

Package ‘ExactVaRTest’

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Title Exact Finite-Sample Value-at-Risk Back-Testing

Version 0.1.3

Language en-US

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Description Provides fast dynamic-programming algorithms in 'C++/Rcpp' (with pure 'R' fallbacks) for the exact finite-sample distributions and p-values of Christoffersen (1998) independence (IND) and conditional-coverage (CC) VaR backtests. For completeness, it also provides the exact unconditional-coverage (UC) test following Kupiec (1995) via a closed-form binomial enumeration. See Christoffersen (1998) <[doi:10.2307/2527341](https://doi.org/10.2307/2527341)> and Kupiec (1995) <[doi:10.3905/jod.1995.407942](https://doi.org/10.3905/jod.1995.407942)>.

License GPL (>= 3)

Depends R (>= 3.5.0)

Imports Rcpp, stats

LinkingTo Rcpp

Suggests bench, dplyr, tidyr, purrr, ggplot2, xts, quantmod, knitr, rmarkdown, testthat (>= 3.0.0)

Encoding UTF-8

RoxygenNote 7.3.2

URL <https://github.com/YujianCHEN219/ExactVaRTest>

BugReports <https://github.com/YujianCHEN219/ExactVaRTest/issues>

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ExactVaRTest-package *ExactVaRTest – Exact Finite-Sample VaR Back-Testing*

Description

Provides fast dynamic-programming algorithms (C++/Rcpp) – with pure-R fall-backs – for the exact finite-sample distributions and p-values of Christoffersen’s (1998) VaR back-tests: Independence (IND) and Conditional Coverage (CC) tests, and the Unconditional Coverage (UC) test via closed-form binomial enumeration.

Author(s)

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See Also

Useful links:

- <https://github.com/YujianCHEN219/ExactVaRTest>
- Report bugs at <https://github.com/YujianCHEN219/ExactVaRTest/issues>

backtest_all	<i>Exact UC/IND/CC back-tests in one call</i>
--------------	---

Description

Exact UC/IND/CC back-tests in one call

Usage

```
backtest_all(x, alpha = 0.05, sig = 0.05, prune_threshold = 1e-15)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.
sig	Significance level (default 0.05).
prune_threshold	Passed to the dynamic programming engine.

Value

An object of class "ExactVaRBacktestAll" (a named list) with components: uc, ind, cc (each a list with stat, pval, reject), and scalars sig (significance level), alpha (model exception probability), n (sample size).

Examples

```
set.seed(1)
x <- rbinom(300, 1, 0.02)
backtest_all(x, alpha = 0.02)
```

backtest_lr	<i>Exact finite-sample back-test for a VaR exception series</i>
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Description

Exact finite-sample back-test for a VaR exception series

Usage

```
backtest_lr(
  x,
  alpha = 0.05,
  type = c("uc", "ind", "cc"),
  sig = 0.05,
  prune_threshold = 1e-15
)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.
type	"uc", "ind" or "cc".
sig	Significance level (default 0.05).
prune_threshold	Passed to the dynamic-programming engine.

Value

An object of class "ExactVaRBacktest" (a named list) with components: stat (numeric LR statistic), pval (numeric exact p -value in $[0, 1]$), reject (logical; TRUE if $p < sig$), type (character; one of "uc", "ind", "cc"), alpha (numeric model exception probability), sig (numeric significance level), n (integer sample size).

Examples

```
set.seed(123)
x <- rbinom(250, 1, 0.01)
backtest_lr(x, alpha = 0.01, type = "uc")
```

lr_cc_dist

Exact LR_cc (and LR_uc) distribution (auto-select engine)

Description

Returns the finite-sample distribution of Christoffersen's conditional-coverage statistic LR_{cc} . The returned list also includes the matching unconditional-coverage distribution LR_{uc} , produced by the same dynamic-programming run.

Usage

```
lr_cc_dist(n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.
prune_threshold	Probability below which states are pruned by the dynamic-programming recursion.

Value

A named list with elements LR_cc, prob_cc, LR_uc, prob_uc. The pairs (LR_cc, prob_cc) and (LR_uc, prob_uc) have equal lengths; each probability vector is in $[0, 1]$ and sums to 1.

Examples

```
lr_cc_dist(8, 0.05)
```

lr_cc_stat	<i>Christoffersen LR_cc statistic</i>
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Description

Christoffersen LR_cc statistic

Usage

```
lr_cc_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_cc statistic.

lr_ind_dist	<i>Exact LR_ind distribution (auto-select engine)</i>
-------------	---

Description

Returns the finite-sample distribution of Christoffersen's independence statistic LR_{ind} .

Usage

```
lr_ind_dist(n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.
prune_threshold	Probability below which states are pruned by the dynamic-programming recursion.

Value

A named list with elements LR and prob of equal length, where LR is the support of the LR statistic and prob are the corresponding probabilities in $[0, 1]$ that sum to 1.

Examples

```
lr_ind_dist(8, 0.05)
```

lr_ind_stat	<i>Christoffersen LR_ind statistic</i>
-------------	--

Description

Christoffersen LR_ind statistic

Usage

```
lr_ind_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_ind statistic.

lr_uc_dist	<i>Exact LR_uc distribution (closed-form binomial)</i>
------------	--

Description

Exact LR_uc distribution (closed-form binomial)

Usage

```
lr_uc_dist(n, alpha = 0.05)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.

Value

A named list with elements LR and prob of equal length, where LR is the support of the LR statistic and prob are the corresponding probabilities in $[0, 1]$ that sum to 1.

Examples

```
lr_uc_dist(8, 0.01)
```

lr_uc_stat	<i>Christoffersen LR_uc statistic</i>
------------	---------------------------------------

Description

Christoffersen LR_uc statistic

Usage

```
lr_uc_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_uc statistic.

print.ExactVaRBacktest	<i>Print method for ExactVaRBacktest</i>
------------------------	--

Description

Print method for ExactVaRBacktest

Usage

```
## S3 method for class 'ExactVaRBacktest'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

x	An object of class 'ExactVaRBacktest'.
digits	Number of digits to print.
...	Further arguments passed to or from other methods (ignored).

Details

Prints the test name, sample size n , model alpha, significance level, LR statistic, exact p-value, and the decision at the specified level.

Value

The input object x, returned invisibly (class ExactVaRBacktest).

```
print.ExactVaRBacktestAll
```

Print method for ExactVaRBacktestAll

Description

Print method for ExactVaRBacktestAll

Usage

```
## S3 method for class 'ExactVaRBacktestAll'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

x	An object of class 'ExactVaRBacktestAll'.
digits	Number of digits to print.
...	Further arguments passed to or from other methods (ignored).

Details

Prints a header with sample size n , model alpha and significance level, followed by per-test blocks for UC, IND, and CC: LR statistic, exact p-value, and the decision at the specified level.

Value

The input object x, returned invisibly (class ExactVaRBacktestAll).

```
pval_lr_cc
```

Exact p-value for LR_cc

Description

Exact p-value for LR_cc

Usage

```
pval_lr_cc(lr_obs, n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

lr_obs	Observed LR_cc statistic.
n	Sample size.
alpha	Exception probability.
prune_threshold	State-pruning threshold for DP engine.

Value

Numeric exact p -value in $[0, 1]$; may be NA_real_ if the finite-sample distribution is unavailable.

pval_lr_ind	<i>Exact p-value for LR_ind</i>
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Description

Exact p-value for LR_ind

Usage

```
pval_lr_ind(lr_obs, n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

lr_obs	Observed LR_ind statistic.
n	Sample size.
alpha	Exception probability.
prune_threshold	State-pruning threshold for DP engine.

Value

Numeric exact p -value in $[0, 1]$; may be NA_real_ if the finite-sample distribution is unavailable.

pval_lr_uc	<i>Exact p-value for LR_uc</i>
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Description

Exact p-value for LR_uc

Usage

```
pval_lr_uc(lr_obs, n, alpha = 0.05)
```

Arguments

lr_obs	Observed LR_uc statistic.
n	Sample size.
alpha	Exception probability.

Value

Numeric exact p -value in $[0, 1]$; may be NA_real_ if the finite-sample distribution is unavailable.

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