

# Package ‘vrtest’

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**Type** Package

**Title** Variance Ratio Tests and Other Tests for Martingale Difference Hypothesis

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**Description**

A collection of statistical tests for martingale difference hypothesis, including automatic port-manteau 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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## R topics documented:

vrtest-package . . . . .	2
Adjust.thin . . . . .	2
Auto.Q . . . . .	3
Auto.VR . . . . .	4
AutoBoot.test . . . . .	5
Ave.Ex . . . . .	6
Boot.test . . . . .	7
Chen.Deo . . . . .	8
Chow.Denning . . . . .	9
DL.test . . . . .	10
exrates . . . . .	11
Gen.Spec.Test . . . . .	11
Joint.Wright . . . . .	12
JWright.crit . . . . .	13

Lo.Mac . . . . .	14
Panel.VR . . . . .	15
Spec.shape . . . . .	16
Subsample.test . . . . .	17
VR.minus.1 . . . . .	18
VR.plot . . . . .	19
Wald . . . . .	19
Wright . . . . .	20
Wright.crit . . . . .	21

## Index 23

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vrtest-package	<i>Variance Ratio tests and other tests for Martingale Difference Hypothesis</i>
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### Description

A collection of variance ratio and spectral shape tests

### Details

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Type:	Package
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Date:	2014-08-10
License:	GPL-2

### Author(s)

Jae H. Kim

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Adjust.thin	<i>Adjustment for thinly-traded returns</i>
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---

### 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 Properties 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**

<code>y</code>	a vector of time series, typically financial return
<code>kvec</code>	a vector of holding periods

**Value**

<code>Holding.Periods</code>	holding periods used
<code>CD1</code>	CD1 statistic
<code>CD2</code>	CD2 statistic
<code>Critical.Values_10_5_1_percent</code>	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**

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

**Value**

<code>Cp</code>	Cramer von Mises test statistic
<code>Kp</code>	Kolmogorov-Smirnov test statistic
<code>Cp_pval</code>	wild bootstrap p-value of the Cp test
<code>Kp_pval</code>	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 Properties 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	<i>wright's Exchange Rates Data</i>
---------	-------------------------------------

---

**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	<i>Generalized spectral Test</i>
-----------------	----------------------------------

---

**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 Finance 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 Finance 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 ratio tests based on Maximum Absolute 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 number 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	<i>Subsampling test of Whang and Kim (2003)</i>
----------------	---

---

**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
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	<i>Variance Ratio Plot</i>
---------	----------------------------

---

**Description**

Plotting unstandardized 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	<i>Wald Test of Richardson and Smith (1991)</i>
------	---

---

**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)
```

# Index

## \* datasets

exrates, [11](#)

## \* htest

Adjust.thin, [2](#)

Auto.Q, [3](#)

Auto.VR, [4](#)

AutoBoot.test, [5](#)

Ave.Ex, [6](#)

Boot.test, [7](#)

Chen.Deo, [8](#)

Chow.Denning, [9](#)

DL.test, [10](#)

Gen.Spec.Test, [11](#)

Joint.Wright, [12](#)

JWright.crit, [13](#)

Lo.Mac, [14](#)

Panel.VR, [15](#)

Spec.shape, [16](#)

Subsample.test, [17](#)

VR.minus.1, [18](#)

VR.plot, [19](#)

vrtest-package, [2](#)

Wald, [19](#)

Wright, [20](#)

Wright.crit, [21](#)

Gen.Spec.Test, [11](#)

Joint.Wright, [12](#)

JWright.crit, [13](#)

Lo.Mac, [14](#)

Panel.VR, [15](#)

Spec.shape, [16](#)

Subsample.test, [17](#)

VR.minus.1, [18](#)

VR.plot, [19](#)

vrtest (vrtest-package), [2](#)

vrtest-package, [2](#)

Wald, [19](#)

Wright, [20](#)

Wright.crit, [21](#)

Adjust.thin, [2](#)

Auto.Q, [3](#)

Auto.VR, [4](#)

AutoBoot.test, [5](#)

Ave.Ex, [6](#)

Boot.test, [7](#)

Chen.Deo, [8](#)

Chow.Denning, [9](#)

DL.test, [10](#)

exrates, [11](#)