

# NAG Fortran Library Routine Document

## G13FFF

**Note:** before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

### 1 Purpose

G13FFF forecasts the conditional variances,  $h_t$ , for  $t = T + 1, \dots, T + \xi$  from a GJR GARCH( $p, q$ ) sequence, where  $\xi$  is the forecast horizon and  $T$  is the current time (see Glosten *et al.* (1993)).

### 2 Specification

```
SUBROUTINE G13FFF(NUM, NT, IP, IQ, THETA, GAMMA, FHT, HT, ET, IFAIL)
INTEGER          NUM, NT, IP, IQ, IFAIL
real           THETA(IQ+IP+1), GAMMA, FHT(NT), HT(NUM), ET(NUM)
```

### 3 Description

Assume the GARCH( $p, q$ ) process can be represented by:

$$h_t = \alpha_0 + \sum_{i=1}^q (\alpha_i + \gamma S_{t-i}) \epsilon_{t-i}^2 + \sum_{i=1}^p \beta_i h_{t-i}, \quad t = 1, \dots, T.$$

where  $\epsilon_t | \psi_{t-1} = N(0, h_t)$  or  $\epsilon_t | \psi_{t-1} = S_t(df, h_t)$ , and  $S_t = 1$ , if  $\epsilon_t < 0$ , or  $S_t = 0$ , if  $\epsilon_t \geq 0$ , has been modelled by G13FEF, and the estimated conditional variances and residuals are contained in the arrays HT and ET respectively.

G13FFF will then use the last  $\max(p, q)$  elements of the arrays HT and ET to estimate the conditional variance forecasts,  $h_t | \psi_T$ , where  $t = T + 1, \dots, T + \xi$  and  $\xi$  is the forecast horizon.

### 4 References

Engle R (1982) Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation *Econometrica* **50** 987–1008

Bollerslev T (1986) Generalised autoregressive conditional heteroskedasticity *Journal of Econometrics* **31** 307–327

Engle R and Ng V (1993) Measuring and Testing the Impact of News on Volatility *Journal of Finance* **48** 1749–1777

Hamilton J (1994) *Time Series Analysis* Princeton University Press

Glosten L, Jagannathan R and Runkle D (1993) Relationship between the expected value and the volatility of nominal excess return on stocks *Journal of Finance* **48** 1779–1801

### 5 Parameters

- 1: NUM – INTEGER *Input*  
*On entry:* the number of terms in the arrays HT and ET from the modelled sequence.  
*Constraint:*  $\max(\text{IP}, \text{IQ}) \leq \text{NUM}$ .
- 2: NT – INTEGER *Input*  
*On entry:* the forecast horizon,  $\xi$ .  
*Constraint:*  $\text{NT} > 0$ .

- 3: IP – INTEGER *Input*  
*On entry:* the number of coefficients,  $\beta_i$ , for  $i = 1, \dots, p$ .  
*Constraints:*  

$$\begin{aligned} \max(\text{IP}, \text{IQ}) &\leq 20, \\ \text{IP} &\geq 0. \end{aligned}$$
- 4: IQ – INTEGER *Input*  
*On entry:* the number of coefficients,  $\alpha_i$ , for  $i = 1, \dots, q$ .  
*Constraints:*  

$$\begin{aligned} \max(\text{IP}, \text{IQ}) &\leq 20, \\ \text{IQ} &\geq 1. \end{aligned}$$
- 5: THETA(IQ+IP+1) – *real* array *Input*  
*On entry:* the first element must contain the coefficient  $\alpha_o$  and the next IQ elements must contain the coefficients  $\alpha_i$ , for  $i = 1, \dots, q$ . The remaining IP elements must contain the coefficients  $\beta_j$ , for  $j = 1, \dots, p$ .
- 6: GAMMA – *real* *Input*  
*On entry:* the asymmetry parameter  $\gamma$  for the GARCH( $p, q$ ) sequence.
- 7: FHT(NT) – *real* array *Output*  
*On exit:* the forecast values of the the conditional variance,  $h_t$ , for  $t = T + 1, \dots, T + \xi$ .
- 8: HT(NUM) – *real* array *Input*  
*On entry:* the sequence of past conditional variances for the GARCH( $p, q$ ) process,  $h_t$ , for  $t = 1, \dots, T$ .
- 9: ET(NUM) – *real* array *Input*  
*On entry:* the sequence of past residuals for the GARCH( $p, q$ ) process,  $\epsilon_t$ , for  $t = 1, \dots, T$ .
- 10: IFAIL – INTEGER *Input/Output*  
*On entry:* IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.  
*On exit:* IFAIL = 0 unless the routine detects an error (see Section 6).

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, because for this routine the values of the output parameters may be useful even if IFAIL  $\neq$  0 on exit, the recommended value is -1. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

## 6 Error Indicators and Warnings

If on entry IFAIL = 0 or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL = 1

On entry, NUM < max(IP, IQ),  
 or IQ < 1,  
 or IP < 0,

or  $\max(\text{IP}, \text{IQ}) > 20$ ,  
or  $\text{NT} \leq 0$ .

## 7 Accuracy

Not applicable

## 8 Further Comments

None.

## 9 Example

See Section 9 of the document for G13FEF.

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