

Package ‘riskSimul’

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Type Package

Title Risk Quantification for Stock Portfolios under the T-Copula Model

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Author Wolfgang Hormann, Ismail Basoglu

Maintainer Wolfgang Hormann <hormannw@boun.edu.tr>

Description Implements efficient simulation procedures to estimate tail loss probabilities and conditional excess for a stock portfolio. The log-returns are assumed to follow a t-copula model with generalized hyperbolic or t marginals.

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riskSimul *Risk Quantification for Stock Portfolios under the T-Copula Model*

Description

This package can estimate the tail loss probabilities and conditional excess for a stock portfolio. The log-returns are assumed to follow a t-copula model with generalized hyperbolic or t marginals.

`SISTCopula()` is the name of the function that uses stratified importance sampling (SIS) to estimate a single or several tailloss probabilities and the corresponding conditional excess in a very efficient way.

`NVTCopula()` estimates the same quantities using naive simulation (without variance reduction).

Details

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Author(s)

Wolfgang Hormann, Ismail Basoglu

References

I Basoglu, W Hormann. 2014. Efficient stratified sampling implementations in multiresponse simulation, in: Proceedings of the 2014 Winter Simulation Conference A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

I Basoglu, W. Hormann, and H. Sak. 2013. Optimally Stratified Importance Sampling for Portfolio Risk with Multiple Loss Thresholds. Optimization 62 (11): 1451-1471

Examples

```
R<- matrix(
c(1, 0.554, 0.632, 0.419, 0.400,
  0.554,1, 0.495, 0.540, 0.479,
  0.632,0.495, 1, 0.426, 0.445,
  0.419,0.540, 0.426, 1, 0.443,
  0.400,0.479, 0.445, 0.443, 1),ncol=5)

pmg<- matrix(NA,ncol=5,nrow=5)
colnames(pmg) <- c("lambda","alpha","beta","delta","mu")
pmg[1,] <- c(-0.602828, 8.52771, -0.533197, 0.014492, -0.000091)
pmg[2,] <- c(-1.331923, 2.72759, -2.573416, 0.019891, 0.001388)
pmg[3,] <- c(-1.602705, 3.26482, 1.456542, 0.035139, -0.001662)
pmg[4,] <- c(-1.131092, 15.13351, -1.722396, 0.014771, 0.001304)
pmg[5,] <- c(-0.955118, 31.14005, 0.896576, 0.015362, -0.000238)
```

```
portfo <- new.portfobj(nu=8.195,R=R,typemg="GH",parmg=pmg,c=rep(1,5),w=rep(0.2,5))
res1<- SISTCopula(n=10^4,npilot=c(10^3,3*10^3),portfobj=portfo,threshold=c(0.97,0.96,0.95,0.94),
stratasize=c(22,22),CEopt=FALSE,beta=0.75,mintype=0)
```

SISTCopula	<i>Efficient tail-loss probability and conditional excess estimation for t-copula model</i>
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Description

Using stratified importance sampling (SIS) or naive simulation (NV) the tail-loss probabilities and conditional excess values for several threshold values are estimated for a stock portfolio. The log-returns of the stocks are assumed to follow a t-copula model with generalized hyperbolic or t marginals.

Usage

```
SISTCopula(n=10^5,npilot=c(10^4,2*10^4),portfobj,threshold=c(0.95,0.9),
stratasize=c(22,22),CEopt=FALSE,beta=0.75,mintype=-1)
```

```
NVTCopula(n=10^5, portfobj, threshold=c(0.95,0.9))
```

```
new.portfobj(nu,R,typemg="GH",parmg,c=rep(1,dim(R)[1]),w=c/sum(c))
```

Arguments

n	total sample size
npilot	size of one or several pilot runs, the sum of them should be smaller than n/2
portfobj	object of portfolio parameters
threshold	one or several threshold values (they should be ordered)
stratasize	a vector of length two holding the number of strata
CEopt	TRUE ... minimize the overall error of Conditional Excess estimates, otherwise of tail-loss estimates
beta	weight of maximal threshold value used for calculating the intermediate threshold used for selecting the IS density, only used when $\text{length}(\text{threshold}) > 1$
mintype	only used when $\text{length}(\text{threshold}) > 1$; 0 ... minimize mean square errors, -1 ... minimize relative MSE, -2 ... minimize the maximal error, -3 minimize the maximal relative error; a positive integer j indicates that the variance of the estimate for the j-th threshold is minimized.
nu	degrees of freedom of the t-copula
R	correlation matrix of the t-copula
typemg	type of the marginal distribution, "GH" generalized hyperbolic distribution, "t" t-distribution

parmg	matrix holding in its rows the parameters of the marginal distribution; for the generalized hyperbolic distribution each row holds the parameters lambda, alpha, beta, delta and mu; for the t-distribution each row holds the parameters mu, sigma and nu (degrees of freedom).
c	scale factor vector of the portfolio
w	portfolio weights

Value

For the case that the variable threshold contains only one value a matrix containing the results for the tail-loss probability in the first row and that of the conditional excess in the second row is returned.

In the case that several threshold values are considered, a list consisting of the result matrices for tail-loss probabilities and for conditional excess and the vector of the threshold values is returned.

Author(s)

Ismail Basoglu, Wolfgang Hormann

Examples

```
R<- matrix(
c(1, 0.554, 0.632, 0.419, 0.400,
  0.554,1, 0.495, 0.540, 0.479,
  0.632,0.495, 1, 0.426, 0.445,
  0.419,0.540, 0.426, 1, 0.443,
  0.400,0.479, 0.445, 0.443, 1),ncol=5)

pmg<- matrix(NA,ncol=5,nrow=5)
colnames(pmg) <- c("lambda","alpha","beta","delta","mu")
pmg[1,] <- c(-0.602828, 8.52771, -0.533197, 0.014492, -0.000091)
pmg[2,] <- c(-1.331923, 2.72759, -2.573416, 0.019891, 0.001388)
pmg[3,] <- c(-1.602705, 3.26482, 1.456542, 0.035139, -0.001662)
pmg[4,] <- c(-1.131092, 15.13351, -1.722396, 0.014771, 0.001304)
pmg[5,] <- c(-0.955118, 31.14005, 0.896576, 0.015362, -0.000238)

portfo <- new.portfobj(nu=8.195,R=R,typemg="GH",parmg=pmg,c=rep(1,5),w=rep(0.2,5))

res1<- SISTCopula(n=10^4,npilot=c(10^3,3*10^3),portfobj=portfo,threshold=c(0.97,0.96,0.95,0.94),
  stratasize=c(22,22),CEopt=FALSE,beta=0.75,mintype=0)

res1
SISTCopula(n=10^4,npilot=c(10^3,3*10^3),portfobj=portfo,threshold=0.94,
  stratasize=c(22,22),CEopt=FALSE)

NVTCopula(n=10^4,portfobj=portfo,threshold=c(0.97,0.96,0.95,0.94))
NVTCopula(n=10^4,portfobj=portfo,threshold=0.94)

#####
# example with t-marginals

R<- matrix(
```

```
c(1, 0.551, 0.636, 0.421, 0.398,  
  0.551,1, 0.496, 0.540, 0.477,  
  0.636,0.496, 1, 0.428, 0.447,  
  0.421,0.540, 0.428, 1, 0.444,  
  0.398,0.477, 0.447, 0.444, 1),ncol=5)
```

```
pmg<- matrix(NA,ncol=3,nrow=5)  
colnames(pmg) <- c("mu","sigma","nu")  
pmg[1,] <- c(-0.000258, 0.013769, 1.78)  
pmg[2,] <- c(0.000794, 0.012166, 2.64)  
pmg[3,] <- c(-0.000837, 0.019616, 3.25)  
pmg[4,] <- c(0.001041, 0.009882, 2.67)  
pmg[5,] <- c(-0.000104, 0.010812, 3.10)
```

```
portfo <- new.portfobj(nu=7.525,R=R,typemg="t",parmg=pmg,c=rep(1,5),w=rep(0.2,5))
```

```
res1<- SISTCopula(n=10^4,npilot=c(10^3,3*10^3),portfobj=portfo,threshold=c(0.97,0.96,0.95,0.94),  
  stratasize=c(22,22),CEopt=FALSE,beta=0.75,mintype=0)
```

```
res1
```

```
SISTCopula(n=10^4,npilot=c(10^3,3000),portfobj=portfo,threshold=0.94,stratasize=c(22,22))
```

```
NVTCopula(n=10^4,portfobj=portfo,threshold=c(0.97,0.96,0.95,0.94))
```

```
NVTCopula(n=10^4,portfobj=portfo,threshold=0.94)
```

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