Package ‘grangers’

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Title Inference on Granger-Causality in the Frequency Domain

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Description Contains five functions performing the calculation of unconditional and conditional Granger-causality spectra, bootstrap inference on both, and inference on the difference between them via the bootstrap approach of Farne' and Montanari, 2018 <doi:10.48550/arXiv.1803.00374>.

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bc_test_cond *Conditional Granger-causality test of Breitung and Candelon (2006)*

Description

Inference on the conditional Granger-causality spectrum is provided by the parametric test of Breitung and Candelon (2006).

Usage

```
bc_test_cond(x, y, z, ic.chosen = "SC", max.lag = min(4, length(x) -
  1), plot = F, type.chosen = "none", p = 0, conf = 0.95)
```

Arguments

`x`	univariate time series.
`y`	univariate time series (of the same length of `x`).
`z`	univariate time series (of the same length of `x`).
`ic.chosen`	estimation method parameter `ic` to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are `c(''AIC'',''HQ'',''SC'',''FPE'')`.
`max.lag`	maximum number of lags `lag.max` to be passed to function `VAR`. Defaults to `min(4, length(x) - 1)`.
`plot`	logical; if TRUE, it returns the plot of conditional Granger-causality spectrum. Defaults to FALSE.
`type.chosen`	parameter `type` to be passed to function `VAR`.
`p`	parameter `p` to be passed to function VAR. It corresponds to the number of lags of the second VAR model. Defaults to 0.
`conf`	prescribed confidence level. It defaults to 0.95.

Details

`bc_test_cond` calculates the test of Breitung and Candelon (2006) on the conditional Granger-causality of a time series `x` (effect variable) on a time series `z` (conditioning variable) respect to a time series `y` (cause variable). It requires package vars.

Value

`frequency`: frequencies used by Fast Fourier Transform.
`n`: time series length.
`confidence_level`: prescribed confidence level.
`significant_frequencies`: frequencies at which the test is significant..
`F-test`: computed F-test at each frequency.
`F-threshold`: F-threshold at each frequency under prescribed confidence level.
`roots`: roots of the estimated VAR model.
`delays`: delays of the estimated VAR model.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', Angela Montanari, <matteo.farne2@unibo.it>

References

Breitung, J., Candelon, B., 2006. Testing for short- and long-run causality: A frequency-domain approach. *Journal of Econometrics*. **132**, 2, 363–378.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
hicp.rate.ts<-euro_area_indicators[,4]
cond_bc<-bc_test_cond(RealGdp.rate.ts,m3.rate.ts,hicp.rate.ts,ic.chosen="SC",max.lag=2)
```

---

bc_test_uncond *Unconditional Granger-causality test of Breitung and Candelon (2006)*

Description

Inference on the unconditional Granger-causality spectrum is provided by the parametric test of Breitung and Candelon (2006).

Usage

```
bc_test_uncond(x, y, ic.chosen = "SC", max.lag = min(4, length(x) - 1),
  plot = F, type.chosen = "none", p = 0, conf = 0.95)
```

Arguments

x	univariate time series.
y	univariate time series (of the same length of x).
ic.chosen	estimation method parameter ic to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are c(''AIC'',''HQ'',''SC'',''FPE'').
max.lag	maximum number of lags lag.max to be passed to function VAR. Defaults to min(4, length(x) - 1).
plot	logical; if TRUE, it returns the plot of conditional Granger-causality spectrum. Defaults to FALSE.
type.chosen	parameter type to be passed to function VAR.

p	parameter p to be passed to function VAR. It corresponds to the number of lags of the second VAR model. Defaults to 0.
conf	prescribed confidence level. It defaults to 0.95.

Details

bc_test_uncond calculates the test of Breitung and Candelon (2006) on the unconditional Granger-causality of a time series x (effect variable) respect to a time series y (cause variable). It require-Namespaces package vars.

Value

frequency: frequencies used by Fast Fourier Transform.
n: time series length.
confidence_level: prescribed confidence level.
significant_frequencies: frequencies at which the test is significant..
F-test: computed F-test at each frequency.
F-threshold: F-threshold at each frequency under prescribed confidence level.
roots: roots of the estimated VAR model.
delays: delays of the estimated VAR model.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', Angela Montanari, <matteo.farne2@unibo.it>

References

Breitung, J., Candelon, B., 2006. Testing for short- and long-run causality: A frequency-domain approach. *Journal of Econometrics*. **132**, 2, 363–378.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
uncond_bc<-bc_test_uncond(RealGdp.rate.ts,m3.rate.ts,ic.chosen="SC",max.lag=2)
```

euro_area_indicators *Six Euro Area Monetary Indicators*

Description

This data set gives thre quarterly time series of real gross domestic product, M3 aggregate, M1 aggregate, inflation rate (HICP), unemployment rate and long-term interest rate for the Euro Area from Q1,1999 to Q4,2017, according to the ECB Real Time DataBase (RTDB).

Usage

```
euro_area_indicators
```

Format

A matrix containing as columns six quarterly time series ranging from Q1,1999 to Q4,2017.

Details

Documentation of the dataset 'euro_area_indicators'

Source

ECB Real Time DataBase 'https://sdw.ecb.europa.eu/browse.do?node=9689716'.

References

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

Euro Area Real Time Database documentation. 'http://sdw.ecb.europa.eu/web/docu/rtdb_docu.pdf'

Granger.conditional *Conditional Granger-causality estimation*

Description

Conditional Granger-causality spectrum was first defined in Geweke (1984). It measures the strength of the causal link from time series `y` to time series `x` once removed the mediating effect of `z` in the frequency domain. Differently from function `Granger.unconditional`, this function provides only the unidirectional causality from `y` to `x`. Here we need to estimate two VAR models: the first on `x` and `z`, the second on `x`, `y`, `z`, by package vars. Parameters specified for function VAR hold for both estimations. For computational details we refer to Ding et al. (2006).

Usage

```
Granger.conditional(x, y, z, ic.chosen = "SC", max.lag = min(4,
  length(x) - 1), plot = F, type.chosen = "none", p1 = 0, p2 = 0)
```

Arguments

x	univariate time series.
y	univariate time series (of the same length of x).
z	univariate time series (of the same length of x).
ic.chosen	estimation method parameter ic to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are c(''AIC'',''HQ'',''SC'',''FPE'').
max.lag	maximum number of lags lag.max to be passed to function VAR. Defaults to min(4, length(x) - 1).
plot	logical; if TRUE, it returns the plot of conditional Granger-causality spectrum. Defaults to FALSE.
type.chosen	parameter type to be passed to function VAR. Defaults to ''none''. Alternatives are c(''none'',''const'',''trend'').
p1	parameter p to be passed to function VAR. It corresponds to the number of lags of the first VAR model. Defaults to 0.
p2	parameter p to be passed to function VAR. It corresponds to the number of lags of the second VAR model. Defaults to 0.

Details

Granger.conditional calculates the Granger-causality conditional spectrum of a time series x (effect variable) on a time series z (conditioning variable) respect to a time series y (cause variable). It requireNamespaces package vars.

Value

frequency: frequencies used by Fast Fourier Transform.
n: time series length.
Conditional_causality_y.to.x.on.z: computed conditional Granger-causality from y to x on z.
roots_1: the roots of the estimated VAR on x and y.
roots_2: the roots of the estimated VAR on x, y and z.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', <matteo.farne2@unibo.it>

References

Geweke J., 1984. Measures of conditional linear dependence and feedback between time series. *J. Am. Stat. Assoc.* **79**, 907–915.

Ding, M., Chen, Y., Bressler, S.L., 2006. Granger Causality: Basic Theory and Application to Neuroscience, Chap.17. *Handbook of Time Series Analysis Recent Theoretical Developments and Applications.*

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted.*

See Also

VAR.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
hicp.rate.ts<-euro_area_indicators[,4]
cond_m3.to.gdp.by.hicp<-
Granger.conditional(RealGdp.rate.ts,m3.rate.ts,hicp.rate.ts,"SC",4)
```

Granger.inference.conditional

Inference on conditional Granger-causality

Description

Inference on the conditional Granger-causality spectrum is provided generating bootstrap time series by the stationary boostrap of Politis and Romano (1994). For computational details we refer to Ding et al. (2006) and Farne' and Montanari (2018).

Usage

```
Granger.inference.conditional(x, y, z, ic.chosen = "SC",
  max.lag = min(4, length(x) - 1), plot = F, type.chosen = "none",
  p1 = 0, p2 = 0, nboots = 1000, conf = 0.95, bp = NULL,
  ts_boot = 1)
```

Arguments

x	univariate time series.
y	univariate time series (of the same length of x).
z	univariate time series (of the same length of x).
ic.chosen	estimation method parameter ic to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are c(''AIC'',''HQ'',''SC'',''FPE'').
max.lag	maximum number of lags lag.max to be passed to function VAR. Defaults to min(4, length(x) - 1).
plot	logical; if TRUE, it returns the plot of unconditional Granger-causality spectra on both directions with computed thresholds. Defaults to FALSE.
type.chosen	parameter type to be passed to function VAR. Defaults to ''none''. Alternatives are c(''none'',''const'',''trend'').
p1	parameter p to be passed to function VAR. It corresponds to the number of lags of the first VAR model. Defaults to 0.
p2	parameter p to be passed to function VAR. It corresponds to the number of lags of the second VAR model. Defaults to 0.

nboots	number of bootstrap series to be computed by function tsbootstrap of package tseries. It defaults to 1000.
conf	prescribed confidence level. It defaults to 0.95.
bp	matrix containing previously simulated bootstrap series, having as rows time points, as columns variables x and y (in this order). It defaults to NULL.
ts_boot	boolean equal to 1 if the stationary bootstrap of Politis and Romano (1994) is applied, 0 otherwise. It defaults to 1.

Details

Granger.inference.conditional provides bootstrap inference for the Granger-causality conditional spectrum of a time series x (effect variable) on a time series z (conditioning variable) respect to a time series y (cause variable). It requires packages vars and tseries.

Value

frequency: frequencies used by Fast Fourier Transform.
n: time series length.
nboots: number of bootstrap series used.
confidence_level: prescribed confidence level.
stat_yes: boolean equal to 0 if no stationary VAR is estimated across bootstrap samples, 1 otherwise.
non_stationarity_rate_1: percentage of non-stationary VAR models (at least one root larger than one) estimated on bootstrapped x and z.
non_stationarity_rate_2: percentage of non-stationary VAR models (at least one root larger than one) estimated on bootstrapped x and y and z.
delay1_mean: mean number of delays of stationary VAR models estimated on x and z.
delay2_mean: mean number of delays of stationary VAR models estimated on x and y and z.
quantile_conditional_causality_y.to.x.on.z: computed quantile of the Granger- causality conditional spectrum from y to x on z. Differently from function Granger.inference.unconditional, this function provides only the quantile of the unidirectional causality from y to x.
freq_y.to.x.on.z: frequencies at which the Granger-causality conditional spectrum from y to x condtional on z exceeds the computed threshold.
q_max_x.on.z: computed quantile of the Granger- causality conditional spectrum from y to x on z under Bonferroni correction. Differently from function Granger.inference.unconditional, this function provides only the quantile of the unidirectional causality from y to x.
freq_max_y.to.x.on.z: frequencies at which the Granger-causality conditional spectrum from y to x conditional on z exceeds the computed threshold under Bonferroni correction.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', Angela Montanari, <matteo.farne2@unibo.it>

References

Politis D. N. and Romano J. P., (1994). "The Stationary Bootstrap". *Journal of the American Statistical Association*, 89, 1303–1313.

Ding, M., Chen, Y., Bressler, S.L., 2006. Granger Causality: Basic Theory and Application to Neuroscience, Chap.17. *Handbook of Time Series Analysis Recent Theoretical Developments and Applications*.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR and `tsbootstrap`.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
hicp.rate.ts<-euro_area_indicators[,4]
inf_cond_m3.to.gdp.by.hicp_0.95<-
Granger.inference.conditional(RealGdp.rate.ts,m3.rate.ts,hicp.rate.ts,nboots=10)
```

`Granger.inference.difference` *Inference on the difference between unconditional and conditional Granger-causality*

Description

Inference on the difference between unconditional and conditional Granger-causality spectrum is provided generating bootstrap time series by the stationary boostrap of Politis and Romano (1994). For computational details we refer to Ding et al. (2006) and Farne' and Montanari (2018).

Usage

```
Granger.inference.difference(x, y, z, ic.chosen = "SC",
  max.lag = min(4, length(x) - 1), plot = F, type.chosen = "none",
  p = 0, p1 = 0, p2 = 0, nboots = 1000, conf = 0.95,
  bp_orig = NULL, ts_boot = 1)
```

Arguments

`x`	univariate time series.
`y`	univariate time series (of the same length of `x`).
`z`	univariate time series (of the same length of `x`).
`ic.chosen`	estimation method parameter `ic` to be passed to function VAR of package "vars". Defaults to "SC" (Schwarz criterion). Alternatives are `c(''AIC'',''HQ'',''SC'',''FPE'')`.
`max.lag`	maximum number of lags `lag.max` to be passed to function `VAR`. Defaults to `min(4, length(x) - 1)`.

`plot`	logical; if TRUE, it returns the plot of the difference between the unconditional Granger-causality spectrum from `y` to `x` and the conditional Granger-causality spectrum from `y` to `x` on `z` with upper and lower computed thresholds. Defaults to FALSE.
`type.chosen`	parameter `type` to be passed to function `VAR`. Defaults to `''none''`. Alternatives are `c(''none'',''const'',''trend'')`.
`p`	parameter `p` to be passed to function VAR. It corresponds to the number of delays for unconditional GC. Defaults to 0.
`p1`	parameter `p` to be passed to function VAR. It corresponds to the number of lags of the first VAR model. Defaults to 0.
`p2`	parameter `p` to be passed to function VAR.
`nboots`	number of bootstrap series to be computed by function `tsbootstrap` of package tseries. It defaults to 1000.
`conf`	prescribed confidence level. It defaults to 0.95.
`bp_orig`	matrix containing previously simulated bootstrap series, having as rows time points, as columns variables `x` and `y` (in this order). It defaults to NULL.
`ts_boot`	boolean equal to 1 if the stationary bootstrap of Politis and Romano (1994) is applied, 0 otherwise. It defaults to 1.

Details

`Granger.inference.difference` provides bootstrap inference for the difference between the Granger-causality unconditional spectrum of a time series `x` (effect variable) respect to a time series `y` (cause variable) and the Granger-causality conditional spectrum of a time series `x` (effect variable) on a time series `z` (conditioning variable) respect to a time series `y` (cause variable). It requires packages vars and tseries.

Value

`frequency`: frequencies used by Fast Fourier Transform.
`n`: time series length.
`nboots`: number of bootstrap series used.
`confidence_level`: prescribed confidence level.
`stat_yes`: boolean equal to 0 if no stationary VAR is estimated across bootstrap samples, 1 otherwise.
`non_stationarity_rate`: percentage of estimated non-stationary VAR models (at least one root larger than one) on bootstrapped `x` and `y`.
`non_stationarity_rate_1`: percentage of estimated non-stationary VAR models (at least one root larger than one) on bootstrapped `x` and `z`.
`non_stationarity_rate_2`: percentage of estimated non-stationary VAR models (at least one root larger than one) on bootstrapped `x`, `y` and `z`.
`quantile_difference_inf`: lower computed quantile of the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z`.
`quantile_difference_sup`: upper computed quantile of the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z`.

`freq_inf`: frequencies at which the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` exceeds the lower computed threshold.
`freq_sup`: frequencies at which the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` exceeds the upper computed threshold.
`quantile_difference_max_inf`: lower computed quantile of the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` under Bonferroni correction.
`quantile_difference_max_sup`: upper computed quantile of the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` under Bonferroni correction.
`freq_max_inf`: frequencies at which the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` exceeds the lower computed threshold under Bonferroni correction.
`freq_max_sup`: frequencies at which the difference between the Granger-causality unconditional spectrum from `y` to `x` and the Granger-causality conditional spectrum from `y` to `x` on `z` exceeds the upper computed threshold under Bonferroni correction.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', Angela Montanari, <`matteo.farne2@unibo.it`>

References

Politis D. N. and Romano J. P., (1994). "The Stationary Bootstrap". *Journal of the American Statistical Association*, 89, 1303–1313.

Ding, M., Chen, Y., Bressler, S.L., 2006. Granger Causality: Basic Theory and Application to Neuroscience, Chap.17. *Handbook of Time Series Analysis Recent Theoretical Developments and Applications*.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR and `tsbootstrap`.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
hicp.rate.ts<-euro_area_indicators[,4]
inf_diff_pre_hicp.to.gdp_0.95<-
Granger.inference.difference(RealGdp.rate.ts,m3.rate.ts,hicp.rate.ts,nboots=10)
```

`Granger.inference.unconditional` *Inference on unconditional Granger-causality*

Description

Inference on the unconditional Granger-causality spectrum is provided generating bootstrap time series by the stationary boostrap of Politis and Romano (1994). For computational details we refer to Ding et al. (2006) and Farne' and Montanari (2018).

Usage

```
Granger.inference.unconditional(x, y, ic.chosen = "SC",
  max.lag = min(4, length(x) - 1), plot = F, type.chosen = "none",
  p = 0, nboots = 1000, conf = 0.95, bp = NULL, ts_boot = 1)
```

Arguments

`x`	univariate time series.
`y`	univariate time series (of the same length of `x`).
`ic.chosen`	estimation method parameter `ic` to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are `c(''AIC'',''HQ'',''SC'',''FPE'')`.
`max.lag`	maximum number of lags `lag.max` to be passed to function `VAR`. Defaults to `min(4, length(x) - 1)`.
`plot`	logical; if TRUE, it returns the plot of unconditional Granger-causality spectra on both directions with computed thresholds. Defaults to FALSE.
`type.chosen`	parameter `type` to be passed to function `VAR`. Defaults to `''none''`. Alternatives are `c(''none'',''const'',''trend'')`.
`p`	parameter `p` to be passed to function VAR. Defaults to 0.
`nboots`	number of bootstrap series to be computed by function `tsbootstrap` of package tseries. It defaults to 1000.
`conf`	prescribed confidence level. It defaults to 0.95.
`bp`	matrix containing previously simulated bootstrap series, having as rows time points, as columns variables `x` and `y` (in this order). It defaults to NULL.
`ts_boot`	boolean equal to 1 if the stationary bootstrap of Politis and Romano (1994) is applied, 0 otherwise. It defaults to 1.

Details

`Granger.inference.unconditional` provides bootstrap inference for the Granger-causality unconditional spectrum of a time series `x` (effect variable) respect to a time series `y` (cause variable). It requires packages vars and tseries.

Value

frequency: frequencies used by Fast Fourier Transform.
n: time series length.
nboots: number of bootstrap series used.
confidence_level: prescribed confidence level.
stat_yes: boolean equal to 0 if no stationary VAR is estimated across bootstrap samples, 1 otherwise.
non_stationarity_rate: percentage of non-stationary VAR models (at least one root larger than one) estimated on bootstrapped x and y.
delay_mean: mean number of delays of stationary VAR models estimated on x and y.
quantile_unconditional_causality_y.to.x: computed quantile of the Granger-causality unconditional spectrum from y to x.
quantile_unconditional_causality_x.to.y: computed quantile of the Granger-causality unconditional spectrum from x to y.
freq_y.to.x: frequencies at which the Granger-causality unconditional spectrum from y to x exceeds the computed threshold.
freq_x.to.y: frequencies at which the Granger-causality unconditional spectrum from x to y exceeds the computed threshold.
q_max_x: computed quantile of the Granger-causality unconditional spectrum from y to x under Bonferroni correction.
q_max_y: computed quantile of the Granger-causality unconditional spectrum from x to y under Bonferroni correction.
freq_max_y.to.x: frequencies at which the Granger-causality unconditional spectrum from y to x exceeds the computed threshold under Bonferroni correction.
freq_max_x.to.y: frequencies at which the Granger-causality unconditional spectrum from x to y exceeds the computed threshold under Bonferroni correction.

The result is returned invisibly if plot is TRUE.

Author(s)

Matteo Farne', Angela Montanari, <matteo.farne2@unibo.it>

References

Politis D. N. and Romano J. P., (1994). "The Stationary Bootstrap". *Journal of the American Statistical Association*, 89, 1303–1313.

Ding, M., Chen, Y., Bressler, S.L., 2006. Granger Causality: Basic Theory and Application to Neuroscience, Chap.17. *Handbook of Time Series Analysis Recent Theoretical Developments and Applications*.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR and tsbootstrap.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
inf_uncond_m3_0.95<-Granger.inference.unconditional(RealGdp.rate.ts,m3.rate.ts,nboots=10)
```

`Granger.unconditional` *Unconditional Granger-causality estimation*

Description

Unconditional Granger-causality spectrum was first defined in Geweke (1982). It measures the strength of the causal link from time series `y` to time series `x` and viceversa in the frequency domain. It needs to estimate a VAR model on `x` and `y` by package vars. For computational details we refer to Ding et al. (2006).

Usage

```
Granger.unconditional(x, y, ic.chosen = "SC", max.lag = min(4,
  length(x) - 1), plot = F, type.chosen = "none", p = 0)
```

Arguments

`x`	univariate time series.
`y`	univariate time series (of the same length of `x`).
`ic.chosen`	estimation method parameter `ic` to be passed to function VAR of package vars. Defaults to "SC" (Schwarz criterion). Alternatives are `c(''AIC'',''HQ'',''SC'',''FPE'')`.
`max.lag`	maximum number of lags `lag.max` to be passed to function VAR. Defaults to `min(4, length(x) - 1)`.
`plot`	logical; if TRUE, it returns the plot of unconditional Granger-causality spectra on both directions. Defaults to FALSE.
`type.chosen`	parameter `type` to be passed to function VAR. Defaults to `''none''`. Alternatives are `c(''none'',''const'',''trend'')`.
`p`	parameter `p` to be passed to function VAR. Defaults to 0.

Details

`Granger.unconditional` calculates the Granger-causality unconditional spectrum of a time series `x` (effect variable) respect to a time series `y` (cause variable). It requireNamespaces package vars.

Value

`frequency`: frequencies used by Fast Fourier Transform.
`n`: time series length.
`Unconditional_causality_y.to.x`: computed unconditional Granger-causality from `y` to `x`.
`Unconditional_causality_x.to.y`: computed unconditional Granger-causality from `x` to `y`.
`roots`: the roots of the estimated VAR on `x` and `y`.

The result is returned invisibly if plot is TRUE.

Author(s)

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References

Geweke, J., 1982. Measurement of linear dependence and feedback between multiple time series. *J. Am. Stat. Assoc*. **77**, 304–313.

Ding, M., Chen, Y., Bressler, S.L., 2006. Granger Causality: Basic Theory and Application to Neuroscience, Chap.17. *Handbook of Time Series Analysis Recent Theoretical Developments and Applications*.

Farne', M., Montanari, A., 2018. A bootstrap test to detect prominent Granger-causalities across frequencies. <arXiv:1803.00374>, *Submitted*.

See Also

VAR.

Examples

```
RealGdp.rate.ts<-euro_area_indicators[,1]
m3.rate.ts<-euro_area_indicators[,2]
uncond_m3<-Granger.unconditional(RealGdp.rate.ts,m3.rate.ts,"SC",4)
```

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