Package 'GCPM'

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Type Package

Title Generalized Credit Portfolio Model

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Author Kevin Jakob

Maintainer Kevin Jakob <Kevin.Jakob.Research@gmail.com>

Description Analyze the default risk of credit portfolios. Commonly known models, like CreditRisk+ or the CreditMetrics model are implemented in their very basic settings. The portfolio loss distribution can be achieved either by simulation or analytically in case of the classic CreditRisk+ model. Models are only implemented to respect losses caused by defaults, i.e. migration risk is not included. The package structure is kept flexible especially with respect to distributional assumptions in order to quantify the sensitivity of risk figures with respect to several assumptions. Therefore the package can be used to determine the credit risk of a given portfolio as well as to quantify model sensitivities.

License GPL-2

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LinkingTo Rcpp, RcppProgress

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GCPM-package *Generalized Credit Portfolio Model*

Description

The package helps to analyze the default risk of credit portfolios. Commonly known models, like CreditRisk+ or the CreditMetrics model are implemented in their very basic settings. The portfolio loss distribution can be achieved either by simulation or analytically in case of the classic CreditRisk+ model. Models are only implemented to respect losses caused by defaults, i.e. migration risk is not included. The package structure is kept flexible especially with respect to distributional assumptions in order to quantify the sensitivity of risk figures with respect to several assumptions. Therefore the package can be used to determine the credit risk of a given portfolio as well as to quantify model sensitivities.

Details

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Author(s)

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References

Jakob, K. & Fischer, M. "GCPM: A flexible package to explore credit portfolio risk" Austrian Journal of Statistics 45.1 (2016): 25:44
Morgan, J. P. "CreditMetrics-technical document." JP Morgan, New York, 1997
First Boston Financial Products, "CreditRisk+", 1997
Gundlach & Lehrbass, "CreditRisk+ in the Banking Industry", Springer, 2003

See Also

GCPM-class, init, analyze

Examples

```
#create a random portfolio with NC counterparties
```

```
NC=100
#assign business lines and countries randomly
business.lines=c("A","B","C")
CP.business=business.lines[ceiling(runif(NC,0,length(business.lines)))]
countries=c("A","B","C","D","E")
CP.country=countries[ceiling(runif(NC,0,length(countries)))]

#create matrix with sector weights (CreditRisk+ setting)
#according to business lines
NS=length(business.lines)
W=matrix(0,nrow = NC,ncol = length(business.lines),
dimnames = list(1:NC,business.lines))
for(i in 1:NC){W[i,CP.business[i]]=1}

#create portfolio data frame
portfolio=data.frame(Number=1:NC,Name=paste("Name ",1:NC),Business=CP.business,
                     Country=CP.country,EAD=runif(NC,1e3,1e6),LGD=runif(NC),
                     PD=runif(NC,0,0.3),Default=rep("Bernoulli",NC),W)

#draw sector variances randomly
sec.var=runif(NS,0.5,1.5)
names(sec.var)=business.lines

#draw N sector realizations (independent gamma distributed sectors)
N=5e4
random.numbers=matrix(NA,ncol=NS,nrow=N,dimnames=list(1:N,business.lines))
for(i in 1:NS){
random.numbers[,i]=rgamma(N,shape = 1/sec.var[i],scale=sec.var[i])}

#create a portfolio model and analyze the portfolio
TestModel=init(model.type = "simulative",link.function = "CRP",N = N,
loss.unit = 1e3, random.numbers = random.numbers,LHR=rep(1,N),loss.thr=5e6,
max.entries=2e4)
TestModel=analyze(TestModel,portfolio)

#plot of pdf of portfolio loss (in million) with indicators for EL, VaR and ES
alpha=c(0.995,0.999)
plot(TestModel,1e6,alpha=alpha)

#calculate portfolio VaR and ES
VaR=VaR(TestModel,alpha)
ES=ES(TestModel,alpha)

#Calculate risk contributions to VaR and ES
risk.cont=cbind(VaR.cont(TestModel,alpha = alpha),
ES.cont(TestModel,alpha = alpha))
```

---

alpha.max-methods *Maximum CDF Level*

Description

Get the maximum value of the model's CDF. For simulative models, the value should be equal to 1. For an analytical model, the value depends on the value specified during initiation of the model (see `init`).

Usage

```
alpha.max(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric of length 1

See Also

`init`

`analyze-methods` *Analyze a Credit Portfolio*

Description

The method analyzes a given portfolio with a predefined portfolio model (i.e. a `GCPM` object). Portfolio key numbers such as the number of portfolio positions, sum of EAD and PL or the expected loss are calculated. Afterwards the loss distribution is estimated according to `model.type`.

Usage

```
analyze(this,portfolio,alpha,Ncores)
```

Arguments

`this`	object of class `GCPM`
`portfolio`	data frame containing portfolio data. The following columns have to be defined (please be aware of the correct spelling of the column names): `Number`: identification number for each portfolio position (numeric) `Name`: counterparty name (character) `Business`: business information (character/factor) `Country`: country information (character/factor) `EAD`: exposure at default (numeric) `LGD`: loss given default (numeric in [0,1]) `PD`: probability of default (numeric in [0,1]) `Default`: default distribution either "Bernoulli" or "Poisson" (employable for pools) sectors: starting with the 9th column, the sector weights have to be defined..

alpha	loss levels for risk measures economic capital, value at risk and expected shortfall (optional)
Ncores	number of (virtual) cores used to perfom Monte Carlo simulation (requires package **parallel**, default=1)

Details

In case of an analytical CreditRisk+ model, a modified version of the algorithm described in Gundlach & Lehrbass (2003) is used. For a simulative model, the loss distribution is estimated based on N simulations with sector drawings specified by random.numbers (see init). The sector names (column names) should not include any white spaces. In case of a CreditMetrics type model, the values of R (not R^2) have to be provided as sector weights. In the standard CreditMetrics or CreditRisk+ framework a counterparty can be assigned to more than one sector. Within a analytical CreditRisk+ model, the sector names have to match the names of sec.var or in a simulative model the column names of random.numbers (see init)

Value

object of class GCPM.

Methods

signature(this = "GCPM", portfolio = "data.frame", alpha = "missing") If loss levels alpha are not provided, risk measures such as economic capital, value at risk and expected shortfall are not calculated by default. However, they can be calculated afterwards by calling the corresponding methods (see VaR, ES, EC)

signature(this = "GCPM", portfolio = "data.frame", alpha = "numeric") If loss levels alpha are provided, risk measures such as economic capital, value at risk and expected shortfall are calculated and printed. To extract these risk measures into a separate variable you can use the corresponding methods.

References

Jakob, K. & Fischer, M. "GCPM: A flexible package to explore credit portfolio risk" Austrian Journal of Statistics 45.1 (2016): 25:44
Morgan, J. P. "CreditMetrics-technical document." JP Morgan, New York, 1997
First Boston Financial Products, "CreditRisk+", 1997
Gundlach & Lehrbass, "CreditRisk+ in the Banking Industry", Springer, 2003

See Also

init

Examples

```
#create a random portfolio with NC counterparties
NC=100
#assign business lines and countries randomly
business.lines=c("A","B","C")
```

```
CP.business=business.lines[ceiling(runif(NC,0,length(business.lines)))]
countries=c("A","B","C","D","E")
CP.country=countries[ceiling(runif(NC,0,length(countries)))]

#create matrix with sector weights (CreditRisk+ setting)
#according to business lines
NS=length(business.lines)
W=matrix(0,nrow = NC,ncol = length(business.lines),
dimnames = list(1:NC,business.lines))
for(i in 1:NC){W[i,CP.business[i]]=1}

#create portfolio data frame
portfolio=data.frame(Number=1:NC,Name=paste("Name ",1:NC),Business=CP.business,
                     Country=CP.country,EAD=runif(NC,1e3,1e6),LGD=runif(NC),
                     PD=runif(NC,0,0.3),Default=rep("Bernoulli",NC),W)

#draw sector variances randomly
sec.var=runif(NS,0.5,1.5)
names(sec.var)=business.lines

#draw N sector realizations (independent gamma distributed sectors)
N=5e4
random.numbers=matrix(NA,ncol=NS,nrow=N,dimnames=list(1:N,business.lines))
for(i in 1:NS){
random.numbers[,i]=rgamma(N,shape = 1/sec.var[i],scale=sec.var[i])}

#create a portfolio model and analyze the portfolio
TestModel=init(model.type = "simulative",link.function = "CRP",N = N,
loss.unit = 1e3, random.numbers = random.numbers,LHR=rep(1,N),loss.thr=5e6,
max.entries=2e4)
TestModel=analyze(TestModel,portfolio)

#plot of pdf of portfolio loss (in million) with indicators for EL, VaR and ES
alpha=c(0.995,0.999)
plot(TestModel,1e6,alpha=alpha)

#calculate portfolio VaR and ES
VaR=VaR(TestModel,alpha)
ES=ES(TestModel,alpha)

#Calculate risk contributions to VaR and ES
risk.cont=cbind(VaR.cont(TestModel,alpha = alpha),
ES.cont(TestModel,alpha = alpha))

#Use parallel computing for Monte Carlo simulation
TestModel=analyze(TestModel,portfolio,Ncores=2)
```

---

business-methods *Counterparty Business Line*

Description

Get the business information for each counterparty defined in the portfolio.

Usage

```
business(this)
```

Arguments

this	Object of class GCPM

Value

factor of length equal to number of portfolio positions

See Also

portfolio.pois

CDF-methods *Cumulative Distribution Function of Portfolio Loss*

Description

Get the CDF of the portfolio loss, available after execution of analyze.

Usage

```
CDF(this)
```

Arguments

this	Object of class GCPM

Value

numeric vector

See Also

analyze

country-methods *Country Information*

Description

Get the country information of each counterparty defined in the portfolio.

Usage

```
country(this)
```

Arguments

this	Object of class GCPM

Value

factor of length equal to number of portfolio positions

See Also

portfolio.pois

default-methods *Default Distribution*

Description

Get the default distribution of each portfolio position. Using "Poisson" as default distribution one can simulate the standard CR+ model or group smaller counterparties into a pool and simulate their defaults.

Usage

```
default(this)
```

Arguments

this	Object of class GCPM

Value

character of length equal to number of portfolio positions

See Also

portfolio.pois

EAD-methods *Exposure at Default*

Description

Get the counterparties' exposure at default defined in the portfolio data.

Usage

```
EAD(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length equal to the number of counterparties

See Also

portfolio.pois

EC-methods *Economic Capital*

Description

Get the value of economic capital for the portfolio on level(s) alpha

Usage

```
EC(this,alpha)
```

Arguments

this	Object of class GCPM
alpha	numeric vector of loss levels between 0 and 1

Value

numeric vector of length equal to length(alpha).

EC.cont-methods *Risk Contributions to Economic Capital*

Description

Calculate contributions to the economic capital on portfolio level for each portfolio position. In case of a simulative model, the risk contributions are calculated as contributions to expected shortfall on a lower loss level τ, such that ES(τ) is as close as possible to EC(α). Furthermore, in case of a simulative model, loss scenarios above a predefined threshold (`loss.thr`) are analyzed in order to calculate the risk contributions. If `loss.thr` is too high (depending on value of `alpha`) the calculation will be not possible.

Usage

```
EC.cont(this,alpha)
```

Arguments

`this`	Object of class `GCPM`
`alpha`	numeric vector of loss levels between 0 and 1

Value

numeric matrix with number of rows equal to number of counterparties within the portfolio and number of columns equal to `length(alpha)`

See Also

`loss.thr`

EL-methods *Expected Loss (from Loss Distribution)*

Description

Get the expected loss (EL) calculated from the portfolio loss distribution. Because of the discretization and/or simulation errors, this is not equal to the analytical EL (see `EL.analyt`). Please also note, that in case of a simulative model (with Bernoulli default distribution) of the CreditRisk+ type the simulated EL tends to be smaller than the analytical one because the conditional PD $\overline{PD} = PD \cdot (w^T x)$ has to be truncated (if $\overline{PD} > 1$).

Usage

```
EL(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

See Also

EL.analyt

EL.analyt-methods *Expected Loss (analytical)*

Description

Get the expected loss (EL) calculated from the portfolio data. Because of the discretization and/or simulation errors, this is not equal to the EL calculated from the portfolio loss distribution (see EL).

Usage

```
EL.analyt(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

See Also

EL

ES-methods *Expected Shortfall*

Description

Get the value of the expected shortfall for the portfolio on level(s) `alpha`

Usage

```
ES(this,alpha)
```

Arguments

`this`	Object of class `GCPM`
`alpha`	numeric vector of loss levels between 0 and 1

Value

numeric vector of length equal to `length(alpha)`.

ES.cont-methods *Risk Contributions to Expected Shortfall*

Description

Calculate contributions to the expected shortfall on portfolio level for each portfolio position. In case of a simulative model, loss scenarios above a predefined threshold (`loss.thr`) are analyzed in order to calculate the risk contributions. If `loss.thr` is too high, calculation may be not possible (depending on value of `alpha`).

Usage

```
ES.cont(this,alpha)
```

Arguments

`this`	Object of class `GCPM`
`alpha`	numeric vector of loss levels between 0 and 1

Value

numeric matrix with number of rows equal to number of counterparties within the portfolio and number of columns equal to `length(alpha)`

See Also

`loss.thr`

export-methods *Export Main Results*

Description

This method provides an easy way to export the main results of the portfolio (i.e. after running `analyze`). A summary file and the portfolio loss distribution (PDF and CDF) are exported to `path.out`. With the help of `file.format` one can specify the csv format ("csv1" or "csv2"). If a vector `alpha` of loss levels is specified, risk contributions to EC, VaR and ES are also exported according to level(s) `alpha`.

Usage

```
export(this,path.out,file.format,alpha)
```

Arguments

`this`	Object of class `GCPM`
`path.out`	string specifying the output path
`file.format`	string specifying the file format (i.e "csv1" or "csv2")
`alpha`	numeric vector with loss levels between 0 and 1

GCPM-class *Class "GCPM"*

Description

The class represents a generalized credit portfolio framework. Users which are not familiar with credit portfolio models in general and the CreditRisk+ model as well as the CreditMetrics model in particular should refer to the references given below. Models can be simulative or analytical (in case of a CreditRisk+ type model). The link function can be chosen to be either of the CreditRisk+ or the CreditMetrics type. Counterparties' default distribution can be specified to be either Bernoulli or Poisson, which is the default distribution in the basic CreditRisk+ framework.

Objects from the Class

Objects can be created via the `init` function (see `init`)

Slots

`model.type`: Character value, specifying the model type. One can choose between "simulative" and "CRP" which corresponds to the analytical version of the CreditRisk+ model (see First Boston Financial Products, 1997)

`default`: Character vector specifying the counterparties' default distribution (either "Bernoulli" or "Poisson")

`link.function`: character value, specifying the type of the link function. One can choose between "CRP", which corresponds to $\overline{PD} = PD \cdot (w^T x)$ and "CM" which corresponds to $\overline{PD} = \Phi\left(\frac{\Phi^{-1} PD - w^T x}{\sqrt{1 - w^T \Sigma w}}\right)$, where PD is the original PD from portfolio data, x is the vector of sector drawings, Φ is the CDF of the standard normal distribution, w is the vector of sector weights given in the portfolio data and Σ is the correlation matrix of the sector variables estimated from `random.numbers`. "CRP" will be used automatically if `model.type` == "CRP".

`loss.unit`: numeric value used to discretize potential losses.

`NS`: number of sectors

`NC`: number of counterparties

`name`: counterparties' names defined in the portfolio

`NR`: counterparties' identification numbers defined in the portfolio

`EAD`: counterparties' exposure at default defined in the portfolio

`LGD`: counterparties' loss given default defined in the portfolio

`PL`: counterparties' potential loss ($EAD * LGD$)

`PD`: counterparties' probability of default defined in the portfolio

`business`: counterparties' business line defined in the portfolio

`country`: counterparties' country defined in the portfolio

`EL.analyt`: Expected loss calculated from portfolio data (without discretization)

`EL`: Expected loss derived from loss distribution

`nu`: multiples of `loss unit` representing discretized potential losses within an analytical CreditRisk+ type model

`PL.disc`: counterparties' potential loss ($EAD * LGD$) after discretization

`PD.disc`: counterparties' probability of default defined in the portfolio after discretization

`sec.var`: sector variances within an analytical CreditRisk+ type model

`sector.names`: sector names

`SD.div`: diversifiable part of portfolio risk (measured by standard deviation) in case of a CreditRisk+ type model

`SD.syst`: Non-diversifiable part of portfolio risk (measured by standard deviation) in case of a CreditRisk+ type model

`SD.analyt`: portfolio standard deviation derived from portfolio data in case of a CreditRisk+ type model

`SD`: portfolio standard deviation derived from loss distribution

`W`: counterparties' sector weights

`idiosyncr`: counterparties idiosyncratic weight in case of a CreditRisk+ type model

`alpha.max`: maximum level of CDF of the loss distribution within an analytical CreditRisk+ type model

`a`: internal parameter used to calculate risk contributions in case of an analytical CreditRisk+ type model

`PDF`: probability density function of portfolio losses

`CDF`: cumulative distribution function of portfolio losses

`B`: internal parameter used to calculate risk contributions in case of an analytical CreditRisk+ type model

`loss`: portfolio losses corresponding to `PDF` and `CDF`

`random.numbers`: sector drawing in case of a simulative model

`LHR`: likelihood ration of sector drawing in case of a simulative model

max.entries numeric value defining the maximum number of loss scenarios stored to calculate risk contributions.

`N`: number of simulations in case of a simulative model

`scenarios`: scenarios (rows) of `random.numbers` used within the simulation of portfolio losses

`seed`: parameter used to initialize the random number generator. If `seed` is not provided a value based on current system time will be used.

`loss.thr`: specifies a lower bound for portfolio losses to be stored in order to derive risk contributions on counterparty level. Using a lower value needs a lot of memory but will be necessary in order to calculate risk contributions on lower CDF levels. This parameter is used only if `model.type` == "simulative".

`sim.losses`: simulated portfolio losses in case of a simulative model

`CP.sim.losses`: simulated losses on counterparty level when the overall portfolio loss is greater or equal to `loss.thr`

Author(s)

Kevin Jakob

References

Jakob, K. & Fischer, M. "GCPM: A flexible package to explore credit portfolio risk" Austrian Journal of Statistics 45.1 (2016): 25:44
Morgan, J. P. "CreditMetrics-technical document." JP Morgan, New York, 1997
First Boston Financial Products, "CreditRisk+", 1997
Gundlach & Lehrbass, "CreditRisk+ in the Banking Industry", Springer, 2003

See Also

`GCPM-package`, `init`, `analyze`

idiosyncr-methods *Idiosyncratic Risk Weights*

Description

Get the idiosyncratic risk weights (i.e. risk weights which are not assigned to any sector). Currently only available if `model.type == "CRP"`.

Usage

```
idiosyncr(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric vector of length equal to number of counterparties

init *Initialize an Object of Class* GCPM

Description

The function helps to create a new object of class `GCPM`. The arguments of the function are passed to the object after performing some plausibility checks.

Usage

```
init(model.type = "CRP", link.function = "CRP", N, seed,
loss.unit, alpha.max = 0.9999, loss.thr = Inf, sec.var,
random.numbers = matrix(), LHR, max.entries=1e3)
```

Arguments

`model.type`	Character value, specifying the model type. One can choose between "simulative" and "CRP" which corresponds to the analytical version of the CreditRisk+ model (see First Boston Financial Products, 1997)
`link.function`	character value, specifying the type of the link function. One can choose between "CRP", which corresponds to $\overline{PD} = PD \cdot (w^T x)$ and "CM" which corresponds to $\overline{PD} = \Phi\left(\frac{\Phi^{-1} PD - w^T x}{\sqrt{1 - w^T \Sigma w}}\right)$, where PD is the original PD from portfolio data, x is the vector of sector drawings, Φ is the CDF of the standard normal distribution, w is the vector of sector weights given in the portfolio data and Σ is the correlation matrix of the sector variables estimated from `random.numbers`. "CRP" will be used automatically if `model.type == "CRP"`.

N	numeric value, defining the number of simulations if model.type == "simulative". If N is greater than the number of scenarios provided via random.numbers, scenarios are reused. This parameter is used only if model.type == "simulative".
seed	numeric value used to initialize the random number generator. If seed is not provided a value based on current system time will be used. This parameter is used only if model.type == "simulative".
loss.unit	numeric positive value used to discretize potential losses.
alpha.max	numeric value between 0 and 1 defining the maximum CDF-level which will be computed in case of an analytical CreditRisk+ type model.
loss.thr	numeric value specifying a lower bound for portfolio losses to be stored in order to derive risk contributions on counterparty level. Using a lower value needs a lot of memory but will be necessary in order to calculate risk contributions on lower CDF levels. This parameter is used only if model.type == "simulative".
sec.var	named numeric vector defining the sector variances in case of a CreditRisk+ type model. The names have to correspond to the sector names given in the portfolio. This parameter is used only if model.type == "CRP".
random.numbers	matrix with sector drawings. The columns represent the sectors, whereas the rows represent the scenarios (number of different simulations). The column names must correspond to the names used in the portfolio data (see analyze) and to the names of sec.var if model.type == "CRP". This parameter is used only if model.type == "simulative".
LHR	numeric vector of length equal to nrow(random.numbers) defining the likelihood ratio of each scenario. If not provided, all scenarios are assumed to be equally likely. This parameter is used only if model.type == "simulative".
max.entries	numeric value defining the maximum number of loss scenarios stored to calculate risk contributions.

Value

object of class GCPM

Author(s)

Kevin Jakob

References

Jakob, K. & Fischer, M. "GCPM: A flexible package to explore credit portfolio risk" Austrian Journal of Statistics 45.1 (2016): 25:44
Morgan, J. P. "CreditMetrics-technical document." JP Morgan, New York, 1997
First Boston Financial Products, "CreditRisk+", 1997
Gundlach & Lehrbass, "CreditRisk+ in the Banking Industry", Springer, 2003

See Also

GCPM, GCPM-class, analyze

Examples

```
#create a random portfolio with NC counterparties
NC=100
#assign business lines and countries randomly
business.lines=c("A","B","C")
CP.business=business.lines[ceiling(runif(NC,0,length(business.lines)))]
countries=c("A","B","C","D","E")
CP.country=countries[ceiling(runif(NC,0,length(countries)))]

#create matrix with sector weights (CreditRisk+ setting)
#according to business lines
NS=length(business.lines)
W=matrix(0,nrow = NC,ncol = length(business.lines),
dimnames = list(1:NC,business.lines))
for(i in 1:NC){W[i,CP.business[i]]=1}

#create portfolio data frame
portfolio=data.frame(Number=1:NC,Name=paste("Name ",1:NC),Business=CP.business,
                     Country=CP.country,EAD=runif(NC,1e3,1e6),LGD=runif(NC),
                     PD=runif(NC,0,0.3),Default=rep("Bernoulli",NC),W)

#draw sector variances randomly
sec.var=runif(NS,0.5,1.5)
names(sec.var)=business.lines

#draw N sector realizations (independent gamma distributed sectors)
N=5e4
random.numbers=matrix(NA,ncol=NS,nrow=N,dimnames=list(1:N,business.lines))
for(i in 1:NS){
random.numbers[,i]=rgamma(N,shape = 1/sec.var[i],scale=sec.var[i])}

#create a portfolio model and analyze the portfolio
TestModel=init(model.type = "simulative",link.function = "CRP",N = N,
loss.unit = 1e3, random.numbers = random.numbers,LHR=rep(1,N),loss.thr=5e6,
max.entries=2e4)
TestModel=analyze(TestModel,portfolio)

#plot of pdf of portfolio loss (in million) with indicators for EL, VaR and ES
alpha=c(0.995,0.999)
plot(TestModel,1e6,alpha=alpha)

#calculate portfolio VaR and ES
VaR=VaR(TestModel,alpha)
ES=ES(TestModel,alpha)

#Calculate risk contributions to VaR and ES
risk.cont=cbind(VaR.cont(TestModel,alpha = alpha),
ES.cont(TestModel,alpha = alpha))
```

LGD-methods *Loss Given Default*

Description

Get the values of LGD, defined within the portfolio

Usage

```
LGD(this)
```

Arguments

this	Object of class GCPM

Value

numeric vector of length equal to number of counterparties

See Also

portfolio.pois

LHR-methods *Likelihood Ratio*

Description

Get the likelihood ratio for each scenario defined in random.numbers (see init)

Usage

```
LHR(this)
```

Arguments

this	Object of class GCPM

Value

numeric vector of length equal to nrow(random.numbers)

link.function-methods *Model Link Function*

Description

Get the models link function (see `init`)

Usage

```
link.function(this)
```

Arguments

`this`	Object of class `GCPM`

Value

character value of length 1

See Also

`init`

loss-methods *Loss Levels*

Description

Get the loss levels of the portfolio loss distribution.

Usage

```
loss(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric vector

loss.thr-methods *Threshold of Saved Portfolio Loss*

Description

Get the value of `loss.thr` (see `init`)

Usage

```
loss.thr(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length 1

See Also

`init`

loss.unit-methods *Loss Unit*

Description

Get the loss unit used for potential loss discretization of the model

Usage

```
loss.unit(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length 1

See Also

`init`

model.type-methods *Model Type*

Description

Get the value of `model.type` (see `init`)

Usage

```
model.type(this)
```

Arguments

`this`	Object of class `GCPM`

Value

character value of length 1

See Also

`init`

N-methods *Number of Simulations*

Description

Get the value of `N` (number of simulations, see `init`)

Usage

```
N(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length 1

See Also

`init`

name-methods *Counterparty Names*

Description

Get the value of name, i.e. the counterparties' names, defined in the portfolio (see analyze)

Usage

```
name(this)
```

Arguments

this	Object of class GCPM

Value

character value of length equal to number of counterparties

See Also

portfolio.pois

NC-methods *Number of Counterparties*

Description

Get the value of NC, representing the number of counterparties within the portfolio (see analyze)

Usage

```
NC(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

See Also

analyze

NR-methods *Counterparty IDs*

Description

Get the value of NR, the counterparties' identification numbers within the portfolio (see analyze)

Usage

```
NR(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length equal to number of counterparties

See Also

portfolio.pois

NS-methods *Number of Sectors*

Description

Get the value of NS, the number of sectors within the model (see init)

Usage

```
NS(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

See Also

init

PD-methods *Counterparty Probability of Default*

Description

Get the value of PD, the counterparties default probabilities within the portfolio (see analyze. Please note, that these PDs are adjusted because of discretization in order to preserve the expected loss.)

Usage

```
PD(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length equal to the number of counterparties

See Also

portfolio.pois

PDF-methods *Probability Density Function*

Description

Get the value of PDF, representing the pdf of the estimated portfolio loss distribution.

Usage

```
PDF(this)
```

Arguments

this	Object of class GCPM

Value

numeric vector

PL-methods *Counterparty Potential Loss*

Description

Get the value of PL, the potential losses of counterparties (see GCPM-class). Please note, that the potential losses are discretized according to loss.unit (see init).

Usage

```
PL(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length equal to the number of counterparties

See Also

portfolio.pois,init

plot-methods *Plot of the Portfolio Loss Distribution*

Description

Plot of the estimated pdf of the portfolio loss distribution.

Usage

```
plot(x,y,...)
```

Arguments

x	Object of class GCPM
y	plot unit for losses (x-axis), default value = 1
...	Further arguments such as: alpha If provided vertical lines are added, representing value at risk and expected shortfall on level(s) alpha or nbins number of supporting points, default value = 100

portfolio.pois *Example Portfolio Data with Poisson Default Mode*

Description

The dataset contains an example portfolio in the structure needed by the `analyze` function.

Usage

```
data("portfolio.pois")
```

Format

A data frame with 3000 counterparties and the following variables.

`Number` Counterparty ID (numeric)

`Name` Counterparty name (character)

`Business` Business line (character)

`Country` Country (character)

`EAD` Exposure at default (numeric)

`LGD` Loss given dafault (numeric)

`PD` Probability of default (numeric)

`Default` Default mode ('Poisson' or 'Benroulli')

`A` sector weights for sector A

`B` sector weights for sector B

`C` sector weights for sector C

portfolio.pool *Pooled Portfolio*

Description

In order to speed up calculations, counterparties of `portfolio.pois` with EAD*LGD < 200,000 are grouped together (pooled).

Usage

```
data("portfolio.pool")
```

Format

A data frame with 1400 counterparties and 3 pools (each per sector) and the following variables.

`Number` Counterparty ID (numeric)

`Name` Counterparty name (character)

`Business` Business line (character)

`Country` Country (character)

`EAD` Exposure at default (numeric); pool: average EAD per counterparty

`LGD` Loss given dafault (numeric); pool: EAD-weighted average LGD per counterparty

`PD` Probability of default (numeric); pool: expectation of number of defaults

`Default` Default mode ('Poisson' for pools or 'Benroulli')

`A` sector weights for sector A

`B` sector weights for sector B

`C` sector weights for sector C

`portfolios` *Example Portfolios for GCPM Package*

Description

The workspace contain the example portfolio (with Poisson default mode) in the structure needed by the `analyze` function as well as a pooled version.

Usage

```
data("portfolios")
```

Format

Two data frames containing the portfolios.

See Also

`portfolio.pois`, `portfolio.pool`, `analyze`

random.numbers-methods *Sector Drawings*

Description

Get the content of `random.numbers`, representing the sector drawings (see `init`)

Usage

```
random.numbers(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric matrix

See Also

`init`

SD-methods *Standard Deviation (Loss Distribution)*

Description

Get the value of `SD`, the portfolio standard deviation derived from the loss distribution.

Usage

```
SD(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length 1

SD.analyt-methods *Standard Deviation (from Portfolio Data)*

Description

Get the value of `SD.analyt`, the portfolio standard deviation derived from the portfolio data (see `GCPM-class`). This value is only available in case of an analytical model.

Usage

```
SD.analyt(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length 1

SD.cont-methods *Risk Contributions to Portfolio Standard Deviation*

Description

Get the counterparties' contributions to portfolio standard deviation (see `GCPM-class`). These values are only available in case of an analytical model.

Usage

```
SD.cont(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length equal to number of counterparties

SD.div-methods *Diversifiable Risk (Standard Deviation)*

Description

Get the value of SD.div, the diversifiable part of portfolio standard deviation (see GCPM-class)

Usage

```
SD.div(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

SD.syst-methods *Systemic Risk (Standard Deviation)*

Description

Get the value of SD.syst, the non-diversifiable part of portfolio standard deviation.

Usage

```
SD.syst(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

sec.var-methods *Sector Variances*

Description

Get the value of `sec.var`, the sector variances in case of an analytical CreditRisk+ like model (see `init`)

Usage

```
sec.var(this)
```

Arguments

`this`	Object of class `GCPM`

Value

numeric value of length equal to number of sectors

See Also

`init`

sector.names-methods *Sector Names*

Description

Get the value of `sector.names`, the sector names (see `init`)

Usage

```
sector.names(this)
```

Arguments

`this`	Object of class `GCPM`

Value

factor of length equal to number of sectors

See Also

`init`

seed-methods *Random Number Seed*

Description

Get the value of seed (see init)

Usage

```
seed(this)
```

Arguments

this	Object of class GCPM

Value

numeric value of length 1

See Also

init

show-methods *Show Parameters of Credit Portfolio Model*

Description

Displays the most important parameters and portfolio statistics (if available).

summary-methods *Model summary*

Description

Create a Summary List with Model Parameters.

Usage

```
summary(object,...)
```

Arguments

object	Object of class GCPM
...	No further arguments

Value

list

`VaR-methods` *Portfolio Value at Risk*

Description

Calculate the portfolio value at risk on level(s) `alpha`.

Usage

```
VaR(this,alpha)
```

Arguments

`this`	Object of class `GCPM`
`alpha`	numeric vector with entries between 0 and 1

Value

numeric value of length equal to length of `alpha`

`VaR.cont-methods` *Risk Contributions to Portfolio Value at Risk*

Description

Get the counterparties' contributions to portfolio value at risk (see `GCPM-class`). In case of a simulative model, these values are calculated from individual losses greater or equal `loss.thr` (see `init`). Contributions are not available if `loss.thr` is too high.

Usage

```
VaR.cont(this,alpha)
```

Arguments

`this`	Object of class `GCPM`
`alpha`	numeric vector with entries between 0 and 1

Value

numeric matrix

See Also

`init`,`loss.thr`

W-methods *Sector Weights*

Description

Get the value of W, the matrix of counterparties' sector weights defined within the portfolio (see analyze)

Usage

```
W(this)
```

Arguments

this	Object of class GCPM

Value

numeric matrix

See Also

init

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