Package 'GEVStableGarch'

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Type Package

Title ARMA-GARCH/APARCH models with GEV and stable distributions

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Enhances stable

Description Package for ARMA-GARCH or ARMA-
APARCH modelling with GEV and stable conditional distributions.

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GEVStableGarch-package

ARMA-GARCH or ARMA-APARCH modelling with GEV and stable distributions

Description

This package is design to perform maximum likelihood estimation of ARMA-GARCH/APARCH models with Generalized Extreme Distribution (GEV) or stable conditional distributions.

Details

Package:	GEVStableGarch
Type:	Package
Version:	1.0
Date:	2014-03-09
License:	GPL(>=2)

This package contains functions for estimating and simulating combined ARMA-GARCH or ARMA-APARCH models with error distributions following GEV or stable densities. The estimation of these models is done by finding i.i.d. sequences by inverse filtering the model equations and then using MLE technique to perform optimization (see Wurtz et al., 2006). The package also allows the user to estimate several models and choose the best one according to the Akaike Information Criterion (AIC). Apart from GEV and stable distribution, the user can also use normal, t-student or skew t-student conditional distributions.

Author(s)

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`GSgarch.Fit` *ARMA-GARCH/APARCH estimation with GEV and stable distributions*

Description

This function uses Maximum Likelihood technique to estimate the parameters of ARMA-GARCH or ARMA-APARCH model with several conditional distributions. It allows the user to specify "GEV" or "stable" as the error distribution of the model.

Usage

```
GSgarch.Fit(data, m, n, p, q, intercept = TRUE, printRes = FALSE, cond.dist = "norm",
APARCH = FALSE, algorithm = "sqp", get.res = FALSE, control = NULL,
GSstable.tol = 0.01, GStol = 1e-08)
```

Arguments

`data`	Data with the time series to be estimated. This object can not contain NULL elements.
`m,n,p,q`	These values are used to specify the order of the model. They will be treated as ARMA(m,n)-GARCH(p,q) or ARMA(m,n)-APARCH(p,q).
`intercept`	This is a boolean variable. It intercept is TRUE than we estimate the model with intercept, otherwise we will not use the intercept variable.
`printRes`	A boolean variable specifying whether or not the user wants to print the results after the function calling.
`cond.dist`	The conditional distribution of the model to be estimated. This parameter should be one of the following strings: "norm" (Normal Distribution), "t-student" (t-Student distribution), "sstd" (skew t-Student Distribution), "GEV" (Generalized Extreme Value Distribution) or "stable" (Stable Distribution).
`APARCH`	You can set this boolean value as FALSE if we want to estimate a pure GARCH model or as TRUE if we want an APARCH model.
`algorithm`	The algorithm to be used to optimize the likelihood of the process. This parameter should be one of the following strings: "nlminb" (nlminb R internal Routine for optimization) or "SQP" (Sequential quadratic programming routine implemented in package RSolnp).
`get.res`	If get.res is TRUE the output of the model will include the Residuals of the ARMA model and the Volatility of the GARCH model with the estimated model.
`control`	Control parameters used either in "SQP" routine (see the RSolnp documentation) or in "nlminb" (see the nlminb R documentation).
`GSstable.tol`	Tolerance used inside this function for stable distribution computation.
`GStol`	Tolerance for parameter estimation.

Details

There is also the possibility to fit models with conditional "Normal", "t-student" and "skew t-student" distributions but the main purpose of this routine is to deal with "GEV" and "stable". The parameters will be interpreted according to the following equations (see Wurtz et al. ,2006)

$$X_t = \mu + \sum_{i=1}^{m} a_i X_{t-i} + \sum_{j=1}^{n} b_j \varepsilon_{t-j} + \varepsilon_t$$

$$\varepsilon_t = \sigma_t z_t, \quad z_t \overset{iid}{\sim} D(0,1) \ ,$$

$$\sigma_t^{\delta} = \omega + \sum_{i=1}^{p} \alpha_i (\varepsilon_{t-i} - \gamma_i |\varepsilon_{t-i}|)^{\delta} + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^{\delta}$$

where

$$X_t$$

is the ARMA process,

$$\sigma_t$$

is the APARCH process and

$$D(0,1)$$

is the standard density distribution to be used in the model.

Value

The function returns an object containing the following items:

`order`	The estimated parameter set for the chosen model.
`hessian`	The estimated Hessian matrix.
`model`	A string describing the estimated model.
`cond.dist`	The conditional distribution used to fit the model.
`data`	The time series data used to fit the model.
`llh`	The negative log likelihood of the estimated model
`par`	a vector containing the estimated parameters
`hessian`	The estimated Hessian matrix.
`ARMA.res`	ARMA residuals
`GARCH.sig`	GARCH or APARCH residuals.
`aic`	The reported AIC (Akaike Information Criterion) for the current model.
`aicc`	The reported corrected AIC (AICc) for the current model.
`bic`	The reported BIC (Bayesian Information Criterion.
`se.coef`	Standard error for the estimated parameters.
`tval`	Calculated t-value for the estimated parameters.
`matcoef`	An organized matrix to present the objects.

Enhances

The estimation of ARMA-GARCH/APARCH models with conditional stable distribution is mainly dependent on the time taken during the calculation of density points. Our routine uses the standard R stable density implemented in package **stabledist**. There is also another numerical routine to calculate stable densities which is part of an R package called **stable**. This package implements a faster computation of stable densities that are accurately enough to perform numerical optimization. When **GEVStableGarch** loads it verifies if package **stable** is available. If it is found the function GSGarch.Fit will perform optimization using **stable**'s routine. Otherwise it will use stable density from package **stabledist**. Package **stable** is available at 'http://www.robustanalysis.com'.

Author(s)

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References

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Examples

```
# This examples uses the dataset of the package fGarch to estimate
# an ARMA(1,1)-GARCH(1,1) with GEV conditional distribution.
library(fGarch)
data(dem2gbp)
x = dem2gbp[, 1]
gF.new = GSgarch.Fit(data = x , 1,1,1,1,
cond.dist = "gev", intercept = TRUE, APARCH = TRUE,
algorithm = "nlminb", printRes = TRUE, get.res = TRUE)
```

GSgarch.FitAIC *ARMA-GARCH/APARCH model with minimum AIC*

Description

This function estimates ARMA-GARCH/APARCH models with varying order and return the one with minimum AIC.

Usage

```
GSgarch.FitAIC(data, mMAX = 1, nMAX = 1, pMAX = 1, qMAX = 1,
cond.dist = "norm", algorithm = "sqp", APARCH = FALSE,
intercept = TRUE, control = NULL)
```

Arguments

data	Data with the time series to be estimated. This object can not contain NULL elements.
mMAX	Maximum m order of the ARMA(m,n) equation to be searched.
nMAX	Maximum n of the ARMA(m,n) equation order to be searched.
pMAX	Maximum p order of the GARCH(p,q) equation to be searched.
qMAX	Maximum q order of the GARCH(p,q) equation to be searched.
cond.dist	The conditional distribution of the model to be estimated. This parameter should be one of the following strings: "norm" (Normal Distribution), "t-student" (t-Student distribution), "sstd" (skew t-Student Distribution), "GEV" (Generalized Extreme Value Distribution) or "stable" (Stable Distribution).
algorithm	The algorithm to be used to optimize the likelihood of the process. This parameter should be one of the following strings: "nlminb" (nlminb R internal Routine for optimization) or "SQP" (Sequential quadratic programming routine implemented in package RSolnp).
APARCH	You can set this boolean value as FALSE if we want to estimate a pure GARCH model or as TRUE if we want an APARCH model.
intercept	This is a boolean variable. It intercept is TRUE than we estimate the model with intercept, otherwise we will not use the intercept variable.
control	Control parameters used either in "SQP" routine (see the RSolnp documentation) or in "nlminb" (see the nlminb R documentation).

Value

The model with minimum AIC found within the specified range in parameters mMAX, nMAX, pMAX, qMAX.

Author(s)

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References

Brockwell, P. J, e Davis, R. A. Introduction to Time Series and Forecasting. Springer, New York, 1996.

Examples

```
# AIC fit using models from ARMA(0,0)-GARCH(1,0) to ARMA(1,1)-GARCH(1,1)
# with GEV conditional distribution
library(fGarch)
data(dem2gbp)
x = dem2gbp[, 1]
GSgarch.FitAIC(data = x,1,0,1,0,cond.dist = "gev")
```

`GSgarch.Sim` *Simulation of ARMA-GARCH/APARCH process with GEV and stable conditional distributions*

Description

This functions simulate time series following ARMA-GARCH/APARCH models with several conditional distributions, including GEV and stable distributions.

Usage

```
GSgarch.Sim(N = 1000, mu = 0.1, a = c(0.5, 0.3), b = c(-0.4, 0.3, -0.1),
omega = 0.05, alpha = c(0.1), gm = c(0), beta = c(0.1, 0.05, 0.03),
delta = 2, skew = 0, shape = 3, cond.dist = "norm")
```

Arguments

`N`	The size of simulated time series
`mu,a,b`	These are the parameters of the ARMA part of the model to be simulated.
`omega,alpha,beta`	GARCH parameters of the model to simulate. Both alpha and beta are given as vectors.
`gm,delta`	APARCH parameters of the model to simulate. Parameters gm and alpha must have the same size.
`skew`	The skew parameter of the conditional distribution. Used only when cond.dist equals "stable" or "sstd".
`shape`	Shape parameter of the conditional distribution. Used only when cond.dist equals to "t-student", "skew t-student","GEV" or "stable".
`cond.dist`	The conditional distribution of the model to be estimated. This parameter should be one of the following lowercase strings: "norm" (Normal Distribution), "t-student" (t-Student distribution), "sstd" (skew t-Student Distribution), "GEV" (Generalized Extreme Value Distribution) or "stable" (Stable Distribution).

Details

The initial values of the time series are fixed and the recursion formulas of the model are used to simulate the dynamics of the process. We do not verify the stationarity conditions of the model because the simulation of non-stationary process could also be of interest.

Value

The function returns an object containing the following items:

`model`	A string describing the estimated model.
`cond.dist`	The conditional distribution used to fit the model.
`series`	An array of two columns. The first column is the simulated process X_t and the second one is the σ_t simulated process.

Author(s)

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References

Brockwell, P. J, e Davis, R. A. Introduction to Time Series and Forecasting. Springer, New York, 1996.

Nolan, J. P. Numerical calculations of stable densities and distribution functions. Communications in Statistics - Stochastic Models 13: 759- 774, 1997.

Examples

```
# Simulation of a ARMA-APARCH process with stable conditional distribution
x <- GSgarch.Sim(N = 2500, mu = 0.1,a = c(0.2,0.3),b = c(0.2,0.5),
omega = 0.1, alpha = c(0.1,0.2),beta = c(0.1,0.1),gm=c(0.3,-0.3),
delta = 1,skew = 0.3,shape = 1.9, cond.dis = "stable")
```

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