

NAG Toolbox for MATLAB

g13bc

1 Purpose

g13bc calculates cross-correlations between two time series.

2 Syntax

```
[s, r0, r, stat, ifail] = g13bc(x, y, nl, 'nxy', nxy)
```

3 Description

Given two series $x_1, x_2, \dots, x_n$ and $y_1, y_2, \dots, y_n$ the function calculates the cross-correlations between x_t and lagged values of y_t :

$$r_{xy}(l) = \frac{\sum_{t=1}^{n-l} (x_t - \bar{x})(y_{t+l} - \bar{y})}{ns_x s_y}, \quad l = 0, 1, \dots, L$$

where

$$\bar{x} = \frac{\sum_{t=1}^n x_t}{n}$$

$$s_x^2 = \frac{\sum_{t=1}^n (x_t - \bar{x})^2}{n}$$

and similarly for y .

The ratio of standard deviations s_y/s_x is also returned, and a portmanteau statistic is calculated:

$$\mathbf{stat} = n \sum_{l=1}^L r_{xy}(l)^2.$$

Provided n is large, L much less than n , and both x_t, y_t are samples of series whose true autocorrelation functions are zero, then, under the null hypothesis that the true cross-correlations between the series are zero, **stat** has a χ^2 -distribution with L degrees of freedom. Values of **stat** in the upper tail of this distribution provide evidence against the null hypothesis.

4 References

Box G E P and Jenkins G M 1976 *Time Series Analysis: Forecasting and Control* (Revised Edition) Holden-Day

5 Parameters

5.1 Compulsory Input Parameters

- 1: **x(nxy)** – double array
The n values of the x series.

2: **y(nxy) – double array**
The n values of the y series.

3: **nl – int32 scalar**
 L , the maximum lag for calculating cross-correlations.
Constraint: $1 \leq \mathbf{nl} < \mathbf{nxy}$.

5.2 Optional Input Parameters

1: **nxy – int32 scalar**
Default: The dimension of the arrays $\mathbf{x}$, $\mathbf{y}$. (An error is raised if these dimensions are not equal.)
 n , the length of the time series.
Constraint: $\mathbf{nxy} \geq 2$.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **s – double scalar**
The ratio of the standard deviation of the y series to the standard deviation of the x series, s_y/s_x .

2: **r0 – double scalar**
The cross-correlation between the x and y series at lag zero.

3: **r(nl) – double array**
 $\mathbf{r}(l)$ contains the cross-correlations between the x and y series at lags L , $r_{xy}(l)$, for $l = 1, 2, \dots, L$.

4: **stat – double scalar**
The statistic for testing for absence of cross-correlation.

5: **ifail – int32 scalar**
0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

On entry, $\mathbf{nxy} \leq 1$,
or $\mathbf{nl} < 1$,
or $\mathbf{nl} \geq \mathbf{nxy}$.

ifail = 2

One or both of the x and y series have zero variance and hence cross-correlations cannot be calculated.

7 Accuracy

All computations are believed to be stable.

8 Further Comments

The time taken by g13bc is approximately proportional to nL .

9 Example

```
x = [0.02;
      0.05;
      0.08;
      0.03;
      -0.05;
      0.11;
      -0.01;
      -0.08;
      -0.08;
      -0.11;
      -0.18;
      -0.19;
      -0.09;
      0.03;
      0.1;
      0.15;
      -0.14;
      0.070000000000000001;
      0.09;
      0.16];
y = [3.18;
      3.21;
      3.26;
      3.25;
      3.08;
      3.01;
      3.06;
      3.17;
      3.12;
      3.04;
      3.26;
      3.45;
      3.33;
      3.7;
      3.31;
      3.81;
      3.33;
      2.96;
      3.28;
      3.1];
nl = int32(15);
[s, r0, r, stat, ifail] = g13bc(x, y, nl)

s =
    2.0053
r0 =
    0.0568
r =
    0.0438
   -0.3762
   -0.4864
   -0.6294
   -0.3871
   -0.1690
   -0.0678
    0.0962
    0.0788
    0.2910
    0.0950
    0.0547
    0.1855
```

```
      0.0243
      0.0034
stat =
      22.1269
ifail =
           0
```
