Package: xtbreakcoint (via r-universe)

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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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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"` (default) starts from `max_lag` and drops the last lag while its t-ratio is below 1.645 in absolute value, as in the GAUSS code; `"fixed"` uses `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).

The computations follow the authors' GAUSS replication code (procedures `factcoint_iter`, `factcoint`, `ADFRC` and `MQ_test`): the cointegrating regression is estimated unit by unit in first differences, break dates minimise the sum of squared residuals over the central 70% of the sample (a common break for model 5), the number of factors is chosen by the Bai and Ng (2002) IC1 criterion, and the ADF regressions on the cumulated idiosyncratic residuals have no deterministic terms. The GAUSS code selects the model 4 break by minimising the squared coefficient vector; this package uses the sum of squared residuals, as for the other models.

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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