Package 'cointsmall'

March 19, 2026

Type Package

Title Cointegration Tests with Structural Breaks in Small Samples

Version 1.0.2

Description Implements cointegration tests with structural breaks designed for small sample sizes, following the methodology of Trinh (2022) <https://ideas.repec.org/p/ema/worpap/2022-01.html>. Supports models with no breaks, breaks in constant only, and breaks in both constant and slope. Provides endogenous break date detection using ADF or SSR minimization criteria, with small-sample adjusted critical values via response surface methodology.

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URL https://github.com/muhammedalkhalaf/cointsmall

BugReports https://github.com/muhammedalkhalaf/cointsmall/issues

Encoding UTF-8

Depends R (>= 3.5.0)

Imports stats

Suggests testthat (>= 3.0.0)

RoxygenNote 7.3.1

Config/testthat/edition 3

NeedsCompilation no

Author Muhammad Alkhalaf [aut, cre, cph] (ORCID: <https://orcid.org/0009-0002-2677-9246>), Hoang Huy Trinh [ctb]

Maintainer Muhammad Alkhalaf <muhammedalkhalaf@gmail.com>

Repository CRAN

Date/Publication 2026-03-19 14:00:02 UTC

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`cointsmall` *Cointegration Test with Structural Breaks in Small Samples*

Description

Tests for cointegration between a dependent variable and one or more independent variables, allowing for structural breaks. The method is designed specifically for small sample sizes following Trinh (2022).

Usage

```
cointsmall(
  y,
  x,
  breaks = 1,
  model = NULL,
  criterion = "adf",
  trim = 0.15,
  maxlags = -1,
  level = 5
)

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

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

Arguments

`y`	Numeric vector of the dependent variable (must be I(1)).
`x`	Numeric vector or matrix of independent variable(s) (must be I(1)).
`breaks`	Integer specifying the number of structural breaks to test for. Must be 0, 1, or 2. Default is 1.
`model`	Character string specifying the model type: **"o"** No structural break (only valid when breaks = 0) **"c"** Break in constant only **"cs"** Break in constant and slope (default for breaks > 0)

criterion	Character string specifying the criterion for break date selection: "adf" (minimize ADF statistic) or "ssr" (minimize sum of squared residuals). Default is "adf".
trim	Numeric value between 0 and 0.5 specifying the trimming parameter for break date search. Default is 0.15.
maxlags	Integer specifying the maximum number of lags for the ADF test. If -1 (default), automatically determined using the rule floor(12*(TT/100)^0.25).
level	Numeric confidence level for critical values (1, 5, or 10). Default is 5.
...	Additional arguments (currently unused).
object	A cointsmall object.

Details

The test follows the two-step Engle-Granger procedure with modifications for structural breaks:

1. Estimate the cointegrating regression (with break dummies if applicable)
2. Apply an ADF test to the residuals

For models with breaks, the break date(s) are determined endogenously by searching over all possible dates within the trimmed sample and selecting the date that minimizes the ADF statistic or SSR.

Critical values are computed using response surface methodology following Trinh (2022), which accounts for the small sample bias.

Value

An object of class "cointsmall" containing:

statistic	The ADF* test statistic
cv	Critical value at the specified level
cv01	Critical value at 1% level
cv05	Critical value at 5% level
cv10	Critical value at 10% level
pvalue	Approximate p-value
decision	Character string with test decision
reject	Logical indicating whether to reject null hypothesis
breaks	Number of breaks tested
model	Model specification used
criterion	Selection criterion used
break_dates	Vector of estimated break date indices (if breaks > 0)
lags	Number of lags used in ADF test
ssr	Sum of squared residuals from cointegrating regression
nobs	Number of observations
nvar	Number of independent variables
coefficients	Estimated cointegrating coefficients
residuals	Residuals from cointegrating regression

References

Trinh, H. H. (2022). Testing for cointegration with structural changes in very small sample. THEMA Working Paper n°2022-01, CY Cergy Paris Université. https://ideas.repec.org/p/ema/worpap/2022-01.html

Examples

```
# Generate cointegrated series
set.seed(42)
n <- 50
e <- cumsum(rnorm(n))  # Common stochastic trend
y <- 2 + 3 * e + rnorm(n, sd = 0.5)
x <- e + rnorm(n, sd = 0.3)

# Test with no break
result0 <- cointsmall(y, x, breaks = 0)
print(result0)

# Test with one break (break in constant and slope)
result1 <- cointsmall(y, x, breaks = 1, model = "cs")
print(result1)

# Generate series with structural break
y_break <- c(2 + 2 * e[1:25], 5 + 4 * e[26:50]) + rnorm(n, sd = 0.3)
result_break <- cointsmall(y_break, x, breaks = 1)
print(result_break)
```

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cointsmall_combined *Combined Cointegration Testing Procedure*

Description

Performs cointegration tests under all model specifications (no break, break in constant, break in constant and slope) and provides model selection guidance.

Usage

```
cointsmall_combined(y, x, breaks = 1, trim = 0.15, maxlags = -1, level = 5)

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

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

Arguments

`y`	Numeric vector of the dependent variable (must be I(1)).
`x`	Numeric vector or matrix of independent variable(s) (must be I(1)).
`breaks`	Integer specifying the number of structural breaks to test for. Must be 1 or 2. Default is 1.
`trim`	Numeric value between 0 and 0.5 specifying the trimming parameter for break date search. Default is 0.15.
`maxlags`	Integer specifying the maximum number of lags for the ADF test. If -1 (default), automatically determined.
`level`	Numeric confidence level for critical values (1, 5, or 10). Default is 5.
`...`	Additional arguments (currently unused).
`object`	A cointsmall_combined object.

Details

The combined procedure tests three model specifications:

1. Model "o": No structural break
2. Model "c": Break in constant only
3. Model "cs": Break in constant and slope

Model selection follows these rules:

- If no model rejects H0: No evidence of cointegration
- If exactly one model rejects H0: Select that model
- If multiple models reject H0: Select the most general model that rejects H0 (cs > c > o)

Value

An object of class `"cointsmall_combined"` containing:

`results`	List of cointsmall objects for each model
`summary`	Data frame summarizing test statistics and decisions
`selected_model`	Character string indicating the selected model
`nobs`	Number of observations
`nvar`	Number of independent variables
`breaks`	Number of breaks tested

References

Trinh, H. H. (2022). Testing for cointegration with structural changes in very small sample. THEMA Working Paper n°2022-01, CY Cergy Paris Université. https://ideas.repec.org/p/ema/worpap/2022-01.html

Examples

```
# Generate cointegrated series with break
set.seed(123)
n <- 50
e <- cumsum(rnorm(n))
x <- e + rnorm(n, sd = 0.3)
y <- c(2 + 2 * e[1:25], 5 + 4 * e[26:50]) + rnorm(n, sd = 0.3)

# Combined test
result <- cointsmall_combined(y, x, breaks = 1)
print(result)
```

`cointsmall_cv` *Critical Values for Cointegration Tests with Structural Breaks*

Description

Computes critical values for the small-sample cointegration test using response surface methodology following Trinh (2022).

Usage

```
cointsmall_cv(TT, m, breaks = 0, model = "o", level = NULL)
```

Arguments

`TT`	Sample size.
`m`	Number of independent variables in the cointegrating regression.
`breaks`	Number of structural breaks (0, 1, or 2).
`model`	Model specification ("o", "c", or "cs").
`level`	Significance level (1, 5, or 10). If NULL, returns all levels.

Details

Critical values are computed using response surface equations that account for:

- Small sample sizes (TT)
- Number of regressors (m)
- Number of structural breaks
- Model specification (level shift vs. regime shift)

The response surface follows the general form:

$$cv = c_\infty + c_1/TT + c_2/TT^2$$

where the coefficients depend on m, breaks, and model.

For model "o" (no breaks), critical values are based on Engle-Granger (1987) and MacKinnon (1991, 2010) response surfaces.

For models with breaks, critical values incorporate adjustments from Gregory-Hansen (1996), Hatemi-J (2008), and small-sample corrections from Trinh (2022).

Value

If level is specified, returns the critical value. If NULL, returns a named list with cv01, cv05, and cv10.

References

Trinh, H. H. (2022). Testing for cointegration with structural changes in very small sample. THEMA Working Paper n°2022-01, CY Cergy Paris Université. https://ideas.repec.org/p/ema/worpap/2022-01.html

MacKinnon, J. G. (2010). Critical values for cointegration tests. Queen's Economics Department Working Paper No. 1227. doi:10.22004/ag.econ.279422

Examples

```
# Critical values for m=1 regressor, TT=30, no breaks
cointsmall_cv(TT = 30, m = 1, breaks = 0, model = "o")

# Critical values with one break (model cs)
cointsmall_cv(TT = 50, m = 2, breaks = 1, model = "cs")
```

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