Package 'scmSpillover'

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Type Package

Title Synthetic Control Method with Spillover Effects

Version 0.1.1

Description A general-purpose implementation of synthetic control methods that accounts for potential spillover effects between units. Based on the methodology of Cao and Dowd (2019) <doi:10.48550/arXiv.1902.07343> ``Estimation and Inference for Synthetic Control Methods with Spillover Effects".

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Contents

`generate_test_data` *Generate simulated data for testing*

Description

Generate simulated data for testing

Usage

```
generate_test_data(
  n_units = 20,
  n_periods = 30,
  treatment_start = 20,
  effect_size = -5
)
```

Arguments

`n_units`	Number of units
`n_periods`	Number of time periods
`treatment_start`	When treatment begins
`effect_size`	Size of treatment effect

Value

A numeric matrix with dimensions (n_periods x n_units). The first column represents the treated unit, remaining columns are control units. Rows represent time periods.

Examples

```
# Generate test data with default parameters
data <- generate_test_data()
dim(data)  # 30 periods x 20 units

# Generate smaller dataset
data <- generate_test_data(n_units = 10, n_periods = 20,
                           treatment_start = 15, effect_size = -3)
```

---

plot.scm_spillover *Plot method for scm_spillover objects*

Description

Plot method for scm_spillover objects

Usage

```
## S3 method for class 'scm_spillover'
plot(x, type = "effects", ...)
```

Arguments

x	An object of class scm_spillover
type	Type of plot: "effects" or "all"
...	Additional arguments passed to plotting functions

Value

A ggplot object (invisibly for type="all")

---

plot_all *Generate all plots for SCM analysis*

Description

Generate all plots for SCM analysis

Usage

```
plot_all(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome",
  treatment_label = "Treatment",
  show_ci = TRUE
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")
treatment_label	Label for treatment (default "Treatment")
show_ci	Logical, whether to show confidence bands (default TRUE)

Value

A list containing three ggplot objects (p1, p2, p3), returned invisibly. Called primarily for side effects (displaying plots).

Examples

```
## Not run:
  data <- generate_test_data()
  result <- run_scm_spillover(data, treatment_start = 20)
  plots <- plot_all(result)

## End(Not run)
```

---

plot_effects *Plot treatment effects only*

Description

Plot treatment effects only

Usage

```
plot_effects(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome",
  show_ci = TRUE,
  show_vanilla = FALSE
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")
show_ci	Logical, whether to show confidence bands (default TRUE)
show_vanilla	Logical, whether to show vanilla SCM comparison (default FALSE)

Value

A ggplot object that can be further customized or saved.

Examples

```
data <- generate_test_data()
result <- run_scm_spillover(data, treatment_start = 20, verbose = FALSE)
p <- plot_effects(result)
```

---

print.scm_spillover *Print method for scm_spillover objects*

Description

Print method for scm_spillover objects

Usage

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

Arguments

x	An object of class scm_spillover
...	Additional arguments (not used)

Value

Invisibly returns the input object

qplot_all *Quick plot all three main plots in sequence*

Description

Quick plot all three main plots in sequence

Usage

```
qplot_all(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome",
  treatment_label = "Treatment",
  show_ci = TRUE,
  pause = TRUE
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")
treatment_label	Label for treatment (default "Treatment")
show_ci	Logical, whether to show confidence bands (default TRUE)
pause	Logical, whether to pause between plots (default TRUE)

Value

List of ggplot objects (invisibly)

qplot_ci *Quick plot with confidence intervals only*

Description

Quick plot with confidence intervals only

Usage

```
qplot_ci(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome"
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")

Value

ggplot object (invisibly)

---

qplot_compare *Quick plot for method comparison (Spillover vs Vanilla)*

Description

Quick plot for method comparison (Spillover vs Vanilla)

Usage

```
qplot_compare(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome"
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")

Value

ggplot object (invisibly)

qplot_effects *Quick plot for treatment effects with confidence intervals*

Description

Quick plot for treatment effects with confidence intervals

Usage

```
qplot_effects(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome",
  show_ci = TRUE,
  show_vanilla = FALSE
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")
show_ci	Logical, whether to show confidence bands (default TRUE)
show_vanilla	Logical, whether to show vanilla SCM comparison (default FALSE)

Value

ggplot object (invisibly)

qplot_point *Quick plot without confidence intervals*

Description

Quick plot without confidence intervals

Usage

```
qplot_point(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome"
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")

Value

ggplot object (invisibly)

---

qplot_series *Quick plot for actual vs synthetic control time series*

Description

Quick plot for actual vs synthetic control time series

Usage

```
qplot_series(
  result,
  start_year = NULL,
  unit_name = "Treated Unit",
  outcome_label = "Outcome",
  treatment_label = "Treatment"
)
```

Arguments

result	Output from run_scm_spillover
start_year	First year of treatment period
unit_name	Name of treated unit (default "Treated Unit")
outcome_label	Label for outcome variable (default "Outcome")
treatment_label	Label for treatment (default "Treatment")

Value

ggplot object (invisibly)

run_scm_spillover *Run Complete SCM Analysis with Spillover Effects*

Description

Run Complete SCM Analysis with Spillover Effects

Usage

```
run_scm_spillover(
  data,
  treatment_start,
  treated_unit = 1,
  affected_units = NULL,
  verbose = TRUE
)
```

Arguments

data	Matrix or data frame (time x units)
treatment_start	Integer, first treatment period (row number)
treated_unit	Integer, column index of treated unit (default = 1)
affected_units	Vector of column indices for all affected units (including treated)
verbose	Logical, print progress

Value

List with all results

safe_solve *Safe matrix inversion with regularization*

Description

Safely inverts a matrix using regularization if needed

Usage

```
safe_solve(M, tol = 1e-10)
```

Arguments

M	Matrix to invert
tol	Tolerance for condition number check

Value

Inverted matrix

`save_all_plots` *Save all plots to files*

Description

Save all plots to files

Usage

```
save_all_plots(
  result,
  prefix = "scm",
  path = NULL,
  width = 10,
  height = 6,
  dpi = 300,
  ...
)
```

Arguments

`result`	Output from run_scm_spillover
`prefix`	File name prefix (default "scm")
`path`	Directory to save plots (required, no default)
`width`	Plot width in inches (default 10)
`height`	Plot height in inches (default 6)
`dpi`	Resolution (default 300)
`...`	Additional arguments passed to plotting functions

Value

Character vector of saved file paths, returned invisibly.

Examples

```
## Not run:
  data <- generate_test_data()
  result <- run_scm_spillover(data, treatment_start = 20)
  save_all_plots(result, path = tempdir())

## End(Not run)
```

scm *Basic SCM function for single unit*

Description

Computes synthetic control weights for a single treated unit

Usage

```
scm(Y, lambda = 1e-06)
```

Arguments

Y	N x T matrix where first row is treated unit
lambda	Regularization parameter for numerical stability

Value

List containing intercept (a) and weights (b)

scm_batch *Batch SCM for all units*

Description

Computes synthetic control weights for all units

Usage

```
scm_batch(Y, verbose = FALSE)
```

Arguments

Y	N x T matrix of outcomes
verbose	Print progress messages

Value

List with intercepts (a) and weight matrix (B)

sp_andrews_spillover *Test for spillover effects*

Description

Tests whether spillover effects are significant

Usage

```
sp_andrews_spillover(Y0, Y1, A, alpha_sig = 0.05)
```

Arguments

Y0	N x T pre-treatment matrix
Y1	N x 1 post-treatment vector
A	N x k spillover structure matrix
alpha_sig	Significance level

Value

List with test results

sp_andrews_te *Andrews test for treatment effects*

Description

Tests significance of treatment effects

Usage

```
sp_andrews_te(Y0, Y1, A, C = NULL, alpha_sig = 0.05)
```

Arguments

Y0	N x T pre-treatment matrix
Y1	N x 1 post-treatment vector (single period)
A	N x k spillover structure matrix
C	Constraint matrix (default tests first unit)
alpha_sig	Significance level

Value

List with estimates, p-values, and confidence intervals

sp_estimation *Spillover-adjusted SCM estimation*

Description

Estimates treatment effects accounting for spillovers

Usage

```
sp_estimation(Y_pre, Y_post, A, verbose = FALSE)
```

Arguments

Y_pre	N x T pre-treatment matrix
Y_post	N x S post-treatment matrix
A	N x k spillover structure matrix
verbose	Print progress messages

Value

List containing treatment effects and other results

summary.scm_spillover *Summary method for scm_spillover objects*

Description

Summary method for scm_spillover objects

Usage

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

Arguments

object	An object of class scm_spillover
...	Additional arguments (not used)

Value

Invisibly returns a data frame with detailed results

`vanilla_scm` *Standard SCM without spillovers*

Description

Computes standard synthetic control for comparison

Usage

```
vanilla_scm(Y_pre, Y_post)
```

Arguments

`Y_pre`	N x T pre-treatment matrix
`Y_post`	N x S post-treatment matrix

Value

Synthetic control values for all periods

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