Skew-Normal stochastic volatility likelihood

Parametrisation

The standardised Skew-Normal distribution is

$$f(z) = \frac{2}{\omega_{\alpha}} \phi \left(\frac{z - \xi_{\alpha}}{\omega_{\alpha}} \right) \Phi \left(\alpha \frac{z - \xi_{\alpha}}{\omega_{\alpha}} \right)$$

where ω_{α} and ξ_{α} are so that the mean is zero and variance is one, and they a functions of the skewness parameter α . The skewness s is the standardised skewness (standardized third central moment), which is a function of α

The skew-normal stochastic likelihood is defined as the density wrt y, where y is Skew-Normal distributed with zero mean, skewness s and variance

variance =
$$\exp(\eta) + 1/\tau$$

and

 η : is the the linear predictor

 τ : is an offset in the variance

Link-function

The variance depends on the linear predictor

$$\mu = \exp(\eta) + 1/\tau$$

Hyperparameters

The (standardised) skewness s, is represented as

$$\gamma = 0.988(2\frac{\exp(\theta_1)}{1 + \exp(\theta_1)} - 1)$$

and the prior is defined on θ_1 .

The offset in the variance, $1/\tau$ is represented as

$$\tau = \exp(\theta_2)$$

and the prior is defined on θ_2 . (By default θ_2 is fixed to a high value which makes $1/\tau \approx 0$.)

Specification

- family="stochvolsn"
- \bullet Required arguments: y.

Hyperparameter specification and default values

 doc The SkewNormal stochvol likelihood

hyper

theta1

hyperid 82101

```
name logit skew
         short.name skew
         output.name Skewness for stochvol_sn observations
         output.name.intern Intern skewness for stochvol_sn observations
         initial 0.00123456789
         fixed FALSE
         prior pc.sn
         param 10
         to.theta function(x, skew.max = 0.988) log((1 + x / skew.max) / (1 - x / skew.max))
         from.theta function(x, skew.max = 0.988) skew.max * (2 * exp(x) / (1 + exp(x)) - 1)
     theta2
         hyperid 82102
         name log precision
         short.name prec
         output.name Offset precision for stochvol_sn
         output.name.intern Log offset precision for stochvol_sn
         initial 500
         fixed TRUE
         prior loggamma
         param 1 0.005
         to.theta function(x) log(x)
         from.theta function(x) exp(x)
survival FALSE
discrete FALSE
link default log
\mathbf{pdf} stochvolsn
Example
library(sn)
n <- 1000
x <- scale(arima.sim(n, model= list(ar = 0.95)))
skew <- 0.2
y <- numeric(n)
for(i in 1:n) {
    variance <- exp(x[i])</pre>
    par <- unlist(INLA:::inla.sn.reparam(moments = c(0, variance, skew)))</pre>
    y[i] \leftarrow rsn(1, dp = par)
}
r = inla(y ~ 1 + f(idx, model="ar1",
                   hyper = list(
                        prec = list(prior = "pc.prec",
                                    param = c(0.5, 0.01)),
                        rho = list(prior = "pc.cor1",
```

```
param = c(0.8, 0.5)))),
control.fixed = list(prec.intercept = 1),
data = data.frame(y, idx=1:n),
family = "stochvolsn",
control.inla = list(cmin = 0, b.strategy="skip"),
num.threads = "3:1",
verbose = TRUE)
summary(r)
```

Notes

This implementation is similar to family="sn", see also that documentation.