Package 'xtbreakcoint'

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Title Panel Cointegration Tests with Structural Breaks

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Description Implements panel cointegration tests allowing for structural breaks and cross-section dependence following the methodology of Banerjee and Carrion-i-Silvestre (2015) <doi:10.1002/jae.2348>. The package provides iterative factor-break estimation, individual ADF tests on defactored residuals, standardized panel test statistics, and the Bai and Ng (2004) <doi:10.1111/j.1468-0262.2004.00528.x> MQ test for identifying common stochastic trends. Supports five model specifications with varying deterministic components and break structures.

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

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

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`xtbreakcoint-package` *Panel Cointegration Tests with Structural Breaks*

Description

Implements panel cointegration tests allowing for structural breaks and cross-section dependence following the methodology of Banerjee and Carrion-i-Silvestre (2015). The package provides iterative factor-break estimation, individual ADF tests on defactored residuals, standardized panel test statistics, and the Bai and Ng (2004) MQ test for identifying common stochastic trends.

Details

The main function is `xtbreakcoint`, which performs the panel cointegration test.

Key Features:

- Accounts for cross-section dependence through common factors
- Allows for structural breaks in the cointegrating relationship
- Supports five model specifications with varying deterministic components
- Provides individual and panel test statistics
- Includes the Bai & Ng (2004) MQ test for stochastic trends

Model Specifications:

Model 1 (constant) Constant only

Model 2 (trend) Constant plus linear trend

Model 3 (levelshift) Constant plus level shift at break

Model 4 (trendshift) Constant, trend, plus level shift (default)

Model 5 (regimeshift) Constant, trend, level shift, plus slope shift

Author(s)

Muhammad Alkhalaf

References

Banerjee, A., & Carrion-i-Silvestre, J. L. (2015). Cointegration in panel data with structural breaks and cross-section dependence. *Journal of Applied Econometrics*, 30(1), 1-22. doi:10.1002/jae.2348

Bai, J., & Ng, S. (2004). A PANIC attack on unit roots and cointegration. *Econometrica*, 72(4), 1127-1177. doi:10.1111/j.14680262.2004.00528.x

Bai, J., & Ng, S. (2002). Determining the number of factors in approximate factor models. *Econometrica*, 70(1), 191-221. doi:10.1111/14680262.00273

`print.xtbreakcoint` *Print Method for xtbreakcoint Objects*

Description

Print method for objects of class `"xtbreakcoint"`.

Usage

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

Arguments

`x`	An object of class `"xtbreakcoint"`.
`...`	Additional arguments (ignored).

Value

Invisibly returns `x`.

See Also

`xtbreakcoint`, `summary.xtbreakcoint`

Examples

```
# Generate example panel data
set.seed(42)
N <- 5
T <- 30

panel_data <- data.frame(
  id = rep(1:N, each = T),
  time = rep(1:T, N),
  y = rnorm(N * T),
  x = rnorm(N * T)
)
```

```
result <- xtbreakcoint(y ~ x, data = panel_data, id = "id", time = "time",
                       max_factors = 0)
print(result)
```

`summary.xtbreakcoint` *Summary Method for xtbreakcoint Objects*

Description

Summary method for objects of class `"xtbreakcoint"`, providing detailed output including individual unit results.

Usage

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

Arguments

`object`	An object of class `"xtbreakcoint"`.
`...`	Additional arguments (ignored).

Value

Invisibly returns `object`.

See Also

`xtbreakcoint`, `print.xtbreakcoint`

Examples

```
# Generate example panel data
set.seed(42)
N <- 5
T <- 30

panel_data <- data.frame(
  id = rep(1:N, each = T),
  time = rep(1:T, N),
  y = rnorm(N * T),
  x = rnorm(N * T)
)

result <- xtbreakcoint(y ~ x, data = panel_data, id = "id", time = "time",
                       max_factors = 0)
summary(result)
```

`xtbreakcoint` *Panel Cointegration Test with Structural Breaks*

Description

Implements the panel cointegration test of Banerjee and Carrion-i-Silvestre (2015), allowing for structural breaks and cross-section dependence through common factors.

Usage

```
xtbreakcoint(
  formula,
  data,
  id,

  time,
  model = "trendshift",
  max_factors = 5,
  max_lag = 4,

  lag_method = c("auto", "fixed"),
  trim = 0.15,
  max_iter = 20,
  tolerance = 0.001
)
```

Arguments

`formula`	A formula of the form `y ~ x1 + x2 + ...` specifying the cointegrating relationship.
`data`	A data frame containing panel data with columns for the panel identifier, time identifier, and all variables in the formula.
`id`	Character string naming the panel (cross-section) identifier.
`time`	Character string naming the time identifier.
`model`	Model specification for deterministic components. One of: `"constant"` (1), `"trend"` (2), `"levelshift"` (3), `"trendshift"` (4, default), or `"regimeshift"` (5). Can also specify as integer 1-5.
`max_factors`	Maximum number of common factors to estimate (default: 5). Set to 0 to skip factor estimation.
`max_lag`	Maximum lag order for ADF tests (default: 4).
`lag_method`	Method for selecting ADF lag order: `"auto"` for automatic selection via BIC (default) or `"fixed"` to use `max_lag`.
`trim`	Trimming parameter for break estimation, proportion of sample excluded from endpoints (default: 0.15). Must be in (0, 0.5).
`max_iter`	Maximum iterations for factor-break estimation (default: 20).
`tolerance`	Convergence tolerance for iterative estimation (default: 0.001).

Details

This function tests for panel cointegration in the presence of structural breaks and cross-sectional dependence. The methodology follows these steps:

1. **Iterative Factor-Break Estimation**: Jointly estimates common factors and individual break dates using an iterative procedure.
2. **Individual ADF Tests**: Applies ADF tests to the defactored (idiosyncratic) residuals for each cross-section unit.
3. **Panel Test Statistic**: Combines individual ADF statistics into a standardized panel statistic using Monte Carlo moments.
4. **MQ Test**: If factors are detected, tests whether they are stationary or represent stochastic trends (Bai & Ng, 2004).

Value

An object of class `"xtbreakcoint"` containing:

Z_t Panel test statistic (standard normal under H0)

p_value One-sided p-value for Z_t

tbar Average of individual ADF t-statistics

mean_t Expected value of t-statistic under H0

var_t Variance of t-statistic under H0

N Number of cross-section units

T Number of time periods

n_factors Number of estimated common factors

n_trends Number of stochastic trends (from MQ test)

MQ_np Non-parametric MQ test statistic

MQ_p Parametric MQ test statistic

iterations Number of iterations for factor-break convergence

reject_pct Percentage of individual units rejecting H0 at 5%

adf_stats Vector of individual ADF t-statistics

lag_orders Vector of selected lag orders for each unit

breaks Vector of estimated break dates (periods from start)

factors Matrix of estimated common factors (T-1 x n_factors)

model Model specification used

call The matched call

Model Specifications

1 - constant Constant only

2 - trend Constant plus linear trend

3 - levelshift Constant plus level shift at break

4 - trendshift Constant, trend, plus level shift (default)

5 - regimeshift Constant, trend, level shift, plus slope shift

Author(s)

Muhammad Alkhalaf

References

Banerjee, A., & Carrion-i-Silvestre, J. L. (2015). Cointegration in panel data with structural breaks and cross-section dependence. *Journal of Applied Econometrics*, 30(1), 1-22. doi:10.1002/jae.2348

Bai, J., & Ng, S. (2004). A PANIC attack on unit roots and cointegration. *Econometrica*, 72(4), 1127-1177. doi:10.1111/j.14680262.2004.00528.x

Examples

```
# Generate example panel data
set.seed(42)
N <- 10  # panels
T <- 50  # time periods

# Create cointegrated data with a structural break
panel_data <- data.frame(
  id = rep(1:N, each = T),
  time = rep(1:T, N),
  y = NA,
  x = NA
)

for (i in 1:N) {
  idx <- panel_data$id == i
  x <- cumsum(rnorm(T))
  u <- rnorm(T, sd = 0.5)
  # Cointegrating relationship with break at t=25
  beta <- ifelse(1:T <= 25, 1, 1.5)
  y <- 1 + beta * x + u
  panel_data$x[idx] <- x
  panel_data$y[idx] <- y
}

# Test for cointegration
result <- xtbreakcoint(y ~ x, data = panel_data, id = "id", time = "time")
print(result)
```

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