

## NAG C Library Function Document

### nag\_forecast\_garchGJR (g13ffc)

#### 1 Purpose

nag\_forecast\_garchGJR (g13ffc) forecasts the conditional variances,  $h_t$ ,  $t = 1, \dots, \tau$  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:

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

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

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 will use the last  $\max(p, q)$  elements of the arrays **ht** and **et** to estimate the conditional variance forecasts,  $h_t | \psi_T$ , where  $t = T + 1, \dots, T + \tau$  and  $\tau$  is the forecast horizon.

#### 4 Parameters

- |    |  |              |
|----|--|--------------|
| 1: | <b>num</b> – Integer   | <i>Input</i> |
|    | <i>On entry:</i> the number of terms in the arrays <b>ht</b> and <b>et</b> from the modelled sequence.   |              |
|    | <i>Constraint:</i> $\max(\mathbf{p}, \mathbf{q}) \leq \mathbf{num}$ , $\mathbf{num} \geq 0$ .  |              |
| 2: | <b>nt</b> – Integer  | <i>Input</i> |
|    | <i>On entry:</i> the forecast horizon, $\tau$ .  |              |
|    | <i>Constraint:</i> $\mathbf{nt} > 0$ .   |              |
| 3: | <b>p</b> – Integer   | <i>Input</i> |
|    | <i>On entry:</i> the GARCH( $p, q$ ) parameter $p$ .   |              |
|    | <i>Constraint:</i> $0 < \max(\mathbf{p}, \mathbf{q}) \leq \mathbf{num}$ , $\mathbf{p} \geq 0$ .  |              |
| 4: | <b>q</b> – Integer   | <i>Input</i> |
|    | <i>On entry:</i> the GARCH( $p, q$ ) parameter $q$ .   |              |
|    | <i>Constraint:</i> $0 < \max(\mathbf{p}, \mathbf{q}) \leq \mathbf{num}$ , $\mathbf{q} \geq 1$ .  |              |
| 5: | <b>theta[q+p+1]</b> – const double   | <i>Input</i> |
|    | <i>On entry:</i> the first element contains the coefficient $\alpha_0$ , the next <b>q</b> elements contain the coefficients $\alpha_i$ , $i = 1, \dots, q$ . The remaining <b>p</b> elements are the coefficients $\beta_j$ , $j = 1, \dots, p$ . |              |

- 6: **gamma** – double Input  
*On entry:* the asymmetry parameter  $\gamma$  for the GARCH( $p, q$ ) sequence.
- 7: **fht[nt]** – double Output  
*On exit:* the forecast values of the conditional variance,  $h_t, t = 1, \dots, \tau$ .
- 8: **ht[num]** – const double Input  
*On entry:* the sequence of past conditional variances for the GARCH( $p, q$ ) process,  $h_t, t = 1, \dots, T$ .
- 9: **et[num]** – const double Input  
*On entry:* the sequence of past residuals for the GARCH( $p, q$ ) process,  $\epsilon_t, t = 1, \dots, T$ .
- 10: **fail** – NagError \* Input/Output  
 The NAG error parameter (see the Essential Introduction).

## 5 Error Indicators and Warnings

### NE\_INT\_ARG\_LT

- On entry, **num** must not be less than 0: **num** = *<value>*.
- On entry, **p** must not be less than 0: **p** = *<value>*.
- On entry, **q** must not be less than 1: **q** = *<value>*.
- On entry, **nt** must not be less than 1: **nt** = *<value>*.

### NE\_2\_INT\_ARG\_LT

- On entry, **num** = *<value>* while  $\max(\mathbf{p}, \mathbf{q}) = \mathbf{num}$ .
- These parameters must satisfy  $\mathbf{num} \geq \max(\mathbf{p}, \mathbf{q})$ .

### NE\_ALLOC\_FAIL

- Memory allocation failed.

## 6 Further Comments

### 6.1 Accuracy

Not applicable.

### 6.2 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

## **7 See Also**

None.

## **8 Example**

See the example for `nag_estimate_agarchII` (g13ffc).

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