Package 'fjohansen'

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Type Package

Title Johansen Cointegration Test with Fourier-Type Smooth Nonlinear Trends

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Maintainer Merwan Roudane <merwanroudane920@gmail.com>

Description Implements the Johansen cointegration test with Fourier-type smooth nonlinear deterministic trends restricted to cointegrating relations, as developed by Kurita and Shintani (2025) <doi:10.1080/07474938.2025.2530640>. Six model variants are supported: CNR (constant plus nonlinear, restricted in the cointegrating space), LNR (linear plus nonlinear, restricted), CNU (constant restricted, nonlinear unrestricted), LNU (linear restricted, nonlinear unrestricted), plus the standard constant- and linear-trend restricted Johansen models. The package also bundles the feasible generalised least squares (FGLS) Wald test of Perron, Shintani and Yabu (2017) <doi:10.1111/obes.12169> used as a frequency-selection pre-step, together with bundled critical-value tables, a vectorised simulator for the limiting distribution, publication-quality table exports (LaTeX and HTML) and 'ggplot2' figures matching those of the paper.

URL https://github.com/merwanroudane/fjohansen

BugReports https://github.com/merwanroudane/fjohansen/issues

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Encoding UTF-8

Depends R (>= 4.0.0)

Imports stats, utils, grDevices, graphics, ggplot2 (>= 3.4.0), scales

Suggests testthat (>= 3.0.0), kableExtra, knitr, rmarkdown, patchwork

RoxygenNote 7.3.3

NeedsCompilation no

Author Merwan Roudane [aut, cre]

Repository CRAN

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Contents

`fjohansen-package` *fjohansen: Johansen Cointegration Test with Fourier-Type Smooth Nonlinear Trends*

Description

Implements the Johansen cointegration test with Fourier-type smooth nonlinear deterministic trends restricted to cointegrating relations, as developed by Kurita and Shintani (2025, Econometric Reviews). Also bundles the FGLS Wald test of Perron, Shintani and Yabu (2017) as a frequency-selection pre-step.

Main entry points

- `johansen_fourier` – the trace test.
- `select_frequencies` – pick the number of Fourier frequencies via PSY 2021.
- `psy_wald_test` – the univariate Wald test.
- `simulate_limit_distribution` – limit distribution of Proposition 3.1 of the paper.

Author / repository

Author:	Merwan Roudane merwanroudane920@gmail.com
Repository:	https://github.com/merwanroudane/fjohansen
License:	MIT

Author(s)

Maintainer: Merwan Roudane <merwanroudane920@gmail.com>

References

Kurita, T. and Shintani, M. (2025). Johansen test with Fourier-type smooth nonlinear trends in cointegrating relations. *Econometric Reviews*, 44(10), 1589-1616. doi:10.1080/07474938.2025.2530640

Perron, P., Shintani, M. and Yabu, T. (2017). Testing for flexible nonlinear trends with an integrated or stationary noise component. *Oxford Bulletin of Economics and Statistics*, 79, 822-850. doi:10.1111/obes.12169

See Also

Useful links:

- https://github.com/merwanroudane/fjohansen
- Report bugs at https://github.com/merwanroudane/fjohansen/issues

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`build_design_matrices` *Build Z0, Z1, Z2 design matrices for the reduced-rank regression*

Description

Build Z0, Z1, Z2 design matrices for the reduced-rank regression

Usage

```
build_design_matrices(X, k, n, model = "CNR")
```

Arguments

X	T x p numeric matrix (levels).
k	VAR order in levels (>= 1).
n	Number of Fourier frequencies (0 disables them).
model	One of "CNR","LNR","CNU","LNU","constant","linear".

Value

A list with elements `Z0, Z1, Z2, info`.

---

clear_jf_cache *Clear the in-memory simulation cache.*

Description

Clear the in-memory simulation cache.

Usage

```
clear_jf_cache()
```

Value

Invisible integer = number of cached entries cleared.

CNR_TABLE_B1 *Approximate limit quantiles for the CNR model (Table B1 of Kurita & Shintani 2025).*

Description

Named-list keyed by string "p_minus_r,n". Values are numeric vectors with names `q90, q95, q975, q99, mean, var`.

Usage

```
CNR_TABLE_B1
```

Format

An object of class `list` of length 35.

fourier_basis *Build the Fourier deterministic basis*

Description

Constructs the matrix

$$F_{t,T} = [\sin(2\pi t/T), \cos(2\pi t/T), \ldots, \sin(2\pi nt/T), \cos(2\pi nt/T)]$$

for t = t_start, ..., t_start + T - 1.

Usage

```
fourier_basis(T_len, n, t_start = 1)
```

Arguments

T_len	Sample size used in the denominator (typically the full sample T).
n	Number of frequencies (>= 0). 0 returns a matrix with 0 columns.
t_start	First time index (default 1).

Value

A numeric matrix of shape `T_len x (2 n)`.

jf_dgps *Data-generating processes from Section 5 of Kurita & Shintani (2025)*

Description

Data-generating processes from Section 5 of Kurita & Shintani (2025)

Usage

```
generate_nf_dgp1(T = 400L, seed = 0L, ...)

generate_nf_dgp2(T = 400L, seed = 0L, ...)

generate_nf_dgp3(T = 400L, seed = 0L, ...)

generate_nf_dgp4(T = 400L, seed = 0L, ...)

generate_f_dgp1(T = 400L, seed = 0L)

generate_f_dgp2(T = 400L, seed = 0L)
```

Arguments

T	Sample length.
seed	RNG seed (integer).
...	Additional arguments forwarded to the internal skeleton (e.g. s, start, no_cointegration).

Value

A data.frame with two or four numeric columns.

---

jf_moments *Mean and variance of the limit distribution*

Description

Mean and variance of the limit distribution

Usage

```
jf_moments(
  p_minus_r,
  n,
  model = "CNR",
  n_sims = 4000,
  grid_size = 250,
  seed = 12345
)
```

Arguments

p_minus_r	Common stochastic trends p - r (>= 1).
n	Number of Fourier frequencies (>= 0).
model	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
n_sims	Replications used if the cell is not tabulated.
grid_size	Discretisation of the unit interval (only used in simulation).
seed	RNG seed (only used in simulation).

Value

Numeric vector of length 2: c(mean, var).

jf_p_value *Gamma-approximation p-value of an observed trace statistic*

Description

Gamma-approximation p-value of an observed trace statistic

Usage

```
jf_p_value(stat, p_minus_r, n, model = "CNR", ...)
```

Arguments

stat	Observed value of -2 log LR.
p_minus_r	Common stochastic trends p - r (>= 1).
n	Number of Fourier frequencies (>= 0).
model	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
...	Additional arguments forwarded to jf_moments() when the requested cell is not tabulated.

Value

Numeric scalar in [0,1].

jf_quantile *Quantile of the limit distribution*

Description

For tabulated CNR cells and the 90/95/97.5/99 percentiles the paper's hard-coded values are returned. Otherwise the Gamma approximation (Doornik 1998) is used.

Usage

```
jf_quantile(level, p_minus_r, n, model = "CNR", ...)
```

Arguments

level	Probability (0 < level < 1) or one of "90%","95%","97.5%","99%".
p_minus_r	Common stochastic trends p - r (>= 1).
n	Number of Fourier frequencies (>= 0).
model	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
...	Additional arguments forwarded to jf_moments() when the requested cell is not tabulated.

Value

Numeric scalar.

`jf_tables` *Publication-quality table formatters for the trace test*

Description

Helpers that turn a fitted `johansen_fourier` result into a printable table in three different formats.

Usage

```
format_trace_table(x)

format_trace_latex(x, caption = NULL, label = NULL)

format_trace_html(x, caption = NULL)
```

Arguments

`x`	A `johansen_fourier` object.
`caption`	Optional caption.
`label`	Optional label.

Value

Each function returns a single character scalar containing the formatted table:

- `format_trace_table()` – plain-text (ASCII) table suitable for `cat()` or `message()`.
- `format_trace_latex()` – a LaTeX `tabular` environment (booktabs style) wrapped in a `table` float.
- `format_trace_html()` – a self-contained HTML fragment with inline CSS, suitable for use in R Markdown / Quarto.

`johansen_fourier` *Johansen-Fourier cointegration test*

Description

Performs the reduced-rank regression of Kurita & Shintani (2025) for a cointegrated VAR(k) with restricted Fourier-type smooth nonlinear trends in the cointegrating space.

Usage

```
johansen_fourier(
  data,
  k,
  n = 1L,
  model = "CNR",
  sig_level = 0.05,
  select_rank = TRUE,
  n_sims = 5000L
)
```

Arguments

`data`	T x p numeric matrix or data.frame of levels.
`k`	VAR order in levels (>= 1). Uses `k - 1` lagged differences as unrestricted regressors.
`n`	Number of Fourier frequencies (0 = standard Johansen).
`model`	One of `"CNR"`, `"LNR"`, `"CNU"`, `"LNU"`, `"constant"`, `"linear"`.
`sig_level`	Significance level for the sequential rank rule.
`select_rank`	Logical; sequentially pick the cointegrating rank.
`n_sims`	Replications used to simulate cells not in the bundled tables.

Value

An S3 object of class `johansen_fourier` with fields:

- `spec` – model spec
- `eigenvalues` – generalised eigenvalues, descending
- `trace_stats` – data.frame, one row per H_0
- `selected_rank` – chosen r
- `alpha`, `beta`, `delta`, `gamma_const`, `gamma_trend`, `Gamma`
- `Sigma`, `residuals`, `fitted_long_run`
- `series_names`, `t_index`

References

Kurita, T., Shintani, M. (2025). *Econometric Reviews*, 44(10), 1589-1616.

Examples

```
## Small fast example (tabulated critical-value cell, no simulation):
set.seed(1)
data <- sample_jgb_data(T = 60)
res  <- johansen_fourier(data, k = 2, n = 1, model = "CNR",
                         n_sims = 200, select_rank = FALSE)
print(res)


  ## Full paper-style call (slower because of the limit-distribution
  ## simulation when the requested cell is not in the bundled tables):
  data <- sample_jgb_data(T = 108)
  res  <- johansen_fourier(data, k = 3, n = 3, model = "CNR")
  summary(res)
  plot(res)
```

---

model_specs *Model specifications used by* johansen_fourier

Description

A list of S3-tagged model specs with the following fields:

- code : canonical name
- label : human-readable description
- z1_constant : restricted constant in cointegrating space
- z1_trend : restricted linear trend in cointegrating space
- z1_fourier : restricted Fourier in cointegrating space
- z2_constant : unrestricted constant
- z2_fourier : unrestricted Fourier

Usage

```
model_specs
```

Format

An object of class list of length 6.

Details

Use one of "CNR", "LNR", "CNU", "LNU", "constant", "linear".

plot_eigenvalues *Bar plot of the Johansen eigenvalues*

Description

Bar plot of the Johansen eigenvalues

Usage

```
plot_eigenvalues(x)
```

Arguments

x	A johansen_fourier object.

Value

A ggplot bar-chart object.

plot_limit_density *Plot the limit-distribution density (paper's Figs. 1-2)*

Description

Plot the limit-distribution density (paper's Figs. 1-2)

Usage

```
plot_limit_density(
  p_minus_r,
  n_values = 0:4,
  model = "CNR",
  n_sims = 4000L,
  grid_size = 300L,
  title = NULL
)
```

Arguments

p_minus_r	Number of common stochastic trends (>= 1).
n_values	Integer vector of n values to compare.
model	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
n_sims	Number of Monte-Carlo replications.
grid_size	Grid size of [0,1].
title	Optional plot title.

Value

A ggplot object showing one kernel-density curve per value of n.

Examples

```
## Fast preview with reduced Monte-Carlo size:
plot_limit_density(p_minus_r = 2, n_values = 0:2,
                   n_sims = 400, grid_size = 80)
```

---

plot_long_run *Plot estimated cointegrating relations*

Description

Plot estimated cointegrating relations

Usage

```
plot_long_run(x)
```

Arguments

x	A johansen_fourier object.

Value

A ggplot object showing one panel per cointegrating relation (the fitted beta' X_t series).

---

plot_residual_diagnostics *Residual diagnostics (paper's Fig. 12)*

Description

Returns a ggplot showing standardised residuals only (a single panel per equation). Use directly with patchwork::wrap_plots to combine with other diagnostic graphics.

Usage

```
plot_residual_diagnostics(x, max_lag = 14L)
```

Arguments

x	A johansen_fourier object.
max_lag	Number of ACF lags to show.

Value

A ggplot object with one panel of standardised residuals per equation and +/- 2 reference bands.

`plot_risk_premium` *Implied risk-premium decomposition (paper's Fig. 13)*

Description

Implied risk-premium decomposition (paper's Fig. 13)

Usage

```
plot_risk_premium(x, index = NULL)
```

Arguments

x	A johansen_fourier object.
index	Optional x-axis vector (length T_eff).

Value

A ggplot object decomposing each cointegrating relation into its estimated risk-premium (rho_t) and the Fourier nonlinear component.

`plot_series` *Plot a (T x p) data set as multi-panel time series (Fig. 11 of the paper)*

Description

Plot a (T x p) data set as multi-panel time series (Fig. 11 of the paper)

Usage

```
plot_series(data, title = NULL, index = NULL)
```

Arguments

data	data.frame or matrix.
title	Optional title.
index	Optional vector of x-axis values.

Value

A ggplot object (one facet per series). Can be further modified with + like any other ggplot.

Examples

```
df <- sample_jgb_data(T = 36)
p  <- plot_series(df, title = "JGB yields")
```

`psy_wald_test` *Perron-Shintani-Yabu (2021) FGLS Wald test*

Description

Tests for the presence of Fourier-type nonlinear components in a univariate series. Robust to both $I(0)$ and $I(1)$ noise via Prais-Winsten transformation with a super-efficient + Roy-Fuller bias-corrected AR(1) estimator.

Usage

```
psy_wald_test(
  y,
  k_freqs,
  p_d = 1,
  subset_freq = NULL,
  version = "upper-biased",
  p_T_max = NULL
)
```

Arguments

`y`	Numeric vector (length T).
`k_freqs`	Integer vector of frequencies.
`p_d`	Polynomial trend order (0 or 1).
`subset_freq`	If supplied, test only that one frequency's two coefficients.
`version`	"upper-biased" or "median-unbiased".
`p_T_max`	Upper bound for the augmentation lag.

Value

An object of class `psy_wald`.

sample_jgb_data *Synthetic JGB-yield surrogate (Section 6 illustration)*

Description

Synthetic JGB-yield surrogate (Section 6 illustration)

Usage

```
sample_jgb_data(T = 108L, seed = 7L)
```

Arguments

T	Sample length (default 108, matching the paper's monthly sample).
seed	RNG seed.

Value

A data.frame with six columns (i_20yr, i_10yr, i_5yr, i_3yr, i_1yr, i_call) and a Date attribute starting 1986-12.

select_frequencies *Frequency selection for a multivariate panel*

Description

Each column is tested independently and the final n is the maximum across columns – the same recipe as in Kurita & Shintani (2025).

Usage

```
select_frequencies(
  data,
  n_max = 5L,
  p_d = 1L,
  sig_level = 0.1,
  version = "upper-biased"
)
```

Arguments

data	Numeric matrix or data.frame.
n_max	Upper bound on the number of frequencies.
p_d	Polynomial trend order.
sig_level	Significance level for stopping the loop.
version	"upper-biased" or "median-unbiased".

Value

A `freq_selection` object.

`select_frequencies_univariate` *General-to-specific frequency selection for a univariate series*

Description

General-to-specific frequency selection for a univariate series

Usage

```
select_frequencies_univariate(
  y,
  n_max = 5L,
  p_d = 1L,
  sig_level = 0.1,
  version = "upper-biased"
)
```

Arguments

`y`	Numeric vector.
`n_max`	Upper bound on the number of frequencies.
`p_d`	Polynomial trend order.
`sig_level`	Significance level for stopping the loop.
`version`	"upper-biased" or "median-unbiased".

Value

A `freq_selection` object.

`set_paper_theme` *Apply the paper-style ggplot2 theme (sunny palette)*

Description

Apply the paper-style ggplot2 theme (sunny palette)

Usage

```
set_paper_theme()
```

Value

Invisibly returns the ggplot2 theme object that has been installed as the global default via ggplot2::theme_set(). Called primarily for its side effect.

`simulate_limit_distribution` *Simulate the limiting Johansen-Fourier trace distribution*

Description

Vectorised across replications. Results are kept in a per-session in-memory cache; clear it with `clear_jf_cache()`.

Usage

```
simulate_limit_distribution(
  p_minus_r,
  n,
  model = "CNR",
  n_sims = 5000,
  grid_size = 300,
  seed = 12345
)
```

Arguments

p_minus_r	Number of common stochastic trends (>= 1).
n	Number of Fourier frequencies (>= 0).
model	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
n_sims	Number of Monte-Carlo replications.
grid_size	Grid size of [0,1].
seed	RNG seed.

Value

Numeric vector of length n_sims.

`simulate_limit_moments` *Simulate moments of the limiting distribution*

Description

Simulate moments of the limiting distribution

Usage

```
simulate_limit_moments(
  p_minus_r,
  n,
  model = "CNR",
  n_sims = 5000,
  grid_size = 300,
  seed = 12345
)
```

Arguments

`p_minus_r`	Number of common stochastic trends (>= 1).
`n`	Number of Fourier frequencies (>= 0).
`model`	One of "CNR","LNR","CNU","LNU","CONSTANT","LINEAR".
`n_sims`	Number of Monte-Carlo replications.
`grid_size`	Grid size of `[0,1]`.
`seed`	RNG seed.

Value

List with elements `mean`, `var`, `draws`.

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