Package ‘vrtest’

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Type Package

Title Variance Ratio Tests and Other Tests for Martingale Difference Hypothesis

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Author Jae H. Kim

Maintainer Jae H. Kim <jaekim8080@gmail.com>

Description

A collection of statistical tests for martingale difference hypothesis, including automatic portmanteau test (Escansiano and Lobato, 2009) <doi:10.1016/j.jeconom.2009.03.001> and automatic variance ratio test (Kim, 2009) <doi:10.1016/j.frl.2009.04.003>.

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`vrtest-package` *Variance Ratio tests and other tests for Martingale Difference Hypothesis*

Description

A collection of variance ratio and spectral shapte tests

Details

Package:	vrtest
Type:	Package
Version:	1.2
Date:	2023-08-31
License:	GPL-2

Author(s)

Jae H. Kim

Maintainer: Jae H. Kim <J.Kim@latrobe.edu.au>

`Adjust.thin` *Adjustment for thinly-traded returns*

Description

The adjustment based on AR(1) fitting as proposed by Miller et al. (1994)

Usage

```
Adjust.thin(y)
```

Arguments

`y`	financial return time series

Value

Adjusted return

Author(s)

Jae H. Kim

References

Miller et al. (1994), Mean Reversion of Standard & Poor's 500 Index Base Changes: Arbitrage Induced or Statistical Illusion Journal of Finance, XLIX, 479-513.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
Adjust.thin(r)
```

`Auto.Q` *Automatic Portmanteau Test*

Description

A robustified portmanteau test with automatic lag selection

Usage

```
Auto.Q(y,lags)
```

Arguments

`y`	financial return time series
`lags`	maximum lag value, the default is 10

Value

`Stat`	Automatic portmanteau test statistic
`Pvalue`	p-value of the test

Author(s)

Jae H. Kim

References

Escanciano, J.C., Lobato, I.N. 2009a. An automatic portmanteau test for serial correlation. Journal of Econometrics 151, 140-149.

Charles, A. Darne, O. Kim, J.H. 2011, Small Sample Proeprties of Alternative Tests for Martingale Difference Hypothesis, Economics Letters, 110(2), 151-154.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
Auto.Q(r)
```

`Auto.VR` *Automatic Variance Ratio Test*

Description

A variance ratio test with holding period value chosen by a data dependent procedure

Usage

```
Auto.VR(y)
```

Arguments

`y`	financial return time series

Value

`stat`	Automatic variance ratio test statistic
`sum`	1+ weighted sum of autocorrelation up to the optimal order

Note

R code translated from Choi's GAUSS code

Author(s)

Jae H. Kim

References

Choi, I. 1999, Testing the random walk hypothesis for real exchange rates Journal of Applied Econometrics, 14, 293-308.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
Auto.VR(r)
```

AutoBoot.test *Wild Bootstrapping of Automatic Variance Ratio Test*

Description

This function returns wild bootstrap test results for the Automatic Variance Ratio Test of Choi (1999)

Usage

```
AutoBoot.test(y, nboot, wild,prob=c(0.025,0.975))
```

Arguments

y	a vector of time series, typically financial return
nboot	the number of bootstrap iterations
wild	"Normal" for the wild bootstrap using the standard normal distribution, "Mammen" for the wild bootstrap using Mammen's two point distribution, "Rademacher" for the wild bootstrap using Rademacher's two point distribution
prob	probability limits for confidence intervals

Value

test.stat	Automatic variance ratio test statistic
VRsum	1+ weighted sum of autocorrelation up to the optimal order
pval	Wild Bootstrap p-value for the test
CI	Confidence Intervals for the test statistic from Bootstrap distribution
CI.VRsum	Confidence Intervals for the VRsum from Bootstrap distribution

Author(s)

Jae H. Kim

References

Kim, J. H., 2009, Automatic Variance Ratio Test under Conditional Heteroskedascity, Finance Research Letters, 6(3), 179-185.

Charles, A. Darne, O. Kim, J.H. 2011, Small Sample Proeprties of Alternative Tests for Martingale Difference Hypothesis, Economics Letters, 110(2), 151-154.

Examples

```
r <- rnorm(100)
AutoBoot.test(r,nboot=500,wild="Normal")
```

Ave.Ex — *Average Exponential Tests*

Description

Average exponential tests of Andrews and Ploberger (1996)

Usage

```
Ave.Ex(y)
```

Arguments

`y`	financial return time series

Value

`Ex.LM`	LM test
`Ex.LR`	LR test

Note

Traslated from Choi's Gauss codes

Author(s)

Jae H. Kim

References

Choi, I. 1999, Testing the random walk hypothesis for real exchange rates, Journal of Applied Econometrics, 14, 293-308.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
Ave.Ex(r)
```

Boot.test *Bootstrap Variance Ratio Tests*

Description

This function returns bootstrap p-values of the Lo-MacKilay (1988) and Chow-Denning (1993) tests.

Users can choose between iid bootstrap and wild bootstrap

Usage

```
Boot.test(y, kvec, nboot, wild, prob=c(0.025,0.975))
```

Arguments

y	a vector of time series, typically financial return
kvec	a vector of holding periods
nboot	the number of bootstrap iterations
wild	"No" for iid bootstrap, "Normal" for the wild bootstrap using the standard normal distribution, "Mammen" for the wild bootstrap using Mammen's two point distribution, "Rademacher" for the wild bootstrap using Rademacher's two point distribution
prob	probability limits for confidence intervals

Value

Holding.Period	holding periods used
LM.pval	Bootstrap p-values for the Lo-MacKinlay tests
CD.pval	Bootstrap p-value for the Chow-Denning test
CI	Confidence Intervals for Lo-Mackinlay tests from Bootstrap distribution

Author(s)

Jae H. Kim

References

Kim, J.H., 2006, Wild Bootstrapping Variance Ratio Tests. Economics Letters, 92, 38-43.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Boot.test(r,kvec,nboot=500,wild="Normal")
```

Chen.Deo *Power Transformed Joint Variance Ratio Test*

Description

See equation (15) of Chen and Deo (2006)

Usage

```
Chen.Deo(x, kvec)
```

Arguments

`x`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Value

`Holding.Period`	holding periods used
`VRsum`	the sum of (power transformed individual VR - 1)
`QPn`	QPn statistic
`ChiSQ.Quantiles_1_2_5_10_20_percent`	Chi-square critical values

Author(s)

Jae H. Kim

References

Chen, W. W., and Deo, R.S., 2006, The Variance Ratio Statistic at Large Horizons, Econometric Theory, 22, 206-234.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Chen.Deo(r,kvec)
```

`Chow.Denning` *Chow-Denning Multiple Variance Ratio Tests*

Description

This function returns Chow-Denning test statistics.

CD1: test for iid series; CD2: test for uncorrelated series with possible heteroskedasticity.

Usage

```
Chow.Denning(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Value

`Holding.Periods`	holding periods used
`CD1`	CD1 statistic
`CD2`	CD2 statistic
`Critical.Values_10_5_1_percent`	10 5 1 percent critical values

Note

See Chow and Denning (1993) for the details of critical value calculation

Author(s)

Jae H. Kim

References

Chow,K. V., K. C. DENNING, 1993, A Simple Multiple Variance Ratio Test, Journal of Econometrics, 58, 385-401.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Chow.Denning(r,kvec)
```

DL.test *Dominguez-Lobato Test for Martingale Difference Hypothesis*

Description

Dominguez-Lobato Test

Usage

```
DL.test(y,B,p)
```

Arguments

y	financial return time series
B	the number of bootstrap iterations, the default is 300
p	the lag value, the default is 1

Value

Cp	Cramer von Mises test statistic
Kp	Kolmogorov-Smirnov test statistic
Cp_pval	wild bootstrap p-value of the Cp test
Kp_pval	wild bootstrap p-value of the Kp test

Author(s)

Jae H. Kim

References

Domingues M.A. and Lobato, I. N., 2003, Testing the Martingale Difference Hypothesis, Econometrics Reviews, 22, p351-377.

Charles, A. Darne, O. Kim, J.H. 2011, Small Sample Proeprties of Alternative Tests for Martingale Difference Hypothesis, Economics Letters, 110(2), 151-154.

Examples

```
r <- rnorm(50)
DL.test(r,B=100)
# B=100 is used for fast execution in the example.
# Use a higher number in actual application
```

exrates *wright's Exchange Rates Data*

Description

The data set used in Wright (2001) as an application, weekly from August, 7, 1974 to May 29 1996

Usage

```
data(exrates)
```

Format

A data frame with 1139 observations on the following 5 variables.

`ca` a numeric vector, Canadian Dollar

`dm` a numeric vector, Deutch Mark

`ff` a numeric vector, French Franc

`uk` a numeric vector, UK Pound

`jp` a numeric vector, Japanese Yen

References

WRIGHT,J.H.,2000,Alternative Variance-Ratio Tests Using Ranks and Signs, Journal of Business & Economic Statistics, 18, 1-9.

Examples

```
data(exrates)
```

Gen.Spec.Test *Generalized spectral Test*

Description

Generalized spectral Test

Usage

```
Gen.Spec.Test(y,B)
```

Arguments

`y`	financial return time series
`B`	the number of bootstrap iterations, the default is 300

Value

`Pboot`	wild bootstrap p-value of the test

Author(s)

Jae H. Kim

References

Escanciano, J.C. and Velasco, C., 2006, Generalized Spectral Tests for the martigale Difference Hypothesis, Journal of Econometrics, 134, p151-185.

Charles, A. Darne, O. Kim, J.H. 2011, Small Sample Proeprties of Alternative Tests for Martingale Difference Hypothesis, Economics Letters, 110(2), 151-154.

Examples

```
r <- rnorm(100)
Gen.Spec.Test(r)
```

`Joint.Wright` *A Joint Version of Wight's Rank and Sign Test*

Description

This function returns joint or multiple version of Wright's rank and sign tests. The test takes the maximum value of the individual rank or sign tests, in the same manner as Chow-Denning test

Usage

```
Joint.Wright(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Value

`Holding.Period`	holding periods used
`JR1`	Joint test based on R1 statistics
`JR2`	Joint test based on R2 statistics
`JS1`	Joint test based on S1 statistics

Author(s)

Jae H. Kim

References

Belaire-Franch G, Contreras D. Ranks and signs-based multiple variance ratio tests, Working paper, University of Valencia 2004.

Kim, J. H. and Shamsuddin, A., 2008, Are Asian Stock Markets Efficient? Evidence from New Multiple Variance Ratio Tests, Journal of Empirical Fiance 15(8), 518-532.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Joint.Wright(r,kvec)
```

JWright.crit — *Critical Values for the joint versions of Wright's rank and sign tests*

Description

This function runs a simulation to calculate the critical values of the joint versions of Wright's tests.

Usage

```
JWright.crit(n, kvec, nit)
```

Arguments

`n`	sample size
`kvec`	holding period vector
`nit`	number of iterations

Value

`Holding.Period`	holding period used
`JR1.crit`	Critical values for the joint R1 statistic
`JR2.crit`	Critical values for the joint R2 statistic
`JS1.crit`	Critical values for the joint S1 statistic

Author(s)

Jae H. Kim

References

Belaire-Franch G, Contreras D. Ranks and signs-based multiple variance ratio tests, Working paper, University of Valencia 2004.

Kim, J. H. and Shamsuddin, A., 2008, Are Asian Stock Markets Efficient? Evidence from New Multiple Variance Ratio Tests, Journal of Empirical Fiance 15(8), 518-532.

Examples

```
kvec <- c(2,5,10)
JWright.crit(n=100,kvec,nit=50)

# nit is set to 50 for fast execution in the example.
# nit=10000 is recommended as in Wright (2000)
```

Lo.Mac *Lo-MacKinlay variance Ratio Tests*

Description

The function returns M1 and M2 statistics of Lo and MacKinlay (1998).

M1: tests for iid series; M2: for uncorrelated series with possible heteroskedasticity.

Usage

```
Lo.Mac(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Value

`Stats`	M1 and M2 statistics

Author(s)

Jae H. Kim

References

LO, A. W., and A. C. MACKINLAY (1988): "Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test," The Review of Financial Studies, 1, 41-66.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Lo.Mac(r,kvec)
```

Panel.VR — *Panel Variance Ratio Tests*

Description

Panel variance tatio tests based on Maximum Absloute Value, Sum of Squares, and Mean of each cross-sectional units

Usage

```
Panel.VR(dat, nboot = 500)
```

Arguments

`dat`	a T by K matrix of asset returns, K is the munber of cross sectional units and T is length of time series
`nboot`	the number of wild bootstrap iterations, the default is set to 500

Details

The component statistics are based on the automatic variance ratio test The set of returns are wild bootstrapped to conserve cross-sectional dependency

Value

`MaxAbs.stat`	the statistic based on the maximum absolute value of individual statistics
`SumSquare.stat`	the statistic based on the sum of squared value of individual statistics
`Mean.stat`	the statistic based on the mean value of individual statistics
`MaxAbs.pval`	the wild bootstrap pvalue based on the maximum absolute value of individual statistics
`SumSquare.pval`	the wild bootstrap pvalue based on the sum of squared value of individual statistics
`Mean.pval`	the wild bootstrap pvalue based on the mean value of individual statistics

Author(s)

Jae H. Kim

References

Kim, J. H., & Shamsuddin, A. (2015). A closer look at return predictability of the US stock market: evidence from new panel variance ratio tests. Quantitative Finance, 15(9), 1501-1514.

Examples

```
ret=matrix(rnorm(200),nrow=100)
Panel.VR(ret)
```

`Spec.shape` *Spectral shape tests for random walk*

Description

Spectral Shape tests proposed by Durlauf (1991) and Choi (1999)

Usage

```
Spec.shape(x)
```

Arguments

`x`	financial return time series

Value

`AD`	Anderson-Darling statistic
`CVM`	Cramer-von Mises statistic
`M`	Mellows statistic

Note

Traslated from Choi's Gauss codes

Author(s)

Jae H. Kim

References

Choi, I. 1999, Testing the random walk hypothesis for real exchange rates, Journal of Applied Econometrics, 14, 293-308. Durlauf, S. N., 1991, Spectral based testing of the martingale hypothesis, Journal of Econometrics, 50, 355-376.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
Spec.shape(r)
```

`Subsample.test` *Subsampling test of Whang and Kim (2003)*

Description

The function returns the p-values of the subsampling test.

Usage

```
Subsample.test(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Details

The block lengths are chosen internally using the rule proposed in Whang and Kim (2003)

Value

`Holding.Period`	holding periods used
`Block.Length`	block lengths chosen
`pval`	p-values of the test for each block length used

Author(s)

Jae H. Kim

References

WHANG,Y.-J., J. KIM, 2003, A Multiple Variance Ratio Test Using Subsampling, Economics Letters, 79, 225-230.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Subsample.test(r,kvec)
```

`VR.minus.1` *Absolute Value of (VR - 1)*

Description

This value is sometimes used to measure the degree of market efficiency

Usage

```
VR.minus.1(y, kvec)
```

Arguments

`y`	financial return time series
`kvec`	a vector of holding periods

Value

`VR.auto`	the value of VR-1 with automatic selection of holding vectors
`Holding.Peiods`	the vector of holding periods
`VR.kvec`	the values of VR-1 for the chosen holding periods

Note

see Auto.VR function for automatic selection of holding periods

Author(s)

Jae H. Kim

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
kvec <- c(2,5,10)
r <- log(y[2:nob])-log(y[1:(nob-1)])
VR.minus.1(r,kvec)
```

VR.plot	*Variance Ratio Plot*

Description

Plotting unstandadized variance ratios against holding periods with 95percent confidence band Standard errors under iid returns are used.

Usage

```
VR.plot(y, kvec)
```

Arguments

`y`	financial return
`kvec`	holding period vector

Value

`VR`	vector of variance ratio values plotted

Author(s)

Jae H. Kim & Alexios Ghalanos

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
VR.plot(r,kvec)
```

Wald	*Wald Test of Richardson and Smith (1991)*

Description

This function returns the Wald test statistic with critical values

Usage

```
Wald(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Value

`Holding.Periods`
: holding periods used

`Wald.stat`
: Wald test statistic

`Critical.Values_10_5_1_percent`
: 10 5 and 1 percent critical values

Note

The statistic asymptotically follows the chi-squared distribution with the degrees of freedom same as the number of holding periods used

Author(s)

Jae H. Kim

References

Richardson, M., T. Smith, 1991, "Tests of Financial Models in the Presence of Overlapping Observations," The Review Financial Studies, 4, 227-254.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Wald(r,kvec)
```

`Wright` *Wright's Rank and Sign Tests*

Description

The function returns R1, R2 and S1 tests statistics detailed in Wright (2000)

Usage

```
Wright(y, kvec)
```

Arguments

`y`	a vector of time series, typically financial return
`kvec`	a vector of holding periods

Details

Nonparametric tests

Value

`Holding.Period`	holding periods used
`R1.test`	rank test R1
`R2.test`	rank test R2
`S1.test`	sign test S1

Author(s)

Jae H. Kim

References

WRIGHT,J.H.,2000,Alternative Variance-Ratio Tests Using Ranks and Signs, Journal of Business & Economic Statistics, 18, 1-9.

Examples

```
data(exrates)
y <- exrates$ca
nob <- length(y)
r <- log(y[2:nob])-log(y[1:(nob-1)])
kvec <- c(2,5,10)
Wright(r,kvec)
```

`Wright.crit` *Critical Values for Wright's rank and sign tests*

Description

This function returns critical values of Wright's tests based on the simulation method detailed in Wright (2000)

Usage

```
Wright.crit(n, k, nit)
```

Arguments

`n`	sample size
`k`	holding period, a scalar
`nit`	number of iterations

Value

`Holding.Period`	holding period used
`R1.crit`	Critical values for the R1 statistic
`R2.crit`	Critical values for the R2 statistic
`S1.crit`	Critical values for the S1 statistic

Author(s)

Jae H. Kim

References

WRIGHT,J.H.,2000,Alternative Variance-Ratio Tests Using Ranks and Signs, Journal of Business & Economic Statistics, 18, 1-9.

Examples

```
Wright.crit(n=10,k=2,nit=50)

# nit is set to 50 for fast execution in the example.
# nit=10000 is recommended as in Wright (2000)
```

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