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 (standarized 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

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

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"`
- 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

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])
    par <- unlist(INLA:::inla.sn.reparam(moments = c(0, variance, skew)))
    y[i] <- 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.