

Package ‘stochvolTMB’

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Type Package

Title Likelihood Estimation of Stochastic Volatility Models

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Description

Parameter estimation for stochastic volatility models using maximum likelihood. The latent log-volatility is integrated out of the likelihood using the Laplace approximation. The models are fitted via 'TMB' (Template Model Builder) (Kristensen, Nielsen, Berg, Skaug, and Bell (2016) <doi:10.18637/jss.v070.i05>).

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Depends R (>= 3.5.0)

Imports TMB, ggplot2, sn, stats, data.table

LinkingTo RcppEigen, TMB

Suggests testthat (>= 2.1.0), shiny, knitr, rmarkdown, stochvol

URL <https://github.com/JensWahl/stochvolTMB>

BugReports <https://github.com/JensWahl/stochvolTMB/issues>

RoxygenNote 7.1.1

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VignetteBuilder knitr

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R topics documented:

demo	2
estimate_parameters	2
plot.stochvolTMB	3
residuals	4
sim_sv	4
spy	5
summary.stochvolTMB	6

Index	7
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demo	<i>Run shiny demo</i>
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Description

Run shiny demo

Usage

demo()

estimate_parameters	<i>Estimate parameters for the stochastic volatility model</i>
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Description

Estimate parameters of a stochastic volatility model with a latent log-volatility following an autoregressive process of order one with normally distributed noise. The following distributions are implemented for the observed process:

- Gaussian distribution
- t-distribution
- Leverage: Gaussian distribution with leverage where the noise of the latent process is correlated with the observational distribution
- Skew gaussian distribution

The parameters is estimated by minimizing the negative log-likelihood (nll) and the latent log-volatility is integrated out by applying the Laplace approximation.

Usage

estimate_parameters(data, model = "gaussian", opt.control = NULL, ...)

Arguments

data	A vector of observations.
model	A character specifying the model. Must be one of the following: "gaussian", "t", "leverage", "skew_gaussian".
opt.control	An optional list of parameters for nlminb.
...	additional arguments passed to MakeADFun .

Value

Object of class stochvolTMB

Examples

```
# load data
data("spy")

# estimate parameters
opt <- estimate_parameters(spy$log_return, model = "gaussian")

# get parameter estimates with standard error
estimates <- summary(opt)

# plot estimated volatility with 95 % confidence interval
plot(opt, include_ci = TRUE)
```

plot.stochvolTMB *Plot estimated latent volatility process*

Description

Displays the estimated latent volatility process over time.

Usage

```
## S3 method for class 'stochvolTMB'
plot(x, ..., include_ci = TRUE, plot_log = TRUE, dates = NULL)
```

Arguments

x	A stochvolTMB object returned from estimate_parameters .
...	Currently not used.
include_ci	logical value indicating if volatility should be plotted with approximately 95 % confidence interval.

plot_log	logical value indicating if the estimated should be plotted on log or original scale. If plot_log = TRUE the process h is plotted. If plot_log = FALSE $100 \sigma_y \exp(h / 2)$ is plotted.
dates	vector of length <code>ncol(x\$nobs)</code> , providing optional dates for labeling the x-axis. The default value is NULL; in this case, the axis will be labeled with numbers.

Value

ggplot object with plot of estimated estimated volatility.

residuals	<i>Calculate one-step-ahead (OSA) residuals for stochastic volatility model.</i>
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Description

Calculate one-step-ahead (OSA) residuals for stochastic volatility model.

Usage

```
residuals(object)
```

Arguments

object A stochvolTMB object.

Value

vector of one-step-ahead residuals of length T, where T is the number of observations.

sim_sv	<i>Simulate data from the stochastic volatility model</i>
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Description

sim_sv simulate observations from a stochastic volatility model.

This function draws the initial log-volatility from its stationary distribution, meaning that h_0 is drawn from a gaussian distribution with mean zero and standard deviation $\sigma_h / \sqrt{1 - \phi^2}$. h_{t+1} is then simulated from its conditional distribution given h_t , which is $N(\phi * h_t, \sigma_h)$. Log-returns (y_t) is simulated from its conditional distribution given the latent process h . If model = "gaussian", then y_t given h_t is gaussian with mean zero and standard deviation equal to $\sigma_y * \exp(h_t / 2)$. Heavy tail returns can be obtained by simulating from the t-distribution by setting model = "t". How heavy of a tail is specified by the degree of freedom parameter df. Asymmetric returns is obtained from the "skew_gaussian" model. How asymmetric is governed by the skewness parameter alpha. The so called leverage model, where we allow for correlation between log-returns and volatility can be simulated by setting model to "leverage" and specifying the correlation parameter rho.

Usage

```
sim_sv(
  param = list(phi = 0.9, sigma_y = 0.4, sigma_h = 0.2, df = 4, alpha = -2, rho = -0.7),
  nobs = 1000,
  seed = NULL,
  model = "gaussian"
)
```

Arguments

param	List of parameters. This includes the standard deviation of the observations, <code>sigma_y</code> , the standard deviation of the latent volatility process, <code>sigma_h</code> , the persistence parameter <code>phi</code> . If <code>model = "t"</code> , the degree of freedom <code>df</code> must be specified. If <code>model = "skew_gaussian"</code> , the skewness parameter <code>alpha</code> must be specified and if <code>model = "leverage"</code> , the correlation <code>rho</code> between the latent error term and the observational error has to be specified.
nobs	Length of time series.
seed	Seed to reproduce simulation.
model	Distribution of error term.

Value

data.table with columns `y` (observations) and `h` (latent log-volatility).

spy	<i>Daily closing prices for the S&P500 from 2005 to 2018.</i>
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Description

A dataset containing the prices and log-returns of the S&P500 from 2005 to 2018

Usage

```
spy
```

Format

A data frame with 3522 rows and 3 variables:

date date

price price, in US dollars

log_return logarithmic return ...

summary.stochvolTMB *Summary tables of model parameters*

Description

Extract parameters, transformed parameters and latent log volatility along with standard error, z-value and p-value

Usage

```
## S3 method for class 'stochvolTMB'  
summary(object, ..., report = c("all", "fixed", "transformed", "random"))
```

Arguments

object	A stochvolTMB object.
...	Currently not used.
report	Parameters to report with uncertainty estimates. Can be any subset of "fixed", "transformed" or "random" (see summary.sdreport). "fixed" report the parameters on the scale they were estimated, for example are all standard deviations are estimated on log scale. "transformed" report all transformed parameters, for example estimated standard deviations transformed from log scale by taking the exponential. Lastly, "random" report the estimated latent log-volatility.

Value

data.table with parameter estimates, standard error, z-value and approximated p-value.

Index

* **datasets**

spy, [5](#)

demo, [2](#)

estimate_parameters, [2](#), [3](#)

MakeADFun, [3](#)

plot.stochvolTMB, [3](#)

residuals, [4](#)

sim_sv, [4](#)

spy, [5](#)

summary.sdreport, [6](#)

summary.stochvolTMB, [6](#)