NAG Toolbox for MATLAB

g05hn

1 Purpose

g05hn generates a given number of terms of an exponential GARCH(p, q) process (see Engle and Ng 1993).

2 Syntax

```
[ht, et, rvec, iseed, rwsav, ifail] = g05hn(dist, num, ip, iq, theta,
df, fcall, rvec, igen, iseed, rwsav)
```

3 Description

An exponential GARCH(p, q) process is represented by:

$$ln(h_t) = \alpha_0 + \sum_{i=1}^{q} \alpha_i z_{t-i} + \sum_{i=1}^{q} \phi_i (|z_{t-i}| - E[|z_{t-i}|]) + \sum_{j=1}^{p} \beta_j ln\left(h_{t-j}\right), \qquad t = 1, \ldots, T,$$

where $z_t = \dfrac{\epsilon_t}{\sqrt{h_t}}$, $E[|z_{t-i}|]$ denotes the expected value of $|z_{t-i}|$, and $\epsilon_t \mid \psi_{t-1} = N(0, h_t)$ or $\epsilon_t \mid \psi_{t-1} = S_t(df, h_t)$. Here S_t is a standardized Student's t-distribution with df degrees of freedom and variance h_t, T is the number of observations in the sequence, ϵ_t is the *observed* value of the GARCH(p, q) process at time t, h_t is the conditional variance at time t, and ψ_t the set of all information up to time t.

One of the initialization functions g05kb (for a repeatable sequence if computed sequentially) or g05kc (for a non-repeatable sequence) must be called prior to the first call to g05hn.

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 Parameters

5.1 Compulsory Input Parameters

1: **dist – string**

The type of distribution to use for ϵ_t.

dist = 'N'

Then a Normal distribution is used.

dist = 'T'

Then a Student's t-distribution is used.

Constraint: **dist** = 'N' or 'T'.

2: **num – int32 scalar**

T, the number of terms in the sequence.

Constraint: **num** > 0.

3: **ip – int32 scalar**

The number of coefficients, β_i, for $i = 1, \ldots, p$.

Constraints:

$2 \times \mathbf{iq} + \mathbf{ip} + 1 \leq 20$;
$\mathbf{ip} \geq 0$.

4: **iq – int32 scalar**

The number of coefficients, α_i, for $i = 1, \ldots, q$.

Constraints:

$2 \times \mathbf{iq} + \mathbf{ip} + 1 \leq 20$;
$\mathbf{iq} \geq 1$.

5: **theta**$(2 \times \mathbf{iq} + \mathbf{ip} + 1)$ **– double array**

The initial parameter estimates for the vector θ. The first element must contain the coefficient α_o and the next **iq** elements must contain the autoregressive coefficients α_i, for $i = 1, \ldots, q$. The next **iq** elements must contain the coefficients ϕ_i, for $i = 1, \ldots, q$. The next **ip** elements must contain the moving average coefficients β_j, for $j = 1, \ldots, p$.

6: **df – double scalar**

The number of degrees of freedom for the Student's t-distribution.

If **dist** $=$ 'N', **df** is not referenced if **dist** $=$ 'N'.

Constraint: **df** > 2.

7: **fcall – logical scalar**

If **fcall** $=$ **true**, a new sequence is to be generated, otherwise a given sequence is to be continued using the information in **rvec**.

8: **rvec**(40) **– double array**

The array contains information required to continue a sequence if **fcall** $=$ **false**.

9: **igen – int32 scalar**

Must contain the identification number for the generator to be used to return a pseudo-random number and should remain unchanged following initialization by a prior call to g05kb or g05kc.

10: **iseed**(4) **– int32 array**

Contains values which define the current state of the selected generator.

11: **rwsav**(9) **– double array**

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **ht(num) – double array**

The conditional variances h_t, for $t = 1, \ldots, T$ for the GARCH(p, q) sequence.

2: **et(num) – double array**

The observations ϵ_t, for $t = 1, \ldots, T$ for the GARCH(p, q) sequence.

3: **rvec(40) – double array**

Contains information that can be used in a subsequent call of g05hn, with **fcall** = **false**.

4: **iseed(4) – int32 array**

Contains updated values defining the new state of the selected generator.

5: **rwsav(9) – double array**

6: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

On entry, **ip** < 0,
or **iq** < 1,
or **df** ≤ 2,
or **num** ≤ 0,
or **dist** $\neq$ 'N' and **dist** $\neq$ 'T',
or $2 \times$ **iq** $+$ **ip** $+ 1 > 20$.

ifail = 2

Invalid sequence generated, use different parameters.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

```
dist = 'N';
num = int32(800);
ip = int32(1);
iq = int32(1);
theta = [0.1;
     -0.3;
     0.1;
     0.9];
df = 5;
```

```
fcall = true;
rvec = zeros(40, 1);
igen = int32(0);
iseed = [int32(28358);
     int32(4261);
     int32(8841);
     int32(3839)];
rwsav = zeros(9, 1);
[ht, et, rvecOut, iseedOut, rwsavOut, ifail] = ...
    g05hn(dist, num, ip, iq, theta, df, fcall, rvec, igen, iseed, rwsav)
```

```
ht =
     array elided
et =
     array elided
rvecOut =
    0.2518
    0.0628
    0.5826
    0.5490
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
    0.7087
    0.6764
    0.7207
    0.7677
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
         0
iseedOut =
        4342
       29232
       31726
       14265
rwsavOut =
    0.8338
         0
         0
         0
         0
         0
         0
         0
```

```
          0
ifail =
            0
```