

# Package ‘Dowd’

March 11, 2016

**Type** Package

**Title** Functions Ported from 'MMR2' Toolbox Offered in Kevin Dowd's Book Measuring Market Risk

**Version** 0.12

**Date** 2015-08-20

**Author** Dinesh Acharya <dines.acharya@gmail.com>

**Maintainer** Dinesh Acharya <dines.acharya@gmail.com>

**Description** 'Kevin Dowd's' book Measuring Market Risk is a widely read book in the area of risk measurement by students and practitioners alike. As he claims, 'MATLAB' indeed might have been the most suitable language when he originally wrote the functions, but, with growing popularity of R it is not entirely valid. As 'Dowd's' code was not intended to be error free and were mainly for reference, some functions in this package have inherited those errors. An attempt will be made in future releases to identify and correct them. 'Dowd's' original code can be downloaded from [www.kevindowd.org/measuring-market-risk/](http://www.kevindowd.org/measuring-market-risk/).

It should be noted that 'Dowd' offers both 'MMR2' and 'MMR1' toolboxes. Only 'MMR2' was ported to R. 'MMR2' is more recent version of 'MMR1' toolbox and they both have mostly similar function. The toolbox mainly contains different parametric and non parametric methods for measurement of market risk as well as backtesting risk measurement methods.

**Depends** R (>= 3.0.0), bootstrap, MASS, forecast

**Suggests** PerformanceAnalytics, testthat

**License** GPL

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2016-03-11 00:45:03

**R topics documented:**

Dowd-package	5
AdjustedNormalESHotsspots	5
AdjustedNormalVaRHotspots	6
AdjustedVarianceCovarianceES	7
AdjustedVarianceCovarianceVaR	8
ADTestStat	9
AmericanPutESBinomial	10
AmericanPutESSim	11
AmericanPutPriceBinomial	13
AmericanPutVaRBinomial	14
BinomialBacktest	15
BlackScholesCallESSim	16
BlackScholesCallPrice	17
BlackScholesPutESSim	18
BlackScholesPutPrice	19
BlancoIhleBacktest	20
BootstrapES	21
BootstrapESConfInterval	22
BootstrapESFigure	23
BootstrapVaR	23
BootstrapVaRConfInterval	24
BootstrapVaRFigure	25
BoxCoxES	26
BoxCoxVaR	27
CdfOfSumUsingGaussianCopula	28
CdfOfSumUsingGumbelCopula	29
CdfOfSumUsingProductCopula	30
ChristoffersenBacktestForIndependence	31
ChristoffersenBacktestForUnconditionalCoverage	32
CornishFisherES	33
CornishFisherVaR	34
DBPensionVaR	35
DCPensionVaR	36
DefaultRiskyBondVaR	37
FilterStrategyLogNormalVaR	38
FrechetES	39
FrechetESPlot2DCI	40
FrechetVaR	41
FrechetVaRPlot2DCI	42
GaussianCopulaVaR	43
GParetoES	44
GParetoMEFPlot	45
GParetoMultipleMEFPlot	45
GParetoVaR	46
GumbelCopulaVaR	47
GumbelES	48

GumbelESPlot2DCI . . . . .	49
GumbelVaR . . . . .	50
GumbelVaRPlot2DCI . . . . .	51
HillEstimator . . . . .	51
HillPlot . . . . .	52
HillQuantileEstimator . . . . .	53
HSES . . . . .	54
HSESDFPerc . . . . .	55
HSEFigure . . . . .	56
HSEPlot2DCI . . . . .	56
HSVaR . . . . .	57
HSVaRDFPerc . . . . .	58
HSVaRESPlot2DCI . . . . .	59
HSVaRFigure . . . . .	59
HSVaRPlot2DCI . . . . .	60
InsuranceVaR . . . . .	61
InsuranceVaRES . . . . .	62
JarqueBeraBacktest . . . . .	63
KernelESBoxKernel . . . . .	64
KernelESEpanechinikovKernel . . . . .	64
KernelESNormalKernel . . . . .	65
KernelESTriangleKernel . . . . .	66
KernelVaRBoxKernel . . . . .	67
KernelVaREpanechinikovKernel . . . . .	67
KernelVaRNormalKernel . . . . .	68
KernelVaRTriangleKernel . . . . .	69
KSTestStat . . . . .	70
KuiperTestStat . . . . .	71
LogNormalES . . . . .	72
LogNormalESDFPerc . . . . .	73
LogNormalESFigure . . . . .	74
LogNormalESPlot2DCL . . . . .	75
LogNormalESPlot2DHP . . . . .	76
LogNormalESPlot3D . . . . .	77
LogNormalVaR . . . . .	78
LogNormalVaRDFPerc . . . . .	79
LogNormalVaRETLPlot2DCL . . . . .	80
LogNormalVaRFigure . . . . .	81
LogNormalVaRPlot2DCL . . . . .	82
LogNormalVaRPlot2DHP . . . . .	83
LogNormalVaRPlot3D . . . . .	84
LogtES . . . . .	85
LogtESDFPerc . . . . .	86
LogtESPlot2DCL . . . . .	87
LogtESPlot2DHP . . . . .	88
LogtESPlot3D . . . . .	89
LogtVaR . . . . .	90
LogtVaRDFPerc . . . . .	91

LogtVaRPlot2DCL . . . . .	92
LogtVaRPlot2DHP . . . . .	93
LogtVaRPlot3D . . . . .	94
LongBlackScholesCallVaR . . . . .	95
LongBlackScholesPutVaR . . . . .	96
LopezBacktest . . . . .	97
MEFPlot . . . . .	98
NormalES . . . . .	98
NormalESConfidenceInterval . . . . .	99
NormalESDFPerc . . . . .	100
NormalESFigure . . . . .	101
NormalESHotspots . . . . .	102
NormalESPlot2DCL . . . . .	103
NormalESPlot2DHP . . . . .	104
NormalESPlot3D . . . . .	105
NormalQQPlot . . . . .	106
NormalQuantileStandardError . . . . .	106
NormalSpectralRiskMeasure . . . . .	107
NormalVaR . . . . .	108
NormalVaRConfidenceInterval . . . . .	109
NormalVaRDFPerc . . . . .	110
NormalVaRFigure . . . . .	111
NormalVaRHotspots . . . . .	112
NormalVaRPlot2DCL . . . . .	113
NormalVaRPlot2DHP . . . . .	114
NormalVaRPlot3D . . . . .	115
PCAES . . . . .	116
PCAESPlot . . . . .	117
PCAPrelim . . . . .	117
PCAVaR . . . . .	118
PCAVaRPlot . . . . .	119
PickandsEstimator . . . . .	120
PickandsPlot . . . . .	120
ProductCopulaVaR . . . . .	121
ShortBlackScholesCallVaR . . . . .	122
ShortBlackScholesPutVaR . . . . .	123
StopLossLogNormalVaR . . . . .	124
tES . . . . .	125
tESDFPerc . . . . .	126
tESFigure . . . . .	127
tESPlot2DCL . . . . .	128
tESPlot2DHP . . . . .	129
tESPlot3D . . . . .	130
TQQPlot . . . . .	131
tQuantileStandardError . . . . .	131
tVaR . . . . .	132
tVaRDFPerc . . . . .	133
tVaRESPlot2DCL . . . . .	134

tVaRFigure . . . . .	135
tVaRPlot2DCL . . . . .	136
tVaRPlot2DHP . . . . .	137
tVaRPlot3D . . . . .	138
VarianceCovarianceES . . . . .	139
VarianceCovarianceVaR . . . . .	140

<b>Index</b>	<b>142</b>
--------------	------------

---

Dowd-package	<i>R-version of Kevin Dowd's MATLAB Toolbox from book "Measuring Market Risk".</i>
--------------	--

---

### Description

Dowd Kevin Dowd's book "Measuring Market Risk" gives overview of risk measurement procedures with focus on Value at Risk (VaR) and Expected Shortfall (ES).

### Acknowledgments

Without Kevin Dowd's book Measuring Market Risk and accompanying MATLAB toolbox, this project would not have been possible.

Peter Carl and Brian G. Peterson deserve special acknowledgement for mentoring me on this project.

### Author(s)

Dinesh Acharya

Maintainer: Dinesh Acharya <dines.acharya@gmail.com>

### References

Dowd, K. *Measuring Market Risk*. Wiley. 2005.

---

AdjustedNormalESHspots	<i>Hotspots for ES adjusted by Cornish-Fisher correction</i>
------------------------	--

---

### Description

Estimates the ES hotspots (or vector of incremental ESs) for a portfolio with portfolio return adjusted for non-normality by Cornish-Fisher correction, for specified confidence level and holding period.

**Usage**

```
AdjustedNormalESHotspots(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

**Arguments**

vc.matrix	Variance covariance matrix for returns
mu	Vector of expected position returns
skew	Return skew
kurtosis	Return kurtosis
positions	Vector of positions
cl	Confidence level and is scalar
hp	Holding period and is scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Hotspots for ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4)
skew <- .5
kurtosis <- 1.2
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
AdjustedNormalESHotspots(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

---

AdjustedNormalVaRHotspots

*Hotspots for VaR adjusted by Cornish-Fisher correction*

---

**Description**

Estimates the VaR hotspots (or vector of incremental VaRs) for a portfolio with portfolio return adjusted for non-normality by Cornish-Fisher correction, for specified confidence level and holding period.

**Usage**

```
AdjustedNormalVaRHotspots(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

**Arguments**

vc.matrix	Variance covariance matrix for returns
mu	Vector of expected position returns
skew	Return skew
kurtosis	Return kurtosis
positions	Vector of positions
cl	Confidence level and is scalar
hp	Holding period and is scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Hotspots for ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4)
skew <- .5
kurtosis <- 1.2
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
AdjustedNormalVaRHotspots(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

---

AdjustedVarianceCovarianceES

*Cornish-Fisher adjusted Variance-Covariance ES*

---

**Description**

Function estimates the Variance-Covariance ES of a multi-asset portfolio using the Cornish - Fisher adjustment for portfolio return non-normality, for specified confidence level and holding period.

**Usage**

```
AdjustedVarianceCovarianceES(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

**Arguments**

vc.matrix	Variance covariance matrix for returns
mu	Vector of expected position returns
skew	Return skew
kurtosis	Return kurtosis
positions	Vector of positions
cl	Confidence level and is scalar
hp	Holding period and is scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Variance-covariance ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16), 4, 4)
mu <- rnorm(4)
skew <- .5
kurtosis <- 1.2
positions <- c(5, 2, 6, 10)
cl <- .95
hp <- 280
AdjustedVarianceCovarianceES(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

---

AdjustedVarianceCovarianceVaR

*Cornish-Fisher adjusted variance-covariance VaR*

---

**Description**

Estimates the variance-covariance VaR of a multi-asset portfolio using the Cornish-Fisher adjustment for portfolio-return non-normality, for specified confidence level and holding period.

**Usage**

```
AdjustedVarianceCovarianceVaR(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```



**Arguments**

vc.matrix	Assumed variance covariance matrix for returns
mu	Vector of expected position returns
skew	Portfolio return skewness
kurtosis	Portfolio return kurtosis
positions	Vector of positions
cl	Confidence level and is scalar or vector
hp	Holding period and is scalar or vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Variance-covariance for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4)
skew <- .5
kurtosis <- 1.2
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
AdjustedVarianceCovarianceVaR(vc.matrix, mu, skew, kurtosis, positions, cl, hp)
```

---

ADTestStat	<i>Plots cumulative density for AD test and computes confidence interval for AD test stat.</i>
------------	--

---

**Description**

Anderson-Darling(AD) test can be used to carry out distribution equality test and is similar to Kolmogorov-Smirnov test. AD test statistic is defined as:

$$A^2 = n \int_{-\infty}^{\infty} \frac{[\hat{F}(x) - F(x)]^2}{F(x)[1 - F(x)]} dF(x)$$

which is equivalent to

$$= -n - \frac{1}{n} \sum_{i=1}^n (2i - 1) [\ln F(X_i) + \ln(1 - F(X_{n+1-i}))]$$

**Usage**

```
ADTestStat(number.trials, sample.size, confidence.interval)
```

**Arguments**

```
number.trials  Number of trials
sample.size    Sample size
confidence.interval
                Confidence Interval
```

**Value**

Confidence Interval for AD test statistic

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Anderson, T.W. and Darling, D.A. Asymptotic Theory of Certain Goodness of Fit Criteria Based on Stochastic Processes, The Annals of Mathematical Statistics, 23(2), 1952, p. 193-212.

Kvam, P.H. and Vidakovic, B. Nonparametric Statistics with Applications to Science and Engineering, Wiley, 2007.

**Examples**

```
# Probability that the VaR model is correct for 3 failures, 100 number
# observations and 95% confidence level
ADTestStat(1000, 100, 0.95)
```

---

AmericanPutESBinomial *Estimates ES of American vanilla put using binomial tree.*

---

**Description**

Estimates ES of American Put Option using binomial tree to price the option and historical method to compute the VaR.

**Usage**

```
AmericanPutESBinomial(amountInvested, stockPrice, strike, r, volatility,
maturity, numberSteps, cl, hp)
```

**Arguments**

amountInvested	Total amount paid for the Put Option.
stockPrice	Stock price of underlying stock.
strike	Strike price of the option.
r	Risk-free rate.
volatility	Volatility of the underlying stock.
maturity	Time to maturity of the option in days.
numberSteps	The number of time-steps considered for the binomial model.
cl	Confidence level for which VaR is computed.
hp	Holding period of the option in days.

**Value**

ES of the American Put Option

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Market Risk of American Put with given parameters.
AmericanPutESBinomial(0.20, 27.2, 25, .16, .05, 60, 20, .95, 30)
```

---

AmericanPutESSim	<i>Estimates ES of American vanilla put using binomial option valuation tree and Monte Carlo Simulation</i>
------------------	---

---

**Description**

Estimates ES of American Put Option using binomial tree to price the option valuation tree and Monte Carlo simulation with a binomial option valuation tree nested within the MCS. Historical method to compute the VaR.

**Usage**

```
AmericanPutESSim(amountInvested, stockPrice, strike, r, mu, sigma, maturity,
numberTrials, numberSteps, cl, hp)
```

**Arguments**

amountInvested	Total amount paid for the Put Option and is positive (negative) if the option position is long (short)
stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate
mu	Expected rate of return on the underlying asset and is in annualised term
sigma	Volatility of the underlying stock and is in annualised term
maturity	The term to maturity of the option in days
numberTrials	The number of iterations in the Monte Carlo simulation exercise
numberSteps	The number of steps over the holding period at each of which early exercise is checked and is at least 2
c1	Confidence level for which VaR is computed and is scalar
hp	Holding period of the option in days and is scalar

**Value**

Monte Carlo Simulation VaR estimate and the bounds of the 95 confidence interval for the VaR, based on an order-statistics analysis of the P/L distribution

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Market Risk of American Put with given parameters.
AmericanPutESSim(0.20, 27.2, 25, .16, .2, .05, 60, 30, 20, .95, 30)
```

---

`AmericanPutPriceBinomial`*Binomial Put Price*

---

**Description**

Estimates the price of an American Put, using the binomial approach.

**Usage**

```
AmericanPutPriceBinomial(stockPrice, strike, r, sigma, maturity, numberSteps)
```

**Arguments**

<code>stockPrice</code>	Stock price of underlying stock
<code>strike</code>	Strike price of the option
<code>r</code>	Risk-free rate
<code>sigma</code>	Volatility of the underlying stock and is in annualised term
<code>maturity</code>	The term to maturity of the option in days
<code>numberSteps</code>	The number of time-steps in the binomial tree

**Value**

Binomial American put price

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Estimates the price of an American Put  
AmericanPutPriceBinomial(27.2, 25, .03, .2, 60, 30)
```

---

AmericanPutVaRBinomial

*Estimates VaR of American vanilla put using binomial tree.*

---

### Description

Estimates VaR of American Put Option using binomial tree to price the option and historical method to compute the VaR.

### Usage

```
AmericanPutVaRBinomial(amountInvested, stockPrice, strike, r, volatility,  
maturity, numberSteps, cl, hp)
```

### Arguments

amountInvested	Total amount paid for the Put Option.
stockPrice	Stock price of underlying stock.
strike	Strike price of the option.
r	Risk-free rate.
volatility	Volatility of the underlying stock.
maturity	Time to maturity of the option in days.
numberSteps	The number of time-steps considered for the binomial model.
cl	Confidence level for which VaR is computed.
hp	Holding period of the option in days.

### Value

VaR of the American Put Option

### Author(s)

Dinesh Acharya

### References

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.  
Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

### Examples

```
# Market Risk of American Put with given parameters.  
AmericanPutVaRBinomial(0.20, 27.2, 25, .16, .05, 60, 20, .95, 30)
```

---

BinomialBacktest	<i>Carries out the binomial backtest for a VaR risk measurement model.</i>
------------------	--

---

**Description**

The basic idea behind binomial backtest (also called basic frequency test) is to test whether the observed frequency of losses that exceed VaR is consistent with the frequency of tail losses predicted by the model. Binomial Backtest carries out the binomial backtest for a VaR risk measurement model for specified VaR confidence level and for a one-sided alternative hypothesis (H1).

**Usage**

```
BinomialBacktest(x, n, cl)
```

**Arguments**

x	Number of failures
n	Number of observations
cl	Confidence level for VaR

**Value**

Probability that the VaR model is correct

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Kupiec, Paul. Techniques for verifying the accuracy of risk measurement models, Journal of Derivatives, Winter 1995, p. 79.

**Examples**

```
# Probability that the VaR model is correct for 3 failures, 100 number  
# observations and 95% confidence level  
BinomialBacktest(55, 1000, 0.95)
```

---

BlackScholesCallESSim *ES of Black-Scholes call using Monte Carlo Simulation*

---

**Description**

Estimates ES of Black-Scholes call Option using Monte Carlo simulation

**Usage**

```
BlackScholesCallESSim(amountInvested, stockPrice, strike, r, mu, sigma,
    maturity, numberTrials, cl, hp)
```

**Arguments**

amountInvested	Total amount paid for the Call Option and is positive (negative) if the option position is long (short)
stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate
mu	Expected rate of return on the underlying asset and is in annualised term
sigma	Volatility of the underlying stock and is in annualised term
maturity	The term to maturity of the option in days
numberTrials	The number of iterations in the Monte Carlo simulation exercise
cl	Confidence level for which ES is computed and is scalar
hp	Holding period of the option in days and is scalar

**Value**

ES

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

Lyu, Yuh-Dauh. *Financial Engineering & Computation: Principles, Mathematics, Algorithms*, Cambridge University Press, 2002.

**Examples**

```
# Market Risk of American call with given parameters.
BlackScholesCallESSim(0.20, 27.2, 25, .16, .2, .05, 60, 30, .95, 30)
```



---

BlackScholesCallPrice *Price of European Call Option*

---

**Description**

Derives the price of European call option using the Black-Scholes approach

**Usage**

```
BlackScholesCallPrice(stockPrice, strike, rf, sigma, t)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
rf	Risk-free rate and is annualised
sigma	Volatility of the underlying stock
t	The term to maturity of the option in years

**Value**

Price of European Call Option

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

Hull, John C.. *Options, Futures, and Other Derivatives*. 5th ed., p. 246.

Lyu, Yuh-Dauh. *Financial Engineering & Computation: Principles, Mathematics, Algorithms*, Cambridge University Press, 2002.

**Examples**

```
# Estimates the price of an American Put  
BlackScholesCallPrice(27.2, 25, .03, .2, 60)
```

---

BlackScholesPutESSim *ES of Black-Scholes put using Monte Carlo Simulation*

---

**Description**

Estimates ES of Black-Scholes Put Option using Monte Carlo simulation

**Usage**

BlackScholesPutESSim(amountInvested, stockPrice, strike, r, mu, sigma, maturity, numberTrials, cl, hp)

**Arguments**

amountInvested	Total amount paid for the Put Option and is positive (negative) if the option position is long (short)
stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate
mu	Expected rate of return on the underlying asset and is in annualised term
sigma	Volatility of the underlying stock and is in annualised term
maturity	The term to maturity of the option in days
numberTrials	The number of iterations in the Monte Carlo simulation exercise
cl	Confidence level for which ES is computed and is scalar
hp	Holding period of the option in days and is scalar

**Value**

ES

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

Lyu, Yuh-Dauh. *Financial Engineering & Computation: Principles, Mathematics, Algorithms*, Cambridge University Press, 2002.

**Examples**

```
# Market Risk of American Put with given parameters.
BlackScholesPutESSim(0.20, 27.2, 25, .03, .12, .05, 60, 1000, .95, 30)
```

---

BlackScholesPutPrice *Price of European Put Option*

---

**Description**

Derives the price of European call option using the Black-Scholes approach

**Usage**

```
BlackScholesPutPrice(stockPrice, strike, rf, sigma, t)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
rf	Risk-free rate and is annualised
sigma	Volatility of the underlying stock
t	The term to maturity of the option in years

**Value**

Price of European Call Option

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.  
Hull, John C.. Options, Futures, and Other Derivatives. 5th ed., p. 246.  
Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Estimates the price of an American Put  
BlackScholesPutPrice(27.2, 25, .03, .2, 60)
```

---

BlancoIhleBacktest      *Blanco-Ihle forecast evaluation backtest measure*

---

**Description**

Derives the Blanco-Ihle forecast evaluation loss measure for a VaR risk measurement model.

**Usage**

```
BlancoIhleBacktest(Ra, Rb, Rc, c1)
```

**Arguments**

Ra	Vector of a portfolio profit and loss
Rb	Vector of corresponding VaR forecasts
Rc	Vector of corresponding Expected Tailed Loss forecasts
c1	VaR confidence interval

**Value**

First Blanco-Ihle score measure.

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Blanco, C. and Ihle, G. How Good is Your Var? Using Backtesting to Assess System Performance. Financial Engineering News, 1999.

**Examples**

```
# Blanco-Ihle Backtest For Independence for given confidence level.  
# The VaR and ES are randomly generated.  
a <- rnorm(1*100)  
b <- abs(rnorm(1*100))+2  
c <- abs(rnorm(1*100))+2  
BlancoIhleBacktest(a, b, c, 0.95)
```

---

BootstrapES	<i>Bootstrapped ES for specified confidence level</i>
-------------	---

---

**Description**

Estimates the bootstrapped ES for confidence level and holding period implied by data frequency.

**Usage**

```
BootstrapES(Ra, number.resamples, cl)
```

**Arguments**

Ra	Vector corresponding to profit and loss distribution
number.resamples	Number of samples to be taken in bootstrap procedure
cl	Number corresponding to Expected Shortfall confidence level

**Value**

Bootstrapped Expected Shortfall

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates bootstrapped ES for given parameters
a <- rnorm(100) # generate a random profit/loss vector
BootstrapVaR(a, 50, 0.95)
```

---

BootstrapESConfInterval

*Bootstrapped ES Confidence Interval*

---

### Description

Estimates the 90 level and holding period implied by data frequency.

### Usage

```
BootstrapESConfInterval(Ra, number.resamples, cl)
```

### Arguments

Ra	Vector corresponding to profit and loss distribution
number.resamples	Number of samples to be taken in bootstrap procedure
cl	Number corresponding to Expected Shortfall confidence level

### Value

90

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# To be modified with appropriate data.  
# Estimates 90% confidence interval for bootstrapped ES for 95%  
# confidence interval  
Ra <- rnorm(1000)  
BootstrapESConfInterval(Ra, 50, 0.95)
```

---

BootstrapESFigure	<i>Plots figure of bootstrapped ES</i>
-------------------	--

---

**Description**

Plots figure for the bootstrapped ES, for confidence level and holding period implied by data frequency.

**Usage**

```
BootstrapESFigure(Ra, number.resamples, cl)
```

**Arguments**

Ra	Vector corresponding to profit and loss distribution
number.resamples	Number of samples to be taken in bootstrap procedure
cl	Number corresponding to Expected Shortfall confidence level

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# To be modified with appropriate data.  
# Estimates 90% confidence interval for bootstrapped ES for 95%  
# confidence interval  
Ra <- rnorm(1000)  
BootstrapESFigure(Ra, 500, 0.95)
```

---

BootstrapVaR	<i>Bootstrapped VaR for specified confidence level</i>
--------------	--

---

**Description**

Estimates the bootstrapped VaR for confidence level and holding period implied by data frequency.

**Usage**

```
BootstrapVaR(Ra, number.resamples, cl)
```

**Arguments**

Ra                    Vector corresponding to profit and loss distribution  
 number.resamples                    Number of samples to be taken in bootstrap procedure  
 c1                    Number corresponding to Value at Risk confidence level

**Value**

Bootstrapped VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates bootstrapped VaR for given parameters
a <- rnorm(100) # generate a random profit/loss vector
BootstrapES(a, 50, 0.95)
```

---

BootstrapVaRConfInterval

*Bootstrapped VaR Confidence Interval*

---

**Description**

Estimates the 90 level and holding period implied by data frequency.

**Usage**

```
BootstrapVaRConfInterval(Ra, number.resamples, c1)
```

**Arguments**

Ra                    Vector corresponding to profit and loss distribution  
 number.resamples                    Number of samples to be taken in bootstrap procedure  
 c1                    Number corresponding to Value at Risk confidence level

**Value**

90



**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# To be modified with appropriate data.
# Estimates 90% confidence interval for bootstrapped Var for 95%
# confidence interval
Ra <- rnorm(1000)
BootstrapVaRConfInterval(Ra, 500, 0.95)
```

---

BootstrapVaRFigure      *Plots figure of bootstrapped VaR*

---

**Description**

Plots figure for the bootstrapped VaR, for confidence level and holding period implied by data frequency.

**Usage**

```
BootstrapVaRFigure(Ra, number.resamples, cl)
```

**Arguments**

Ra	Vector corresponding to profit and loss distribution
number.resamples	Number of samples to be taken in bootstrap procedure
cl	Number corresponding to Value at Risk confidence level

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# To be modified with appropriate data.
# Estimates 90% confidence interval for bootstrapped VaR for 95%
# confidence interval
Ra <- rnorm(1000)
BootstrapESFigure(Ra, 500, 0.95)
```

---

`BoxCoxES`*Estimates ES with Box-Cox transformation*

---

**Description**

Function estimates the ES of a portfolio assuming P and L data set transformed using the BoxCox transformation to make it as near normal as possible, for specified confidence level and holding period implied by data frequency.

**Usage**

```
BoxCoxES(loss.data, cl)
```

**Arguments**

<code>loss.data</code>	Daily Profit/Loss data
<code>cl</code>	Confidence Level. It can be a scalar or a vector.

**Value**

Estimated Box-Cox ES. Its dimension is same as that of `cl`

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Hamilton, S. A. and Taylor, M. G. A Comparison of the Box-Cox transformation method and nonparametric methods for estimating quantiles in clinical data with repeated measures. J. Statist. Comput. Simul., vol. 45, 1993, pp. 185 - 201.

**Examples**

```
# Estimates Box-Cox VaR
a<-rnorm(200)
BoxCoxES(a, .95)
```

---

BoxCoxVaR

*Estimates VaR with Box-Cox transformation*

---

### Description

Function estimates the VaR of a portfolio assuming P and L data set transformed using the BoxCox transformation to make it as near normal as possible, for specified confidence level and holding period implied by data frequency.

### Usage

```
BoxCoxVaR(PandLdata, cl)
```

### Arguments

PandLdata	Daily Profit/Loss data
cl	Confidence Level. It can be a scalar or a vector.

### Value

Estimated Box-Cox VaR. Its dimension is same as that of cl

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Hamilton, S. A. and Taylor, M. G. A Comparison of the Box-Cox transformation method and nonparametric methods for estimating quantiles in clinical data with repeated measures. J. Statist. Comput. Simul., vol. 45, 1993, pp. 185 - 201.

### Examples

```
# Estimates Box-Cox VaR
a<-rnorm(100)
BoxCoxVaR(a, .95)
```

---

CdfOfSumUsingGaussianCopula

*Derives prob ( X + Y < quantile) using Gaussian copula*

---

### Description

If X and Y are position P/Ls, then the VaR is equal to minus quantile. In such cases, we insert the negative of the VaR as the quantile, and the function gives us the value of 1 minus VaR confidence level. In other words, if X and Y are position P/Ls, the quantile is the negative of the VaR, and the output is 1 minus the VaR confidence level.

### Usage

```
CdfOfSumUsingGaussianCopula(quantile, mu1, mu2, sigma1, sigma2, rho,
    number.steps.in.copula)
```

### Arguments

quantile	Portfolio quantile (or negative of Var, if X, Y are position P/Ls)
mu1	Mean of Profit/Loss on first position
mu2	Mean of Profit/Loss on second position
sigma1	Standard Deviation of Profit/Loss on first position
sigma2	Standard Deviation of Profit/Loss on second position
rho	Correlation between P/Ls on two positions
number.steps.in.copula	The number of steps used in the copula approximation

### Value

Probability of X + Y being less than quantile

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

### Examples

```
# Prob ( X + Y < q ) using Gaussian Copula for X with mean 2.3 and std. .2
# and Y with mean 4.5 and std. 1.5 with beta 1.2 at 0.9 quantile
CdfOfSumUsingGaussianCopula(0.9, 2.3, 4.5, 1.2, 1.5, 0.6, 15)
```

---

CdfOfSumUsingGumbelCopula

*Derives prob ( X + Y < quantile) using Gumbel copula*


---

**Description**

If X and Y are position P/Ls, then the VaR is equal to minus quantile. In such cases, we insert the negative of the VaR as the quantile, and the function gives us the value of 1 minus VaR confidence level. In other words, if X and Y are position P/Ls, the quantile is the negative of the VaR, and the output is 1 minus the VaR confidence level.

**Usage**

```
CdfOfSumUsingGumbelCopula(quantile, mu1, mu2, sigma1, sigma2, beta)
```

**Arguments**

quantile	Portfolio quantile (or negative of Var, if X, Y are position P/Ls)
mu1	Mean of Profit/Loss on first position
mu2	Mean of Profit/Loss on second position
sigma1	Standard Deviation of Profit/Loss on first position
sigma2	Standard Deviation of Profit/Loss on second position
beta	Gumber copula parameter (greater than 1)

**Value**

Probability of X + Y being less than quantile

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

**Examples**

```
# Prob ( X + Y < q ) using Gumbel Copula for X with mean 2.3 and std. .2
# and Y with mean 4.5 and std. 1.5 with beta 1.2 at 0.9 quantile
CdfOfSumUsingGumbelCopula(0.9, 2.3, 4.5, 1.2, 1.5, 1.2)
```

---

CdfOfSumUsingProductCopula

*Derives prob ( X + Y < quantile) using Product copula*

---

### Description

If X and Y are position P/Ls, then the VaR is equal to minus quantile. In such cases, we insert the negative of the VaR as the quantile, and the function gives us the value of 1 minus VaR confidence level. In other words, if X and Y are position P/Ls, the quantile is the negative of the VaR, and the output is 1 minus the VaR confidence level.

### Usage

```
CdfOfSumUsingProductCopula(quantile, mu1, mu2, sigma1, sigma2)
```

### Arguments

quantile	Portfolio quantile (or negative of Var, if X, Y are position P/Ls)
mu1	Mean of Profit/Loss on first position
mu2	Mean of Profit/Loss on second position
sigma1	Standard Deviation of Profit/Loss on first position
sigma2	Standard Deviation of Profit/Loss on second position

### Value

Probability of X + Y being less than quantile

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

### Examples

```
# Prob ( X + Y < q ) using Product Copula for X with mean 2.3 and std. .2
# and Y with mean 4.5 and std. 1.5 with beta 1.2 at 0.9 quantile
CdfOfSumUsingProductCopula(0.9, 2.3, 4.5, 1.2, 1.5)
```

---

ChristoffersenBacktestForIndependence  
*Christoffersen Backtest for Independence*

---

**Description**

Carries out the Christoffersen backtest of independence for a VaR risk measurement model, for specified VaR confidence level.

**Usage**

```
ChristoffersenBacktestForIndependence(Ra, Rb, cl)
```

**Arguments**

Ra	Vector of portfolio profit and loss observations
Rb	Vector of corresponding VaR forecasts
cl	Confidence interval for

**Value**

Probability that given the data set, the null hypothesis (i.e. independence) is correct.

**Author(s)**

Dinesh Acharya  
Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.  
Christoffersen, P. Evaluating Interval Forecasts. International Economic Review, 39(4), 1992, 841-862.

**Examples**

```
# Has to be modified with appropriate data:  
# Christoffersen Backtest For Independence for given parameters  
a <- rnorm(1*100)  
b <- abs(rnorm(1*100))+2  
ChristoffersenBacktestForIndependence(a, b, 0.95)
```

---

ChristoffersenBacktestForUnconditionalCoverage

*Christoffersen Backtest for Unconditional Coverage*

---

### Description

Carries out the Christoffersen backtest for unconditional coverage for a VaR risk measurement model, for specified VaR confidence level.

### Usage

```
ChristoffersenBacktestForUnconditionalCoverage(Ra, Rb, cl)
```

### Arguments

Ra	Vector of portfolio profit and loss observations
Rb	Vector of VaR forecasts corresponding to PandL observations
cl	Confidence level for VaR

### Value

Probability, given the data set, that the null hypothesis (i.e. a correct model) is correct.

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Christoffersen, P. Evaluating interval forecasts. International Economic Review, 39(4), 1998, 841-862.

### Examples

```
# Has to be modified with appropriate data:
# Christoffersen Backtest For Unconditional Coverage for given parameters
a <- rnorm(1*100)
b <- abs(rnorm(1*100))+2
ChristoffersenBacktestForUnconditionalCoverage(a, b, 0.95)
```



---

CornishFisherES	<i>Corn-Fisher ES</i>
-----------------	-----------------------

---

**Description**

Function estimates the ES for near-normal P/L using the Cornish-Fisher adjustment for non-normality, for specified confidence level.

**Usage**

```
CornishFisherES(mu, sigma, skew, kurtosis, cl)
```

**Arguments**

mu	Mean of P/L distribution
sigma	Variance of of P/L distribution
skew	Skew of P/L distribution
kurtosis	Kurtosis of P/L distribution
cl	ES confidence level

**Value**

Expected Shortfall

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Zangri, P. A VaR methodology for portfolios that include options. RiskMetrics Monitor, First quarter, 1996, p. 4-12.

**Examples**

```
# Estimates Cornish-Fisher ES for given parameters  
CornishFisherES(3.2, 5.6, 2, 3, .9)
```

---

CornishFisherVaR      *Corn-Fisher VaR*

---

**Description**

Function estimates the VaR for near-normal P/L using the Cornish-Fisher adjustment for non-normality, for specified confidence level.

**Usage**

```
CornishFisherVaR(mu, sigma, skew, kurtosis, cl)
```

**Arguments**

mu	Mean of P/L distribution
sigma	Variance of of P/L distribution
skew	Skew of P/L distribution
kurtosis	Kurtosis of P/L distribution
cl	VaR confidence level

**Value**

Value at Risk

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Zangri, P. A VaR methodology for portfolios that include options. RiskMetrics Monitor, First quarter, 1996, p. 4-12.

**Examples**

```
# Estimates Cornish-Fisher VaR for given parameters  
CornishFisherVaR(3.2, 5.6, 2, 3, .9)
```

---

`DBPensionVaR`*Monte Carlo VaR for DB pension*

---

**Description**

Generates Monte Carlo VaR for DB pension in Chapter 6.7.

**Usage**

```
DBPensionVaR(mu, sigma, p, life.expectancy, number.trials, cl)
```

**Arguments**

<code>mu</code>	Expected rate of return on pension-fund assets
<code>sigma</code>	Volatility of rate of return of pension-fund assets
<code>p</code>	Probability of unemployment in any period
<code>life.expectancy</code>	Life expectancy
<code>number.trials</code>	Number of trials
<code>cl</code>	VaR confidence level

**Value**

VaR for DB pension

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

**Examples**

```
# Estimates the price of an American Put  
DBPensionVaR(.06, .2, .05, 80, 100, .95)
```

---

`DCPensionVaR`*Monte Carlo VaR for DC pension*

---

**Description**

Generates Monte Carlo VaR for DC pension in Chapter 6.7.

**Usage**

```
DCPensionVaR(mu, sigma, p, life.expectancy, number.trials, cl)
```

**Arguments**

<code>mu</code>	Expected rate of return on pension-fund assets
<code>sigma</code>	Volatility of rate of return of pension-fund assets
<code>p</code>	Probability of unemployment in any period
<code>life.expectancy</code>	Life expectancy
<code>number.trials</code>	Number of trials
<code>cl</code>	VaR confidence level

**Value**

VaR for DC pension

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

**Examples**

```
# Estimates the price of an American Put
DCPensionVaR(.06, .2, .05, 80, 100, .95)
```

---

DefaultRiskyBondVaR    *VaR for default risky bond portfolio*

---

### Description

Generates Monte Carlo VaR for default risky bond portfolio in Chapter 6.4

### Usage

```
DefaultRiskyBondVaR(r, rf, coupon, sigma, amount.invested, recovery.rate, p,
  number.trials, hp, cl)
```

### Arguments

r	Spot (interest) rate, assumed to be flat
rf	Risk-free rate
coupon	Coupon rate
sigma	Variance
amount.invested	Amount Invested
recovery.rate	Recovery rate
p	Probability of default
number.trials	Number of trials
hp	Holding period
cl	Confidence level

### Value

Monte Carlo VaR

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# VaR for default risky bond portfolio for given parameters
DefaultRiskyBondVaR(.01, .01, .1, .01, 1, .1, .2, 100, 100, .95)
```

---

FilterStrategyLogNormalVaR

*Log Normal VaR with filter strategy*

---

### Description

Generates Monte Carlo lognormal VaR with filter portfolio strategy

### Usage

```
FilterStrategyLogNormalVaR(mu, sigma, number.trials, alpha, cl, hp)
```

### Arguments

mu	Mean arithmetic return
sigma	Standard deviation of arithmetic return
number.trials	Number of trials used in the simulations
alpha	Participation parameter
cl	Confidence Level
hp	Holding Period

### Value

Lognormal VaR

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Estimates standard error of normal quantile estimate  
FilterStrategyLogNormalVaR(0, .2, 100, 1.2, .95, 10)
```

---

FrechetES	<i>Frechet Expected Shortfall</i>
-----------	-----------------------------------

---

**Description**

Estimates the ES of a portfolio assuming extreme losses are Frechet distributed, for specified confidence level and a given holding period.

**Usage**

```
FrechetES(mu, sigma, tail.index, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Scale parameter for daily L/P
tail.index	Tail index
n	Block size from which maxima are drawn
cl	Confidence level
hp	Holding period

**Details**

Note that the long-right-hand tail is fitted to losses, not profits.

**Value**

Estimated ES. If cl and hp are scalars, it returns scalar VaR. If cl is vector and hp is a scalar, or viceversa, returns vector of VaRs. If both cl and hp are vectors, returns a matrix of VaRs.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.  
Embrechts, P., Kluppelberg, C. and Mikosch, T., Modelling Extremal Events for Insurance and Finance. Springer, Berlin, 1997, p. 324.  
Reiss, R. D. and Thomas, M. Statistical Analysis of Extreme Values from Insurance, Finance, Hydrology and Other Fields, Birkhaeser, Basel, 1997, 15-18.

**Examples**

```
# Computes ES assuming Frechet Distribution for given parameters  
FrechetES(3.5, 2.3, 1.6, 10, .95, 30)
```

---

FrechetESPlot2DCI      *Plots Frechet Expected Shortfall against confidence level*

---

**Description**

Plots the ES of a portfolio against confidence level assuming extreme losses are Frechet distributed, for specified confidence level and a given holding period.

**Usage**

```
FrechetESPlot2DCI(mu, sigma, tail.index, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Scale parameter for daily L/P
tail.index	Tail index
n	Block size from which maxima are drawn
cl	Confidence level and should be a vector
hp	Holding period

**Details**

Note that the long-right-hand tail is fitted to losses, not profits.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Embrechts, P., Kluppelberg, C. and Mikosch, T., Modelling Extremal Events for Insurance and Finance. Springer, Berlin, 1997, p. 324.

Reiss, R. D. and Thomas, M. Statistical Analysis of Extreme Values from Insurance, Finance, Hydrology and Other Fields, Birkhaueser, Basel, 1997, 15-18.

**Examples**

```
# Plots ES against vector of cl assuming Frechet Distribution for given parameters
cl <- seq(0.9,0.99,0.01)
FrechetESPlot2DCI(3.5, 2.3, 1.6, 10, cl, 30)
```



---

FrechetVaR	<i>Frechet Value at Risk</i>
------------	------------------------------

---

**Description**

Estimates the VaR of a portfolio assuming extreme losses are Frechet distributed, for specified range of confidence level and a given holding period.

**Usage**

```
FrechetVaR(mu, sigma, tail.index, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Scale parameter for daily L/P
tail.index	Tail index
n	Block size from which maxima are drawn
cl	Confidence level
hp	Holding period

**Details**

Note that the long-right-hand tail is fitted to losses, not profits.

**Value**

Value at Risk. If cl and hp are scalars, it returns scalar VaR. If cl is vector and hp is a scalar, or viceversa, returns vector of VaRs. If both cl and hp are vectors, returns a matrix of VaRs.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Embrechts, P., Kluppelberg, C. and Mikosch, T., Modelling Extremal Events for Insurance and Finance. Springer, Berlin, 1997, p. 324.

Reiss, R. D. and Thomas, M. Statistical Analysis of Extreme Values from Insurance, Finance, Hydrology and Other Fields, Birkhauser, Basel, 1997, 15-18.

**Examples**

```
# Computes VaR assuming Frechet Distribution for given parameters
FrechetVaR(3.5, 2.3, 1.6, 10, .95, 30)
```

---

FrechetVaRPlot2DCI      *Plots Frechet Value at Risk against Cl*

---

### Description

Plots the VaR of a portfolio against confidence level assuming extreme losses are Frechet distributed, for specified range of confidence level and a given holding period.

### Usage

```
FrechetVaRPlot2DCI(mu, sigma, tail.index, n, cl, hp)
```

### Arguments

mu	Location parameter for daily L/P
sigma	Scale parameter for daily L/P
tail.index	Tail index
n	Block size from which maxima are drawn
cl	Confidence level and should be a vector
hp	Holding period and should be a scalar

### Details

Note that the long-right-hand tail is fitted to losses, not profits.

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Embrechts, P., Kluppelberg, C. and Mikosch, T., Modelling Extremal Events for Insurance and Finance. Springer, Berlin, 1997, p. 324.

Reiss, R. D. and Thomas, M. Statistical Analysis of Extreme Values from Insurance, Finance, Hydrology and Other Fields, Birkhauser, Basel, 1997, 15-18.

### Examples

```
# Plots VaR against vector of cl assuming Frechet Distribution for given parameters
cl <- seq(0.9, .99, .01)
FrechetVaRPlot2DCI(3.5, 2.3, 1.6, 10, cl, 30)
```

---

GaussianCopulaVaR      *Bivariate Gaussian Copula VaR*

---

**Description**

Derives VaR using bivariate Gaussian copula with specified inputs for normal marginals.

**Usage**

GaussianCopulaVaR(mu1, mu2, sigma1, sigma2, rho, number.steps.in.copula, c1)

**Arguments**

mu1	Mean of Profit/Loss on first position
mu2	Mean of Profit/Loss on second position
sigma1	Standard Deviation of Profit/Loss on first position
sigma2	Standard Deviation of Profit/Loss on second position
rho	Correlation between Profit/Loss on two positions
number.steps.in.copula	Number of steps used in the copula approximation ( approximation being needed because Gaussian copula lacks a closed form solution)
c1	VaR confidece level

**Value**

Copula based VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.  
 Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

**Examples**

```
# VaR using bivariate Gaussian for X and Y with given parameters:
  GaussianCopulaVaR(2.3, 4.1, 1.2, 1.5, .6, 10, .95)
```

---

GParetoES

*Expected Shortfall for Generalized Pareto*

---

### Description

Estimates the ES of a portfolio assuming losses are distributed as a generalised Pareto.

### Usage

```
GParetoES(Ra, beta, zeta, threshold.prob, cl)
```

### Arguments

Ra	Vector of daily Profit/Loss data
beta	Assumed scale parameter
zeta	Assumed tail index
threshold.prob	Threshold probability
cl	VaR confidence level

### Value

Expected Shortfall

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.  
McNeil, A., Extreme value theory for risk managers. Mimeo, ETHZ, 1999.

### Examples

```
# Computes ES assuming generalised Pareto for following parameters
Ra <- 5 * rnorm(100)
beta <- 1.2
zeta <- 1.6
threshold.prob <- .85
cl <- .99
GParetoES(Ra, beta, zeta, threshold.prob, cl)
```

---

GParetoMEFPlot      *Plot of Emperical and Generalised Pareto mean excess functions*

---

**Description**

Plots of emperical mean excess function and Generalized mean excess function.

**Usage**

```
GParetoMEFPlot(Ra, mu, beta, zeta)
```

**Arguments**

Ra	Vector of daily Profit/Loss data
mu	Location parameter
beta	Scale parameter
zeta	Assumed tail index

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes ES assuming generalised Pareto for following parameters
Ra <- 5 * rnorm(100)
mu <- 0
beta <- 1.2
zeta <- 1.6
GParetoMEFPlot(Ra, mu, beta, zeta)
```

---

GParetoMultipleMEFPlot      *Plot of Emperical and 2 Generalised Pareto mean excess functions*

---

**Description**

Plots of emperical mean excess function and two generalized pareto mean excess functions which differ in their tail-index value.

**Usage**

```
GParetoMultipleMEFPlot(Ra, mu, beta, zeta1, zeta2)
```

**Arguments**

Ra	Vector of daily Profit/Loss data
mu	Location parameter
beta	Scale parameter
zeta1	Assumed tail index for first mean excess function
zeta2	Assumed tail index for second mean excess function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes ES assuming generalised Pareto for following parameters
Ra <- 5 * rnorm(100)
mu <- 1
beta <- 1.2
zeta1 <- 1.6
zeta2 <- 2.2
GParetoMultipleMEFPlot(Ra, mu, beta, zeta1, zeta2)
```

---

GParetoVaR

*VaR for Generalized Pareto*

---

**Description**

Estimates the Value at Risk of a portfolio assuming losses are distributed as a generalised Pareto.

**Usage**

```
GParetoVaR(Ra, beta, zeta, threshold.prob, cl)
```

**Arguments**

Ra	Vector of daily Profit/Loss data
beta	Assumed scale parameter
zeta	Assumed tail index
threshold.prob	Threshold probability corresponding to threshold u and x
cl	VaR confidence level

**Value**

Expected Shortfall

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

McNeil, A., Extreme value theory for risk managers. Mimeo, ETHZ, 1999.

**Examples**

```
# Computes ES assuming generalised Pareto for following parameters
Ra <- 5 * rnorm(100)
beta <- 1.2
zeta <- 1.6
threshold.prob <- .85
cl <- .99
GParetoVaR(Ra, beta, zeta, threshold.prob, cl)
```

---

GumbelCopulaVaR

*Bivariate Gumbel Copule VaR*

---

**Description**

Derives VaR using bivariate Gumbel or logistic copula with specified inputs for normal marginals.

**Usage**

```
GumbelCopulaVaR(mu1, mu2, sigma1, sigma2, beta, cl)
```

**Arguments**

mu1	Mean of Profit/Loss on first position
mu2	Mean of Profit/Loss on second position
sigma1	Standard Deviation of Profit/Loss on first position
sigma2	Standard Deviation of Profit/Loss on second position
beta	Gumber copula parameter (greater than 1)
cl	VaR onfidece level

**Value**

Copula based VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

**Examples**

```
# VaR using bivariate Gumbel for X and Y with given parameters:
  GumbelCopulaVaR(1.1, 3.1, 1.2, 1.5, 1.1, .95)
```

---

GumbeIES

*Gumbel ES*


---

**Description**

Estimates the ES of a portfolio assuming extreme losses are Gumbel distributed, for specified confidence level and holding period. Note that the long-right-hand tail is fitted to losses, not profits.

**Usage**

```
GumbeIES(mu, sigma, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Assumed scale parameter for daily L/P
n	Assumed block size from which the maxima are drawn
cl	VaR confidence level
hp	VaR holding period

**Value**

Estimated ES. If cl and hp are scalars, it returns scalar VaR. If cl is vector and hp is a scalar, or viceversa, returns vector of VaRs. If both cl and hp are vectors, returns a matrix of VaRs.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

National Institute of Standards and Technology, Dataplot Reference Manual. Volume 1: Commands. NIST: Washington, DC, 1997, p. 8-67.



**Examples**

```
# Gumber ES Plot
GumbelES(0, 1.2, 100, c(.9, .88, .85, .8), 280)
```

---

GumbelESPlot2DCI	<i>Gumbel VaR</i>
------------------	-------------------

---

**Description**

Estimates the EV VaR of a portfolio assuming extreme losses are Gumbel distributed, for specified confidence level and holding period.

**Usage**

```
GumbelESPlot2DCI(mu, sigma, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Assumed scale parameter for daily L/P
n	size from which the maxima are drawn
cl	VaR confidence level
hp	VaR holding period

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots ES against Cl
GumbelESPlot2DCI(0, 1.2, 100, seq(0.8, 0.99, 0.02), 280)
```

---

GumbelVaR

*Gumbel VaR*

---

### Description

Estimates the EV VaR of a portfolio assuming extreme losses are Gumbel distributed, for specified confidence level and holding period.

### Usage

```
GumbelVaR(mu, sigma, n, cl, hp)
```

### Arguments

mu	Location parameter for daily L/P
sigma	Assumed scale parameter for daily L/P
n	Size from which the maxima are drawn
cl	VaR confidence level
hp	VaR holding period

### Value

Estimated VaR

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Gumbel VaR  
GumbelVaR(0, 1.2, 100, c(.9, .88, .85, .8), 280)
```

---

GumbelVaRPlot2DC1	<i>Gumbel VaR</i>
-------------------	-------------------

---

**Description**

Estimates the EV VaR of a portfolio assuming extreme losses are Gumbel distributed, for specified confidence level and holding period.

**Usage**

```
GumbelVaRPlot2DC1(mu, sigma, n, cl, hp)
```

**Arguments**

mu	Location parameter for daily L/P
sigma	Assumed scale parameter for daily L/P
n	size from which the maxima are drawn
cl	VaR confidence level
hp	VaR holding period

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against Cl
GumbelVaRPlot2DC1(0, 1.2, 100, c(.9, .88, .85, .8), 280)
```

---

HillEstimator	<i>Hill Estimator</i>
---------------	-----------------------

---

**Description**

Estimates the value of the Hill Estimator for a given specified data set and chosen tail size. Notes: 1) We estimate Hill Estimator by looking at the upper tail. 2) If the specified tail size is such that any included observations are negative, the tail is truncated at the point before observations become negative. 3) The tail size must be a scalar.

**Usage**

```
HillEstimator(Ra, tail.size)
```

**Arguments**

Ra                    Data set  
tail.size            Number of observations to be used to estimate the Hill estimator.

**Value**

Estimated value of Hill Estimator

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Hill Estimator of  
Ra <- rnorm(15)  
HillEstimator(Ra, 10)
```

---

HillPlot

*Hill Plot*

---

**Description**

Displays a plot of the Hill Estimator against tail sample size.

**Usage**

```
HillPlot(Ra, maximum.tail.size)
```

**Arguments**

Ra                    The data set  
maximum.tail.size                    maximum tail size and should be greater than a quarter of the sample size.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Hill Estimator - Tail Sample Size Plot for random normal dataset
Ra <- rnorm(1000)
HillPlot(Ra, 180)
```

---

HillQuantileEstimator *Hill Quantile Estimator*

---

**Description**

Estimates value of Hill Quantile Estimator for a specified data set, tail index, in-sample probability and confidence level.

**Usage**

```
HillQuantileEstimator(Ra, tail.index, in.sample.prob, cl)
```

**Arguments**

Ra	A data set
tail.index	Assumed tail index
in.sample.prob	In-sample probability (used as basis for projection)
cl	Confidence level

**Value**

Value of Hill Quantile Estimator

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.  
Next reference

**Examples**

```
# Computes estimates value of hill estimator for a specified data set
Ra <- rnorm(1000)
HillQuantileEstimator(Ra, 40, .5, .9)
```

---

HSES

---

*Expected Shortfall of a portfolio using Historical Estimator*


---

**Description**

Estimates the Expected Shortfall (aka. Average Value at Risk or Conditional Value at Risk) using historical estimator approach for the specified confidence level and the holding period implied by data frequency.

**Usage**

HSES(Ra, c1)

**Arguments**

Ra	Vector corresponding to profit and loss distribution
c1	Number between 0 and 1 corresponding to confidence level

**Value**

Expected Shortfall of the portfolio

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. *Measuring Market Risk*, Wiley, 2007.

Cont, R., Deguest, R. and Scandolo, G. Robustness and sensitivity analysis of risk measurement procedures. *Quantitative Finance*, 10(6), 2010, 593-606.

Acerbi, C. and Tasche, D. On the coherence of Expected Shortfall. *Journal of Banking and Finance*, 26(7), 2002, 1487-1503

Artzner, P., Delbaen, F., Eber, J.M. and Heath, D. Coherent Risk Measures of Risk. *Mathematical Finance* 9(3), 1999, 203.

Foellmer, H. and Scheid, A. *Stochastic Finance: An Introduction in Discrete Time*. De Gruyter, 2011.

**Examples**

```
# Computes Historical Expected Shortfall for a given profit/loss
# distribution and confidence level
a <- rnorm(100) # generate a random profit/loss vector
HSES(a, 0.95)
```

---

HSESDFPerc	<i>Percentile of historical simulation ES distribution function</i>
------------	---

---

**Description**

Estimates percentiles of historical simulation ES distribution function, using theory of order statistics, for specified confidence level.

**Usage**

```
HSESDFPerc(Ra, perc, c1)
```

**Arguments**

Ra	Vector of daily P/L data
perc	Desired percentile and is scalar
c1	VaR confidence level and is scalar

**Value**

Value of percentile of VaR distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles for random standard normal returns and given perc  
# and c1  
Ra <- rnorm(100)  
HSESDFPerc(Ra, .75, .95)
```

---

HSEFigure

*Figure of Historical Simulation VaR and ES and histogram of L/P*

---

**Description**

Plots figure showing the historical simulation VaR and ES and histogram of L/P for specified confidence level and holding period implied by data frequency.

**Usage**

```
HSEFigure(Ra, cl)
```

**Arguments**

Ra	Vector of profit loss data
cl	VaR confidence level

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots figure showing VaR and histogram of P/L data
Ra <- rnorm(100)
HSEFigure(Ra, .95)
```

---

HSESPlot2DC1

*Plots historical simulation ES against confidence level*

---

**Description**

Function plots the historical simulation ES of a portfolio against confidence level, for specified range of confidence level and holding period implied by data frequency.

**Usage**

```
HSESPlot2DC1(Ra, cl)
```

**Arguments**

Ra	Vector of daily P/L data
cl	Vector of ES confidence levels



**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots historical simulation ES against confidence level
Ra <- rnorm(100)
cl <- seq(.90, .99, .01)
HSESPlot2DC1(Ra, cl)
```

---

HSVaR

*Value at Risk of a portfolio using Historical Estimator*

---

**Description**

Estimates the Value at Risk (VaR) using historical estimator approach for the specified range of confidence levels and the holding period implied by data frequency.

**Usage**

HSVaR(Ra, Rb)

**Arguments**

Ra                    Vector corresponding to profit and loss distribution  
Rb                    Scalar corresponding to VaR confidence levels.

**Value**

Value at Risk of the portfolio

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Jorion, P. Value at Risk: The New Benchmark for Managing Financial Risk. McGraw-Hill, 2006

Cont, R., Deguest, R. and Scandolo, G. Robustness and sensitivity analysis of risk measurement procedures. Quantitative Finance, 10(6), 2010, 593-606.

Artzner, P., Delbaen, F., Eber, J.M. and Heath, D. Coherent Risk Measures of Risk. Mathematical Finance 9(3), 1999, 203.

Foellmer, H. and Scheid, A. Stochastic Finance: An Introduction in Discrete Time. De Gruyter, 2011.

**Examples**

```
# To be added
a <- rnorm(1000) # Payoffs of random portfolio
HSVaR(a, .95)
```

---

HSVaRDFPerc

*Percentile of historical simulation VaR distribution function*

---

**Description**

Estimates percentiles of historical simulation VaR distribution function, using theory of order statistics, for specified confidence level.

**Usage**

```
HSVaRDFPerc(Ra, perc, cl)
```

**Arguments**

Ra	Vector of daily P/L data
perc	Desired percentile and is scalar
cl	VaR confidence level and is scalar

**Value**

Value of percentile of VaR distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles for random standard normal returns and given perc
# and cl
Ra <- rnorm(100)
HSVaRDFPerc(Ra, .75, .95)
```

---

HSVaRESPlot2DCI	<i>Plots historical simulation VaR and ES against confidence level</i>
-----------------	--

---

**Description**

Function plots the historical simulation VaR and ES of a portfolio against confidence level, for specified range of confidence level and holding period implied by data frequency.

**Usage**

```
HSVaRESPlot2DCI(Ra, cl)
```

**Arguments**

Ra	Vector of daily P/L data
cl	Vectof of VaR confidence levels

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots historical simulation VaR and ES against confidence level
Ra <- rnorm(100)
cl <- seq(.90, .99, .01)
HSVaRESPlot2DCI(Ra, cl)
```

---

HSVaRFigure	<i>Figure of Historical Simulation VaR and histogram of L/P</i>
-------------	---

---

**Description**

Plots figure showing the historical simulation VaR and histogram of L/P for specified confidence level and holding period implied by data frequency.

**Usage**

```
HSVaRFigure(Ra, cl)
```

**Arguments**

Ra                Vector of profit loss data  
c1                ES confidence level

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots figure showing VaR and histogram of P/L data
Ra <- rnorm(100)
HSVaRFigure(Ra, .95)
```

---

HSVaRPlot2DCI

*Plots historical simulation VaR against confidence level*

---

**Description**

Function plots the historical simulation VaR of a portfolio against confidence level, for specified range of confidence level and holding period implied by data frequency.

**Usage**

```
HSVaRPlot2DCI(Ra, c1)
```

**Arguments**

Ra                Vector of daily P/L data  
c1                Vector of VaR confidence levels

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots historical simulation VaR against confidence level
Ra <- rnorm(100)
c1 <- seq(.90, .99, .01)
HSVaRPlot2DCI(Ra, c1)
```

---

InsuranceVaR

*VaR of Insurance Portfolio*

---

**Description**

Generates Monte Carlo VaR for insurance portfolio in Chapter 6.5

**Usage**

```
InsuranceVaR(mu, sigma, n, p, theta, deductible, number.trials, cl)
```

**Arguments**

mu	Mean of returns
sigma	Volatility of returns
n	Number of contracts
p	Probability of any loss event
theta	Expected profit per contract
deductible	Deductible
number.trials	Number of simulation trials
cl	VaR confidence level

**Value**

VaR of the specified portfolio

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates VaR of Insurance portfolio with given parameters
InsuranceVaR(.8, 1.3, 100, .6, 21, 12, 50, .95)
```

---

InsuranceVaRES

*VaR and ES of Insurance Portfolio*

---

**Description**

Generates Monte Carlo VaR and ES for insurance portfolio.

**Usage**

```
InsuranceVaRES(mu, sigma, n, p, theta, deductible, number.trials, cl)
```

**Arguments**

mu	Mean of returns
sigma	Volatility of returns
n	Number of contracts
p	Probability of any loss event
theta	Expected profit per contract
deductible	Deductible
number.trials	Number of simulation trials
cl	VaR confidence level

**Value**

A list with "VaR" and "ES" of the specified portfolio

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates VaR and ES of Insurance portfolio with given parameters  
y<-InsuranceVaRES(.8, 1.3, 100, .6, 21, 12, 50, .95)
```

---

JarqueBeraBacktest      *Jarque-Bera backtest for normality.*

---

### Description

Jarque-Bera (JB) is a backtest to test whether the skewness and kurtosis of a given sample matches that of normal distribution. JB test statistic is defined as

$$JB = \frac{n}{6} \left( s^2 + \frac{(k-3)^2}{4} \right)$$

where  $n$  is sample size,  $s$  and  $k$  are coefficients of sample skewness and kurtosis.

### Usage

```
JarqueBeraBacktest(sample.skewness, sample.kurtosis, n)
```

### Arguments

sample.skewness	Coefficient of Skewness of the sample
sample.kurtosis	Coefficient of Kurtosis of the sample
n	Number of observations

### Value

Probability of null hypothesis H0

### Author(s)

Dinesh Acharya

### References

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Jarque, C. M. and Bera, A. K. A test for normality of observations and regression residuals, International Statistical Review, 55(2): 163-172.

### Examples

```
# JB test statistic for sample with 500 observations with sample
# skewness and kurtosis of -0.075 and 2.888
JarqueBeraBacktest(-0.075,2.888,500)
```

KernelESBoxKernel      *Calculates ES using box kernel approach*

---

**Description**

The output consists of a scalar ES for specified confidence level.

**Usage**

```
KernelESBoxKernel(Ra, cl)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using box kernel approach
Ra <- rnorm(30)
KernelESBoxKernel(Ra, .95)
```

---

KernelESEpanechnikovKernel  
*Calculates ES using Epanechnikov kernel approach*

---

**Description**

The output consists of a scalar ES for specified confidence level.

**Usage**

```
KernelESEpanechnikovKernel(Ra, cl, plot = TRUE)
```



**Arguments**

Ra	Profit and Loss data set
c1	ES confidence level
plot	Bool, plots cdf if true

**Value**

Scalar ES

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# ES for specified confidence level using Epanechnikov kernel approach
Ra <- rnorm(30)
KernelESEpanechnikovKernel(Ra, .95)
```

---

KernelESNormalKernel *Calculates ES using normal kernel approach*

---

**Description**

The output consists of a scalar ES for specified confidence level.

**Usage**

```
KernelESNormalKernel(Ra, c1)
```

**Arguments**

Ra	Profit and Loss data set
c1	VaR confidence level

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# ES for specified confidence level using normal kernel approach
Ra <- rnorm(30)
KernelESNormalKernel(Ra, .95)
```

---

KernelESTriangleKernel

*Calculates ES using triangle kernel approach*

---

**Description**

The output consists of a scalar ES for specified confidence level.

**Usage**

```
KernelESTriangleKernel(Ra, cl)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using triangle kernel approach
Ra <- rnorm(30)
KernelESTriangleKernel(Ra, .95)
```

---

KernelVaRBoxKernel      *Calculates VaR using box kernel approach*

---

**Description**

The output consists of a scalar VaR for specified confidence level.

**Usage**

```
KernelVaRBoxKernel(Ra, cl, plot = TRUE)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level
plot	Bool which indicates whether the graph is plotted or not

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using box kernel approach
Ra <- rnorm(30)
KernelVaRBoxKernel(Ra, .95)
```

---

KernelVaREpanechnikovKernel  
*Calculates VaR using epanechnikov kernel approach*

---

**Description**

The output consists of a scalar VaR for specified confidence level.

**Usage**

```
KernelVaREpanechnikovKernel(Ra, cl, plot = TRUE)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level
plot	Bool, plots the cdf if true.

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using epanechnikov kernel approach
Ra <- rnorm(30)
KernelVaREpanechnikovKernel(Ra, .95)
```

---

KernelVaRNormalKernel *Calculates VaR using normal kernel approach*

---

**Description**

The output consists of a scalar VaR for specified confidence level.

**Usage**

```
KernelVaRNormalKernel(Ra, cl, plot = TRUE)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level
plot	Bool, plots cdf if true

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using normal kernel approach
Ra <- rnorm(30)
KernelVaRNormalKernel(Ra, .95)
```

---

KernelVaRTriangleKernel

*Calculates VaR using triangle kernel approach*

---

**Description**

The output consists of a scalar VaR for specified confidence level.

**Usage**

```
KernelVaRTriangleKernel(Ra, cl, plot = TRUE)
```

**Arguments**

Ra	Profit and Loss data set
cl	VaR confidence level
plot	Bool, plots cdf if true.

**Value**

Scalar VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# VaR for specified confidence level using triangle kernel approach
Ra <- rnorm(30)
KernelVaRTriangleKernel(Ra, .95)
```

---

KSTestStat	<i>Plots cumulative density for KS test and computes confidence interval for KS test stat.</i>
------------	--

---

**Description**

Kolmogorov-Smirnov (KS) test statistic is a non parametric test for distribution equality and measures the maximum distance between two cdfs. Formally, the KS test statistic is :

$$D = \max_i |F(X_i) - \hat{F}(X_i)|$$

**Usage**

```
KSTestStat(number.trials, sample.size, confidence.interval)
```

**Arguments**

```
number.trials  Number of trials
sample.size    Sizes of the trial samples
confidence.interval
                Confidence interval expressed as a fraction of 1
```

**Value**

Confidence Interval for KS test stat

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.  
Chakravarti, I. M., Laha, R. G. and Roy, J. Handbook of Methods of # Applied Statistics, Volume 1, Wiley, 1967.

**Examples**

```
# Plots the cdf for KS Test statistic and returns KS confidence interval
# for 100 trials with 1000 sample size and 0.95 confidence interval
KSTestStat(100, 1000, 0.95)
```

---

KuiperTestStat	<i>Plots cumulative density for Kuiper test and computes confidence interval for Kuiper test stat.</i>
----------------	--

---

**Description**

Kuiper test statistic is a non parametric test for distribution equality and is closely related to KS test. Formally, the Kuiper test statistic is :

$$D^* = \max_i \{F(X_i) - \hat{F}(x_i)\} + \max_i \{\hat{F}(X_i) - F(X_i)\}$$

**Usage**

```
KuiperTestStat(number.trials, sample.size, confidence.interval)
```

**Arguments**

```
number.trials  Number of trials  
sample.size    Sizes of the trial samples  
confidence.interval  
                Confidence interval expressed as a fraction of 1
```

**Value**

Confidence Interval for KS test stat

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots the cdf for Kuiper Test statistic and returns Kuiper confidence  
# interval for 100 trials with 1000 sample size and 0.95 confidence  
# interval.  
KuiperTestStat(100, 1000, 0.95)
```

LogNormalES

*ES for normally distributed geometric returns***Description**

Estimates the ES of a portfolio assuming that geometric returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
LogNormalES(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 investment Size of investment  
 cl VaR confidence level  
 hp VaR holding period in days

**Value**

Matrix of ES whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalES(returns = data, investment = 5, cl = .95, hp = 90)

# Computes ES given mean and standard deviation of return data
LogNormalES(mu = .012, sigma = .03, investment = 5, cl = .95, hp = 90)
```



---

LogNormalESDFPerc	<i>Percentiles of ES distribution function for normally distributed geometric returns</i>
-------------------	---

---

**Description**

Estimates the percentiles of ES distribution for normally distributed geometric returns, for specified confidence level and holding period using the theory of order statistics.

**Usage**

```
LogNormalESDFPerc(...)
```

**Arguments**

```
...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 7. In case there 5 input arguments, the mean, standard deviation and number of samples is computed from return data. See examples for details.
returns  Vector of daily geometric return data
mu       Mean of daily geometric return data
sigma    Standard deviation of daily geometric return data
n        Sample size
investment Size of investment
perc     Desired percentile
cl       ES confidence level and must be a scalar
hp      ES holding period and must be a scalar
```

**Value**

Percentiles of ES distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of ES distribution
data <- runif(5, min = 0, max = .2)
LogNormalESDFPerc(returns = data, investment = 5, perc = .7, cl = .95, hp = 60)

# Estimates Percentiles given mean, standard deviation and number of samples of return data
LogNormalESDFPerc(mu = .012, sigma = .03, n = 10, investment = 5, perc = .8, cl = .99, hp = 40)
```

---

LogNormalESFigure      *Figure of lognormal VaR and ES and pdf against L/P*

---

### Description

Gives figure showing the VaR and ES and probability distribution function against L/P of a portfolio assuming geometric returns are normally distributed, for specified confidence level and holding period.

### Usage

```
LogNormalESFigure(...)
```

### Arguments

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl VaR confidence level and should be scalar

hp VaR holding period in days and should be scalar

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots lognormal VaR, ES and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
LogNormalESFigure(returns = data, investment = 5, cl = .95, hp = 90)

# Plots lognormal VaR, ES and pdf against L/P data with given parameters
LogNormalESFigure(mu = .012, sigma = .03, investment = 5, cl = .95, hp = 90)
```

---

LogNormalESPlot2DCL *Plots log normal ES against confidence level*

---

### Description

Plots the ES of a portfolio against confidence level assuming that geometric returns are normally distributed, for specified confidence level and holding period.

### Usage

```
LogNormalESPlot2DCL(...)
```

### Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
cl ES confidence level and must be a vector  
hp ES holding period and must be a scalar

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots ES against confidence level
data <- runif(5, min = 0, max = .2)
LogNormalESPlot2DCL(returns = data, investment = 5,
  cl = seq(.9,.99,.01), hp = 60)

# Plots ES against confidence level
LogNormalESPlot2DCL(mu = .012, sigma = .03, investment = 5,
  cl = seq(.9,.99,.01), hp = 40)
```

---

LogNormalESPlot2DHP *Plots log normal ES against holding period*

---

### Description

Plots the ES of a portfolio against holding period assuming that geometric returns are normal distributed, for specified confidence level and holding period.

### Usage

```
LogNormalESPlot2DHP(...)
```

### Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl ES confidence level and must be a scalar

hp ES holding period and must be a vector

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalESPlot2DHP(returns = data, investment = 5, cl = .95, hp = 60:90)

# Computes v given mean and standard deviation of return data
LogNormalESPlot2DHP(mu = .012, sigma = .03, investment = 5, cl = .99, hp = 40:80)
```

---

LogNormalESPlot3D      *Plots log normal ES against confidence level and holding period*

---

### Description

Plots the ES of a portfolio against confidence level and holding period assuming that geometric returns are normally distributed, for specified confidence level and holding period.

### Usage

```
LogNormalESPlot3D(...)
```

### Arguments

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl VaR confidence level and must be a vector

hp VaR holding period and must be a vector

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalESPlot3D(returns = data, investment = 5, cl = seq(.9,.99,.01), hp = 1:100)

# Computes VaR against confidence level given mean and standard deviation of return data
LogNormalESPlot3D(mu = .012, sigma = .03, investment = 5, cl = seq(.9,.99,.01), hp = 1:100)
```

---

 LogNormalVaR

*VaR for normally distributed geometric returns*


---

**Description**

Estimates the VaR of a portfolio assuming that geometric returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
LogNormalVaR(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 investment Size of investment  
 cl VaR confidence level  
 hp VaR holding period in days

**Value**

Matrix of VaR whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalVaR(returns = data, investment = 5, cl = .95, hp = 90)

# Computes VaR given mean and standard deviation of return data
LogNormalVaR(mu = .012, sigma = .03, investment = 5, cl = .95, hp = 90)
```

---

LogNormalVaRDFPerc	<i>Percentiles of VaR distribution function for normally distributed geometric returns</i>
--------------------	--

---

**Description**

Estimates the percentile of VaR distribution function for normally distributed geometric returns, using the theory of order statistics.

**Usage**

```
LogNormalVaRDFPerc(...)
```

**Arguments**

```
...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 7. In case there 5 input arguments, the mean, standard deviation and number of observations of data are computed from returns data. See examples for details.
returns  Vector of daily geometric return data
mu       Mean of daily geometric return data
sigma   Standard deviation of daily geometric return data
n        Sample size
investment Size of investment
perc     Desired percentile
cl       VaR confidence level and must be a scalar
hp       VaR holding period and must be a scalar
          Percentiles of VaR distribution function and is scalar
```

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of VaR distribution
data <- runif(5, min = 0, max = .2)
LogNormalVaRDFPerc(returns = data, investment = 5, perc = .7, cl = .95, hp = 60)

# Computes v given mean and standard deviation of return data
LogNormalVaRDFPerc(mu = .012, sigma = .03, n = 10, investment = 5, perc = .8, cl = .99, hp = 40)
```

---

 LogNormalVaRETLPlot2DCL

*Plots log normal VaR and ETL against confidence level*


---

## Description

Plots the VaR and ETL of a portfolio against confidence level assuming that geometric returns are normally distributed, for specified confidence level and holding period.

## Usage

```
LogNormalVaRETLPlot2DCL(...)
```

## Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there are 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl VaR confidence level and must be a vector

hp VaR holding period and must be a scalar

## Author(s)

Dinesh Acharya

## References

Dowd, K. Measuring Market Risk, Wiley, 2007.

## Examples

```
# Plots VaR and ETL against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalVaRETLPlot2DCL(returns = data, investment = 5, cl = seq(.85,.99,.01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of return data
LogNormalVaRETLPlot2DCL(mu = .012, sigma = .03, investment = 5, cl = seq(.85,.99,.01), hp = 40)
```



---

LogNormalVaRFigure      *Figure of lognormal VaR and pdf against L/P*

---

**Description**

Gives figure showing the VaR and probability distribution function against L/P of a portfolio assuming geometric returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
LogNormalVaRFigure(...)
```

**Arguments**

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl VaR confidence level and should be scalar

hp VaR holding period in days and should be scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots lognormal VaR and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
LogNormalVaRFigure(returns = data, investment = 5, cl = .95, hp = 90)

# Plots lognormal VaR and pdf against L/P data with given parameters
LogNormalVaRFigure(mu = .012, sigma = .03, investment = 5, cl = .95, hp = 90)
```

---

LogNormalVaRPlot2DCL *Plots log normal VaR against confidence level*

---

### Description

Plots the VaR of a portfolio against confidence level assuming that geometric returns are normally distributed, for specified confidence level and holding period.

### Usage

```
LogNormalVaRPlot2DCL(...)
```

### Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there are 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a scalar

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalVaRPlot2DCL(returns = data, investment = 5, cl = seq(.85,.99,.01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of return data
LogNormalVaRPlot2DCL(mu = .012, sigma = .03, investment = 5, cl = seq(.85,.99,.01), hp = 40)
```

---

LogNormalVaRPlot2DHP *Plots log normal VaR against holding period*

---

### Description

Plots the VaR of a portfolio against holding period assuming that geometric returns are normal distributed, for specified confidence level and holding period.

### Usage

```
LogNormalVaRPlot2DHP(...)
```

### Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl VaR confidence level and must be a scalar

hp VaR holding period and must be a vector

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Computes VaR given geometric return data
data <- runif(5, min = 0, max = .2)
LogNormalVaRPlot2DHP(returns = data, investment = 5, cl = .95, hp = 60:90)

# Computes VaR given mean and standard deviation of return data
LogNormalVaRPlot2DHP(mu = .012, sigma = .03, investment = 5, cl = .99, hp = 40:80)
```

---

LogNormalVaRPlot3D      *Plots log normal VaR against confidence level and holding period*

---

### Description

Plots the VaR of a portfolio against confidence level and holding period assuming that geometric returns are normal distributed, for specified confidence level and holding period.

### Usage

```
LogNormalVaRPlot3D(...)
```

### Arguments

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

cl VaR confidence level and must be a vector

hp VaR holding period and must be a vector

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots VaR against confidence level given geometric return data
data <- rnorm(5, .09, .03)
LogNormalVaRPlot3D(returns = data, investment = 5, cl = seq(.9,.99,.01), hp = 1:100)

# Computes VaR against confidence level given mean and standard deviation of return data
LogNormalVaRPlot3D(mu = .012, sigma = .03, investment = 5, cl = seq(.9,.99,.01), hp = 1:100)
```

---

LogtES

*ES for t distributed geometric returns*

---

### Description

Estimates the ES of a portfolio assuming that geometric returns are Student-t distributed, for specified confidence level and holding period.

### Usage

LogtES(...)

### Arguments

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

df Number of degrees of freedom in the t distribution

cl VaR confidence level

hp VaR holding period

### Value

Matrix of ES whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
LogtES(returns = data, investment = 5, df = 6, cl = .95, hp = 90)

# Computes ES given mean and standard deviation of return data
LogtES(mu = .012, sigma = .03, investment = 5, df = 6, cl = .95, hp = 90)
```

---

LogtESDFPerc

*Percentiles of ES distribution function for Student-t*


---

**Description**

Plots the ES of a portfolio against confidence level assuming that geometric returns are Student t distributed, for specified confidence level and holding period.

**Usage**

```
LogtESDFPerc(...)
```

**Arguments**

...

The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 6 or 8. In case there 6 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

n Sample size

investment Size of investment

perc Desired percentile

df Number of degrees of freedom in the t distribution

cl ES confidence level and must be a scalar

hp ES holding period and must be a scalar

**Value**

Percentiles of ES distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of ES distribution
data <- runif(5, min = 0, max = .2)
LogtESDFPerc(returns = data, investment = 5, perc = .7, df = 6, cl = .95, hp = 60)

# Computes v given mean and standard deviation of return data
LogtESDFPerc(mu = .012, sigma = .03, n = 10, investment = 5, perc = .8, df = 6, cl = .99, hp = 40)
```

---

LogtESPlot2DCL

*Plots log-t ES against confidence level*


---

**Description**

Plots the ES of a portfolio against confidence level assuming that geometric returns are Student t distributed, for specified confidence level and holding period.

**Usage**

```
LogtESPlot2DCL(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the t distribution  
cl ES confidence level and must be a vector  
hp ES holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
LogtESPlot2DCL(returns = data, investment = 5, df = 6, cl = seq(.9,.99,.01), hp = 60)

# Computes v given mean and standard deviation of return data
LogtESPlot2DCL(mu = .012, sigma = .03, investment = 5, df = 6, cl = seq(.9,.99,.01), hp = 40)
```

---

LogtESPlot2DHP

*Plots log-t ES against holding period*


---

**Description**

Plots the ES of a portfolio against holding period assuming that geometric returns are Student t distributed, for specified confidence level and holding period.

**Usage**

```
LogtESPlot2DHP(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the t distribution  
cl ES confidence level and must be a scalar  
hp ES holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.



**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
LogtESPlot2DHP(returns = data, investment = 5, df = 6, cl = .95, hp = 60:90)

# Computes v given mean and standard deviation of return data
LogtESPlot2DHP(mu = .012, sigma = .03, investment = 5, df = 6, cl = .99, hp = 40:80)
```

---

LogtESPlot3D

*Plots log-t ES against confidence level and holding period*


---

**Description**

Plots the ES of a portfolio against confidence level and holding period assuming that geometric returns are Student-t distributed, for specified confidence level and holding period.

**Usage**

```
LogtESPlot3D(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the t distribution  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots ES against confidence level given geometric return data
data <- rnorm(5, .09, .03)
LogtESPlot3D(returns = data, investment = 5, df = 6, cl = seq(.9, .99, .01), hp = 1:100)

# Computes ES against confidence level given mean and standard deviation of return data
LogtESPlot3D(mu = .012, sigma = .03, investment = 5, df = 6, cl = seq(.9, .99, .01), hp = 1:100)
```

---

LogtVaR

*VaR for t distributed geometric returns*


---

**Description**

Estimates the VaR of a portfolio assuming that geometric returns are Student t distributed, for specified confidence level and holding period.

**Usage**

```
LogtVaR(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

investment Size of investment

df Number of degrees of freedom in the t distribution

cl VaR confidence level

hp VaR holding period

**Value**

Matrix of VaRs whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given geometric return data
data <- runif(5, min = 0, max = .2)
LogtVaR(returns = data, investment = 5, df = 6, cl = .95, hp = 90)

# Computes VaR given mean and standard deviation of return data
LogtVaR(mu = .012, sigma = .03, investment = 5, df = 6, cl = .95, hp = 90)
```

---

LogtVaRDFPerc

*Percentiles of VaR distribution function for Student-t*


---

**Description**

Plots the VaR of a portfolio against confidence level assuming that geometric returns are Student t distributed, for specified confidence level and holding period.

**Usage**

```
LogtVaRDFPerc(...)
```

**Arguments**

```
... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 6 or 8. In case there 6 input arguments, the mean, standard deviation and number of observations of the data is computed from return data. See examples for details.
returns Vector of daily geometric return data
mu Mean of daily geometric return data
sigma Standard deviation of daily geometric return data
n Sample size
investment Size of investment
perc Desired percentile
df Number of degrees of freedom in the t distribution
cl VaR confidence level and must be a scalar
hp VaR holding period and must be a scalar
Percentiles of VaR distribution function
```

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of VaR distribution
data <- runif(5, min = 0, max = .2)
LogtVaRDFPerc(returns = data, investment = 5, perc = .7,
              df = 6, cl = .95, hp = 60)

# Computes v given mean and standard deviation of return data
LogtVaRDFPerc(mu = .012, sigma = .03, n= 10, investment = 5,
              perc = .8, df = 6, cl = .99, hp = 40)
```

---

LogtVaRPlot2DCL

*Plots log-t VaR against confidence level*

---

**Description**

Plots the VaR of a portfolio against confidence level assuming that geometric returns are Student-t distributed, for specified confidence level and holding period.

**Usage**

```
LogtVaRPlot2DCL(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the t distribution  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
LogtVaRPlot2DCL(returns = data, investment = 5, df = 6, cl = seq(.85,.99,.01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of return data
LogtVaRPlot2DCL(mu = .012, sigma = .03, investment = 5, df = 6, cl = seq(.85,.99,.01), hp = 40)
```

---

LogtVaRPlot2DHP

*Plots log-t VaR against holding period*


---

**Description**

Plots the VaR of a portfolio against holding period assuming that geometric returns are Student  $t$  distributed, for specified confidence level and holding period.

**Usage**

```
LogtVaRPlot2DHP(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the  $t$  distribution  
cl VaR confidence level and must be a scalar  
hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given geometric return data
data <- runif(5, min = 0, max = .2)
LogtVaRPlot2DHP(returns = data, investment = 5, df = 6, cl = .95, hp = 60:90)

# Computes VaR given mean and standard deviation of return data
LogtVaRPlot2DHP(mu = .012, sigma = .03, investment = 5, df = 6, cl = .99, hp = 40:80)
```

---

LogtVaRPlot3D

*Plots log-t VaR against confidence level and holding period*


---

**Description**

Plots the VaR of a portfolio against confidence level and holding period assuming that geometric returns are Student-t distributed, for specified confidence level and holding period.

**Usage**

```
LogtVaRPlot3D(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 6. In case there 5 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
investment Size of investment  
df Number of degrees of freedom in the t distribution  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
LogtVaRPlot3D(returns = data, investment = 5, df = 6, cl = seq(.9,.99,.01), hp = 1:100)

# Computes VaR against confidence level given mean and standard deviation of return data
LogtVaRPlot3D(mu = .012, sigma = .03, investment = 5, df = 6, cl = seq(.9,.99,.01), hp = 1:100)
```

---

LongBlackScholesCallVaR

*Derives VaR of a long Black Scholes call option*

---

**Description**

Function derives the VaR of a long Black Scholes call for specified confidence level and holding period, using analytical solution.

**Usage**

```
LongBlackScholesCallVaR(stockPrice, strike, r, mu, sigma, maturity, cl, hp)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate and is annualised
mu	Mean return
sigma	Volatility of the underlying stock
maturity	Term to maturity and is expressed in days
cl	Confidence level and is scalar
hp	Holding period and is scalar and is expressed in days

**Value**

Price of European Call Option

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. Measuring Market Risk, Wiley, 2007.

Hull, John C.. Options, Futures, and Other Derivatives. 4th ed., Upper Saddle River, NJ: Prentice Hall, 200, ch. 11.

Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Estimates the price of an American Put
LongBlackScholesCallVaR(27.2, 25, .03, .12, .2, 60, .95, 40)
```

---

LongBlackScholesPutVaR

*Derives VaR of a long Black Scholes put option*

---

**Description**

Function derives the VaR of a long Black Scholes put for specified confidence level and holding period, using analytical solution.

**Usage**

```
LongBlackScholesPutVaR(stockPrice, strike, r, mu, sigma, maturity, cl, hp)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate and is annualised
mu	Mean return
sigma	Volatility of the underlying stock
maturity	Term to maturity and is expressed in days
cl	Confidence level and is scalar
hp	Holding period and is scalar and is expressed in days

**Value**

Price of European put Option

**Author(s)**

Dinesh Acharya

**References**

Dowd, Kevin. *Measuring Market Risk*, Wiley, 2007.

Hull, John C.. *Options, Futures, and Other Derivatives*. 4th ed., Upper Saddle River, NJ: Prentice Hall, 200, ch. 11.

Lyu, Yuh-Dauh. *Financial Engineering & Computation: Principles, Mathematics, Algorithms*, Cambridge University Press, 2002.



**Examples**

```
# Estimates the price of an American Put
LongBlackScholesPutVaR(27.2, 25, .03, .12, .2, 60, .95, 40)
```

---

LopezBacktest	<i>First (binomial) Lopez forecast evaluation backtest score measure</i>
---------------	--

---

**Description**

Derives the first Lopez (i.e. binomial) forecast evaluation score for a VaR risk measurement model.

**Usage**

```
LopezBacktest(Ra, Rb, cl)
```

**Arguments**

Ra	Vector of portfolio of profit loss distribution
Rb	Vector of corresponding VaR forecasts
cl	VaR confidence level

**Value**

Something

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Lopez, J. A. Methods for Evaluating Value-at-Risk Estimates. Federal Reserve Bank of New York Economic Policy Review, 1998, p. 121.

Lopez, J. A. Regulatory Evaluations of Value-at-Risk Models. Journal of Risk 1999, 37-64.

**Examples**

```
# Has to be modified with appropriate data:
# LopezBacktest for given parameters
a <- rnorm(1*100)
b <- abs(rnorm(1*100))+2
LopezBacktest(a, b, 0.95)
```

---

MEFPlot

*Mean Excess Function Plot*

---

### Description

Plots mean-excess function values of the data set.

### Usage

```
MEFPlot(Ra)
```

### Arguments

Ra                    Vector data

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots mean-excess function values
Ra <- rnorm(1000)
MEFPlot(Ra)
```

---

NormalES

*ES for normally distributed P/L*

---

### Description

Estimates the ES of a portfolio assuming that P/L is normally distributed, for specified confidence level and holding period.

### Usage

```
NormalES(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data along with the remaining arguments. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 cl VaR confidence level  
 hp VaR holding period in days

**Value**

Matrix of ES whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given P/L
data <- runif(5, min = 0, max = .2)
NormalES(returns = data, cl = .95, hp = 90)

# Computes VaR given mean and standard deviation of P/L data
NormalES(mu = .012, sigma = .03, cl = .95, hp = 90)
```

---

NormalESConfidenceInterval

*Generates Monte Carlo 95% Confidence Intervals for normal ES*

---

**Description**

Generates 95% confidence intervals for normal ES using Monte Carlo simulation

**Usage**

```
NormalESConfidenceInterval(mu, sigma, number.trials, sample.size, cl, hp)
```

**Arguments**

mu	Mean of the P/L process
sigma	Standard deviation of the P/L process
number.trials	Number of trials used in the simulations
sample.size	Sample drawn in each trial
cl	Confidence Level
hp	Holding Period

**Value**

95% confidence intervals for normal ES

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Generates 95% confidence intervals for normal ES for given parameters
NormalESConfidenceInterval(0, .5, 20, 20, .95, 90)
```

---

NormalESDFPerc	<i>Percentiles of ES distribution function for normally distributed P/L data</i>
----------------	--

---

**Description**

Estimates the percentiles of ES distribution for normally distributed P/L data, for specified confidence level and holding period using the theory of order statistics.

**Usage**

```
NormalESDFPerc(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 6. In case there 4 input arguments, the mean, standard deviation and number of samples is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 n Sample size  
 perc Desired percentile  
 cl ES confidence level and must be a scalar  
 hp ES holding period and must be a scalar

**Value**

Percentiles of ES distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of ES distribution
data <- runif(5, min = 0, max = .2)
NormalESDFPerc(returns = data, perc = .7, cl = .95, hp = 60)

# Estimates Percentiles given mean, standard deviation and number of samples of return data
NormalESDFPerc(mu = .012, sigma = .03, n = 10, perc = .8, cl = .99, hp = 40)
```

---

NormalESFigure

*Figure of normal VaR and ES and pdf against L/P*

---

**Description**

Gives figure showing the VaR and ES and probability distribution function against L/P of a portfolio assuming geometric returns are normally distributed, for specified confidence level and holding period.

**Usage**

NormalESFigure(...)

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details. returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl VaR confidence level and should be scalar

hp VaR holding period in days and should be scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots lognormal VaR, ES and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
NormalESFigure(returns = data, cl = .95, hp = 90)

# Plots lognormal VaR, ES and pdf against L/P data with given parameters
NormalESFigure(mu = .012, sigma = .03, cl = .95, hp = 90)
```

---

NormalESHspots

*Hotspots for normal ES*

---

**Description**

Estimates the ES hotspots (or vector of incremental ESs) for a portfolio assuming individual asset returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalESHspots(vc.matrix, mu, positions, cl, hp)
```

**Arguments**

vc.matrix Variance covariance matrix for returns

mu Vector of expected position returns

positions Vector of positions

cl Confidence level and is scalar

hp Holding period and is scalar

**Value**

Hotspots for normal ES

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Hotspots for ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4,.08,.04)
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
NormalESHotspots(vc.matrix, mu, positions, cl, hp)
```

---

NormalESPlot2DCL

*Plots normal ES against confidence level*

---

**Description**

Plots the ES of a portfolio against confidence level assuming that P/L are normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalESPlot2DCL(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl ES confidence level and must be a vector

hp ES holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots ES against confidence level
data <- runif(5, min = 0, max = .2)
NormalESPlot2DCL(returns = data, cl = seq(.9,.99,.01), hp = 60)

# Plots ES against confidence level
NormalESPlot2DCL(mu = .012, sigma = .03, cl = seq(.9,.99,.01), hp = 40)
```

---

NormalESPlot2DHP	<i>Plots normal ES against holding period</i>
------------------	---

---

**Description**

Plots the ES of a portfolio against holding period assuming that P/L distribution is normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalESPlot2DHP(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
cl ES confidence level and must be a scalar  
hp ES holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.



**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
NormalESPlot2DHP(returns = data, cl = .95, hp = 60:90)

# Computes v given mean and standard deviation of return data
NormalESPlot2DHP(mu = .012, sigma = .03, cl = .99, hp = 40:80)
```

---

NormalESPlot3D

*Plots normal ES against confidence level and holding period*


---

**Description**

Plots the ES of a portfolio against confidence level and holding period assuming that P/L is normally distributed, for specified ranges of confidence level and holding period.

**Usage**

```
NormalESPlot3D(...)
```

**Arguments**

```
...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.
returns  Vector of daily geometric return data
mu       Mean of daily geometric return data
sigma    Standard deviation of daily geometric return data
cl       VaR confidence level and must be a vector
hp       VaR holding period and must be a vector
```

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
NormalESPlot3D(returns = data, cl = seq(.9,.99,.01), hp = 1:100)

# Computes VaR against confidence level given mean and standard deviation of return data
NormalESPlot3D(mu = .012, sigma = .03, cl = seq(.9,.99,.01), hp = 1:100)
```

NormalQQPlot

*Normal Quantile Quantile Plot*

---

**Description**

Produces an empirical QQ-Plot of the quantiles of the data set 'Ra' versus the quantiles of a normal distribution. The purpose of the quantile-quantile plot is to determine whether the sample in 'Ra' is drawn from a normal (i.e., Gaussian) distribution.

**Usage**

```
NormalQQPlot(Ra)
```

**Arguments**

Ra                    Vector data set

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Normal QQ Plot for randomly generated standard normal data
Ra <- rnorm(100)
NormalQQPlot(Ra)
```

---

NormalQuantileStandardError*Standard error of normal quantile estimate*

---

**Description**

Estimates standard error of normal quantile estimate

**Usage**

```
NormalQuantileStandardError(prob, n, mu, sigma, bin.size)
```

**Arguments**

prob	Tail probability. Can be a vector or scalar
n	Sample size
mu	Mean of the normal distribution
sigma	Standard deviation of the distribution
bin.size	Bin size. It is optional parameter with default value 1

**Value**

Vector or scalar depending on whether the probability is a vector or scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates standard error of normal quantile estimate
NormalQuantileStandardError(.8, 100, 0, .5, 3)
```

---

NormalSpectralRiskMeasure

*Estimates the spectral risk measure of a portfolio*

---

**Description**

Function estimates the spectral risk measure of a portfolio assuming losses are normally distributed, assuming exponential weighting function with specified gamma.

**Usage**

```
NormalSpectralRiskMeasure(mu, sigma, gamma, number.of.slices)
```

**Arguments**

mu	Mean losses
sigma	Standard deviation of losses
gamma	Gamma parameter in exponential risk aversion
number.of.slices	Number of slices into which density function is divided

**Value**

Estimated spectral risk measure

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Generates 95% confidence intervals for normal VaR for given parameters
NormalSpectralRiskMeasure(0, .5, .8, 20)
```

---

NormalVaR

*VaR for normally distributed P/L*

---

**Description**

Estimates the VaR of a portfolio assuming that P/L is normally distributed, for specified confidence level and holding period.

**Usage**

NormalVaR(...)

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data along with the remaining arguments. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 cl VaR confidence level  
 hp VaR holding period in days

**Value**

Matrix of VaR whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given geometric return data
data <- runif(5, min = 0, max = .2)
NormalVaR(returns = data, cl = .95, hp = 90)

# Computes VaR given mean and standard deviation of return data
NormalVaR(mu = .012, sigma = .03, cl = .95, hp = 90)
```

---

NormalVaRConfidenceInterval

*Generates Monte Carlo 95% Confidence Intervals for normal VaR*

---

**Description**

Generates 95% confidence intervals for normal VaR using Monte Carlo simulation

**Usage**

```
NormalVaRConfidenceInterval(mu, sigma, number.trials, sample.size, cl, hp)
```

**Arguments**

mu	Mean of the P/L process
sigma	Standard deviation of the P/L process
number.trials	Number of trials used in the simulations
sample.size	Sample drawn in each trial
cl	Confidence Level
hp	Holding Period

**Value**

95% confidence intervals for normal VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Generates 95% confidence intervals for normal VaR for given parameters
NormalVaRConfidenceInterval(0, .5, 20, 15, .95, 90)
```

---

NormalVaRDFPerc	<i>Percentiles of VaR distribution function for normally distributed P/L</i>
-----------------	--

---

**Description**

Estimates the percentile of VaR distribution function for normally distributed P/L, using the theory of order statistics.

**Usage**

```
NormalVaRDFPerc(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 6. In case there 4 input arguments, the mean, standard deviation and number of observations of data are computed from returns data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data sigma Standard deviation of daily geometric return data  
n Sample size  
perc Desired percentile  
cl VaR confidence level and must be a scalar  
hp VaR holding period and must be a scalar

**Value**

Percentiles of VaR distribution function and is scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of VaR distribution
data <- runif(5, min = 0, max = .2)
NormalVaRDFPerc(returns = data, perc = .7, cl = .95, hp = 60)

# Estimates Percentiles of VaR distribution
NormalVaRDFPerc(mu = .012, sigma = .03, n= 10, perc = .8, cl = .99, hp = 40)
```

---

NormalVaRFigure

*Figure of normal VaR and pdf against L/P*


---

**Description**

Gives figure showing the VaR and probability distribution function against L/P of a portfolio assuming P/L are normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalVaRFigure(...)
```

**Arguments**

```
...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.
returns  Vector of daily geometric return data
mu       Mean of daily geometric return data
sigma    Standard deviation of daily geometric return data
cl       VaR confidence level and should be scalar
hp       VaR holding period in days and should be scalar
```

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots normal VaR and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
NormalVaRFigure(returns = data, cl = .95, hp = 90)

# Plots normal VaR and pdf against L/P data with given parameters
NormalVaRFigure(mu = .012, sigma = .03, cl = .95, hp = 90)
```

---

NormalVaRHotspots      *Hotspots for normal VaR*

---

**Description**

Estimates the VaR hotspots (or vector of incremental VaRs) for a portfolio assuming individual asset returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalVaRHotspots(vc.matrix, mu, positions, cl, hp)
```

**Arguments**

vc.matrix	Variance covariance matrix for returns
mu	Vector of expected position returns
positions	Vector of positions
cl	Confidence level and is scalar
hp	Holding period and is scalar

**Value**

Hotspots for normal VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Hotspots for ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4,.08,.04)
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
NormalVaRHotspots(vc.matrix, mu, positions, cl, hp)
```



---

NormalVaRPlot2DCL      *Plots normal VaR against confidence level*

---

### Description

Plots the VaR of a portfolio against confidence level assuming that P/L are normally distributed, for specified confidence level and holding period.

### Usage

```
NormalVaRPlot2DCL(...)
```

### Arguments

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there are 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl VaR confidence level and must be a vector

hp VaR holding period and must be a scalar

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Plots VaR against confidence level given P/L data
data <- runif(5, min = 0, max = .2)
NormalVaRPlot2DCL(returns = data, cl = seq(.85,.99,.01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of return data
NormalVaRPlot2DCL(mu = .012, sigma = .03, cl = seq(.85,.99,.01), hp = 40)
```

---

NormalVaRPlot2DHP      *Plots normal VaR against holding period*

---

### Description

Plots the VaR of a portfolio against holding period assuming that P/L are normally distributed, for specified confidence level and holding period.

### Usage

```
NormalVaRPlot2DHP(...)
```

### Arguments

...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details. returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl VaR confidence level and must be a scalar

hp VaR holding period and must be a vector

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Computes VaR given P/L data
data <- runif(5, min = 0, max = .2)
NormalVaRPlot2DHP(returns = data, cl = .95, hp = 60:90)

# Computes VaR given mean and standard deviation of P/L data
NormalVaRPlot2DHP(mu = .012, sigma = .03, cl = .99, hp = 40:80)
```

---

NormalVaRPlot3D	<i>Plots normal VaR in 3D against confidence level and holding period</i>
-----------------	---

---

**Description**

Plots the VaR of a portfolio against confidence level and holding period assuming that P/L are normally distributed, for specified confidence level and holding period.

**Usage**

```
NormalVaRPlot3D(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 3 or 4. In case there 3 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

cl VaR confidence level and must be a vector

hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given geometric return data
data <- rnorm(5, .07, .03)
NormalVaRPlot3D(returns = data, cl = seq(.9, .99, .01), hp = 1:100)

# Computes VaR against confidence level given mean and standard deviation of return data
NormalVaRPlot3D(mu = .012, sigma = .03, cl = seq(.9, .99, .01), hp = 1:100)
```

---

PCAES

*Estimates ES by principal components analysis*

---

### Description

Estimates the ES of a multi position portfolio by principal components analysis, using chosen number of principal components and a specified confidence level or range of confidence levels.

### Usage

```
PCAES(Ra, position.data, number.of.principal.components, cl)
```

### Arguments

Ra	Matrix return data set where each row is interpreted as a set of daily observations, and each column as the returns to each position in a portfolio
position.data	Position-size vector, giving amount invested in each position
number.of.principal.components	Chosen number of principal components
cl	Chosen confidence level

### Value

ES

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

### Examples

```
# Computes PCA ES
Ra <- matrix(rnorm(4*6),4,6)
position.data <- rnorm(6)
PCAES(Ra, position.data, 2, .95)
```

---

PCAESPlot

*ES plot*

---

**Description**

Estimates ES plot using principal components analysis

**Usage**

```
PCAESPlot(Ra, position.data)
```

**Arguments**

**Ra** Matrix return data set where each row is interpreted as a set of daily observations, and each column as the returns to each position in a portfolio

**position.data** Position-size vector, giving amount invested in each position

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes PCA ES
Ra <- matrix(rnorm(15*20),15,20)
position.data <- rnorm(20)
PCAESPlot(Ra, position.data)
```

---

PCAPrelim

*Estimates VaR plot using principal components analysis*

---

**Description**

Estimates VaR plot using principal components analysis

**Usage**

```
PCAPrelim(Ra)
```

**Arguments**

**Ra** Matrix return data set where each row is interpreted as a set of daily observations, and each column as the returns to each position in a portfolio position

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes PCA Prelim
# This code was based on Dowd's code and similar to Dowd's code,
# it is inconsistent for non-scalar data (Ra).
library(MASS)
Ra <- .15
PCAPrelim(Ra)
```

PCAVaR

*Estimates VaR by principal components analysis***Description**

Estimates the VaR of a multi position portfolio by principal components analysis, using chosen number of principal components and a specified confidence level or range of confidence levels.

**Usage**

```
PCAVaR(Ra, position.data, number.of.principal.components, cl)
```

**Arguments**

Ra	Matrix return data set where each row is interpreted as a set of daily observations, and each column as the returns to each position in a portfolio
position.data	Position-size vector, giving amount invested in each position
number.of.principal.components	Chosen number of principal components
cl	Chosen confidence level

**Value**

VaR

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes PCA VaR
Ra <- matrix(rnorm(4*6),4,6)
position.data <- rnorm(6)
PCAVaR(Ra, position.data, 2, .95)
```

---

PCAVaRPlot

*VaR plot*

---

**Description**

Estimates VaR plot using principal components analysis

**Usage**

```
PCAVaRPlot(Ra, position.data)
```

**Arguments**

Ra                    Matrix return data set where each row is interpreted as a set of daily observations, and each column as the returns to each position in a portfolio

position.data        Position-size vector, giving amount invested in each position

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes PCA VaR
Ra <- matrix(rnorm(15*20),15,20)
position.data <- rnorm(20)
PCAVaRPlot(Ra, position.data)
```

PickandsEstimator      *Pickands Estimator*

---

**Description**

Estimates the Value of Pickands Estimator for a specified data set and chosen tail size. Notes: (1) We estimate the Pickands Estimator by looking at the upper tail. (2) The tail size must be less than one quarter of the total sample size. (3) The tail size must be a scalar.

**Usage**

```
PickandsEstimator(Ra, tail.size)
```

**Arguments**

Ra	A data set
tail.size	Number of observations to be used to estimate the Pickands estimator

**Value**

Value of Pickands estimator

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes estimated Pickands estimator for randomly generated data.  
Ra <- rnorm(1000)  
PickandsEstimator(Ra, 40)
```

---

PickandsPlot      *Pickand Estimator - Tail Sample Size Plot*

---

**Description**

Displays a plot of the Pickands Estimator against Tail Sample Size.

**Usage**

```
PickandsPlot(Ra, maximum.tail.size)
```



**Arguments**

Ra                    The data set  
 maximum.tail.size                    maximum tail size and should be greater than a quarter of the sample size.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Pickand - Sample Tail Size Plot for random standard normal data
Ra <- rnorm(1000)
PickandsPlot(Ra, 40)
```

---

ProductCopulaVaR                    *Bivariate Product Copule VaR*

---

**Description**

Derives VaR using bivariate Product or logistic copula with specified inputs for normal marginals.

**Usage**

```
ProductCopulaVaR(mu1, mu2, sigma1, sigma2, c1)
```

**Arguments**

mu1                    Mean of Profit/Loss on first position  
 mu2                    Mean of Profit/Loss on second position  
 sigma1                    Standard Deviation of Profit/Loss on first position  
 sigma2                    Standard Deviation of Profit/Loss on second position  
 c1                    VaR onfidece level

**Value**

Copula based VaR

**Author(s)**

Dinesh Acharya

**References**

- Dowd, K. Measuring Market Risk, Wiley, 2007.
- Dowd, K. and Fackler, P. Estimating VaR with copulas. Financial Engineering News, 2004.

**Examples**

```
# VaR using bivariate Product for X and Y with given parameters:
ProductCopulaVaR(.9, 2.1, 1.2, 1.5, .95)
```

---

ShortBlackScholesCallVaR

*Derives VaR of a short Black Scholes call option*

---

**Description**

Function derives the VaR of a short Black Scholes call for specified confidence level and holding period, using analytical solution.

**Usage**

```
ShortBlackScholesCallVaR(stockPrice, strike, r, mu, sigma, maturity, cl, hp)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate and is annualised
mu	Mean return
sigma	Volatility of the underlying stock
maturity	Term to maturity and is expressed in days
cl	Confidence level and is scalar
hp	Holding period and is scalar and is expressed in days

**Value**

Price of European Call Option

**Author(s)**

Dinesh Acharya

**References**

- Dowd, Kevin. Measuring Market Risk, Wiley, 2007.
- Hull, John C.. Options, Futures, and Other Derivatives. 4th ed., Upper Saddle River, NJ: Prentice Hall, 200, ch. 11.
- Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Estimates the price of an American Put
ShortBlackScholesCallVaR(27.2, 25, .03, .12, .2, 60, .95, 40)
```

---

```
ShortBlackScholesPutVaR
```

*Derives VaR of a short Black Scholes put option*

---

**Description**

Function derives the VaR of a Short Black Scholes put for specified confidence level and holding period, using analytical solution.

**Usage**

```
ShortBlackScholesPutVaR(stockPrice, strike, r, mu, sigma, maturity, cl, hp)
```

**Arguments**

stockPrice	Stock price of underlying stock
strike	Strike price of the option
r	Risk-free rate and is annualised
mu	Mean return
sigma	Volatility of the underlying stock
maturity	Term to maturity and is expressed in days
cl	Confidence level and is scalar
hp	Holding period and is scalar and is expressed in days

**Value**

Price of European put Option

**Author(s)**

Dinesh Acharya

**References**

- Dowd, Kevin. Measuring Market Risk, Wiley, 2007.
- Hull, John C.. Options, Futures, and Other Derivatives. 4th ed., Upper Saddle River, NJ: Prentice Hall, 200, ch. 11.
- Lyu, Yuh-Dauh. Financial Engineering & Computation: Principles, Mathematics, Algorithms, Cambridge University Press, 2002.

**Examples**

```
# Derives VaR of a short Black Scholes put option
ShortBlackScholesPutVaR(27.2, 25, .03, .12, .2, 60, .95, 40)
```

---

StopLossLogNormalVaR *Log Normal VaR with stop loss limit*

---

**Description**

Generates Monte Carlo lognormal VaR with stop-loss limit

**Usage**

```
StopLossLogNormalVaR(mu, sigma, number.trials, loss.limit, cl, hp)
```

**Arguments**

mu	Mean arithmetic return
sigma	Standard deviation of arithmetic return
number.trials	Number of trials used in the simulations
loss.limit	Stop Loss limit
cl	Confidence Level
hp	Holding Period

**Value**

Lognormal VaR

**Author(s)**

Dinesh Acharya

**References**

- Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates standard error of normal quantile estimate
StopLossLogNormalVaR(0, .2, 100, 1.2, .95, 10)
```

---

tES

*ES for t distributed P/L*


---

**Description**

Estimates the ES of a portfolio assuming that P/L are t-distributed, for specified confidence level and holding period.

**Usage**

tES(...)

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily P/L data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

df Number of degrees of freedom in the t-distribution

cl ES confidence level

hp ES holding period in days

**Value**

Matrix of ES whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Evans, M., Hastings, M. and Peacock, B. Statistical Distributions, 3rd edition, New York: John Wiley, ch. 38,39.

**Examples**

```
# Computes ES given P/L data
data <- runif(5, min = 0, max = .2)
tES(returns = data, df = 6, cl = .95, hp = 90)

# Computes ES given mean and standard deviation of P/L data
tES(mu = .012, sigma = .03, df = 6, cl = .95, hp = 90)
```

tESDFPerc

*Percentiles of ES distribution function for t-distributed P/L***Description**

Estimates percentiles of ES distribution function for t-distributed P/L, using the theory of order statistics

**Usage**

```
tESDFPerc(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 7. In case there 5 input arguments, the mean, standard deviation and assumed sample size of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
n Sample size  
df Degrees of freedom  
perc Desired percentile  
df Number of degrees of freedom in the t distribution  
cl ES confidence level and must be a scalar  
hp ES holding period and must be a scalar

**Value**

Percentiles of ES distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of ES distribution given P/L data
data <- runif(5, min = 0, max = .2)
tESDFPerc(returns = data, perc = .7, df = 6, cl = .95, hp = 60)

# Estimates Percentiles of ES distribution given mean, std. deviation and sample size
tESDFPerc(mu = .012, sigma = .03, n = 10, perc = .8, df = 6, cl = .99, hp = 40)
```

tESFigure

*Figure of t - VaR and ES and pdf against L/P***Description**

Gives figure showing the VaR and ES and probability distribution function assuming P/L is t- distributed, for specified confidence level and holding period.

**Usage**

```
tESFigure(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details. returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

df Number of degrees of freedom

cl VaR confidence level and should be scalar

hp VaR holding period in days and should be scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Evans, M., Hastings, M. and Peacock, B. Statistical Distributions, 3rd edition, New York: John Wiley, ch. 38,39.

**Examples**

```
# Plots lognormal VaR, ES and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
tESFigure(returns = data, df = 10, cl = .95, hp = 90)

# Plots lognormal VaR, ES and pdf against L/P data with given parameters
tESFigure(mu = .012, sigma = .03, df = 10, cl = .95, hp = 90)
```

---

tESPlot2DCL

*Plots t- ES against confidence level*


---

**Description**

Plots the ES of a portfolio against confidence level, assuming that L/P is t distributed, for specified confidence level and holding period.

**Usage**

```
tESPlot2DCL(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
df Number of degrees of freedom in the t distribution  
cl ES confidence level and must be a vector  
hp ES holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Evans, M., Hastings, M. and Peacock, B. Statistical Distributions, 3rd edition, New York: John Wiley, ch. 38,39.



**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
tESPlot2DCL(returns = data, df = 6, cl = seq(.9,.99,.01), hp = 60)

# Computes v given mean and standard deviation of return data
tESPlot2DCL(mu = .012, sigma = .03, df = 6, cl = seq(.9,.99,.01), hp = 40)
```

---

tESPlot2DHP

*Plots t ES against holding period*


---

**Description**

Plots the ES of a portfolio against holding period assuming that L/P is t distributed, for specified confidence level and holding periods.

**Usage**

```
tESPlot2DHP(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily P/L data  
mu Mean of daily P/L data  
sigma Standard deviation of daily P/L data  
df Number of degrees of freedom in the t distribution  
cl ES confidence level and must be a scalar  
hp ES holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

Evans, M., Hastings, M. and Peacock, B. Statistical Distributions, 3rd edition, New York: John Wiley, ch. 38,39.

**Examples**

```
# Computes ES given geometric return data
data <- runif(5, min = 0, max = .2)
tESPlot2DHP(returns = data, df = 6, cl = .95, hp = 60:90)

# Computes v given mean and standard deviation of return data
tESPlot2DHP(mu = .012, sigma = .03, df = 6, cl = .99, hp = 40:80)
```

tESPlot3D

*Plots t ES against confidence level and holding period***Description**

Plots the ES of a portfolio against confidence level and holding period assuming that P/L are Student-t distributed, for specified confidence level and holding period.

**Usage**

```
tESPlot3D(...)
```

**Arguments**

```
...      The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.
returns  Vector of daily P/L data
mu       Mean of daily P/L data
sigma    Standard deviation of daily P/L data
df       Number of degrees of freedom in the t distribution
cl       VaR confidence level and must be a vector
hp       VaR holding period and must be a vector
```

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots ES against confidence level given P/L data
data <- runif(5, min = 0, max = .2)
tESPlot3D(returns = data, df = 6, cl = seq(.85,.99,.01), hp = 60:90)

# Computes ES against confidence level given mean and standard deviation of return data
tESPlot3D(mu = .012, sigma = .03, df = 6, cl = seq(.85,.99,.02), hp = 40:80)
```

---

`TQQPlot`*Student's T Quantile - Quantile Plot*

---

**Description**

Creates empirical QQ-plot of the quantiles of the data set `x` versus of a `t` distribution. The QQ-plot can be used to determine whether the sample in `x` is drawn from a `t` distribution with specified number of degrees of freedom.

**Usage**

```
TQQPlot(Ra, df)
```

**Arguments**

<code>Ra</code>	Sample data set
<code>df</code>	Number of degrees of freedom of the <code>t</code> distribution

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# t-QQ Plot for randomly generated standard normal data
Ra <- rnorm(100)
TQQPlot(Ra, 20)
```

---

`tQuantileStandardError`*Standard error of t quantile estimate*

---

**Description**

Estimates standard error of `t` quantile estimate

**Usage**

```
tQuantileStandardError(prob, n, mu, sigma, df, bin.size)
```

**Arguments**

prob	Tail probability. Can be a vector or scalar
n	Sample size
mu	Mean of the normal distribution
sigma	Standard deviation of the distribution
df	Number of degrees of freedom
bin.size	Bin size. It is optional parameter with default value 1

**Value**

Vector or scalar depending on whether the probability is a vector or scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates standard error of normal quantile estimate
tQuantileStandardError(.8, 100, 0, .5, 5, 3)
```

---

tVaR	<i>VaR for t distributed P/L</i>
------	----------------------------------

---

**Description**

Estimates the VaR of a portfolio assuming that P/L are t distributed, for specified confidence level and holding period.

**Usage**

```
tVaR(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data

mu Mean of daily geometric return data

sigma Standard deviation of daily geometric return data

df Number of degrees of freedom in the t distribution  
cl VaR confidence level  
hp VaR holding period

### Value

Matrix of VaRs whose dimension depends on dimension of hp and cl. If cl and hp are both scalars, the matrix is 1 by 1. If cl is a vector and hp is a scalar, the matrix is row matrix, if cl is a scalar and hp is a vector, the matrix is column matrix and if both cl and hp are vectors, the matrix has dimension length of cl \* length of hp.

### Author(s)

Dinesh Acharya

### References

Dowd, K. Measuring Market Risk, Wiley, 2007.

Evans, M., Hastings, M. and Peacock, B. Statistical Distributions, 3rd edition, New York: John Wiley, ch. 38,39.

### Examples

```
# Computes VaR given P/L data
data <- runif(5, min = 0, max = .2)
tVaR(returns = data, df = 6, cl = .95, hp = 90)

# Computes VaR given mean and standard deviation of P/L data
tVaR(mu = .012, sigma = .03, df = 6, cl = .95, hp = 90)
```

---

tVaRDFPerc

*Percentiles of VaR distribution function*

---

### Description

Plots the VaR of a portfolio against confidence level assuming that P/L are t- distributed, for specified confidence level and holding period.

### Usage

```
tVaRDFPerc(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 5 or 7. In case there 6 input arguments, the mean, standard deviation and number of observations of the data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 n Sample size  
 perc Desired percentile  
 df Number of degrees of freedom in the t distribution  
 cl VaR confidence level and must be a scalar  
 hp VaR holding period and must be a scalar  
 Percentiles of VaR distribution function

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Estimates Percentiles of VaR distribution
data <- runif(5, min = 0, max = .2)
tVaRDFPerc(returns = data, perc = .7,
           df = 6, cl = .95, hp = 60)

# Computes v given mean and standard deviation of return data
tVaRDFPerc(mu = .012, sigma = .03, n= 10,
           perc = .8, df = 6, cl = .99, hp = 40)
```

---

tVaRESPlot2DCL

*Plots t VaR and ES against confidence level*


---

**Description**

Plots the VaR and ES of a portfolio against confidence level assuming that P/L data are t distributed, for specified confidence level and holding period.

**Usage**

```
tVaRESPlot2DCL(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there are 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR and ETL against confidence level given P/L data
data <- runif(5, min = 0, max = .2)
tVaRPlot2DCL(returns = data, df = 7, cl = seq(.85, .99, .01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of P/L data
tVaRPlot2DCL(mu = .012, sigma = .03, df = 7, cl = seq(.85, .99, .01), hp = 40)
```

---

tVaRFigure

---

*Figure of t- VaR and pdf against L/P*


---

**Description**

Gives figure showing the VaR and probability distribution function against L/P of a portfolio assuming P/L are normally distributed, for specified confidence level and holding period.

**Usage**

```
tVaRFigure(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
 mu Mean of daily geometric return data  
 sigma Standard deviation of daily geometric return data  
 df Number of degrees of freedom  
 cl VaR confidence level and should be scalar  
 hp VaR holding period in days and should be scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots normal VaR and pdf against L/P data for given returns data
data <- runif(5, min = 0, max = .2)
tVaRFigure(returns = data, df = 7, cl = .95, hp = 90)

# Plots normal VaR and pdf against L/P data with given parameters
tVaRFigure(mu = .012, sigma = .03, df=7, cl = .95, hp = 90)
```

---

tVaRPlot2DCL

*Plots t VaR against confidence level*

---

**Description**

Plots the VaR of a portfolio against confidence level assuming that P/L data is t distributed, for specified confidence level and holding period.

**Usage**

tVaRPlot2DCL(...)



**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily P/L data data

mu Mean of daily P/L data data

sigma Standard deviation of daily P/L data data

df Number of degrees of freedom in the t distribution

cl VaR confidence level and must be a vector

hp VaR holding period and must be a scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given P/L data data
data <- runif(5, min = 0, max = .2)
tVaRPlot2DCL(returns = data, df = 6, cl = seq(.85,.99,.01), hp = 60)

# Computes VaR against confidence level given mean and standard deviation of P/L data
tVaRPlot2DCL(mu = .012, sigma = .03, df = 6, cl = seq(.85,.99,.01), hp = 40)
```

---

tVaRPlot2DHP

*Plots t VaR against holding period*


---

**Description**

Plots the VaR of a portfolio against holding period assuming that P/L are t- distributed, for specified confidence level and holding period.

**Usage**

```
tVaRPlot2DHP(...)
```

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily P/L data data

mu Mean of daily P/L data data

sigma Standard deviation of daily P/L data data

df Number of degrees of freedom in the t distribution

cl VaR confidence level and must be a scalar

hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Computes VaR given P/L data data
data <- runif(5, min = 0, max = .2)
tVaRPlot2DHP(returns = data, df = 6, cl = .95, hp = 60:90)

# Computes VaR given mean and standard deviation of return data
tVaRPlot2DHP(mu = .012, sigma = .03, df = 6, cl = .99, hp = 40:80)
```

---

tVaRPlot3D

*Plots t VaR against confidence level and holding period*

---

**Description**

Plots the VaR of a portfolio against confidence level and holding period assuming that P/L are t distributed, for specified confidence level and holding period.

**Usage**

tVaRPlot3D(...)

**Arguments**

... The input arguments contain either return data or else mean and standard deviation data. Accordingly, number of input arguments is either 4 or 5. In case there 4 input arguments, the mean and standard deviation of data is computed from return data. See examples for details.

returns Vector of daily geometric return data  
mu Mean of daily geometric return data  
sigma Standard deviation of daily geometric return data  
df Number of degrees of freedom in the t distribution  
cl VaR confidence level and must be a vector  
hp VaR holding period and must be a vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Plots VaR against confidence level given geometric return data
data <- runif(5, min = 0, max = .2)
tVaRPlot3D(returns = data, df = 6, cl = seq(.85,.99,.01), hp = 60:90)

# Computes VaR against confidence level given mean and standard deviation of return data
tVaRPlot3D(mu = .012, sigma = .03, df = 6, cl = seq(.85,.99,.02), hp = 40:80)
```

---

VarianceCovarianceES *Variance-covariance ES for normally distributed returns*

---

**Description**

Estimates the variance-covariance VaR of a portfolio assuming individual asset returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
VarianceCovarianceES(vc.matrix, mu, positions, cl, hp)
```

**Arguments**

vc.matrix Variance covariance matrix for returns  
mu Vector of expected position returns  
positions Vector of positions  
cl Confidence level and is scalar  
hp Holding period and is scalar

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**Examples**

```
# Variance-covariance ES for randomly generated portfolio
vc.matrix <- matrix(rnorm(16), 4, 4)
mu <- rnorm(4)
positions <- c(5, 2, 6, 10)
cl <- .95
hp <- 280
VarianceCovarianceES(vc.matrix, mu, positions, cl, hp)
```

---

VarianceCovarianceVaR *Variance-covariance VaR for normally distributed returns*

---

**Description**

Estimates the variance-covariance VaR of a portfolio assuming individual asset returns are normally distributed, for specified confidence level and holding period.

**Usage**

```
VarianceCovarianceVaR(vc.matrix, mu, positions, cl, hp)
```

**Arguments**

<code>vc.matrix</code>	Assumed variance covariance matrix for returns
<code>mu</code>	Vector of expected position returns
<code>positions</code>	Vector of positions
<code>cl</code>	Confidence level and is scalar or vector
<code>hp</code>	Holding period and is scalar or vector

**Author(s)**

Dinesh Acharya

**References**

Dowd, K. Measuring Market Risk, Wiley, 2007.

**See Also**

AdjustedVarianceCovarianceVaR

**Examples**

```
# Variance-covariance VaR for randomly generated portfolio
vc.matrix <- matrix(rnorm(16),4,4)
mu <- rnorm(4)
positions <- c(5,2,6,10)
cl <- .95
hp <- 280
VarianceCovarianceVaR(vc.matrix, mu, positions, cl, hp)
```

# Index

## \*Topic **package**

- Dowd-package, 5
  
- AdjustedNormalESHotsspots, 5
- AdjustedNormalVaRHotspots, 6
- AdjustedVarianceCovarianceES, 7
- AdjustedVarianceCovarianceVaR, 8
- ADTestStat, 9
- AmericanPutESBinomial, 10
- AmericanPutESSim, 11
- AmericanPutPriceBinomial, 13
- AmericanPutVaRBinomial, 14
  
- BinomialBacktest, 15
- BlackScholesCallESSim, 16
- BlackScholesCallPrice, 17
- BlackScholesPutESSim, 18
- BlackScholesPutPrice, 19
- BlancoIhleBacktest, 20
- BootstrapES, 21
- BootstrapESConfInterval, 22
- BootstrapESFigure, 23
- BootstrapVaR, 23
- BootstrapVaRConfInterval, 24
- BootstrapVaRFigure, 25
- BoxCoxES, 26
- BoxCoxVaR, 27
  
- CdfOfSumUsingGaussianCopula, 28
- CdfOfSumUsingGumbelCopula, 29
- CdfOfSumUsingProductCopula, 30
- ChristoffersenBacktestForIndependence, 31
- ChristoffersenBacktestForUnconditionalCoverage, 32
- CornishFisherES, 33
- CornishFisherVaR, 34
  
- DBPensionVaR, 35
- DCPensionVaR, 36
  
- DefaultRiskyBondVaR, 37
- Dowd-package, 5
  
- FilterStrategyLogNormalVaR, 38
- FrechetES, 39
- FrechetESPlot2DCI, 40
- FrechetVaR, 41
- FrechetVaRPlot2DCI, 42
  
- GaussianCopulaVaR, 43
- GParetoES, 44
- GParetoMEFPlot, 45
- GParetoMultipleMEFPlot, 45
- GParetoVaR, 46
- GumbelCopulaVaR, 47
- GumbelES, 48
- GumbelESPlot2DCI, 49
- GumbelVaR, 50
- GumbelVaRPlot2DCI, 51
  
- HillEstimator, 51
- HillPlot, 52
- HillQuantileEstimator, 53
- HSES, 54
- HSESDFPerc, 55
- HSESFigure, 56
- HSESPlot2DCI, 56
- HSVAr, 57
- HSVARDFPerc, 58
- HSVARESPlot2DCI, 59
- HSVArFigure, 59
- HSVArPlot2DCI, 60
  
- InsuranceVaR, 61
- InsuranceVaRES, 62
  
- JarqueBeraBacktest, 63
  
- KernelESBoxKernel, 64
- KernelESEpanechnikovKernel, 64
- KernelESNormalKernel, 65

- KernelESTriangleKernel, 66
- KernelVaRBoxKernel, 67
- KernelVaREpanechnikovKernel, 67
- KernelVaRNormalKernel, 68
- KernelVaRTriangleKernel, 69
- KSTestStat, 70
- KuiperTestStat, 71
  
- LogNormalES, 72
- LogNormalESDFPerc, 73
- LogNormalESFigure, 74
- LogNormalESPlot2DCL, 75
- LogNormalESPlot2DHP, 76
- LogNormalESPlot3D, 77
- LogNormalVaR, 78
- LogNormalVaRDFPerc, 79
- LogNormalVaRETLPlot2DCL, 80
- LogNormalVaRFigure, 81
- LogNormalVaRPlot2DCL, 82
- LogNormalVaRPlot2DHP, 83
- LogNormalVaRPlot3D, 84
- LogtES, 85
- LogtESDFPerc, 86
- LogtESPlot2DCL, 87
- LogtESPlot2DHP, 88
- LogtESPlot3D, 89
- LogtVaR, 90
- LogtVaRDFPerc, 91
- LogtVaRPlot2DCL, 92
- LogtVaRPlot2DHP, 93
- LogtVaRPlot3D, 94
- LongBlackScholesCallVaR, 95
- LongBlackScholesPutVaR, 96
- LopezBacktest, 97
  
- MEFPlot, 98
  
- NormalES, 98
- NormalESConfidenceInterval, 99
- NormalESDFPerc, 100
- NormalESFigure, 101
- NormalESHotsspots, 102
- NormalESPlot2DCL, 103
- NormalESPlot2DHP, 104
- NormalESPlot3D, 105
- NormalQQPlot, 106
- NormalQuantileStandardError, 106
- NormalSpectralRiskMeasure, 107
- NormalVaR, 108
- NormalVaRConfidenceInterval, 109
- NormalVaRDFPerc, 110
- NormalVaRFigure, 111
- NormalVaRHotspots, 112
- NormalVaRPlot2DCL, 113
- NormalVaRPlot2DHP, 114
- NormalVaRPlot3D, 115
  
- PCAES, 116
- PCAESPlot, 117
- PCAPrelim, 117
- PCAVaR, 118
- PCAVaRPlot, 119
- PickandsEstimator, 120
- PickandsPlot, 120
- ProductCopulaVaR, 121
  
- ShortBlackScholesCallVaR, 122
- ShortBlackScholesPutVaR, 123
- StopLossLogNormalVaR, 124
  
- tES, 125
- tESDFPerc, 126
- tESFigure, 127
- tESPlot2DCL, 128
- tESPlot2DHP, 129
- tESPlot3D, 130
- TQQPlot, 131
- tQuantileStandardError, 131
- tVaR, 132
- tVaRDFPerc, 133
- tVaRESPlot2DCL, 134
- tVaRFigure, 135
- tVaRPlot2DCL, 136
- tVaRPlot2DHP, 137
- tVaRPlot3D, 138
  
- VarianceCovarianceES, 139
- VarianceCovarianceVaR, 140