Package ‘extremogram’

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Title Estimation of Extreme Value Dependence for Time Series Data

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Description Estimation of the sample univariate, cross and return time extremograms. The package can also adds empirical confidence bands to each of the extremogram plots via a permutation procedure under the assumption that the data are independent. Finally, the stationary bootstrap allows us to construct credible confidence bands for the extremograms.

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extremogram-package *extremogram*

Description

The package estimates the sample univariate, cross and return time extremograms. It can also add empirical confidence bands to each of the extremogram plots via a permutation procedure under the assumption that the data are independent. Finally, the stationary bootstrap allows us to construct credible confidence bands for the extremograms.

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7. `permfn1`
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References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

bootconf1 *Confidence bands for the sample univariate extremogram*

Description

The function estimates confidence bands for the sample univariate extremogram using the stationary bootstrap.

Usage

```
bootconf1(x, R, l, maxlag, quant, type, par, start = 1, cutoff = 1,
  alpha = 0.05)
```

Arguments

x	Univariate time series (a vector).
R	Number of bootstrap replications (an integer).
l	Mean block size for stationary bootstrap or mean of the geometric distribution used to generate resampling blocks (an integer that is not longer than the length of the time series).
maxlag	Number of lags to include in the extremogram (an integer).
quant	Quantile of the time series to indicate an extreme event (a number between 0 and 1).
type	Extremogram type (see function extremogram1).
par	If par = 1, the bootstrap replication procedure will be parallelized. If par = 0, no parallelization will be used.
start	The lag that the extremogram plots starts at (an integer not greater than maxlag, default is 1).
cutoff	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).
alpha	Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

Value

Returns a plot of the confidence bands for the sample univariate extremogram.

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega  = 1
alpha  = 0.1
beta   = 0.6
n      = 1000
quant  = 0.95
type   = 1
maxlag = 70
df     = 3
R      = 10
l      = 30
par    = 0
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogram1(G, quant, maxlag, type, 1, 1, 0)
bootconf1(G, R, l, maxlag, quant, type, par, 1, 1, 0.05)
```

bootconf2 *Confidence bands for the sample cross extremogram*

Description

The function estimates confidence bands for the sample cross extremogram using the stationary bootstrap.

Usage

```
bootconf2(x, R, l, maxlag, quant1, quant2, type, par, start = 1, cutoff = 1,
  alpha = 0.05)
```

Arguments

`x`	Bivariate time series (n by 2 matrix).
`R`	Number of bootstrap replications (an integer).
`l`	Mean block size for stationary bootstrap or mean of the geometric distribution used to generate resampling blocks (an integer that is not longer than the length of the time series).
`maxlag`	Number of lags to include in the extremogram (an integer).
`quant1`	Quantile of the first time series to indicate an extreme event (a number between 0 and 1).
`quant2`	Quantile of the second series to indicate an extreme event (a number between 0 and 1).
`type`	Extremogram type (see function `extremogram2`).
`par`	If par = 1, the bootstrap replication procedure will be parallelized. If par = 0, no parallelization will be used.
`start`	The lag that the extremogram plots starts at (an integer not greater than `maxlag`, default is 1).
`cutoff`	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).
`alpha`	Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

Value

Returns a plot of the confidence bands for the sample cross extremogram.

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega  = 1
alpha1 = 0.1
beta1  = 0.6
alpha2 = 0.11
beta2  = 0.78
n      = 1000
quant  = 0.95
type   = 1
maxlag = 70
df     = 3
R      = 10
l      = 30
par    = 0
G1     = extremogram:::garchsim(omega,alpha1,beta1,n,df)
G2     = extremogram:::garchsim(omega,alpha2,beta2,n,df)
data   = cbind(G1, G2)

extremogram2(data, quant, quant, maxlag, type, 1, 1, 0)
bootconf2(data, R, l, maxlag, quant, quant, type, par, 1, 1, 0.05)
```

---

bootconfr — *Confidence bands for the sample return time extremogram*

Description

The function estimates confidence bands for the sample return time extremogram using the stationary bootstrap.

Usage

```
bootconfr(x, R, l, maxlag, uplevel = 1, lowlevel = 0, type, par,
  start = 1, cutoff = 1, alpha = 0.05)
```

Arguments

`x`	Univariate time series (a vector).
`R`	Number of bootstrap replications (an integer).
`l`	Mean block size for stationary bootstrap or mean of the geometric distribution used to generate resampling blocks (an integer that is not longer than the length of the time series).
`maxlag`	Number of lags to include in the extremogram (an integer)
`uplevel`	Quantile of the time series to indicate a upper tail extreme event (a number between 0 and 1, default is 1).
`lowlevel`	Quantile of the time series to indicate a lower tail extreme event (a number between 0 and 1, default is 0).

type	Extremogram type (see function extremogramr).
par	If par = 1, the bootstrap replication procedure will be parallelized. If par = 0, no parallelization will be used.
start	The lag that the extremogram plots starts at (an integer not greater than maxlag, default is 1).
cutoff	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).
alpha	Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

Value

Returns a plot of the confidence bands for the sample return time extremogram.

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega    = 1
alpha    = 0.1
beta     = 0.6
n        = 1000
uplevel  = 0.95
lowlevel = 0.05
type     = 3
maxlag   = 70
df       = 3
R        = 10
l        = 30
par      = 0
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogramr(G, type, maxlag, uplevel, lowlevel, 1, 1)
bootconfr(G, R, l, maxlag, uplevel, lowlevel, type, par, 1, 1, 0.05)
```

---

extremogram1 *Sample univariate extremogram*

Description

The function estimates the sample univariate extremogram and creates an extremogram plot.

Usage

```
extremogram1(x, quant, maxlag, type, ploting = 1, cutoff = 1, start = 0)
```

Arguments

x	Univariate time series (a vector).
quant	Quantile of the time series to indicate an extreme event (a number between 0 and 1).
maxlag	Number of lags to include in the extremogram (an integer).
type	Extremogram type. If type = 1, the upper tail extremogram is estimated. If type = 2, the lower tail extremogram is estimated.
ploting	An extremogram plot. If ploting = 1, a plot is created (default). If ploting = 0, no plot is created.
cutoff	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).
start	The lag that the extremogram plots starts at (an integer not greater than `maxlag`, default is 0).

Value

Extremogram values and a plot (if requested).

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega  = 1
alpha  = 0.1
beta   = 0.6
n      = 1000
quant  = 0.95
type   = 1
maxlag = 70
df     = 3
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogram1(G, quant, maxlag, type, 1, 1, 0)
```

`extremogram2` *Sample cross extremogram*

Description

The function estimates the sample cross extremogram and creates an extremogram plot.

Usage

```
extremogram2(a, quant1, quant2, maxlag, type, ploting = 1, cutoff = 1,
  start = 0)
```

Arguments

`a`	Bivariate time series (n by 2 matrix).
`quant1`	Quantile of the first time series to indicate an extreme event (a number between 0 and 1).
`quant2`	Quantile of the second time series to indicate an extreme event (a number between 0 and 1).
`maxlag`	Number of lags to include in the extremogram (an integer).
`type`	If type=1, the upper tail extremogram is estimated - P(Y>y,X>x). If type=2, the lower tail extremogram is estimated - P(Y<y,X<x). If type=3, the extremogram is estimated for a lower tail extreme value in the first time series and an upper tail extreme value in the second time series - P(Y>y,X<x). If type=4, the extremogram is estimated for a lower tail extreme value in the second time series and an upper tail extreme value in the first time series - P(Y<y,X>x).
`ploting`	An extremogram plot. If ploting = 1, a plot is created (default). If ploting = 0, no plot is created.
`cutoff`	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).
`start`	The lag that the extremogram plots starts at (an integer not greater than `maxlag`, default is 0).

Value

Cross extremogram values and a plot (if requested).

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega  = 1
alpha1 = 0.1
beta1  = 0.6
alpha2 = 0.11
beta2  = 0.78
n      = 1000
quant  = 0.95
type   = 1
maxlag = 70
df     = 3
G1     = extremogram:::garchsim(omega,alpha1,beta1,n,df)
G2     = extremogram:::garchsim(omega,alpha2,beta2,n,df)
data   = cbind(G1, G2)

extremogram2(data, quant, quant, maxlag, type, 1, 1, 0)
```

`extremogramr` *Sample return time extremogram*

Description

The function estimates the sample return time extremogram and creates an extremogram plot.

Usage

```
extremogramr(x, type, maxlag, uplevel = 1, lowlevel = 0, histogram = 1,
  cutoff = 1)
```

Arguments

`x`	Univariate time series (a vector).
`type`	Extremogram type. If type = 1, the upper tail extremogram is estimated. If type = 2, the lower tail extremogram is estimated. If type = 3, both upper and lower tail extremogram is estimated.
`maxlag`	Number of lags to include in the extremogram (an integer).
`uplevel`	Quantile of the time series to indicate a upper tail extreme event (a number between 0 and 1, default is 1).
`lowlevel`	Quantile of the time series to indicate a lower tail extreme event (a number between 0 and 1, default is 0).
`histogram`	An extremogram plot. If histogram = 1, a plot is created (default). If histogram = 0, no plot is created.
`cutoff`	The cutoff of the y-axis on the plot (a number between 0 and 1, default is 1).

Value

Extremogram values, return time for extreme events, mean return time and a plot (if requested).

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega    = 1
alpha    = 0.1
beta     = 0.6
n        = 1000
uplevel  = 0.95
lowlevel = 0.05
type     = 3
maxlag   = 70
df       = 3
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogramr(G, type, maxlag, uplevel, lowlevel, 1, 1)
```

---

permfn1 *Confidence bands for the sample univariate extremogram*

Description

The function estimates empirical confidence bands for the sample univariate extremogram via a permutation procedure under the assumption that the data are independent.

Usage

```
permfn1(x, p, m, type, exttype, maxlag, start = 1, alpha = 0.05)
```

Arguments

x	Univariate time series (a vector).
p	Quantile of the time series to indicate an extreme event (a number between 0 and 1).
m	Number of permutations (an integer).
type	Type of confidence bands. If type=1, it adds all permutations to the sample extremogram plot. If type=2, it adds the alpha/2 and (1-alpha)/2 empirical confidence bands for each lag. If type=3, it calculates the lag 1 alpha/2 and (1-alpha)/2 empirical confidence bands lag and uses them for all of the lags.

exttype	Extremogram type (see extremogram1).
maxlag	Number of lags to include in the extremogram (an integer).
start	The lag that the extremogram plots starts at (an integer not greater than maxlag, default is 1).
alpha	Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

Value

The empirical confidence bands are added to the sample univariate extremogram plot.

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega   = 1
alpha   = 0.1
beta    = 0.6
n       = 1000
quant   = 0.95
exttype = 1
maxlag  = 70
df      = 3
type    = 3
m       = 10
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogram1(G, quant, maxlag, exttype, 1, 1, 0)
permfn1(G, quant, m, type, exttype, maxlag, 1, 0.05)
```

---

permfn2 *Confidence bands for the sample cross extremogram*

Description

The function estimates empirical confidence bands for the sample cross extremogram via a permutation procedure under the assumption that the data are independent.

Usage

```
permfn2(x, p1, p2, m, type, exttype, maxlag, start = 1, alpha = 0.05)
```

Arguments

- `x` — Bivariate time series (n by 2 matrix).
- `p1` — Quantile of the first time series to indicate an extreme event (a number between 0 and 1).
- `p2` — Quantile of the second time series to indicate an extreme event (a number between 0 and 1).
- `m` — Number of permutations (an integer).
- `type` — Type of confidence bands. If type=1, it adds all permutations to the sample extremogram plot. If type=2, it adds the `alpha`/2 and (1-`alpha`)/2 empirical confidence bands for each lag. If type=3, it calculates the lag 1 `alpha`/2 and (1-`alpha`)/2 empirical confidence bands lag and uses them for all of the lags.
- `exttype` — Extremogram type (see `extremogram2`).
- `maxlag` — Number of lags to include in the extremogram (an integer).
- `start` — The lag that the extremogram plots starts at (an integer not greater than `maxlag`, default is 1).
- `alpha` — Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

Value

The empirical confidence bands are added to the sample cross extremogram plot.

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega   = 1
alpha1  = 0.1
beta1   = 0.6
alpha2  = 0.11
beta2   = 0.78
n       = 1000
quant   = 0.95
exttype = 1
maxlag  = 70
df      = 3
type    = 3
m       = 10
G1      = extremogram:::garchsim(omega,alpha1,beta1,n,df)
G2      = extremogram:::garchsim(omega,alpha2,beta2,n,df)
data    = cbind(G1, G2)
```

```
extremogram2(data, quant, quant, maxlag, type, 1, 1, 0)
permfn2(data, quant, quant, m, type, exttype, maxlag, 1, 0.05)
```

---

permfnr *Confidence bands for the sample return time extremogram*

Description

The function estimates empirical confidence bands for the sample returt time extremogram via a permutation procedure under the assumption that the data are independent.

Usage

```
permfnr(x, m, type, exttype, maxlag, uplevel = 1, lowlevel = 0, start = 1,
  alpha = 0.05)
```

Arguments

x	Univariate time series (a vector).
m	Number of permutations (an integer).
type	Type of confidence bands. If type=1, it adds all permutations to the sample extremogram plot. If type=2, it adds the alpha/2 and (1-alpha)/2 empirical confidence bands for each lag. If type=3, it calculates the lag 1 alpha/2 and (1-alpha)/2 empirical confidence bands lag and uses them for all of the lags.
exttype	Extremogram type (see extremogramr).
maxlag	Number of lags to include in the extremogram (an integer).
uplevel	Quantile of the time series to indicate a upper tail extreme event (a number between 0 and 1, default is 1).
lowlevel	Quantile of the time series to indicate a lower tail extreme event (a number between 0 and 1, default is 0).
start	The lag that the extremogram plots starts at (an integer not greater than maxlag, default is 1).
alpha	Significance level for the confidence bands (a number between 0 and 1, default is 0.05).

References

1. Davis, R. A., Mikosch, T., & Cribben, I. (2012). Towards estimating extremal serial dependence via the bootstrapped extremogram. Journal of Econometrics,170(1), 142-152.
2. Davis, R. A., Mikosch, T., & Cribben, I. (2011). Estimating extremal dependence in univariate and multivariate time series via the extremogram.arXiv preprint arXiv:1107.5592.

Examples

```
# generate a GARCH(1,1) process
omega    = 1
alpha    = 0.1
beta     = 0.6
n        = 1000
uplevel  = 0.95
lowlevel = 0.05
exttype  = 3
maxlag   = 70
type     = 3
m        = 10
df       = 3
G = extremogram:::garchsim(omega,alpha,beta,n,df)

extremogramr(G, type, maxlag, uplevel, lowlevel, 1, 1)
permfnr(G, m, type, exttype, maxlag, uplevel, lowlevel, 1, 0.05)
```

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