# NAG Library Function Document

# nag_forecast_garchGJR (g13ffc)

## 1 Purpose

nag_forecast_garchGJR (g13ffc) forecasts the conditional variances, $h_t$, $t = 1, \ldots, \tau$ from a GJR GARCH$(p, q)$ sequence, where $\tau$ is the forecast horizon (see Glosten *et al.* (1993)).

## 2 Specification

```
#include <nag.h>
#include <nagg13.h>
void nag_forecast_garchGJR (Integer num, Integer nt, Integer p, Integer q,
     const double theta[], double gamma, double fht[], const double ht[],
     const double et[], NagError *fail)
```

## 3 Description

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

$$\epsilon_t \mid \psi_{t-1} \sim N(0, h_t)$$

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

where $S_t = 1$, if $\epsilon_t < 0$, and $S_t = 0$, if $\epsilon_t \geq 0$ has been modelled by nag_estimate_garchGJR (g13fec) and the estimated conditional variances and residuals are contained in the arrays **ht** and **et** respectively. Then nag_forecast_garchGJR (g13ffc) will use the last max$(p, q)$ elements of the arrays **ht** and **et** to estimate the conditional variance forecasts, $h_t \mid \psi_T$, where $t = T + 1, \ldots, T + \tau$ and $\tau$ is the forecast horizon.

## 4 References

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

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

Engle R and Ng V (1993) Measuring and testing the impact of news on volatility *Journal of Finance* **48** 1749–1777

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

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

## 5 Arguments

1: **num** – Integer *Input*

*On entry*: the number of terms in the arrays **ht** and **et** from the modelled sequence.

*Constraint*: max$(\mathbf{p}, \mathbf{q}) \leq$ **num**.

2: **nt** – Integer *Input*

*On entry*: $\tau$, the forecast horizon.

*Constraint*: **nt** $> 0$.

3: **p** – Integer *Input*

*On entry*: the GARCH$(p, q)$ argument $p$.

*Constraint*: $0 < \max(\mathbf{p}, \mathbf{q}) \leq$ **num**, $\mathbf{p} \geq 0$.

4: **q** – Integer *Input*

*On entry*: the GARCH$(p, q)$ argument $q$.

*Constraint*: $0 < \max(\mathbf{p}, \mathbf{q}) \leq$ **num**, $\mathbf{q} \geq 1$.

5: **theta**[**q** + **p** + **1**] – const double *Input*

*On entry*: the first element must contain the coefficient $\alpha_o$ and the next **q** elements must contain the coefficients $\alpha_i$, for $i = 1, 2, \ldots, q$. The remaining **p** elements must contain the coefficients $\beta_j$, for $j = 1, 2, \ldots, p$.

6: **gamma** – double *Input*

*On entry*: the asymmetry argument $\gamma$ for the GARCH$(p, q)$ sequence.

7: **fht**[**nt**] – double *Output*

*On exit*: the forecast values of the conditional variance, $h_t$, for $t = 1, 2, \ldots, \tau$.

8: **ht**[**num**] – const double *Input*

*On entry*: the sequence of past conditional variances for the GARCH$(p, q)$ process, $h_t$, for $t = 1, 2, \ldots, T$.

9: **et**[**num**] – const double *Input*

*On entry*: the sequence of past residuals for the GARCH$(p, q)$ process, $\epsilon_t$, for $t = 1, 2, \ldots, T$.

10: **fail** – NagError * *Input/Output*

The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

## 6 Error Indicators and Warnings

**NE_2_INT_ARG_LT**

On entry, **num** $= \langle value \rangle$ while $\max(\mathbf{p}, \mathbf{q}) = \langle value \rangle$. These arguments must satisfy **num** $\geq \max(\mathbf{p}, \mathbf{q})$.

**NE_ALLOC_FAIL**

Dynamic memory allocation failed.

**NE_INT_ARG_LT**

On entry, **nt** $= \langle value \rangle$.
Constraint: **nt** $\geq 1$.

On entry, **num** $= \langle value \rangle$.
Constraint: **num** $\geq 0$.

On entry, $\mathbf{p} = \langle value \rangle$.
Constraint: $\mathbf{p} \geq 0$.

On entry, $\mathbf{q} = \langle value \rangle$.
Constraint: $\mathbf{q} \geq 1$.

## 7 Accuracy

Not applicable.

## 8 Parallelism and Performance

nag_forecast_garchGJR (g13ffc) is not threaded in any implementation.

## 9 Further Comments

None.

## 10 Example

See the example for nag_estimate_agarchII (g13fcc).