group" computes average treatment effects across different groups/cohorts; here the overall effect averages the effect across different groups using group size as weights; "calendar" computes average treatment effects across different time periods, with weights proportional to the group size; here the overall effect averages the effect across each time period. |

| | |
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| balance_e | If set (and if one computes event study), it balances the sample with respect to event time. For example, if balance_e=2, agg_ddd will drop groups that are not exposed to treatment for at least three periods, the initial period e=0 as well as the next two periods, e=1 and e=2. 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, min_e = -Inf 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, max_e = Inf 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. |
| boot | Boolean for whether or not to compute standard errors using the multiplier bootstrap. If standard errors are clustered, then one must set boot=TRUE. Default is value set in the ddd object. If boot = FALSE, then analytical standard errors are reported. |
| nboot | The number of bootstrap iterations to use. The default is the value set in the ddd object, and this is only applicable if boot=TRUE. |
| 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 0.95. In order to compute uniform confidence bands, boot must also be set to TRUE. The default is the value set in the ddd object |
| alpha | The level of confidence for the confidence intervals. The default is 0.05. Otherwise, it will use the value set in the ddd object. |

Value

A object (list) of class `agg_ddd` that holds the results from the aggregation step.

Examples

```
#-----
# Triple Diff with multiple time periods
#-----

data <- gen_dgp_mult_periods(size = 500, dgp_type = 1)[["data"]]

out <- ddd(yname = "y", tname = "time", idname = "id",
          gname = "state", pname = "partition", xformla = ~cov1 + cov2 + cov3 + cov4,
          data = data, control_group = "nevertreated", base_period = "varying",
          est_method = "dr")

# Simple aggregation
agg_ddd(out, type = "simple", alpha = 0.10)

# Event study aggregation
agg_ddd(out, type = "eventstudy", alpha = 0.10)

# Group aggregation
agg_ddd(out, type = "group", alpha = 0.10)
```

```
# Calendar aggregation
agg_ddd(out, type = "calendar", alpha = 0.10)
```

| | |
|-----|---|
| ddd | <i>Doubly Robust DDD estimators for the group-time average treatment effects.</i> |
|-----|---|

Description

ddd is the main function for computing the Doubly Robust DDD estimators for the ATT, with balanced panel data. It can be used with covariates and/or under multiple time periods. At its core, tripleddiff employs the doubly robust estimator for the ATT, which is a combination of the propensity score weighting and the outcome regression. Furthermore, this package supports the application of machine learning methods for the estimation of the nuisance parameters.

Usage

```
ddd(  
  yname,  
  tname,  
  idname = NULL,  
  gname,  
  pname,  
  xformula,  
  data,  
  control_group = NULL,  
  base_period = NULL,  
  est_method = "dr",  
  panel = TRUE,  
  allow_unbalanced_panel = FALSE,  
  weightsname = NULL,  
  boot = FALSE,  
  nboot = NULL,  
  cluster = NULL,  
  cband = FALSE,  
  alpha = 0.05,  
  use_parallel = FALSE,  
  cores = 1,  
  inffunc = FALSE,  
  skip_data_checks = FALSE  
)
```

Arguments

| | |
|------------------------|---|
| yname | The name of the outcome variable. |
| tname | The name of the column containing the time periods. |
| idname | The name of the column containing the unit id. |
| gname | The name of the column containing the first period when a particular observation is treated. It is a positive number for treated units and defines which group the unit belongs to. It takes value 0 or Inf for untreated units. |
| pname | The name of the column containing the partition variable (e.g., the subgroup identifier). This is an indicator variable that is 1 for the units eligible for treatment and 0 otherwise. |
| xformula | The formula for the covariates to be included in the model. It should be of the form $\sim x_1 + x_2$. Default is <code>xformula = ~1</code> (no covariates). |
| data | A data frame or data table containing the data. |
| control_group | Valid for multiple periods only. The control group to be used in the estimation. Default is <code>control_group = "notyettreated"</code> which sets as control group the units that have not yet participated in the treatment. The alternative is <code>control_group = "nevertreated"</code> which sets as control group the units that never participate in the treatment and does not change across groups or time periods. |
| base_period | Valid for multiple periods. Choose between a "varying" or "universal" base period. Both yield the same post-treatment $ATT(g,t)$ estimates. Varying base period: Computes pseudo-ATT in pre-treatment periods by comparing outcome changes for a group to its comparison group from $t-1$ to t , repeatedly changing t . Universal base period: Fixes the base period to $(g-1)$, reporting average changes from t to $(g-1)$ for a group relative to its comparison group, similar to event study regressions. Varying base period reports $ATT(g,t)$ right before treatment. Universal base period normalizes the estimate before treatment to be 0, adding one extra estimate in an earlier period. |
| est_method | The estimation method to be used. Default is "dr" (doubly robust). It computes propensity score using logistic regression and outcome regression using OLS. The alternative are <code>c("reg", "ipw")</code> . |
| panel | Logical. If TRUE (default), the data is treated as panel data where each unit is observed in all time periods. If FALSE, the data is treated as repeated cross-sections (RCS) where each observation may represent a different unit. For RCS data, <code>idname</code> can be omitted or set to NULL, and the function will automatically create unique IDs for each observation. |
| allow_unbalanced_panel | Logical. If TRUE, allows for unbalanced panel data where units may not be observed in all time periods. Default is FALSE. Note: This parameter requires <code>panel = TRUE</code> and a valid <code>idname</code> . |
| weightsname | The name of the column containing the weights. Default is NULL. As part of data processing, weights are enforced to be normalized and have mean 1 across all observations. |
| boot | Logical. If TRUE, the function computes standard errors using the multiplier bootstrap. Default is FALSE. |

| | |
|------------------|---|
| nboot | The number of bootstrap samples to be used. Default is NULL. If boot = TRUE, the default is nboot = 999. |
| cluster | The name of the variable to be used for clustering. The maximum number of cluster variables is 1. Default is NULL. If boot = TRUE, the function computes the bootstrap standard errors clustering at the unit level setting as cluster variable the one in idname. |
| cband | Logical. If TRUE, the function computes a uniform confidence band that covers all of the average treatment effects with fixed probability 1-alpha. In order to compute uniform confidence bands, boot must also be set to TRUE. The default is FALSE. |
| alpha | The level of significance for the confidence intervals. Default is 0.05. |
| use_parallel | Logical. If TRUE, the function runs in parallel processing. Valid only when boot = TRUE. Default is FALSE. |
| cores | The number of cores to be used in the parallel processing. Default is cores = 1. |
| inffunc | Logical. If TRUE, the function returns the influence function. Default is FALSE. |
| skip_data_checks | Logical. If TRUE, the function skips data validation checks and proceeds directly to estimation. This can improve performance when you are confident the data is correctly formatted. Default is FALSE. Use with caution as skipping checks may lead to unexpected errors if data is malformed. |

Value

A ddd object with the following basic elements:

| | |
|----------|--|
| ATT | The average treatment effect on the treated. |
| se | The standard error of the ATT. |
| uci | The upper confidence interval of the ATT. |
| lci | The lower confidence interval of the ATT. |
| inf_func | The estimate of the influence function. |

Examples

```
#-----
# Triple Diff with covariates and 2 time periods
#-----
set.seed(1234) # Set seed for reproducibility
# Simulate data for a two-periods DDD setup
df <- gen_dgp_2periods(size = 5000, dgp_type = 1)$data

head(df)

att_22 <- ddd(yname = "y", tname = "time", idname = "id", gname = "state",
             pname = "partition", xformula = ~cov1 + cov2 + cov3 + cov4,
             data = df, control_group = "nevertreated", est_method = "dr")

summary(att_22)
```

```

# Performing clustered standard errors with mutiplier bootstrap

att_cluster <- ddd(yname = "y", tname = "time", idname = "id", gname = "state",
  pname = "partition", xformula = ~cov1 + cov2 + cov3 + cov4,
  data = df, control_group = "nevertreated",
  base_period = "universal", est_method = "dr",
  boot = TRUE, nboot = 500, cband = TRUE, cluster = "cluster")

summary(att_cluster)

#-----
# Triple Diff with multiple time periods
#-----
data <- gen_dgp_mult_periods(size = 1000, dgp_type = 1)[["data"]]

ddd(yname = "y", tname = "time", idname = "id",
  gname = "state", pname = "partition", xformula = ~cov1 + cov2 + cov3 + cov4,
  data = data, control_group = "nevertreated", base_period = "varying",
  est_method = "dr")

```

| | |
|------------------|---|
| gen_dgp_2periods | <i>Function that generates panel data with single treatment date assignment and two time periods.</i> |
|------------------|---|

Description

Generate panel data with a single treatment date and two periods

Usage

```
gen_dgp_2periods(size, dgp_type)
```

Arguments

| | |
|----------|--|
| size | Integer. Number of units. |
| dgp_type | Integer in {1,2,3,4}. 1 = both nuisance functions correct; 2 = only the outcome model correct; 3 = only the propensity score correct; 4 = both nuisance functions incorrect. |

Value

A list with the following elements:

data A data.table in long format with columns:

- id: unit identifier
- state: state variable

- time: time variable
- partition: partition assignment
- x1, x2, x3, x4: covariates
- y: outcome variable
- cluster: cluster ID (no within-cluster correlation)

att True average treatment effect on the treated (ATT), set to 0.

att.unf Oracle ATT computed under the unfeasible specification.

eff Theoretical efficiency bound for the estimator.

gen_dgp_mult_periods *Generate panel data with staggered treatment adoption (three periods)*

Description

Generate panel data where units adopt treatment at different times across three periods.

Usage

```
gen_dgp_mult_periods(size, dgp_type = 1, include_covariates = TRUE)
```

Arguments

| | |
|--------------------|---|
| size | Integer. Number of units to simulate. |
| dgp_type | Integer in {1,2,3,4}. Only used when include_covariates = TRUE. 1 = both nuisance functions correct (default); 2 = only the outcome model correct; 3 = only the propensity-score model correct; 4 = both nuisance functions misspecified. |
| include_covariates | Logical. If TRUE (default), generates covariates with transformations and uses dgp_type specification. If FALSE, uses constant covariates and fixed propensity score probabilities for a simpler DGP. |

Value

A named list with components:

data A data table in long format with columns:

- id: unit identifier
- cohort: first period when treatment is assigned
- partition: partition indicator
- x1, x2, x3, x4: covariates
- cluster: cluster identifier (no within-cluster correlation)
- time: time period index
- y: observed outcome

data_wide A data.table in wide format (one row per id) with columns:

- id, cohort, partition, x1, x2, x3, x4, cluster
- y_t0, y_t1, y_t2: outcomes in periods 0, 1, and 2

ES_0_unf (Only if include_covariates = TRUE) Unfeasible (oracle) event-study parameter at time 0.

prob_g2_p1 (Only if include_covariates = TRUE) Proportion of units with cohort == 2 and eligibility in period 1.

prob_g3_p1 (Only if include_covariates = TRUE) Proportion of units with cohort == 3 and eligibility in period 1.

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