

# Package ‘fixes’

July 4, 2026

**Type** Package

**Title** Staggered DiD Tools: Event Studies and ATT Aggregation

**Version** 0.12.0

**Date** 2026-07-05

**Description** Provides tools for difference-in-differences (DiD) estimation and visualization with staggered adoption. Includes `run_es()` for event-study curves (dynamic effects by relative time) and `calc_att()` for aggregated ATT estimation (overall, by cohort, by calendar time). Supports multiple modern estimators: Callaway-Sant'Anna (2021), Sun-Abraham (2021), Borusyak-Jaravel-Spiess (2024), Wooldridge TWM, and Deb et al. FLEX.

**Depends** R (>= 4.1.0)

**Imports** dplyr, ggplot2, fixest, broom, tibble, rlang, Rcpp, scales, parallel

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**Encoding** UTF-8

**Suggests** knitr, rmarkdown, haven, testthat, plotly, tidyr, did, didimputation, modelsummary, tinytable, lpSolveAPI, Rglpk, TruncatedNormal, Matrix, pracma, HonestDiD

**VignetteBuilder** knitr

**URL** <https://github.com/yo5uke/fixes>, <https://yo5uke.com/fixes/>

**BugReports** <https://github.com/yo5uke/fixes/issues>

**Config/roxygen2/version** 8.0.0

**Config/roxygen2/markdown** TRUE

**LinkingTo** Rcpp, RcppArmadillo

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2026-07-04 16:10:02 UTC

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|                    |                                         |
|--------------------|-----------------------------------------|
| autoplot.es_result | <i>Autoplot for event-study results</i> |
|--------------------|-----------------------------------------|

---

Description

S3 method that plots an es\_result (from run\_es()). It forwards arguments to plot\_es().

Usage

```
## S3 method for class 'es_result'
autoplot(object, ci_level = 0.95, type = "ribbon", ...)
```

Arguments

- object           An es\_result returned by run\_es().
- ci\_level        Confidence level (numeric, e.g., 0.95). Passed to plot\_es().
- type            Plot type: "ribbon" (default) or "errorbar". Passed to plot\_es().
- ...             Additional arguments forwarded to plot\_es().

Value

A ggplot object.

Examples

```
# res <- run_es(...)
# ggplot2::autoplot(res, ci_level = 0.95, type = "ribbon")
```

calc\_att

*Compute ATT Aggregations for Staggered Adoption Designs***Description**

Estimates average treatment effects on the treated (ATT) using either the Callaway-Sant’Anna (2021) or Borusyak-Jaravel-Spiess (2024) estimator, aggregated to a single summary effect ("simple"), per-cohort effects ("by\_cohort"), or per calendar-time effects ("by\_time").

**Usage**

```
calc_att(
  data,
  outcome,
  treatment = NULL,
  time,
  timing,
  fe = NULL,
  covariates = NULL,
  cluster = NULL,
  weights = NULL,
  interval = 1,
  time_transform = FALSE,
  unit = NULL,
  estimator = c("cs", "bjs"),
  aggregation = c("simple", "by_cohort", "by_time"),
  control_group = c("nevertreated", "notyettreated"),
  anticipation = 0L,
  conf.level = 0.95,
  vcov = "HC1",
  vcov_args = list()
)
```

**Arguments**

|            |                                                                                 |
|------------|---------------------------------------------------------------------------------|
| data       | A data.frame containing panel data.                                             |
| outcome    | Unquoted outcome variable (name or expression, e.g., log(y)).                   |
| treatment  | Unused; reserved for future use.                                                |
| time       | Unquoted calendar time variable (numeric).                                      |
| timing     | Unquoted column giving each unit’s first treatment period (NA = never treated). |
| fe         | Ignored (CS and BJS absorb fixed effects internally).                           |
| covariates | Ignored; reserved for future use.                                               |
| cluster    | Ignored; reserved for future use.                                               |
| weights    | Ignored; reserved for future use.                                               |

|                |                                                                                                                                                 |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| interval       | Numeric time spacing (default 1; informational only).                                                                                           |
| time_transform | Logical; if TRUE, creates consecutive integer time within unit via <code>dplyr::dense_rank()</code> . Requires unit.                            |
| unit           | Unquoted unit identifier (required).                                                                                                            |
| estimator      | Estimation strategy: "cs" (Callaway-Sant'Anna 2021, default) or "bjs" (Borusyak-Jaravel-Spiess 2024).                                           |
| aggregation    | Aggregation type: "simple" (overall ATT, default), "by_cohort" (one ATT per treatment cohort), or "by_time" (one ATT per calendar time period). |
| control_group  | For estimator = "cs": comparison group, "nevertreated" (default) or "notyettreated".                                                            |
| anticipation   | For estimator = "cs": number of anticipation periods before treatment (non-negative integer, default 0L).                                       |
| conf.level     | Numeric confidence level(s) (default 0.95). Multiple levels are supported, e.g., <code>c(0.90, 0.95)</code> .                                   |
| vcov           | Ignored (SE is analytical for CS; approximate for BJS).                                                                                         |
| vcov_args      | Ignored.                                                                                                                                        |

## Details

This function complements `run_es()`: use `run_es()` when you want a full event-study curve (dynamic effects by relative time), and `calc_att()` when you want aggregated ATT estimates that collapse the time dimension.

The result has `broom::tidy()` and `broom::glance()` methods, so it can be passed to `modelsummary::modelsummary()` (rendered with `tinytable`) to build a publication table — including stacking several estimators (e.g. `run_did()` TWFE, CS, and BJS) side by side in one table.

## Value

A data.frame of class "att\_result" with columns:

group Cohort or calendar time (NA for "simple").  
estimate ATT point estimate.  
std.error Standard error.  
statistic t-statistic (estimate / std.error).  
p.value Two-sided p-value (normal approximation).  
conf\_low\_XX, conf\_high\_XX CI bounds for each conf.level.

Attributes: aggregation, estimator, conf.level, N, N\_units, N\_treated, N\_nevertreated, control\_group (CS only), att\_gt (CS raw ATT(g,t) table), tau\_it (BJS unit-time effects table).

## Aggregation formulas (CS estimator)

- **simple:**  $\theta = \sum_g (n_g / n_{treated}) \cdot \overline{ATT(g, \cdot)}$  where  $\overline{ATT(g, \cdot)}$  is the mean over post-treatment periods.
- **by\_cohort:**  $\theta(g) = \overline{ATT(g, \cdot)}$  per cohort.
- **by\_time:**  $\theta(t) = \sum_{g \leq t} w(g, t) \cdot ATT(g, t)$  with  $w(g, t) = n_g / \sum_{g' \leq t} n_{g'}$ .

**Standard errors (BJS estimator)**

BJS SEs are approximate (naive sample variance of unit-time effects). Cluster-robust SEs for BJS aggregations are planned for a future release.

**See Also**

[run\\_es\(\)](#) for event-study (dynamic) estimates.

---

compute\_contamination\_weights

*Contamination Weights for TWFE Event-Study Coefficients (Sun-Abraham 2021)*

---

**Description**

Estimates the contamination weights  $\omega_{e,\ell}^{\ell''}$  that decompose each TWFE event-study coefficient  $\hat{\mu}_{\ell''}$  into a linear combination of cohort-specific ATTs (CATTs):

$$\hat{\mu}_{\ell''} = \sum_{(e,\ell)} \omega_{e,\ell}^{\ell''} \cdot \widehat{CATT}_{e,\ell}$$

(Sun and Abraham 2021, Equation 20).

The weights are obtained via the OVB auxiliary regression (Eq. 12): for each cohort-period CATT cell  $(e, \ell)$ , regress the cohort-specific indicator  $1\{E_i = e\} \cdot 1\{t - E_i = \ell\}$  on all cohort-aggregated relative-time indicators  $D_{i,t}^{\ell''}$  and two-way fixed effects. The resulting regression coefficient on  $D_{i,t}^{\ell''}$  is  $\omega_{e,\ell}^{\ell''}$ .

**Usage**

```
compute_contamination_weights(
  data,
  time,
  timing,
  unit,
  fe = NULL,
  baseline = -1L
)
```

**Arguments**

|                     |                                                                                     |
|---------------------|-------------------------------------------------------------------------------------|
| <code>data</code>   | A data.frame with one row per unit-period (balanced panel).                         |
| <code>time</code>   | Unquoted name of the calendar time variable (numeric).                              |
| <code>timing</code> | Unquoted name of the first-treatment-period variable; NA marks never-treated units. |
| <code>unit</code>   | Unquoted name of the unit identifier.                                               |

|          |                                                                                                                                                                |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fe       | One-sided fixed-effects formula, e.g. <code>~ id + year</code> . When NULL (default), falls back to <code>~ &lt;unit&gt; + &lt;time&gt;</code> with a warning. |
| baseline | Integer reference (baseline) period excluded from the TWFE specification (default -1L). Must match the baseline argument used in <code>run_es()</code> .       |

### Value

An object of class `c("sa_contamination_weights", "data.frame")` with one row per (catt\_cohort, catt\_period, twfe\_period), and columns:

catt\_cohort Cohort  $e$  (first treatment period).

catt\_period Relative event time  $\ell$  of the CATT.

twfe\_period Relative event time  $\ell''$  of the TWFE coefficient being decomposed.

weight Contamination weight  $\omega_{e,\ell}^{\ell''}$ .

is\_own Logical; TRUE when `catt_period == twfe_period`.

Attributes: baseline, cohorts, cohort\_sizes, incl\_periods.

### Interpretation

- **Own-period cell** (`catt_period == twfe_period`):  $\omega_{e,\ell}^{\ell}$  represents the weight the TWFE estimator places on  $CATT_{e,\ell}$ . Under the SA IW estimator these equal the cohort-size weights  $n_e / \sum n_{e'}$ .
- **Cross-period cell** (`catt_period != twfe_period`): Any non-zero weight indicates contamination: the TWFE coefficient  $\hat{\mu}_{\ell''}$  also picks up treatment effects from period  $\ell \neq \ell''$ .
- **Verification**: the OVB identity (property iii) holds exactly, so  $\hat{\mu}_{\ell''} = \sum_{(e,\ell)} \omega_{e,\ell}^{\ell''} \cdot \widehat{CATT}_{e,\ell}$  up to floating-point precision.

### References

Sun, L. and Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, 225(2), 175–199.

### See Also

`plot_contamination_weights()`, `run_es()`

### Examples

```
## Not run:
# Estimate contamination weights
cw <- compute_contamination_weights(
  data      = panel_data,
  time      = year,
  timing    = first_treat,
  unit      = id,
  fe        = ~ id + year,
  baseline  = -1L
)
```

```
print(cw)
plot_contamination_weights(cw)

## End(Not run)
```

---

|                   |                                       |
|-------------------|---------------------------------------|
| glance.att_result | <i>Glance at an att_result object</i> |
|-------------------|---------------------------------------|

---

### Description

Returns a one-row summary of an `calc_att()` result for the goodness-of-fit block of a `modelsummary::modelsummary()` table.

### Usage

```
glance.att_result(x, ...)
```

### Arguments

|     |                                                            |
|-----|------------------------------------------------------------|
| x   | An att_result object returned by <code>calc_att()</code> . |
| ... | Unused; for S3 generic compatibility.                      |

### Value

A one-row data frame with nobs, n.units, n.treated, estimator, and aggregation.

### Examples

```
## Not run:
att <- calc_att(df, outcome = y, time = year, timing = g, unit = id)
broom::glance(att)

## End(Not run)
```

---

|                   |                                      |
|-------------------|--------------------------------------|
| glance.did_result | <i>Glance at a did_result object</i> |
|-------------------|--------------------------------------|

---

### Description

Returns a single-row summary of model-level statistics from a `run_did()` result. Delegates to `broom::glance.fixest()` which provides nobs, r.squared, adj.r.squared, within.r.squared, AIC, BIC, and related statistics.

**Usage**

```
glance.did_result(x, ...)
```

**Arguments**

`x` A `did_result` object returned by `run_did()`.  
`...` Additional arguments passed to `broom::glance.fixest()`.

**Value**

A one-row data frame of model-level statistics.

**Examples**

```
## Not run:
res <- run_did(df, outcome = y, treatment = D, fe = ~ id + year)
broom::glance(res)

## End(Not run)
```

---

|                    |                                                                   |
|--------------------|-------------------------------------------------------------------|
| honest_sensitivity | <i>Honest sensitivity analysis for parallel-trends violations</i> |
|--------------------|-------------------------------------------------------------------|

---

**Description**

Robust inference and sensitivity analysis for event-study / DiD designs following Rambachan and Roth (2023). Instead of assuming parallel trends holds exactly, it asks how large a violation of parallel trends would have to be before the causal conclusion changes, returning confidence sets for a post-treatment effect under a sequence of restrictions on the possible difference in trends.

Two restriction families are supported:

- "relative\_magnitude" ( $\Delta^{RM}(\bar{M})$ ): post-treatment violations are at most  $\bar{M}$  times the largest pre-treatment violation (Rambachan & Roth 2023, Section 2.4.1).
- "smoothness" ( $\Delta^{SD}(M)$ ): the difference in trends deviates from linearity by at most  $M$  per period (Section 2.4.3).

Inference uses the Andrews-Roth-Pakes (ARP) conditional moment-inequality test (Section 3.2.1), which is uniformly valid and recommended for general restriction sets.

**Usage**

```
honest_sensitivity(
  object = NULL,
  type = c("relative_magnitude", "smoothness"),
  Mvec = NULL,
  l_vec = NULL,
```



```

    alpha = 0.05,
    gridPoints = 1000L,
    betahat = NULL,
    sigma = NULL,
    numPrePeriods = NULL,
    numPostPeriods = NULL
  )

```

## Arguments

|                               |                                                                                                                                                                                                                                                                                               |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| object                        | An <code>es_result</code> from <code>run_es()</code> (with <code>estimator = "twfe"</code> , i.e. classic or method = "sunab", which carry the event-study coefficient covariance). Alternatively, supply <code>betahat</code> and <code>sigma</code> directly (see below) for any estimator. |
| type                          | Restriction family: "relative_magnitude" (default) or "smoothness".                                                                                                                                                                                                                           |
| Mvec                          | Numeric vector of restriction parameters. For "relative_magnitude" these are $\bar{M}$ values (default <code>seq(0, 2, by = 0.5)</code> ); for "smoothness" these are $M$ values (default a data-driven sequence from 0 to the largest pre-period SD).                                        |
| l_vec                         | Numeric weight vector over post-treatment periods defining the target $\theta = l'\tau_{post}$ . Defaults to the first post-treatment period.                                                                                                                                                 |
| alpha                         | Significance level (default 0.05 for 95% confidence sets).                                                                                                                                                                                                                                    |
| gridPoints                    | Number of grid points for test inversion (default 1000).                                                                                                                                                                                                                                      |
| betahat                       | Optional event-study coefficient vector (pre then post, excluding the reference period), ordered by relative time. Required when object does not carry an <code>es_vcov</code> attribute.                                                                                                     |
| sigma                         | Optional covariance matrix of <code>betahat</code> .                                                                                                                                                                                                                                          |
| numPrePeriods, numPostPeriods | Optional integer counts; inferred from object or from <code>betahat/l_vec</code> when omitted.                                                                                                                                                                                                |

## Value

A `data.frame` of class "honest\_result" with one row per restriction value plus the original (parallel-trends) confidence interval, with columns `M`, `lb`, `ub`, `method`, and `type`. The breakdown value (largest restriction at which the robust CI still excludes 0) is stored in `attr(, "breakdown")`.

## References

Rambachan, A. and Roth, J. (2023). A More Credible Approach to Parallel Trends. *Review of Economic Studies*, 90(5), 2555-2591.

## See Also

`run_es()`, `plot_honest()`

plot\_att\_gt

*Plot the  $ATT(g,t)$  matrix from a Callaway-Sant'Anna event study***Description**

Visualises the full cohort-by-period  $ATT(g,t)$  matrix stored in the `att_gt` attribute of an `es_result` object produced by `run_es(estimator = "cs")`. Two display styles are available:

- "heatmap": a tile plot with calendar time  $t$  on the x-axis and cohort  $g$  on the y-axis, colour-filled by the point estimate. Cells whose pointwise confidence interval excludes zero are marked with a filled dot; cells that are simultaneously significant (when bootstrap data are available) are additionally marked with an open diamond.
- "facet": one panel per cohort showing  $ATT(g,t)$  over calendar time  $t$  with a pointwise confidence ribbon, mirroring the style of `plot_es()`. A lighter simultaneous CI ribbon is overlaid when bootstrap data are available.

Both types draw a vertical dashed line at  $t = g$  (treatment onset) for each cohort.

**Usage**

```
plot_att_gt(
  x,
  type = c("heatmap", "facet"),
  ci_level = 0.95,
  zero_line = TRUE,
  theme = c("bw", "minimal", "classic"),
  color = "#B25D91FF",
  fill = "#B25D91FF",
  alpha = 0.2
)

## S3 method for class 'att_gt_result'
autoplot(object, ...)
```

**Arguments**

|                        |                                                                                                                                                                                                                                           |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>x</code>         | An <code>es_result</code> object returned by <code>run_es(estimator = "cs")</code> , or an <code>att_gt_result</code> data frame produced by extracting <code>attr(x, "att_gt")</code> and giving it class <code>"att_gt_result"</code> . |
| <code>type</code>      | "heatmap" (default) or "facet".                                                                                                                                                                                                           |
| <code>ci_level</code>  | Confidence level for pointwise intervals (default 0.95).                                                                                                                                                                                  |
| <code>zero_line</code> | Logical; draw a horizontal reference line at zero in the "facet" display (default TRUE).                                                                                                                                                  |
| <code>theme</code>     | One of "bw" (default), "minimal", or "classic".                                                                                                                                                                                           |
| <code>color</code>     | Line and point colour used in the "facet" display (default "#B25D91FF", matching <code>plot_es()</code> ).                                                                                                                                |
| <code>fill</code>      | Ribbon fill colour in the "facet" display (default "#B25D91FF").                                                                                                                                                                          |

|        |                                                                                   |
|--------|-----------------------------------------------------------------------------------|
| alpha  | Ribbon transparency in the "facet" display (default 0.2).                         |
| object | An att_gt_result object (extracted from an es_result via attr(result, "att_gt")). |
| ...    | Passed to <code>plot_att_gt</code> .                                              |

**Value**

A `ggplot2::ggplot()` object.

**Bootstrap annotation**

When `attr(x, "bootstrap")` is present (i.e., `run_es()` was called with `bootstrap = TRUE`), both plot types add simultaneous inference overlays sourced from the (g,t)-level bootstrap object.

**See Also**

`plot_es()`, `run_es()`

**Examples**

```
## Not run:
cs_result <- run_es(data = mydata, outcome = y, time = year,
                    timing = g, unit = id, fe = ~id + year,
                    staggered = TRUE, estimator = "cs")
plot_att_gt(cs_result)
plot_att_gt(cs_result, type = "facet")

## End(Not run)
```

---

plot\_contamination\_weights

*Plot Contamination Weights as a Tile Heatmap*

---

**Description**

Creates a `ggplot2` tile heatmap of the contamination weights returned by `compute_contamination_weights()`.

Each cell at position (twfe\_period, catt\_label) shows the weight  $\omega_{e,\ell}^{\ell''}$ : how much of  $CATT_{e,\ell}$  leaks into the TWFE coefficient  $\hat{\mu}_{\ell''}$ .

- **Diagonal cells** (catt\_period == twfe\_period): own-period weights (sum across cohorts should be  $\approx 1$ ).
- **Off-diagonal cells**: cross-period contamination (ideally close to zero under treatment effect homogeneity).

**Usage**

```
plot_contamination_weights(
  x,
  limit_abs = NULL,
  midpoint = 0,
  low = "#2166AC",
  mid = "white",
  high = "#B2182B",
  theme = c("bw", "minimal", "classic"),
  show_values = FALSE,
  value_digits = 2L
)
```

**Arguments**

|                           |                                                                                                                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <code>x</code>            | An <code>sa_contamination_weights</code> object from <code>compute_contamination_weights()</code> .                            |
| <code>limit_abs</code>    | Numeric; symmetric colour scale limit $[-limit, limit]$ . Defaults to the maximum absolute weight (rounded up to one decimal). |
| <code>midpoint</code>     | Numeric; midpoint of the diverging colour scale (default 0).                                                                   |
| <code>low</code>          | Colour for negative weights (default "#2166AC").                                                                               |
| <code>mid</code>          | Colour for zero weight (default "white").                                                                                      |
| <code>high</code>         | Colour for positive weights (default "#B2182B").                                                                               |
| <code>theme</code>        | Character; "bw" (default), "minimal", or "classic".                                                                            |
| <code>show_values</code>  | Logical; overlay weight values in each tile (default FALSE).                                                                   |
| <code>value_digits</code> | Integer; decimal digits when <code>show_values = TRUE</code> (default 2L).                                                     |

**Value**

A `ggplot2::ggplot()` object.

**See Also**

`compute_contamination_weights()`

---

plot\_es

*Plot event-study results with ribbons or error bars*

---

**Description**

Plot event-study results with ribbons or error bars

**Usage**

```
plot_es(
  data,
  ci_level = 0.95,
  type = "ribbon",
  vline_val = 0,
  vline_color = "#000",
  hline_val = 0,
  hline_color = "#000",
  linewidth = 1,
  pointsize = 2,
  alpha = 0.2,
  barwidth = 0.2,
  color = "#B25D91FF",
  fill = "#B25D91FF",
  theme_style = "bw",
  show_simultaneous = FALSE
)
```

**Arguments**

|                                                    |                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>data</code>                                  | An object of class <code>es_result</code> returned by <code>run_es()</code> .                                                                                                                                                                                                         |
| <code>ci_level</code>                              | Confidence level to display (e.g., 0.95).                                                                                                                                                                                                                                             |
| <code>type</code>                                  | One of "ribbon" (default) or "errorbar".                                                                                                                                                                                                                                              |
| <code>vline_val, hline_val</code>                  | Numeric locations for vertical/horizontal reference lines (default 0).                                                                                                                                                                                                                |
| <code>vline_color, hline_color</code>              | Colors for reference lines.                                                                                                                                                                                                                                                           |
| <code>linewidth, pointsize, alpha, barwidth</code> | Styling parameters for lines/points/bands/bars.                                                                                                                                                                                                                                       |
| <code>color, fill</code>                           | Optional, override line/point color and ribbon fill.                                                                                                                                                                                                                                  |
| <code>theme_style</code>                           | One of "bw", "minimal", or "classic" for ggplot theme.                                                                                                                                                                                                                                |
| <code>show_simultaneous</code>                     | Logical; if TRUE, overlays the simultaneous bootstrap CI (lighter band, alpha 0.15) alongside the standard pointwise CI (alpha 0.3), with a legend distinguishing the two bands. Requires <code>bootstrap = TRUE</code> in the originating <code>run_es()</code> call. Default FALSE. |

**Value**

A ggplot object.

**Examples**

```
# Assuming `res <- run_es(...)`
# p <- plot_es(res, ci_level = 0.95, type = "ribbon")
# print(p)
```

---

plot\_es\_interactive     *Interactive event-study plot with hover details*

---

## Description

Creates an interactive plotly visualization of event study results with hover-over displays showing coefficients, confidence intervals, and other details.

## Usage

```
plot_es_interactive(
  data,
  ci_level = 0.95,
  vline_val = 0,
  hline_val = 0,
  vline_color = "#000",
  hline_color = "#000",
  color = "#B25D91FF",
  fill = "#B25D91FF",
  alpha = 0.2,
  linewidth = 2,
  markersize = 8,
  show_ribbon = TRUE,
  show_simultaneous = FALSE,
  height = NULL,
  width = NULL
)
```

## Arguments

|             |                                                                               |
|-------------|-------------------------------------------------------------------------------|
| data        | An object of class <code>es_result</code> returned by <code>run_es()</code> . |
| ci_level    | Confidence level to display (e.g., 0.95). Default is 0.95.                    |
| vline_val   | Numeric location for vertical reference line (default 0).                     |
| hline_val   | Numeric location for horizontal reference line (default 0).                   |
| vline_color | Color for vertical reference line (default "#000").                           |
| hline_color | Color for horizontal reference line (default "#000").                         |
| color       | Point and line color (default "#B25D91FF").                                   |
| fill        | Ribbon/band fill color (default "#B25D91FF").                                 |
| alpha       | Ribbon transparency (default 0.2).                                            |
| linewidth   | Line width (default 2).                                                       |
| markersize  | Marker size (default 8).                                                      |
| show_ribbon | Logical; if TRUE, shows confidence interval as a ribbon band (default TRUE).  |

|                   |                                                                                                                                                                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| show_simultaneous | Logical; if TRUE, overlays a second (lighter) ribbon for the simultaneous bootstrap CI and extends the hover tooltip with simultaneous CI bounds. Requires <code>bootstrap = TRUE</code> in the originating <code>run_es()</code> call. Default FALSE. |
| height            | Plot height in pixels (default NULL for auto).                                                                                                                                                                                                         |
| width             | Plot width in pixels (default NULL for auto).                                                                                                                                                                                                          |

## Details

The hover tooltip displays:

- Relative time to treatment
- Point estimate (coefficient)
- Confidence interval bounds
- Standard error
- P-value
- Simultaneous CI bounds (when `show_simultaneous = TRUE`)

## Value

A plotly object that can be displayed interactively.

## Examples

```
## Not run:
# Assuming res <- run_es(...)
plot_es_interactive(res)
plot_es_interactive(res, ci_level = 0.99, show_ribbon = FALSE)
plot_es_interactive(res, show_simultaneous = TRUE)

## End(Not run)
```

---

plot\_honest

*Plot a honest sensitivity analysis*

---

## Description

Visualises the output of `honest_sensitivity()`: robust confidence intervals for the target effect under progressively weaker parallel-trends restrictions (increasing  $M$  or  $\bar{M}$ ), alongside the original confidence interval that assumes parallel trends holds exactly. This is the "top-down" sensitivity plot of Rambachan and Roth (2023).

## Usage

```
plot_honest(x, ...)

## S3 method for class 'honest_result'
autoplot(object, ...)
```

**Arguments**

`x` A `honest_result` object from `honest_sensitivity()`.  
`...` Unused.  
`object` A `honest_result` object.

**Value**

A `ggplot` object.

**See Also**

`honest_sensitivity()`

---

|         |                                                    |
|---------|----------------------------------------------------|
| run_did | <i>Run a basic two-way fixed-effects DiD model</i> |
|---------|----------------------------------------------------|

---

**Description**

Estimates a classic difference-in-differences model of the form `outcome ~ D_it | fe` using `fixest::feols()`.

There are two ways to supply the treatment indicator:

**Option A — pre-built `D_it`** (maximum flexibility):

```
df$D <- as.integer(df$treated & df$year >= 2006)
run_did(df, outcome = y, treatment = D, fe = ~ id + year)
```

**Option B — timing-based construction** (convenience; consistent with `run_es()` and `calc_att()`):

```
run_did(df, outcome = y, treatment = treated, time = year, timing = 2006,
        fe = ~ id + year)
```

Here `treatment` is a binary group indicator (1 = treated unit, 0 = control), `time` is the calendar-time variable, and `timing` is the scalar treatment onset period. Internally `D_it = treatment * (time >= timing)` is constructed automatically. For staggered-adoption settings use `calc_att()`; for dynamic event-study estimates use `run_es()`.

**Usage**

```
run_did(
  data,
  outcome,
  treatment,
  timing = NULL,
  fe = NULL,
  unit = NULL,
  time = NULL,
```



```

    covariates = NULL,
    cluster = NULL,
    weights = NULL,
    conf.level = 0.95,
    vcov = "HC1",
    vcov_args = list()
  )

```

## Arguments

|                         |                                                                                                                                                                                                                                                                                                                                  |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>data</code>       | A <code>data.frame</code> (panel format).                                                                                                                                                                                                                                                                                        |
| <code>outcome</code>    | Unquoted outcome variable or expression (e.g., <code>log(y)</code> ).                                                                                                                                                                                                                                                            |
| <code>treatment</code>  | Unquoted column name. When <code>timing = NULL</code> (default): a pre-built binary <code>D_it</code> indicator (1 = treated unit-time, 0 = otherwise). When <code>timing</code> is provided: a binary group indicator (1 = treated unit, 0 = control unit; constant within units).                                              |
| <code>timing</code>     | Numeric scalar. When provided, <code>D_it</code> is constructed as <code>treatment * (time &gt;= timing)</code> . Requires <code>time</code> to be specified. Default <code>NULL</code> (user supplies pre-built <code>D_it</code> via <code>treatment</code> ).                                                                 |
| <code>fe</code>         | One-sided formula specifying fixed effects, e.g. <code>~ id + year</code> . If <code>NULL</code> and both <code>unit</code> and <code>time</code> are supplied, <code>fe</code> is auto-inferred as <code>~ unit + time</code> . If <code>NULL</code> and neither is supplied, a pooled OLS model is estimated (with a message). |
| <code>unit</code>       | Unquoted unit identifier column (for metadata and <code>fe</code> auto-inference).                                                                                                                                                                                                                                               |
| <code>time</code>       | Unquoted time variable column. Used for (a) <code>fe</code> auto-inference and (b) <code>D_it</code> construction when <code>timing</code> is provided.                                                                                                                                                                          |
| <code>covariates</code> | One-sided formula of additional controls, e.g. <code>~ x1 + x2</code> .                                                                                                                                                                                                                                                          |
| <code>cluster</code>    | Clustering specification: a one-sided formula ( <code>~ id</code> ), a single character column name, or a numeric vector of length <code>nrow(data)</code> . When <code>cluster</code> is specified and <code>vcov</code> is the default <code>"HC1"</code> , cluster-robust standard errors are used automatically.             |
| <code>weights</code>    | Observation weights (formula or numeric vector).                                                                                                                                                                                                                                                                                 |
| <code>conf.level</code> | Confidence level(s) for CIs. Scalar or vector (e.g., <code>c(0.90, 0.95)</code> ). Default <code>0.95</code> .                                                                                                                                                                                                                   |
| <code>vcov</code>       | VCOV type string passed to <code>fixest::vcov()</code> . Default <code>"HC1"</code> . Ignored in favour of cluster-robust SE when <code>cluster</code> is supplied and <code>vcov</code> is left at its default <code>"HC1"</code> .                                                                                             |
| <code>vcov_args</code>  | Named list of additional arguments forwarded to <code>fixest::vcov()</code> .                                                                                                                                                                                                                                                    |

## Value

A `did_result` object (named list) with elements:

`estimates` Data frame with the treatment coefficient: `term`, `estimate`, `std.error`, `statistic`, `p.value`, and `conf_low_XX/conf_high_XX` for each `conf.level` entry.

`model` The underlying `fixest` model object.

Attributes: call, formula\_str, outcome, treatment, timing, fe, vcov\_type, cluster\_vars, conf.level, N, N\_units, N\_treated, unit, time. N, N\_units, and N\_treated describe the *estimation* sample (after `fixest::feols()` drops rows with missing values), matching `nobs(model)` and `broom::glance()`, not `nrow(data)`.

## Examples

```
## Not run:
# Option A: pre-built D_it
df$D <- as.integer(df$treated & df$year >= 2006)
res <- run_did(df, outcome = y, treatment = D, fe = ~ id + year)

# Option B: timing-based construction
res <- run_did(df, outcome = y, treatment = treated, time = year,
               timing = 2006, fe = ~ id + year)

# Cluster-robust SE
res <- run_did(df, outcome = y, treatment = D, fe = ~ id + year,
               cluster = ~ id)

print(res)
broom::tidy(res)
broom::glance(res)
# modelsummary::modelsummary(res)

## End(Not run)
```

---

run\_es

---

*Event Study Estimation for Panel Data*


---

## Description

Runs an event study regression on panel data, supporting both classic (universal timing) and staggered (unit-varying timing via `sunab`). The function builds the design (lead/lag factor or `sunab`), estimates with `fixest::feols()`, and returns a tidy table with metadata.

## Usage

```
run_es(
  data,
  outcome,
  treatment = NULL,
  time,
  timing,
  fe = NULL,
  lead_range = NULL,
  lag_range = NULL,
  covariates = NULL,
```

```

cluster = NULL,
weights = NULL,
baseline = -1L,
interval = 1,
time_transform = FALSE,
rel_time = NULL,
unit = NULL,
staggered = FALSE,
method = c("classic", "sunab"),
estimator = c("twfe", "cs", "sa", "bjs", "twm", "flex"),
control_group = c("nevertreated", "notyettreated"),
anticipation = 0L,
conf.level = 0.95,
vcov = "HC1",
vcov_args = list(),
bootstrap = FALSE,
B = 999L,
alpha = 0.05,
boot_seed = NULL,
group = NULL,
trends = FALSE
)

```

## Arguments

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data                  | A data.frame containing panel data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| outcome               | Unquoted outcome (name or expression, e.g., $\log(y)$ ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| treatment             | Unquoted treatment indicator (0/1 or logical). Used only when method = "classic".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| time                  | Unquoted time variable (numeric or Date).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| timing                | For classic: a numeric/Date (universal) or a variable (unquoted) if staggered = TRUE. For sunab: an unquoted variable with adoption time. For estimator = "cs": unquoted column giving each unit's first treatment period (NA = never treated). <b>Convention for staggered estimators (cs, sa, bjs, twm, flex, classic with staggered = TRUE):</b> NA in the timing column means the unit is <i>never treated</i> and will be used as a control. This follows the same convention as <code>did::att_gt()</code> , <code>fixest::sunab()</code> , and <code>didimputation</code> . If NA instead represents <i>missing</i> treatment timing for an otherwise treated unit, those observations will be silently absorbed into the control group, which is almost certainly wrong. For estimator = "twfe" with staggered = TRUE, a warning is emitted when units with treatment = 1 also have timing = NA. |
| fe                    | One-sided fixed-effects formula, e.g., $\sim \text{id} + \text{year}$ . Can be NULL for no fixed effects. Ignored when estimator = "cs".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| lead_range, lag_range | Integers for pre/post windows. If NULL, determined automatically.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| covariates            | One-sided formula of additional controls, e.g., $\sim x1 + \log(x2)$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| cluster               | Cluster specification (one-sided formula like $\sim \text{id} + \text{year}$ , a single character column name, or a vector of length <code>nrow(data)</code> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| weights        | Observation weights (a name/one-sided formula or a numeric vector of length <code>nrow(data)</code> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| baseline       | Integer baseline period (default -1); reference period excluded from results for both "classic" and "sunab" methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| interval       | Numeric spacing of the time variable (default 1; ignored internally for Dates).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| time_transform | Logical; if TRUE, creates consecutive integer time within unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| rel_time       | Optional unquoted column holding a <b>pre-built event time</b> (time relative to treatment), e.g. the <code>Time_to_Treatment</code> produced by <code>paneltools/fect</code> 's <code>get.cohort()</code> . When supplied, <code>run_es()</code> uses this column verbatim as the event-study factor — <code>i(rel_time, treatment, ref = baseline)</code> — instead of computing relative time internally from time and timing. Never-treated / control rows should be NA. Requires <code>estimator = "twfe"</code> and <code>method = "classic"</code> ; cannot be combined with <code>staggered = TRUE</code> or <code>time_transform = TRUE</code> . This normalises the older time = event_time, timing = 0 idiom. See <b>Details</b> for how this differs from the calendar-difference and time_transform conventions. |
| unit           | Unit identifier variable (required when <code>estimator = "cs"</code> or <code>time_transform = TRUE</code> ); also used for metadata when supplied.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| staggered      | Logical; if TRUE, timing is a variable (classic) or is used by unab.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| method         | Either "classic" or "unab" (default: "classic").                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| estimator      | Estimation strategy: "twfe" (default, existing fixed-based paths), "cs" for the Callaway-Sant'Anna (2021) group-time ATT estimator, or "sa" for the Sun-Abraham (2021) interaction-weighted estimator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| control_group  | For estimator = "cs": comparison group, either "nevertreated" (default) or "notyettreated".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| anticipation   | For estimator = "cs": number of anticipation periods before treatment (non-negative integer, default 0L).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| conf.level     | Numeric vector of confidence levels (default 0.95).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| vcov           | VCOV type passed to <code>fixest::vcov()</code> or used via <code>broom::tidy(vcov = ...)</code> . Default "HC1".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| vcov_args      | List of additional arguments forwarded to <code>fixest::vcov()</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| bootstrap      | Logical; if TRUE and estimator = "cs", compute simultaneous confidence bands via the multiplier bootstrap (Algorithm 1, Callaway and Sant'Anna 2021). Adds <code>conf_low_sim</code> and <code>conf_high_sim</code> columns to the result and stores the full (g,t)-level bootstrap object as <code>attr(result, "bootstrap")</code> . Default FALSE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| B              | Integer number of bootstrap draws (default 999). Used only when <code>bootstrap = TRUE</code> and <code>estimator = "cs"</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| alpha          | Significance level for the simultaneous band (default 0.05). Note: this is independent of <code>conf.level</code> , which governs the pointwise delta-method CIs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| boot_seed      | Integer seed for the bootstrap RNG; NULL (default) does not set a seed. Pass an integer for reproducible results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| group          | Unquoted group identifier for estimator = "flex" only. Identifies which treatment group (cohort) each observation belongs to in a repeated cross-section design ( $R_{ig}$ in Deb et al. 2024). Each group must map to exactly one value of timing (or NA for never-treated groups). Not used by other estimators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

trends Logical; for estimator = "twm" only. When TRUE, adds cohort-specific linear trend regressors  $d_g \cdot t$  to the Procedure 5.1 regression (Wooldridge 2025, Section 8), allowing each cohort's counterfactual trend to deviate linearly from the common time trend. Requires at least 2 pre-treatment periods per cohort. Default FALSE.

## Details

**How relative (event) time is defined.** run\_es() can build the event-time axis in three different ways, and in sparse or unbalanced panels (e.g. monthly surveys observed only a few times a year) they do **not** coincide:

| Method                        | Definition                        | How to invoke                       |
|-------------------------------|-----------------------------------|-------------------------------------|
| Calendar difference (default) | (time - timing) / interval        | staggered = TRUE (or scalar timing) |
| Within-unit rank              | dense_rank(time) within each unit | time_transform = TRUE               |
| Pre-built event time          | supplied column, used verbatim    | rel_time = <col>                    |

In a balanced panel all three agree. When observation spacing is irregular they diverge: for a unit observed at periods {1, 5, 9, 20} treated at 20, the calendar difference puts period 9 at  $9 - 20 = -11$ , whereas a global observed-period grid (as used by paneltools/fect's get\_cohort()) places it two observed waves before treatment (-2). To reproduce an analysis built on such a grid, pass that grid's event-time column via rel\_time so the design matches fixest::feols( $y \sim i(\text{rel\_time}, \text{treatment}, \text{ref}) \mid \text{fe}$ ) exactly. calc\_att() uses the same calendar-difference convention as the default here.

## Value

A data.frame of class "es\_result" with columns:

- term, estimate, std.error, statistic, p.value
- conf\_low\_XX, conf\_high\_XX (for each requested conf.level)
- relative\_time (integer; 0 = event), is\_baseline (logical; marks the reference period)

Attributes include: lead\_range, lag\_range, baseline, interval, call, model\_formula, conf.level, N, N\_units, N\_treated, N\_nevertreated, fe, vcov\_type, cluster\_vars, staggered, sunab\_used.

## Key Features

- One-step event study: specify outcome, treatment, time, timing, fixed effects, and (optionally) covariates.
- Switch between Classic (factor expansion) and Staggered-SAFE (method = "sunab").
- Flexible clustering, weights, and VCOV choices (e.g., vcov = "HC1" | "HC3" | "CR2" | "iid" ...).
- Automatic lead/lag window detection and customizable baseline period.
- Returns an "es\_result" object compatible with print() and autoplot().

---

|                 |                                  |
|-----------------|----------------------------------|
| tidy.att_result | <i>Tidy an att_result object</i> |
|-----------------|----------------------------------|

---

## Description

Returns a tidy data frame of the aggregated ATT estimates from a `calc_att()` result, in the column format expected by `modelsummary::modelsummary()` (and therefore renderable with `tinytable::tt()`). This makes it easy to put overall, by-cohort, or by-time ATTs into a publication table, and to stack several estimators (e.g. `run_did()` TWFE, CS, and BJS) side by side in one table.

The term column is derived from the aggregation type so that rows align across models:

- `aggregation = "simple"` -> "ATT"
- `aggregation = "by_cohort"` -> "Cohort <g>"
- `aggregation = "by_time"` -> "Time <t>"

## Usage

```
## S3 method for class 'att_result'
tidy(x, conf.int = FALSE, conf.level = 0.95, ...)
```

## Arguments

|                         |                                                                                     |
|-------------------------|-------------------------------------------------------------------------------------|
| <code>x</code>          | An <code>att_result</code> object returned by <code>calc_att()</code> .             |
| <code>conf.int</code>   | Logical; add <code>conf.low</code> / <code>conf.high</code> columns? Default FALSE. |
| <code>conf.level</code> | Confidence level for <code>conf.int</code> (normal approximation). Default 0.95.    |
| <code>...</code>        | Unused; for S3 generic compatibility.                                               |

## Value

A data frame with columns `term`, `estimate`, `std.error`, `statistic`, `p.value` (and optionally `conf.low`, `conf.high`).

## Examples

```
## Not run:
att <- calc_att(df, outcome = y, time = year, timing = g, unit = id,
               estimator = "cs", aggregation = "by_cohort")
broom::tidy(att)

# Compare estimators in one table:
twfe <- run_did(df, outcome = y, treatment = D, fe = ~ id + year)
cs    <- calc_att(df, outcome = y, time = year, timing = g, unit = id,
               estimator = "cs")
bjs   <- calc_att(df, outcome = y, time = year, timing = g, unit = id,
               estimator = "bjs")
modelsummary::modelsummary(list(TWFE = twfe, CS = cs, BJS = bjs))
```

```
## End(Not run)
```

---

|                 |                                 |
|-----------------|---------------------------------|
| tidy.did_result | <i>Tidy a did_result object</i> |
|-----------------|---------------------------------|

---

## Description

Returns a tidy data frame of model coefficients from a `run_did()` result. Delegates to `broom::tidy.fixest()` on the underlying `fixest` model so that all regressors (treatment and covariates) appear in the output — the format expected by `modelsummary::modelsummary()`.

## Usage

```
## S3 method for class 'did_result'
tidy(x, conf.int = FALSE, conf.level = 0.95, ...)
```

## Arguments

|                         |                                                                                                   |
|-------------------------|---------------------------------------------------------------------------------------------------|
| <code>x</code>          | A <code>did_result</code> object returned by <code>run_did()</code> .                             |
| <code>conf.int</code>   | Logical; add <code>conf.low</code> / <code>conf.high</code> columns? Default <code>FALSE</code> . |
| <code>conf.level</code> | Confidence level for <code>conf.int</code> . Default <code>0.95</code> .                          |
| <code>...</code>        | Additional arguments passed to <code>broom::tidy.fixest()</code> .                                |

## Value

A data frame with columns `term`, `estimate`, `std.error`, `statistic`, `p.value` (and optionally `conf.low`, `conf.high`).

## Examples

```
## Not run:
res <- run_did(df, outcome = y, treatment = D, fe = ~ id + year)
broom::tidy(res)
broom::tidy(res, conf.int = TRUE)

## End(Not run)
```

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