Package ‘AssetCorr’

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Date 2021-05-04

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Description

Details

The DESCRIPTION file:

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References


analyze_AssetCorr

Function to evaluate several default time series simultaneously

Description

To give a first insight of several default time series, this function combines multiple estimator functions (intra and inter) and visualize the results.

Usage

analyze_AssetCorr(DTS,N, B=NA, DB=NA, JC=FALSE, CI_Boot=NA, Adjust=0.0001, type="bca", Intra=c("AMM","FMM","CMM","JDP1","JDP2","MLE","AMLE","Beta","Mode"), Inter=c("Copula","Cov","JDP","MLE"))

Arguments

DTS  a matrix, containing the default time series of each sector.
N    a matrix, containing the number of obligors at the beginning of the period of sector.
B    an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate (intra and inter).
DB   a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap (intra and inter).
JC   a logical variable, indicating if the jackknife corrected estimate should be calculated (intra and inter).
CI_Boot   a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot(intra and inter).
Adjust a number, which should be added to a observed default rate of 0 or subtracted form a observed default rate of 1 (only for the intraAMLE).
type a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see boot.ci. Studendized confidence intervals are not supported.
Intra a combined string, indicating which intra correlation estimators should be used. All estimators are set as default.
Inter a combined string, indicating which inter correlation estimators should be used. All estimators are set as default.
Details

To give an first insight, the function provides an overview of the several default time series and estimates using different estimators (intra and inter) simultaneously. The plug-in estimates of the intra correlation using inter correlation methods will be estimated via intraMLE. If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop.

Value

The returned value is a list, containing the following entries:

Estimators_Intra

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of the sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector_Name</td>
<td>Name of the sector</td>
</tr>
<tr>
<td>Estimator</td>
<td>Name of the applied estimator</td>
</tr>
<tr>
<td>Estimate</td>
<td>Value of the calculated estimate</td>
</tr>
<tr>
<td>Type</td>
<td>String, which indicating corrected/non-corrected estimates</td>
</tr>
<tr>
<td>correction</td>
<td>Name of the correction method</td>
</tr>
<tr>
<td>B</td>
<td>Number of single bootstrap repetitions</td>
</tr>
<tr>
<td>DB</td>
<td>Number of the double bootstrap repetitions</td>
</tr>
<tr>
<td>CI_Boot</td>
<td>Selected two-sided bootstrap confidence interval</td>
</tr>
<tr>
<td>CI</td>
<td>A string, indicating if the corresponding value is the upper or lower bound</td>
</tr>
</tbody>
</table>

Estimators_Inter

| Sector_1 | Number of the sector |
| Sector_Name_1 | Name of the sector |
| Sector_2 | Number of the sector |
| Sector_Name_2 | Name of the sector |
| Estimator | Name of the applied estimator to Sector_1 and Sector_2 |
| Estimate | Value of the calculated estimator to Sector_1 and Sector_2 |
| Type | String, which indicating corrected/non-corrected estimates |
| correction | Name of the correction method |
| B | Number of single bootstrap repetitions |
| DB | Number of the double bootstrap repetitions |
| CI_Boot | Selected two-sided bootstrap confidence interval |
| CI | A string, indicating if the corresponding value is the upper or lower bound |

Author(s)

Kevin Jakob
References


See Also

intraAMM, intraFMM, intraJDP2, intraMLE, intraJDP1, intraCMM, intraMode, intraBeta, interJDP, interCopula, interCMM, interCov, interMLE, intraALL, interALL

Examples

```r
library(mvtnorm)
set.seed(111)
NoO=1000 #Number of obligors in each sector
Years=20
AC=0.3
PD=0.01
Psi=rmvnorm(Years,sigma=matrix(c(1,0.5,0.5,0.5,1,0.5,0.5,0.5,1),3))
PDcond1=pnorm((qnorm(PD)-sqrt(AC)*Psi[,1])/sqrt(1-AC))
```


PDcond2=pnorm((qnorm(PD)-sqrt(AC/2)*Psi[,2])/sqrt(1-AC/2))
PDcond3=pnorm((qnorm(PD)-sqrt(AC*2)*Psi[,3])/sqrt(1-AC*2))

DTS=cbind(rbinom(Years,NoO,PDcond1),rbinom(Years,NoO,PDcond2),rbinom(Years,NoO,PDcond3))
N=matrix(NoO,nrow = Years,ncol = 3)

Output<-analyze_AssetCorr(DTS,N)

#Bootstrap Correction and CIs
Output<-analyze_AssetCorr(DTS,N,B=100,CI_Boot=0.95)

#Double Bootstrap Correction and Jackknife
Output<-analyze_AssetCorr(DTS,N,DB=c(50,50),JC=TRUE)

---

**defaultTimeseries**

Creating a hypothetical Default Time Series.

**Description**

This function return a time series of defaults.

**Usage**

defaultTimeseries(N, AC, Years, PD)

**Arguments**

N  Number of obligors for each point in time.
AC Desired asset correlation.
Years Number of points in time, which corresponds to the length of the default time series.
PD Uniform probability of default assumed for each obligor.

**Details**

This function can be used to draw a random default time series, assuming a specific length of the time series, number of obligors, a uniform asset correlation and a uniform probability of default.

**Value**

The output contains a Nx1-vector with simulated defaults for each point in time.
**Examples**

```r
D1<-defaultTimeseries(1000,0.1,10,0.01)
```

---

**interALL**

*Function to use multiple estimators simultaneously*

---

**Description**

To give a first insight of the default time series, this function combines multiple estimator functions and visualize the results.

**Usage**

```r
interALL(d1,n1,d2,n2,rho1,rho2, B=NA, DB=NA, JC=FALSE, CI_Boot=NA, plot=FALSE,
            type="bca",Estimator=c("Copula","Cov","JDP","MLE"),show_progress=FALSE)
```

**Arguments**

- `d1`: a vector, containing the default time series of sector 1.
- `n1`: a vector, containing the number of obligors at the beginning of the period in sector 1.
- `d2`: a vector, containing the default time series of sector 2.
- `n2`: a vector, containing the number of obligors at the beginning of the period in sector 2.
- `rho1`: estimated intra correlation of sector 1.
- `rho2`: estimated intra correlation of sector 2.
- `B`: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- `DB`: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- `JC`: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- `CI_Boot`: a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.
- `plot`: a logical variable, indicating whether a plot of the default time series and the estimates should be generated using the `multiplot` function of Teetor (2011).
- `type`: a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studendized confidence intervals are not supported.
- `Estimator`: a combined string, indicating which estimators should be used. All estimators are set as default.
- `show_progress`: a logical variable, indicating whether a progress bar should be displayed.
Details

To give an first insight, the function provides an overview of the default time series and estimates using different estimators simultaneously. If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop.

Value

The returned value is a data frame, containing the following columns:

- **Estimator**: Name of the applied estimator
- **Estimate**: Value of the calculated estimate
- **Type**: String, which indicating corrected/non-corrected estimates
- **correction**: Name of the correction method
- **B**: Number of single bootstrap repetitions
- **DB**: Number of the double bootstrap repetitions
- **CI_Boot**: Selected two-sided bootstrap confidence interval
- **CI**: A string, indicating if the corresponding value is the upper or lower bound

Author(s)

Kevin Jakob

References


**See Also**

intraAMM, intraFMM, intraJDP2, intraMLE, intraJDP1, intraCMM

**Examples**

```r
set.seed(111)
Psi = rmvnorm(20, sigma = matrix(c(1, 0.5, 0.5, 1), 2))
PDcond1 = pnorm((qnorm(0.01) - sqrt(0.05) * Psi[,1]) / sqrt(1-0.05))
PDcond2 = pnorm((qnorm(0.01) - sqrt(0.2) * Psi[,2]) / sqrt(1-0.2))

D1 = rbinom(20, 1000, PDcond1)
D2 = rbinom(20, 1000, PDcond2)

N1 = N2 = rep(1000, 20)
DTS = cbind(D1, D2)
N = cbind(N1, N2)

rho1 = intraMLE(D1, N1)$Original
rho2 = intraMLE(D2, N2)$Original

# Point Estimates
interALL(D1, N1, D2, N2, rho1, rho2, plot = TRUE)

# Bootstrap corrected estimates of all available estimators:
InterCorr = interALL(D1, N1, D2, N2, rho1, rho2, B = 500, CI_Boot = 0.95, plot = TRUE, show_progress = TRUE)

# Jackknife correction
InterCorr = interALL(D1, N1, D2, N2, rho1, rho2, JC = TRUE, plot = TRUE)

# Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
InterCorr = interALL(D1, N1, D2, N2, rho1, rho2, DB = c(10, 50), plot = TRUE)
```

---

**interCMM**

*Corrected Asymptotic Method of Moments Estimator of Frei and Wunsch (2018)*
Description

This method provides analytical bias correction via Taylor series expansion. Additionally the bias due to autocorrelated default time series can be corrected. The estimated parameter is the inter correlation of the asset variables (in contrast to all other inter correlation methods of this package).

Usage

interCMM(d1,n1,d2,n2,rho,l=0, B=0,DB=c(0,0), JC=FALSE, CI_Boot, type="bca", plot=FALSE)

Arguments

d1                         a vector, containing the default time series of sector 1.
n1                         a vector, containing the number of obligors at the beginning of the period in sector 1.
d2                         a vector, containing the default time series of sector 2.
n2                         a vector, containing the number of obligors at the beginning of the period in sector 2.
rho                        estimated inter asset correlation of another estimator.
l                           a number, indicating how many lags of autocorrelation should be used for the correction.
B                           an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
DB                          a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
JC                          a logical variable, indicating if the jackknife corrected estimate should be calculated.
CI_Boot                     a number, indicating the desired confidence level if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.
type                       a string, indicating the desired method to calculate the confidence intervals. For more details see boot.ci.
plot                       a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

This function estimates the inter correlation of the asset variables. In general, the inter correlation can be estimated for the asset variables or the systematic factors. This estimator uses a inter correlation estimate of another method to correct the bias due to small sample or autocorrelation. Only one parameter (inter correlation) must be estimated. Additionally, asymptotic confidence interval can be provided, as shown by Frei and Wunsch (2018). The inter correlation of the asset variables can be transformed to the correlation of the systematic factors as follows:
\[ \rho_{\text{systematic}} = \frac{\rho_{\text{asset}}}{\sqrt{\rho_1 \ast \rho_2}} \]

If DB is specified, the single bootstrap corrected estimate will be calculated using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original**
- **Bootstrap**
- **Double_Bootstrap**
- **Jackknife**
- **CI_Boot**
- **bValues**
- **iValues**
- **oValues**

References


See Also

`interJDP, interCopula, interMLE, interCov`

Examples

```r
d1=defaultTimeseries(1000,0.1,10,0.01)
d2=defaultTimeseries(1000,0.2,10,0.01)
n1=n2=rep(1000,10)

#Using the Covariance method to estimate the plug-in inter correlation.
inter_sys=interCov(d1,n1,d2,n2,0.1,0.2)$Original
inter_asset=inter_sys*sqrt(0.1*0.2)

interCMM(d1,n1,d2,n2,inter_asset,l=0)

InterCorr=interCMM(d1,n1,d2,n2,inter_asset, JC=TRUE)
```


```r
InterCorr=interCMM(d1,n1,d2,n2,inter_asset, B=1000, CI_Boot=0.95, plot=TRUE)

InterCorr=interCMM(d1,n1,d2,n2,inter_asset, DB=c(10,50))
```

---

**interCopula**

*Copula Based Maximum Likelihood Estimator*

---

**Description**

The inter correlation parameter can be estimated by fitting a Gaussian copula with Vasicek distributed margins on two observed default rate time series. The estimated parameter is the inter correlation of the systematic factors.

**Usage**

```r
interCopula(df1, df2, B = 0, DB=c(0,0),JC = FALSE, CI, CI_Boot, type="bca", plot=FALSE)
```

**Arguments**

- `df1`: a vector, containing the default rate time series of sector 1.
- `df2`: a vector, containing the default rate time series of sector 2.
- `B`: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- `DB`: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- `JC`: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- `CI`: a number, indicating the desired asymptotic confidence interval of the estimate.
- `CI_Boot`: a number, indicating the desired bootstrap confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as `CI_Boot`.
- `type`: a string, indicating the desired method to calculate the confidence intervals. For more details see `boot.ci`.
- `plot`: a logical variable, indicating whether a plot of the single bootstrap density should be generated.
Details

This function estimates the inter correlation of the systematic factors. In general the inter correlation can be estimated for the asset variables or the systematic factors. This method estimates the inter correlation of the systematic factors. The parameter will be estimated via Maximum Likelihood estimation, which ensures that an asymptotic confidence interval can be provided. The inter correlation of the systematic factors can be transformed to the correlation of the asset variables as follows:

\[ \rho_{\text{Asset}} = \rho_{\text{Systematic}} \times \sqrt{\rho_1 \times \rho_2} \]

The estimated inter correlation of the systematic factors lies between -1 and 1. If DB is specified, the single bootstrap corrected estimate will be calculated using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

- Original: Estimate of the original method
- Bootstrap: Bootstrap corrected estimate
- Double_Bootstrap: Double bootstrap corrected estimate
- Jackknife: Jackknife corrected estimate
- CI: Selected two-sided asymptotic bootstrap confidence interval
- CI_Boot: Selected two-sided bootstrap confidence interval
- bValues: Estimates from the bootstrap resampling
- iValues: Estimates from the double bootstrap resampling- inner loop
- oValues: Estimates from the double bootstrap resampling- outer loop

References


See Also

interJDP, interCMM, interMLE, interCov
Examples

```r
set.seed(10)
d1=defaultTimeseries(1000,0.1,10,0.01)
d2=defaultTimeseries(1000,0.2,10,0.01)
n=rep(1000,10)

df1=d1/n
df2=d2/n

InterCorr=interCopula(df1,df2, CI=0.95)

InterCorr=interCopula(df1,df2, JC=TRUE)

InterCorr=interCopula(df1,df2, B=1000, CI_Boot=0.95, plot=TRUE)

InterCorr=interCopula(df1,df2, DB=c(50,50))
```

---

**interCov**

*Covariance Matching Estimator*

---

**Description**

The inter correlation parameter can be estimated by matching the empirical covariance of two default time series with the theoretical. The estimated parameter is the inter correlation of the systematic factors.

**Usage**

```r
interCov(d1, n1, d2, n2, rho1, rho2, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)
```

**Arguments**

- **d1**: a vector, containing the default time series of sector 1.
- **n1**: a vector, containing the number of obligors at the beginning of the period in sector 1.
- **d2**: a vector, containing the default time series of sector 2.
- **n2**: a vector, containing the number of obligors at the beginning of the period in sector 2.
- **rho1**: estimated intra asset correlation of sector 1.
- **rho2**: estimated intra asset correlation of sector 2.
- **B**: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
interCov

DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.

JC a logical variable, indicating if the jackknife corrected estimate should be calculated.

CI_Boot a number, indicating the desired confidence level if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).

type a string indicating the desired method to calculate the confidence intervals. For more details see boot.ci.

plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

This function estimates the inter correlation of the systematic factors. In general, the inter correlation can be estimated for the asset variables or the systematic factors. To ensure the traceability of the estimation, the intra correlation estimates will be used as plug-in estimates. Hence only one parameter (inter correlation) must be estimated. The inter correlation of the systematic factors can be transformed to the correlation of the asset variables as follows:

$$\rho_{\text{Asset}} = \rho_{\text{Systematic}} \times \sqrt{\rho_1 \times \rho_2}$$

The estimated inter correlation of the systematic factors lies between -1 and 1.

If DB is specified, the single bootstrap corrected estimate will be calculated using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

Original Estimate of the original method
Bootstrap Bootstrap corrected estimate
Double_Bootstrap Double bootstrap corrected estimate
Jackknife Jackknife corrected estimate
CI_Boot Selected two-sided bootstrap confidence interval
bValues Estimates from the single bootstrap resampling
iValues Estimates from the double bootstrap resampling - inner loop
oValues Estimates from the double bootstrap resampling - outer loop
References


See Also

`interJDP`, `interCMM`, `interMLE`, `interCopula`

Examples

```r
set.seed(10)
d1=defaultTimeseries(1000,0.1,10,0.01)
d2=defaultTimeseries(1000,0.2,10,0.01)
n1=n2=rep(1000,10)

InterCorr=interCov(d1,n1,d2,n2,0.1,0.2)

InterCorr=interCov(d1,n1,d2,n2,0.1,0.2, JC=TRUE)
InterCorr=interCov(d1,n1,d2,n2,0.1,0.2, B=1000, CI_Boot=0.95)
InterCorr=interCov(d1,n1,d2,n2,0.1,0.2, DB=c(50,50))
```

---

**interJDP**

*Joint Default Probability Matching Estimator, De Servigny and Renault (2002)*

**Description**

The inter correlation parameter can be estimated by matching the empirical Joint Default Probability of two default time series with the theoretical one. The estimated parameter is the correlation of the systematic factors.

**Usage**

```r
interJDP(d1, n1, d2, n2, rho1, rho2, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)
```
Arguments

d1  a vector, containing the default time series of sector 1.
n1  a vector, containing the number of obligors at the beginning of the period in sector 1.
d2  a vector, containing the default time series of sector 2.
n2  a vector, containing the number of obligors at the beginning of the period in sector 2.
rho1 estimated intra correlation of sector 1.
rho2 estimated intra correlation of sector 2.
B   an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
DB  a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
JC  a logical variable, indicating if the jackknife corrected estimate should be calculated.
CI_Boot  a number, indicating the desired confidence level if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).
type  a string, indicating the desired method to calculate the confidence intervals. For more details see `boot.ci`.
plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

This function estimates the inter correlation of the systematic factor. In general, the inter correlation can be estimated for the asset variables or the systematic factors. To ensure the traceability of the estimation, the intra correlation estimates will be used as plug-in estimates. Hence only one parameter (inter correlation) must be estimated. The inter correlation of the systematic factor can be transformed to the correlation of the asset variables as follows:

\[
\rho_{\text{Asset}} = \rho_{\text{Systematic}} \times \sqrt{\rho_1 \times \rho_2}
\]

The estimated inter correlation of the systematic factors lies between -1 and 1.

If DB is specified, the single bootstrap systematic factors will be calculated using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

Original Estimate of the original method
Bootstrap  
Bootstrap corrected estimate

Double_Bootstrap  
Double bootstrap corrected estimate

Jackknife  
Jackknife corrected estimate

CI_Boot  
Selected two-sided bootstrap confidence interval

bValues  
Estimates from the bootstrap resampling

iValues  
Estimates from the double bootstrap resampling - inner loop

oValues  
Estimates from the double bootstrap resampling - outer loop

References


See Also

`interCov, interCMM, interMLE, interCopula`

Examples

```r
  d1=defaultTimeseries(1000,0.1,10,0.01)
  d2=defaultTimeseries(1000,0.2,10,0.01)
  n1=n2=rep(1000,10)
  InterCorr=interJDP(d1,n1,d2,n2,0.1,0.2)

  InterCorr=interJDP(d1,n1,d2,n2,0.1,0.2, JC=TRUE)
  InterCorr=interJDP(d1,n1,d2,n2,0.1,0.2, B=1000, CI_Boot=0.95)
  InterCorr=interJDP(d1,n1,d2,n2,0.1,0.2, DB=c(10,50))
```
interMLE  

Binomial Maximum Likelihood Estimator

Description

The inter correlation parameter can be estimated by maximizing the Vasicek-binomial log-likelihood. The default process in the Vasicek model follows a binomial distribution, conditional on the realisation of the systematic factor. Hence, the inter correlation of the systematic factor can be estimated by maximizing the resulting log likelihood.

Usage

interMLE(d1, n1, d2, n2, rho1, rho2, B = 0, DB=c(0,0), JC = FALSE, CI, plot=FALSE)

Arguments

d1 a vector, containing the default time series of sector 1.
n1 a vector, containing the number of obligors at the beginning of the period in sector 1.
d2 a vector, containing the default time series of sector 2.
n2 a vector, containing the number of obligors at the beginning of the period in sector 2.
rho1 estimated intra correlation of sector 1.
rho2 estimated intra correlation of sector 2.
B an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
JC a logical variable, indicating if the jackknife corrected estimate should be calculated.
CI a number, indicating the desired asymptotic confidence bound of the estimate.
plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

This function estimates the inter correlation of the systematic factor. In general, the inter correlation can be estimated for the asset variables or the systematic factors. To ensure the traceability of the estimation, the intra correlation estimates will be used as plug-in estimates. Hence only one parameter (inter correlation) must be estimated. The inter correlation of the systematic factor can be transformed to the correlation of the asset variables as follows:
\[ \rho_{\text{Asset}} = \rho_{\text{Systematic}} \times \sqrt{\rho_1 \times \rho_2} \]

The estimated inter correlation of the systematic factors lies between -1 and 1.

If DB is specified, the single bootstrap corrected estimate will be calculated using the bootstrap values of the outer loop (oValues).

**Value**

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original**: Estimate of the original method
- **Bootstrap**: Bootstrap corrected estimate
- **Double_Bootstrap**: Double bootstrap corrected estimate
- **Jackknife**: Jackknife corrected estimate
- **CI**: Selected two-sided asymptotic bootstrap confidence interval
- **CI_Boot**: Selected two-sided bootstrap confidence interval
- **bValues**: Estimates from the bootstrap resampling
- **iValues**: Estimates from the double bootstrap resampling - inner loop
- **oValues**: Estimates from the double bootstrap resampling - outer loop

**References**


**Examples**

```r
d1=defaultTimeseries(1000,0.1,10,0.01)
d2=defaultTimeseries(1000,0.2,10,0.01)
n1=n2=rep(1000,10)
InterCorr=interMLE(d1,n1,d2,n2,0.1,0.2, CI=0.95)
```
intraALL

Function to use multiple estimators simultaneously

Description

To give a first insight of the default time series, this function combines multiple estimator functions and visualize the results.

Usage

intraALL(d, n, B=NA, DB=NA, JC=FALSE, CI_Boot=NA, Adjust=0.0001, plot=FALSE, type="bca", Quantile=0.999, Estimator=c("AMM", "FMM", "CMM", "JDP1", "JDP2", "MLE", "AMLE", "Beta", "Mode"), show_progress=FALSE)

Arguments

d a vector, containing the default time series of the sector.
n a vector, containing the number of obligors at the beginning of the period in the sector.
B an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
JC a logical variable, indicating if the jackknife corrected estimate should be calculated.
CI_Boot a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.
Adjust a number, which should be added to a observed default rate of 0 or subtracted form a observed default rate of 1 (only for the AMLE).
plot a logical variable, indicating whether a plot of the default time series and the estimates should be generated using the multiplot function of Teetor (2011).
type a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studentized confidence intervals are not supported.

Quantile a number, indicating the desired confidence level of the Value-at-Risk (only for the intraBeta).

Estimator a combined string, indicating which estimators should be used. All estimators are set as default.

show_progress a logical variable, indicating whether a progress bar should be displayed.

Details

To give an first insight, the function provides an overview of the default time series and estimates using different estimators simultaneously. If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop.

Value

The returned value is a data frame, containing the following columns:

- **Estimator** Name of the applied estimator
- **Estimate** Value of the calculated estimate
- **Type** String, which indicating corrected/non-corrected estimates
- **correction** Name of the correction method
- **B** Number of single bootstrap repetitions
- **DB** Number of the double bootstrap repetitions
- **CI_Boot** Selected two-sided bootstrap confidence interval
- **CI** A string, indicating if the corresponding value is the upper or lower bound

Author(s)

Kevin Jakob

References


See Also

`intraAMM, intraFMM, intraJDP2, intraMLE, intraJDP1, intraCMM, intraMode, intraBeta`

Examples

```r
set.seed(10)
d=defaultTimeseries(1000,0.01,20,0.01)
n=rep(1000,20)

#Point Estimate of all available estimators:
intraALL(d,n,Adjust=0.001, plot=TRUE)

#Bootstrap corrected estimates of all available estimators:
IntraCorr=intraALL(d,n, Adjust=0.001, B=500, CI_Boot=0.95 , plot=TRUE, show_progress=TRUE)

#Select some estimators
IntraCorr=intraALL(d,n,B=500, CI_Boot=0.95, Adjust=0.001 ,Estimator=c("AMM","FMM"), plot=TRUE)

#Jackknife correction
IntraCorr=intraALL(d,n, JC=TRUE,Adjust=0.001, plot=TRUE)

#Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraALL(d,n, DB=c(10,50),Adjust=0.001, plot=TRUE)
```
**Description**

This estimator is based on the assumption of infinitely large portfolio size and a sufficient length of the default time series. In the asymptotic case, neither the default rate of 0 or a 1 occur. Hence one has to make an adjustment in these cases.

**Usage**

```r
intraAMLE(d, n, B = 0, DB=c(0,0),JC = FALSE, Adjust = 0, CI_1, CI_2, CI_Boot, VaR=0.99, VaR_CI=0.95, ES=0.975, ES_CI=0.95, type="bca", plot=FALSE)
```

**Arguments**

- `d`: a vector, containing the default time series of the sector.
- `n`: a vector, containing the number of obligors at the beginning of the period in the sector.
- `B`: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- `DB`: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- `JC`: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- `Adjust`: a number, which should be added to a observed default rate of 0 or subtracted form a observed default rate of 1.
- `CI_1`: a number, indicating the desired analytical confidence interval of the estimate. The interval is computed by asymptotic Cramer-Rao lower bound for the standard deviation of the estimate based on Duellmann and Gehde-Trapp (2004). Additionally the asymptotic confidence interval for the unconditional PD is computed.
- `CI_2`: a number, indicating the desired analytical confidence interval of the estimate. The interval is computed by constructing a confidence interval for the variance, which can be transferred to the estimate based on Hoese and Huschens (2011).
- `CI_Boot`: a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.
- `VaR`: a number, indicating the desired confidence level for the asymptotic Value-at-Risk.
VaR_CI a number, indicating the desired confidence interval for the asymptotic Value-at-Risk, derived by the delta method.

ES a number, indicating the desired confidence level for the asymptotic Expected Shortfall.

ES_CI a number, indicating the desired confidence interval for the asymptotic Expected Shortfall, derived by the delta method.

type a string, indicating the desired method to calculate the confidence intervals. For more details see boot.ci.

plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

This estimator is based on the asymptotic assumptions of the Vasicek model, especially the assumption of an infinite large portfolio. If a 0 or 1 occurs at least once in the default rate time series, the estimator can not converge. Therefore, an adjustment (Adjust) can be made. Nevertheless, Meyer (2009) argued that the adjustment can harm the estimation efficiency.

Additionally two different asymptotic confidence intervals are provided. Bootstrap and jackknife corrections are also possible. If DB is specified, the single bootstrap corrected estimate will be calculated using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

PD Estimate of the unconditional PD based on Duellmann and Gehde-Trapp (2004)
PD_CI_1 Two-sided asymptotic confidence interval for the unconditional PD based on Duellmann and Gehde-Trapp (2004)
Original Estimate of the original method
Bootstrap Bootstrap corrected estimate
Double_Bootstrap Double bootstrap corrected estimate
Jackknife Jackknife corrected estimate
CI_1 Selected two-sided asymptotic confidence interval based on Duellmann and Gehde-Trapp (2004)
CI_2 Selected two-sided asymptotic confidence interval based on Hoese and Huschens (2011)
CI_Boot Selected two-sided bootstrap confidence interval
VaR Asymptotic Value-at-Risk
VaR_CI Confidence interval for the asymptotic Value-at-Risk
ES Asymptotic Expected Shortfall
ES_CI Confidence interval for the asymptotic Expected Shortfall
bValues Estimates from the single bootstrap resampling
iValues Estimates from the double bootstrap resampling- inner loop
oValues Estimates from the double bootstrap resampling- outer loop
References


See Also

  intraAMM, intraFMM, intraJDP2, intraMLE, intraJDP1, intraCMM, intraMode, intraBeta

Examples

```r
set.seed(10)
d=defaultTimeseries(100,0.01,10,0.01)
n=rep(100,10)

  #Sensitivity to the adjustment
  intraAMLE(d,n,Adjust=0.001)
intraAMLE(d,n,Adjust=0.0001)

  #Estimation with confidence intervals- I
  IntraCorr=intraAMLE(d,n, Adjust=0.001, CI_1=0.95 )

  #Estimation with confidence intervals- II
  IntraCorr=intraAMLE(d,n, Adjust=0.001, CI_2=0.95 )

  #Jackknife correction
  IntraCorr=intraAMLE(d,n,Adjust=0.001, JC=TRUE)

  #Bootstrap correction with bootstrap confidence intervals
  IntraCorr=intraAMLE(d,n, Adjust=0.001, B=1000, CI_Boot=0.95 )

  #Bootstrap correction with bootstrap confidence intervals and plot
  IntraCorr=intraAMLE(d,n, B=1000, Adjust=0.001, CI_Boot=0.95, plot=TRUE )

  #Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
  IntraCorr=intraAMLE(d,n,Adjust=0.001, DB=c(10,50))
```
Description

The intra asset correlation will be estimated by fitting the first two moments of the default rate time series to the theoretical moments of the default rate and backing out the remaining correlation parameter numerically. Additionally, bootstrap and jackknife corrections are implemented.

Usage

```
intraAMM(d, n, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)
```

Arguments

- `d`: a vector, containing the default time series of the sector.
- `n`: a vector, containing the number of obligors at the beginning of the period over time.
- `B`: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- `DB`: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- `JC`: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- `CI_Boot`: a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).
- `type`: a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studentized confidence intervals are not supported.
- `plot`: a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

As stated by Vasicek (1991) and Vasicek (2002), the asset variables follow a bivariate normal distribution. Since this distribution can be parametrized by the first two moments, namely the expected value and the variance, the remaining correlation parameter can be backed out numerically. The expected value will be approximated by the mean of the default rate and the variance is defined as the sample variance of the default rate. For theoretical background, see Gordy (2000). If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).
**Value**

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original** Estimate of the original method
- **Bootstrap** Bootstrap corrected estimate
- **Double_Bootstrap** Double bootstrap corrected estimate
- **Jackknife** Jackknife corrected estimate
- **CI_Boot** Selected two-sided bootstrap confidence interval
- **bValues** Estimates from the bootstrap resampling
- **iValues** Estimates from the double bootstrap resampling - inner loop
- **oValues** Estimates from the double bootstrap resampling - outer loop

**References**


**See Also**

`intraFMM, intraJDP1, intraJDP2, intraCMM, intraMLE, intraAMLE, intraMode, intraBeta`

**Examples**

```r
set.seed(111)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)
IntraCorr=intraAMM(d,n)

#Jackknife correction
IntraCorr=intraAMM(d,n, JC=TRUE)

#Bootstrap correction with confidence intervals
IntraCorr=intraAMM(d,n, B=1000, CI_Boot=0.95 )

#Bootstrap correction with confidence intervals and plot
IntraCorr=intraAMM(d,n, B=1000, CI_Boot=0.95, plot=TRUE )
```
# Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraAMM(d,n, DB=c(10,50))

**Description**

The intra asset correlation will be estimated by fitting a beta distribution onto the default rate time series, then calculating the Value-at-Risk (VaR) of this beta distribution and fit it to the theoretical VaR of the Vasicek distribution. The correlation parameter will be backed out numerically. Additionally, bootstrap and jackknife corrections are implemented.

**Usage**

```r
intraBeta(d, n, Quantile=0.999, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)
```

**Arguments**

- **d**: a vector, containing the default time series of the sector.
- **n**: a vector, containing the number of obligors at the beginning of the period over time.
- **Quantile**: a number, indicating the desired confidence level of the Value-at-Risk.
- **B**: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- **DB**: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- **JC**: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- **CI_Boot**: a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).
- **type**: a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studendized confidence intervals are not supported.
- **plot**: a logical variable, indicating whether a plot of the single bootstrap density should be generated.
Details

As stated by Botha and van Vuuren (2010) one can estimate the intra correlation by matching VaR of a parametrized beta distribution onto the VaR of the Vasicek distribution. To do so, the shape parameters (alpha and beta) of the beta distribution are estimated according to Botha and van Vuuren (2010). Afterwards, the VaR_Beta at the confidence level of Quantile will be estimated. In a third step, this VaR_Beta is matched with the theoretical VaR of the Vasicek distribution, given by Vasicek (1991):

\[ VaR_{Vasicek} = \Phi((\Phi^{-1}(PD) + \sqrt{\rho} \cdot \Phi^{-1}(Quantile)))/\sqrt{1 - \rho} \]

Since Quantile and the corresponding VaR_Beta is known, the intra correlation parameter can be backed out numerically. This estimator is sensitive to the chosen Quantile. Botha and van Vuuren (2010) suggested to use Quantile=0.999, but for validation purposes one may choose different values of Quantile to infer information about the robustness of the correlation estimate.

If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

- Original
- Bootstrap
- Double_Bootstrap
- Jackknife
- CI_Boot
- bValues
- iValues
- oValues

References


**intraCMM**

*Corrected Asymptotic Method of Moments Estimator of Frei and Wunsch (2018)*

**Description**

The estimator is based on Frei and Wunsch (2018), who introduced an analytic bias correction via Taylor series expansion. Additionally, the bias due to autocorrelated default time series can be corrected. Furthermore, additional bootstrap and jackknife bias corrections are implemented.

**Usage**

```r
intraCMM(d, n, l=0, B=0, DB=c(0,0), JC=FALSE, CI_Boot,type="bca", plot=FALSE)
```

**Arguments**

- `d` a vector, containing the default time series of the sector.
- `n` a vector, containing the number of obligors at the beginning of the period in the sector.
- `l` a number, indicating how many lags of autocorrelation should be used for the correction.
B an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.

DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.

JC a logical variable, indicating if the jackknife corrected estimate should be calculated.

CI_Boot a number, indicating the desired confidence level if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.

type a string, indicating the desired method to calculate the confidence intervals. For more details see boot.ci.

plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

Frei and Wunsch (2018) introduced an estimator which simultaneously corrects the bias of a short default time series and an bias due to autocorrelation. Additionally, further corrections are implemented. If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

Original Estimate of the original method
Bootstrap Bootstrap corrected estimate
Double_Bootstrap Double bootstrap corrected estimate
Jackknife Jackknife corrected estimate
CI_Boot Selected two-sided bootstrap confidence interval
bValues Estimates from the single bootstrap resampling
iValues Estimates from the double bootstrap resampling- inner loop
oValues Estimates from the double bootstrap resampling- outer loop

References


intraFMM

See Also

intraAMM, intraFMM, intraJDP2, intraMLE, intraJDP1, intraAMLE, intraMode, intraBeta

Examples

set.seed(10)
d=defaultTimeseries(1000,0.1,10,0.01)
n=rep(1000,10)

IntraCorr=intraCMM(d,n,l=0)

#Estimation with two lags of autocorrelation
IntraCorr=intraCMM(d,n, l=2)

#Jackknife correction
IntraCorr=intraCMM(d,n, JC=TRUE)

#Bootstrap correction with bootstrap confidence intervals
IntraCorr=intraCMM(d,n, B=1000, CI_Boot=0.95)

#Bootstrap correction with bootstrap confidence intervals and plot
IntraCorr=intraCMM(d,n, B=1000, CI_Boot=0.95, plot=TRUE)

#Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraCMM(d,n, B=1000, CI_Boot=0.95, plot=TRUE)

intraFMM  Finite Sample Method of Moments Estimator

Description

The intra asset correlation will be estimated by fitting the first two moments of the default rate
time series to the theoretical moments of the default rate and backing out the remaining correlation
parameter numerically. The sample variance will be adjusted for an insufficiently large portfolio
size. Additionally, bootstrap and jackknife corrections are implemented.

Usage

intraFMM(d, n, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)
Arguments

d a vector, containing the default time series of the sector.

n a vector, containing the number of obligors at the beginning of the period over time.

B an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.

DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.

JC a logical variable, indicating if the jackknife corrected estimate should be calculated.

CI_Boot a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).

type a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see boot.ci. Studentized confidence intervals are not supported.

plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

As stated by Vasicek (1991) and Vasicek (2002), the asset variables follow a bivariate normal distribution. Since this distribution can be parametrized by the first two moments, namely the expected value and the variance, the remaining correlation parameter can be backed out numerically. The expected value will be approximated by the mean of the default rate and the variance is defined as the (corrected) sample variance of the default rate. For theoretical background, see Gordy (2000). If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

Original Estimate of the original method
Bootstrap Bootstrap corrected estimate
Double_Bootstrap Double bootstrap corrected estimate
Jackknife Jackknife corrected estimate
CI_Boot Selected two-sided bootstrap confidence interval
bValues Estimates from the bootstrap resampling
iValues Estimates from the double bootstrap resampling - inner loop
oValues Estimates from the double bootstrap resampling - outer loop
References


See Also

intraAMM, intraJDP1, intraJDP2, intraCMM, intraAMLE, intraAMLE, intraMode, intraBeta

Examples

```r
set.seed(111)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)
IntraCorr=intraFMM(d,n)

#Jackknife correction
IntraCorr=intraFMM(d,n, JC=TRUE)

#Bootstrap correction with confidence intervals
IntraCorr=intraFMM(d,n, B=1000, CI_Boot=0.95 )

#Bootstrap correction with confidence intervals and plot
IntraCorr=intraFMM(d,n, B=1000, CI_Boot=0.95, plot=TRUE )

#Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraFMM(D1,N1, DB=c(10,50))
```

Description

The intra asset correlation will be estimated by fitting the empirical joint default probability (JDP) of the default rate time series to the theoretical one and backing out the remaining correlation parameter numerically. The unbiased estimator of Lucas (1995) will be used for the empirical JDP. Additionally, bootstrap and jackknife corrections are implemented.
Usage

\texttt{intraJDP1(d, n, B = 0, DB=c(0,0), JC = FALSE, CI_Boot, type="bca", plot=FALSE)}

Arguments

d 

a vector, containing the default time series of the sector.

n 

a vector, containing the number of obligors at the beginning of the period over time.

B 

an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.

DB 

a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.

JC 

a logical variable, indicating if the jackknife corrected estimate should be calculated.

CI_Boot 

a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).

type 

a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see \texttt{boot.ci}. Studentized confidence intervals are not supported.

plot 

a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

Kalkbrener and Onwunta (2010) for example showed that the JDP of the default rates follow a bivariate normal distribution. The intra asset correlation will be estimated by fitting the empirical JDP of the default rate time series on the theoretical JDP of the default rate and backing out the remaining correlation parameter numerically. The empirical JDP is calculated by the (unbiased) estimator of Lucas (1995). If \texttt{DB} is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (\texttt{oValues}).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

Original 

Estimate of the original method

Bootstrap 

Bootstrap corrected estimate

Double_Bootstrap 

Double bootstrap corrected estimate

Jackknife 

Jackknife corrected estimate

CI_Boot 

Selected two-sided bootstrap confidence interval

bValues 

Estimates from the bootstrap resampling

iValues 

Estimates from the double bootstrap resampling- inner loop

oValues 

Estimates from the double bootstrap resampling- outer loop
References


See Also

intraAMM, intraFMM, intraJDP2, intraCMM, intraAMLE, intraAMLE, intraMode, intraBeta

Examples

```r
set.seed(111)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)

IntraCorr=intraJDP1(d,n) #Jackknife correction
IntraCorr=intraJDP1(d,n,JC=TRUE)

#Bootstrap correction with confidence intervals
IntraCorr=intraJDP1(d,n,B=1000,CI_Boot=0.95)

#Bootstrap correction with confidence intervals and plot
IntraCorr=intraJDP1(d,n,B=1000,CI_Boot=0.95,plot=TRUE)

#Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraJDP1(D1,N1,DB=c(10,50))
```

intraJDP2


Description

The intra asset correlation will be estimated by fitting the empirical joint default probability (JDP) of the default rate time series to the theoretical one and backing out the remaining correlation parameter numerically. The biased estimator of De Servigny and Renault (2002) will be used for the empirical JDP. Additionally, bootstrap and jackknife corrections are implemented.
**Usage**

\[ \text{intraJDP2}(d, n, B = 0, DB = c(0, 0), JC = \text{FALSE}, \text{CI}_\text{Boot}, \text{type} = \text{"bca"}, \text{plot} = \text{FALSE}) \]

**Arguments**

- **d**
  - a vector, containing the default time series of the sector.
- **n**
  - a vector, containing the number of obligors at the beginning of the period over time.
- **B**
  - an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- **DB**
  - a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- **JC**
  - a logical variable, indicating if the jackknife corrected estimate should be calculated.
- **CI_Boot**
  - a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).
- **type**
  - a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studentized confidence intervals are not supported.
- **plot**
  - a logical variable, indicating whether a plot of the single bootstrap density should be generated.

**Details**

Kalkbrener and Onwunta (2010) for example showed that the JDP of the default rates follow a bivariate normal distribution. The intra asset correlation will be estimated by fitting the empirical JDP of the default rate time series on the theoretical JDP of the default rate and backing out the remaining correlation parameter numerically. The empirical JDP is calculated by the (unbiased) estimator of De Servigny and Renault (2002). If `DB` is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (`oValues`).

**Value**

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original**
  - Estimate of the original method
- **Bootstrap**
  - Bootstrap corrected estimate
- **Double_Bootstrap**
  - Double bootstrap corrected estimate
- **Jackknife**
  - Jackknife corrected estimate
- **CI_Boot**
  - Selected two-sided bootstrap confidence interval
- **bValues**
  - Estimates from the single bootstrap resampling
- **iValues**
  - Estimates from the double bootstrap resampling- inner loop
- **oValues**
  - Estimates from the double bootstrap resampling- outer loop
References


See Also

intraAMM, intraFMM, intraJDP1, intraCMM, intraMLE, intraAMLE, intraMode, intraBeta

Examples

```r
set.seed(10)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)

IntraCorr=intraJDP2(d,n)
#Jackknife correction
IntraCorr=intraJDP2(d,n, JC=TRUE)

#Bootstrap correction with confidence intervals
IntraCorr=intraJDP2(d,n, B=1000, CI_Boot=0.95 )

#Bootstrap correction with confidence intervals and plot
IntraCorr=intraJDP2(d,n, B=1000, CI_Boot=0.95, plot=TRUE )

#Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraJDP2(D1,N1, DB=c(10,50))
```

intraMLE

*Binomial Maximum Likelihood Estimator*

Description

The default process in the Vasicek model follows a binomial distribution, conditional on the realization of the systematic factor. Hence, the intra asset correlation can be estimated by maximizing the Vasicek-binomial log likelihood.

Usage

```r
intraMLE(d, n, B =0, DB=c(0,0), JC = FALSE, CI, CI_Boot, type="bca", plot=FALSE)
```
Arguments

d a vector, containing the default time series of the sector.
n a vector, containing the number of obligors at the beginning of the period in the sector.
B an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
DB a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
JC a logical variable, indicating if the jackknife corrected estimate should be calculated.
CI a number, indicating the desired asymptotic confidence interval of the estimate.
CI_Boot a number, indicating the desired bootstrap confidence interval of the estimate, if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca). Furthermore, the analytical confidence intervals are provided, using the same value as CI_Boot.
type a string, indicating the type of bootstrap intervals. For more details see boot.ci.
plot a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

In the Vasicek model the default process can be expressed as independent binomial trials, conditional on the realization of the systematic factor. Therefore Gordy and Heitfield (2010) introduced an estimator of the intra asset correlation based on the log-likelihood maximization. For theoretical background see Gordy and Heitfield (2010).

The log-likelihood will be maximized for values between 0 and 1. The asymptotic confidence interval will be estimated using maximum likelihood theory. If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).

Value

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original**: Estimate of the original method
- **Bootstrap**: Bootstrap corrected estimate
- **Double_Bootstrap**: Double bootstrap corrected estimate
- **Jackknife**: Jackknife corrected estimate
- **CI**: Selected two-sided asymptotic confidence interval
- **CI_Boot**: Selected two-sided bootstrap confidence interval
- **bValues**: Estimates from the single bootstrap resampling
- **iValues**: Estimates from the double bootstrap resampling- inner loop
- **oValues**: Estimates from the double bootstrap resampling- outer loop
References


See Also

intraAMM, intraFMM, intraJDP2, intraCMM, intraJDP1, intraAMLE, intraMode, intraBeta

Examples

```r
set.seed(11)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)

IntraCorr=intraMLE(d,n)

# Estimation with confidence intervals
IntraCorr=intraMLE(d,n, CI=0.95 )

# Jackknife correction
IntraCorr=intraMLE(d,n, JC=TRUE)

# Bootstrap correction with bootstrap confidence intervals
IntraCorr=intraMLE(d,n, B=1000, CI_Boot=0.95 )

# Bootstrap correction with bootstrap confidence intervals and plot
IntraCorr=intraMLE(d,n, B=1000, CI_Boot=0.95, plot=TRUE )

# Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr=intraMLE(D1,N1, DB=c(10,50))
```

---

intraMode  
*Parametric Approach of Botha and van Vuuren (2010)- Mode*
Description

The intra asset correlation will be estimated by fitting the mode of the default rate time series to the theoretical mode of the default rates and backing out the remaining correlation parameter numerically. Additionally, bootstrap and jackknife corrections are implemented.

Usage

\[
\text{intraMode}(d, n, B = 0, DB = c(0, 0), JC = \text{FALSE}, CI_\text{Boot}, \text{type} = \text{"bca"}, \text{plot} = \text{FALSE})
\]

Arguments

- **d**: a vector, containing the default time series of the sector.
- **n**: a vector, containing the number of obligors at the beginning of the period over time.
- **B**: an integer, indicating how many bootstrap repetitions should be used for the single bootstrap corrected estimate.
- **DB**: a combined vector, indicating how many bootstrap repetitions should be used for the inner (first entry) and outer loop (second entry) to correct the bias using the double bootstrap.
- **JC**: a logical variable, indicating if the jackknife corrected estimate should be calculated.
- **CI_Boot**: a number, indicating the desired confidence interval if the single bootstrap correction is specified. By default, the interval is calculated as the bootstrap corrected and accelerated confidence interval (Bca).
- **type**: a string, indicating the desired method to calculate the bootstrap confidence intervals. For more details see `boot.ci`. Studentized confidence intervals are not supported.
- **plot**: a logical variable, indicating whether a plot of the single bootstrap density should be generated.

Details

As stated by Botha and van Vuuren (2010) one can estimate the intra correlation by matching the theoretical and empirical mode. According to Vasicek (1991) the default rates are only unimodal if the intra correlation is smaller than 0.5. Therefore, this estimator cannot be used for higher intra correlations. The theoretical mode is given by Vasicek (1991):

\[
\text{Mode}_{\text{Vasicek}} = \Phi(\sqrt{1 - \rho} / (1 - 2 \times \rho) \times \Phi^{-1}(PD))
\]

If DB is specified, the single bootstrap corrected estimate will be calculated by using the bootstrap values of the outer loop (oValues).
**Value**

The returned value is a list, containing the following components (depending on the selected arguments):

- **Original**: Estimate of the original method
- **Bootstrap**: Bootstrap corrected estimate
- **Double_Bootstrap**: Double bootstrap corrected estimate
- **Jackknife**: Jackknife corrected estimate
- **CI_Boot**: Selected two-sided bootstrap confidence interval
- **bValues**: Estimates from the bootstrap resampling
- **iValues**: Estimates from the double bootstrap resampling- inner loop
- **oValues**: Estimates from the double bootstrap resampling- outer loop

**References**


**See Also**

`intraFMM, intraJDP1, intraJDP2, intraCMM, intraMLE, intraAMLE, intraBeta`

**Examples**

```r
set.seed(111)
d=defaultTimeseries(1000,0.3,20,0.01)
n=rep(1000,20)
IntraCorr=intraMode(d,n)

#Jackknife correction
IntraCorr=intraMode(d,n, JC=TRUE)

#Bootstrap correction with confidence intervals
IntraCorr=intraMode(d,n, B=1000, CI_Boot=0.95 )

#Bootstrap correction with confidence intervals and plot
IntraCorr=intraMode(d,n, B=1000, CI_Boot=0.95, plot=TRUE )
```
Double Bootstrap correction with 10 repetitions in the inner loop and 50 in the outer loop
IntraCorr = intraMode(D1, N1, DB=c(10, 50))
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