

# NAG C Library Function Document

## nag\_generate\_garchGJR (g05hmc)

### 1 Purpose

nag\_generate\_garchGJR (g05hmc) generates a given number of a GJR GARCH( $p, q$ ) process (see Glosten, *et al.* (1993)).

### 2 Specification

```
#include <nag.h>
#include <nagg05.h>

void nag_generate_garchGJR (Integer num, Integer p, Integer q,
    const double theta[], double gamma, double ht[], double et[],
    Nag_Garch_Fcall_Type fcall, double rvec[], NagError *fail)
```

### 3 Description

A GJR GARCH( $p, q$ ) process is 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  $\epsilon_t \geq 0$ .

Here  $T$  is the number of observations in the sequence,  $\epsilon_t$  is the *observed* value of the GARCH( $p, q$ ) process at time  $t$ ,  $h_t$  is the conditional variance at time  $t$ , and  $\psi_t$  the information set of all information up to time  $t$ . Symmetric GARCH( $p, q$ ) sequences are generated when  $\gamma$  is zero, otherwise asymmetric GARCH( $p, q$ ) sequences are generated with  $\gamma$  specifying the amount by which negative shocks are to be enhanced.

### 4 Parameters

- 1: **num** – Integer *Input*  
*On entry:* the number of terms in the sequence,  $T$ .  
*Constraints:*  
     **num**  $\geq 1$ ,  
     **num**  $> p+q+1$ .
- 2: **p** – Integer *Input*  
*On entry:* the GARCH( $p, q$ ) parameter  $p$ .  
*Constraint:* **p**  $\geq 0$ .
- 3: **q** – Integer *Input*  
*On entry:* the GARCH( $p, q$ ) parameter  $q$ .  
*Constraint:* **q**  $\geq 1$ .

- 4: **theta[q+p+1]** – const double *Input*  
*On entry:* the first element contains the coefficient  $\alpha_0$ , the next **q** elements contain the coefficients  $\alpha_i$ ,  $i = 1, \dots, q$ . The remaining **p** elements are the coefficients  $\beta_j$ ,  $j = 1, \dots, p$ .
- 5: **gamma** – double *Input*  
*On entry:* the asymmetry parameter  $\gamma$  for the GARCH( $p, q$ ) sequence.
- 6: **ht[num]** – double *Output*  
*On exit:* the conditional variances  $h_t$ ,  $t = 1, \dots, T$  for the GARCH( $p, q$ ) sequence.
- 7: **et[num]** – double *Output*  
*On exit:* the observations  $\epsilon_t$ ,  $t = 1, \dots, T$  for the GARCH( $p, q$ ) sequence.
- 8: **fcall** – Nag\_Garch\_Fcall\_Type *Input*  
*On entry:* if **fcall** = **Nag\_Garch\_Fcall\_True** then a new sequence is to be generated, else if **fcall** = **Nag\_Garch\_Fcall\_False** a given sequence is to be continued using the information in **rvec**.
- 9: **rvec[2\*(p+q+1)]** – double *Input/Output*  
*On entry:* the array contains information required to continue a sequence if **fcall** = **Nag\_Garch\_Fcall\_False**.  
*On exit:* contains information that can be used in a subsequent call of nag\_generate\_garchGJR, with **fcall** = **Nag\_Garch\_Fcall\_False**.
- 10: **fail** – NagError \* *Input/Output*  
The NAG error parameter (see the Essential Introduction).

## 5 Error Indicators and Warnings

### NE\_BAD\_PARAM

On entry, parameter **fcall** had an illegal value.

On entry, parameter **gamma** had an illegal value.

### NE\_INT\_ARG\_LT

On entry, **p** must not be less than 0: **p** = *<value>*.

On entry, **q** must not be less than 1: **q** = *<value>*.

On entry, **num** must not be less than 1: **num** = *<value>*.

On entry, **num** = *<value>* while **p+q+1** = *<value>*

These parameters must satisfy **num**  $\geq$  **p+q+1**.

## 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\_garchGJR (g13fec).

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