

NAG Fortran Library Routine Document

G13FHF

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

G13FHF forecasts the conditional variances, $h_t, t = T + 1, \dots, T + \xi$ from an exponential GARCH(p, q) sequence, where ξ is the forecast horizon and T is the current time (see Engle and Ng (1993)).

2 Specification

```
SUBROUTINE G13FHF(NUM, NT, IP, IQ, THETA, FHT, HT, ET, IFAIL)
INTEGER          NUM, NT, IP, IQ, IFAIL
real           THETA(2*IQ+IP+1), FHT(NT), HT(NUM), ET(NUM)
```

3 Description

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

$$\ln(h_t) = \alpha_0 + \sum_{i=1}^q \alpha_i z_{t-i} + \sum_{j=1}^q \phi_j (|z_{t-j}| - E[|z_{t-j}|]) + \sum_{j=1}^p \beta_j \ln(h_{t-j}), \quad t = 1, \dots, T.$$

where $\epsilon_t | \psi_{t-1} = N(0, h_t)$ or $\epsilon_t | \psi_{t-1} = S_t(df, h_t)$, and $z_t = \frac{\epsilon_t}{\sqrt{h_t}}$, $E[|z_{t-i}|]$ denotes the expected value of $|z_{t-i}|$, has been modelled by G13FGF, and the estimated conditional variances and residuals are contained in the arrays HT and ET respectively.

G13FHF 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 ξ 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: $\max(IP, IQ) \leq \text{NUM}$.

2: NT – INTEGER *Input*

On entry: the forecast horizon, ξ .

Constraint: $NT > 0$.

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

$$\begin{aligned} \max(\text{IP}, \text{IQ}) &\leq 20, \\ \text{IQ} &\geq 1. \end{aligned}$$
- 5: THETA(2*IQ+IP+1) – *real* array *Input*
On entry: the initial parameter estimates for the vector θ . The first element must contain the coefficient α_0 and the next IQ elements must contain the autoregressive coefficients α_i , for $i = 1, \dots, q$. The next IQ elements must contain the coefficients ϕ_i , for $i = 1, \dots, q$. The next IP elements must contain the moving average coefficients β_j , for $j = 1, \dots, p$.
- 6: FHT(NT) – *real* array *Output*
On exit: the forecast values of the conditional variance, h_t , for $t = T + 1, \dots, T + \xi$.
- 7: HT(NUM) – *real* array *Input*
On entry: the sequence of past conditional variances for the GARCH(p, q) process, h_t , for $t = 1, \dots, T$.
- 8: ET(NUM) – *real* array *Input*
On entry: the sequence of past residuals for the GARCH(p, q) process, ϵ_t , for $t = 1, \dots, T$.
- 9: 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(IP, IQ) > 20,

or $NT \leq 0$.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

See Section 9 of the document for G13FGF.
