Package: fixedCV (via r-universe)

July 1, 2026

Type Package

Title Fixed-b Critical Values for Robust Inference with Time Series Data

Version 0.1.0

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Description Provides functions for computing fixed-b critical values and conducting robust inference procedures for time series data with unknown correlation structures. Implements long-run variance estimators using various kernel functions and lugsail transformations for improved finite-sample properties as described by Kurtz-Garcia and Flegal (2026) <doi:10.48550/arXiv.2606.17369>.

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Encoding UTF-8

LazyData true

Depends R (>= 3.5)

Imports Matrix

Suggests aTSA, tseries, dplyr, lubridate, lmtest

Config/roxygen2/version 8.0.0

Repository https://rpkgarcia.r-universe.dev

Date/Publication 2026-06-25 15:33:40 UTC

RemoteUrl https://github.com/rpkgarcia/fixedcv

RemoteRef HEAD

RemoteSha fd1d86a5ee6e1304fc3914456e35c968a0145733

Contents

`fitted_CV` *Fixed Critical Values using the Fitted Method*

Description

A look up table containing the fitted coefficients for robust critical values. It also contains the adjusted R^2 values for the respective fit.

Usage

```
fitted_CV
```

Format

A data frame with the following columns:

- intercept:a parameter for the approximation
- beta1: a parameter for the approximation
- beta2: a parameter for the approximation
- beta3: a parameter for the approximation
- adj.r.sq: Adjusted R^2
- d: dimensions
- kernel: mother kernel selected
- lugsail: lugsail setting
- alpha: objective type 1 error rate

Details

This data set contains critical values that the `get_cv` and `get_cv_fitted` functions search for. For a given kernel, lugsail setting, dimension, and desired α, the critical value is approximated via the formula, $CV = \text{intercept} + \beta_1 * b + \beta_2 * b^2 + \beta_3 * b^3$

generate_cv *Generate Fixed-b Critical Values*

Description

Generates fixed-b critical values for robust hypothesis testing. Simulate from a fixed-b distribution to get custom critical values.

Usage

```
generate_cv(
  b,
  d = 2,
  alpha = 0.05,
  the_kernel = bartlett,
  lugsail_type = "Mother",
  q = 1,
  return_F_stats = FALSE,
  num_replicates = 50000,
  replicate_size = 1000
)
```

Arguments

b	Numeric vector of bandwidth values between 0 and 1. The bandwidth represents the proportion of autocovariances given non-zero weight.
d	Integer, the dimension (degrees of freedom) of the test statistic. Default is 1.
alpha	Numeric vector of desired significance levels between 0 and 1. Default is 0.05.
the_kernel	A function for the kernel used to generate the weights. The package supports Bartlett (bartlett), Parzen (parzen), Tukey-Hanning (th), or Quadratic Spectral qs. User supplied functions are also supported.
lugsail_type	Character string specifying the lugsail transformation. Options are "Mother" (default), "Zero", or "Over".
q	The Parzen characteristic exponent of the kernel supplied. The default is 1.
return_F_stats	A logical value indicating if test statistics used to approximate the fixed-b distribution should be returned. The default value is FALSE.
num_replicates	A integer indicating of test statistics to be generated used to approximate the fixed-b distribution. Default is 50,000.
replicate_size	A integer indicating the sample size used to construct the test statistics that are used to approximate the fixed-b distribution. Default is 1000.

Details

This function is used to generate custom simulated critical values. Both package kernels and user supplied kernels maybe supplied. It is not recommended to decrease num_replicates or replicate_size, especially for higher dimensions.

Value

If return_F_stats = FALSE (default) a matrix is returned where the rows correspond to the values for b and the columns correspond to the significance levels (alpha) supplied by the user. If return_F_stats = TRUE, then a list is returned. The second element in the list is a matrix of the F statistics generated to approximate the fixed-b distribution.

Examples

```
# Multiple b's and alpha's
set.seed(62)
CVs <- generate_cv(b = c(0.005, 0.006), d=1, alpha = c(0.05, 0.01),
num_replicates = 100)
CVs
# Custom kernel function
my_kernel <- function(x){
  k_x <- exp(-x^2/2)
  return(k_x)
}
CVs <- generate_cv(b = 0.005, d=1, alpha = 0.05, the_kernel = my_kernel,
 q = 2, num_replicates = 100)
CVs
```

---

get_b *Automatic Bandwidth Selection*

Description

Selects optimal bandwidth for long-run variance estimation by controlling Type I error distortion. The bandwidth determines what proportion of autocovariances receive non-zero weight in the spectral variance estimator.

Usage

```
get_b(
  the_data,
  alpha = 0.05,
  the_kernel = "Bartlett",
  lugsail = "Mother",
  tau = NA,
  auto_adjust = TRUE
)
```

Arguments

the_data	Numeric vector, matrix, or data frame containing the data (typically residuals or moment conditions from a model). For matrices, each column represents a different series.
alpha	Numeric significance level for hypothesis testing. Default is 0.05.

the_kernel	Character string specifying the kernel function. Options are "Bartlett" (default), "Parzen", "TH", or "QS".
lugsail	Character string specifying the lugsail transformation. Options are "Mother" (default), "Zero", or "Over".
tau	Numeric tolerance level for acceptable Type I error distortion. If NA (default), uses recommended values: -alpha^(0.5*d)/(T*log(rho)) for Zero lugsail, alpha*0.15 for others.
auto_adjust	Logical indicating whether to automatically increase tolerance if no suitable bandwidth is found. Default is TRUE.

Details

Returns a bandwidth optimized for hypothesis testing. If no hypothesis test is being conducted, using alpha = 0.05 as a guideline is recommended. The selected bandwidth is the smallest value whose Type I error rate falls within tau of alpha. If no bandwidth yields a Type I error rate within tau of alpha and auto_adjust = TRUE, then tau is increased by 25% iteratively until a bandwidth satisfies the criterion.

When lugsail = "Zero", the default setting tau = NA uses the tolerance recommended by Kurtz-Garcia and Flegal (2026). For other lugsail settings, larger tolerance levels are typically needed, hence when tau = NA, the default is set to alpha * 0.15.

Value

Numeric scalar, the selected optimal bandwidth value between 0 and 1.

References

Rebecca P. Kurtz-Garcia and James M. Flegal. Inference optimal long run variance estimation with lugsail kernels, 2026. URL https://arxiv.org/abs/2606.17369.

Examples

```
# Simulate AR(1) data
set.seed(123)
data <- arima.sim(list(ar = 0.7), n = 100)

# Get optimal bandwidth
get_b(data)

# With different kernel
get_b(data, the_kernel = "QS")

# With custom tolerance
get_b(data, tau = 0.01)
```

get_cv *Get Fixed-b Critical Values*

Description

Retrieves fixed-b critical values for robust hypothesis testing. Critical values can be computed using simulated lookup tables, fitted polynomial approximations, or analytical formulas.

Usage

```
get_cv(
  new_b,
  d = 1,
  alpha = 0.05,
  the_kernel = "Bartlett",
  lugsail = "Mother",
  method = "simulated"
)
```

Arguments

new_b	Numeric vector of bandwidth values between 0 and 1. The bandwidth represents the proportion of autocovariances given non-zero weight.
d	Integer, the dimension (degrees of freedom) of the test statistic. Default is 1 for t-tests.
alpha	Numeric significance level for the test. Common values are 0.01, 0.025, 0.05, or 0.10. Default is 0.05.
the_kernel	Character string specifying the kernel function. Options are "Bartlett" (default), "Parzen", "TH", or "QS".
lugsail	Character string specifying the lugsail transformation. Options are "Mother" (default), "Zero", or "Over".
method	Character string specifying computation method. Options are "simulated" (default, uses pre-computed tables), "fitted" (polynomial approximation), "analytical" (closed-form formulas), "analytical" (closed-form formulas), or "adaptive" (classical limiting distributions). .

Value

Numeric vector of critical values corresponding to each bandwidth in new_b. When b = 0, returns chi-square critical values.

Examples

```
# Get critical value for single bandwidth
get_cv(0.1, d = 1, alpha = 0.05)
```

```
# Get critical values for multiple bandwidths
get_cv(c(0, 0.1, 0.2, 0.3), d = 1, alpha = 0.05)

# Using different methods
get_cv(0.1, method = "fitted")
get_cv(0.1, method = "analytical")

# For F-test with 3 degrees of freedom
get_cv(0.1, d = 3, alpha = 0.05)
```

GillStream *Stream Temperature data*

Description

This data set contains daily average temperature readings in Celsius for a stream in Gill, Massachusetts. The original data was recorded via a submerged logger at 15 minutes intervals from August to December 2024 by the Organismic & Evolutionary Biology Department at the University of Massachusetts Amherst.

Usage

```
GillStream
```

Format

A data frame with 153 rows and 3 columns:

Date The date the temperature was recorded.

AvgTemp Temperature in Celsius

time_index index values for the date

---

kernels *Kernel Functions for Long-Run Variance Estimation*

Description

Kernel weight functions used in spectral variance (long-run variance) estimation. These functions generate weights for autocovariances in robust inference procedures.

Usage

```
bartlett(x)

qs(x)

parzen(x)

th(x)
```

Arguments

x	Numeric value, typically in the range [0, 1], representing the scaled lag.

Details

The kernel functions are:

- bartlett: Bartlett (Newey-West) kernel. q = 1 kernel.
- parzen: Parzen kernel. q = 2 kernel.
- th: Tukey-Hanning kernel. q = 2 kernel.
- qs: Quadratic Spectral kernel. q = 2 kernel.

Value

Numeric kernel weight value.

Examples

```
# Evaluate kernels at x = 0.5
bartlett(0.5)
parzen(0.5)
th(0.5)
qs(0.5)

# Plot kernel shapes
x <- seq(-1.5, 1.5, length.out = 200)
plot(x, sapply(x, bartlett), type = "l", ylab = "Weight", main = "Bartlett Kernel")
```

---

robust_lm *Robust Linear Model Inference with Fixed-b Critical Values*

Description

Conducts robust inference for linear models using fixed-b asymptotics. This function computes robust standard errors, test statistics, and p-values for linear model coefficients, accounting for unknown serial correlation in the errors.

Usage

```
robust_lm(
  fit,
  the_kernel = "Bartlett",
  lugsail = "Mother",
  method = "simulated",
  tau = NA,
  alpha = 0.05,
  conf.int = FALSE
)
```

Arguments

fit	An lm object from a linear regression model.
the_kernel	Character string specifying the kernel function. Options are "Bartlett" (default), "Parzen", "TH" (Tukey-Hanning), or "QS" (Quadratic Spectral).
lugsail	Character string specifying the lugsail transformation. Options are "Mother" (default), "Zero", or "Over".
method	Character string specifying how critical values are computed. Options are "simulated" (default), "fitted", "analytical", or "adaptive".
tau	Numeric tolerance level for bandwidth selection. If NA (default), uses recommended values based on lugsail type.
alpha	Numeric significance level for hypothesis tests (default is 0.05).
conf.int	Logical indicating whether to compute confidence intervals (default is FALSE). If TRUE and alpha is one of 0.10, 0.05, 0.025, or 0.01, confidence intervals are added.

Details

This function largely follows the robust inference procedure described in Kurtz-Garcia and Flegal (2026). Standard errors are estimated using a HAC estimator with a choice of kernel functions. Both classical adaptive limiting theory `method = "adaptive"` and fixed limiting theory are supported, with multiple approximations available for the fixed-limiting theory.

The method = "simulated" option is only available for problems with up to 12 dimensions. In general, method = "analytical" is recommended for F-tests and for non-univariate tests.

By default, the null hypothesis for the F-test is that all slope coefficients are zero. If the model contains no slope coefficients, the null hypothesis is that the intercept is zero.

Because obtaining quantiles for the fixed-limit distribution is computationally expensive, exact p-values are not reported. Instead, thresholds are given indicating if the p-value is above 0.10 (>= 0.10), between 0.10 and 0.05 (<0.10), between 0.05 and 0.025 (<0.05.), between 0.025 and 0.01 (<0.025.), and less than 0.01 (<0.01*). For the same reason, confidence intervals are only available for a limited set of confidence levels.

Value

A list containing:

Summary_Table	Data frame with coefficient estimates, robust standard errors, t-statistics, and p-values.
F_test	Data frame with F-statistic and p-value for joint significance test.
CV_table	Data frame showing bandwidth (b), dimension, and critical values at different significance levels for each coefficient and the F-test.
vcov	The variance covariance matrix of the regression coefficients.

References

Rebecca P. Kurtz-Garcia and James M. Flegal. Inference optimal long run variance estimation with lugsail kernels, 2026. URL https://arxiv.org/abs/2606.17369.

Examples

```
# Simulate AR(1) data
set.seed(123)
n <- 100
x <- arima.sim(list(ar = 0.5), n)
y <- 2 + 3*x + arima.sim(list(ar = 0.7), n)
fit <- lm(y ~ x)

# Robust inference with default settings
robust_lm(fit)

# With different kernel and method
robust_lm(fit, the_kernel = "QS", method = "fitted")

# With confidence intervals
robust_lm(fit, conf.int = TRUE)
```

---

simulated_CV *Fixed Critical Values using the Simulated Method*

Description

The title of each data set is the <Mother>_<Lugsail>_<alpha>_Master.

Usage

```
Bartlett_Mother_01_Master

Bartlett_Mother_025_Master

Bartlett_Mother_05_Master

Bartlett_Mother_10_Master

Bartlett_Zero_01_Master

Bartlett_Zero_025_Master

Bartlett_Zero_05_Master

Bartlett_Zero_10_Master

Bartlett_Over_01_Master

Bartlett_Over_025_Master

Bartlett_Over_05_Master
```

Bartlett_Over_10_Master

QS_Mother_01_Master

QS_Mother_025_Master

QS_Mother_05_Master

QS_Mother_10_Master

QS_Zero_01_Master

QS_Zero_025_Master

QS_Zero_05_Master

QS_Zero_10_Master

QS_Over_01_Master

QS_Over_025_Master

QS_Over_05_Master

QS_Over_10_Master

Parzen_Mother_01_Master

Parzen_Mother_025_Master

Parzen_Mother_05_Master

Parzen_Mother_10_Master

Parzen_Zero_01_Master

Parzen_Zero_025_Master

Parzen_Zero_05_Master

Parzen_Zero_10_Master

Parzen_Over_01_Master

Parzen_Over_025_Master

Parzen_Over_05_Master

Parzen_Over_10_Master

TH_Mother_01_Master

TH_Mother_025_Master

TH_Mother_05_Master

TH_Mother_10_Master

TH_Zero_01_Master

TH_Zero_025_Master

TH_Zero_05_Master

TH_Zero_10_Master

TH_Over_01_Master

TH_Over_025_Master

TH_Over_05_Master

TH_Over_10_Master

Format

A look up table containing the simulated robust critical values. The 'b' column contains the bandwidth, and subsequent columns are the dimensions

- b: bandwidth of the test statistics. The proportion of autocovariances given a non-zero weight.
- d: the dimension of the test statistic.

Details

The title of each data set is the <Mother>_<Lugsail>_<alpha>_Master. Supported mother kernels are Bartlett, Parzen, Tukey-Hanning (TH), and Quadratic Spectral (QS). Supported lugsail settings are mother, zero, and over. The available critical values are 0.01, 0.025, 0.05, and 0.10. Note that when b = 0 the robust critical value are equivalent to chi-square critical values.

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