

# Normal Inverse Gaussian (NIG) model for Stochastic volatility

## Parametrization

The NIG likelihood for stochastic volatility models is defined as:

$$\pi(y|\eta) = \sigma\epsilon$$

where

$$\epsilon \sim \text{NIG}(\beta, \psi)$$

and  $\text{NIG}(\beta, \psi)$  is a standardised NIG distribution with density

$$\pi(\cdot|\beta, \psi) = \frac{\gamma\psi}{\pi} \sqrt{\frac{\beta^2 + \psi^2}{(\gamma x + \beta)^2 + \psi^2}} \exp\left(\psi^2 + \beta(\gamma x + \beta)\right) K_1\left(\sqrt{(\beta^2 + \psi^2)((\gamma x + \beta)^2 + \psi^2)}\right)$$

where  $\gamma^2 = 1 + \beta^2/\psi^2$ .

## Link-function

The squared scale parameter  $\sigma$  is linked to the linear predictor  $\eta$  as:

$$\sigma^2 = \exp(\eta)$$

## Hyperparameters

The skewness parameter  $\beta$  is represented as:

$$\theta_1 = \beta$$

and the shape parameter  $\psi$  as

$$\theta_2 = \log(\psi - 1)$$

as the prior is defined on  $\theta = (\theta_1, \theta_2)$

## Specification

- family="stochvol.nig"
- Required argument:  $y$ .

## Hyperparameter spesification and default values

`doc` The Normal inverse Gaussian stochvol likelihood

`hyper`

`theta1`

`hyperid 84001`

`name skewness`

`short.name skew`

`output.name.intern skewness_param_intern for stochvol-nig`

`output.name skewness parameter for stochvol-nig`

`initial 0`

`fixed FALSE`

```

    prior gaussian
    param 0 10
    to.theta function(x) x
    from.theta function(x) x
  theta2
    hyperid 84002
    name shape
    short.name shape
    output.name shape parameter for stochvol-nig
    output.name.intern shape_param_intern for stochvol-nig
    initial 0
    fixed FALSE
    prior loggamma
    param 1 0.5
    to.theta function(x) log(x - 1)
    from.theta function(x) 1 + exp(x)

survival FALSE

discrete FALSE

link default log

pdf stochvolnig

```

## Example

In the following example we specify the likelihood for the stochastic volatility model to be NIG

```

#simulated data
n=500
phi=0.53
eta=rep(0.1,n)
for(i in 2:n)
  eta[i]=0.1+phi*(eta[i-1]-0.1)+rnorm(1,0,0.6)
y=exp(eta/2)*rnorm(n)
time=1:n
data=list(ret=y,time=time)

#fit the model
formula=ret~f(time,model="ar1")
result=inla(formula,family="stochvol.nig",data=data)

```

## Notes

None