mgarchBEKK: A Package for the Analysis of Multivariate GARCH Models

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Description of the Package

- *Package:* mgarchBEKK
- *Version:* 0.07-7
- *Date:* 2006-06-13
- *Title:* BEKK(p,q) implementation for MGARCH model
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- *Packaged:* Wed Jun 14 00:05:55 2006; vst

Where to Obtain The Package

You can find the latest package, older packages and the manual on authors' websites:

- `http://www.hs-stat.com`
- `http://www.vsthost.com`

The upcoming version of the package will be submitted to CRAN.

How to Get Help

- *Manual:* On authors' websites, there is a comprehensive manual that describes the package and its functionality, together with a real world case-study.
- *Email:* You can ask package related questions to the R mailing-list. This is the preferred way of obtaining help through email (for automatically archiving the replies). Of course, you are welcome to send emails about the package to us.

MGARCH-BEKK: THE MODEL

Consider the following model for a vector process (Z_t):

$$\begin{aligned} Z_t &= M_t + \epsilon_t, \\ \epsilon_t &= \mathtt{H}_t^{1/2} \cdot \nu_t, \qquad (\nu_t)\text{: white noise,} \\ \mathtt{H}_t &= \mathtt{C}'\mathtt{C} + \underbrace{\sum_{i=1}^{q} \mathtt{A}_i' \epsilon_{t-i} \epsilon_{t-i}' \mathtt{A}_i}_{\text{ARCH term}} + \underbrace{\sum_{j=1}^{p} \mathtt{B}_j' \mathtt{H}_{t-j} \mathtt{B}_j}_{\text{GARCH term}} \end{aligned}$$

Then:

$$\mathsf{E}(Z_t|\mathcal{F}_{t-1}) = M_t, \quad \mathsf{var}(Z_t|\mathcal{F}_{t-1}) = H_t$$

USAGE EXAMPLE 1

The command line

```
sim = BEKK.sim(2500, order = c(1,1),
      params = c(1.0,  0.5,  1.0,
                 0.3,  0.0, -0.1, 0.3,
                 0.9, -0.2,  0.2, 0.9))
```

simulates 2500 observations of an MGARCH-BEKK of order (1,1) with

$$\mathtt{C} = \begin{pmatrix} 1 & 0.5 \\ 0 & 1 \end{pmatrix}, \ \mathtt{A} = \begin{pmatrix} 0.3 & -0.1 \\ 0 & 0.3 \end{pmatrix}, \mathtt{B} = \begin{pmatrix} 0.9 & 0.2 \\ -0.2 & 0.9 \end{pmatrix}$$

USAGE EXAMPLE 2

To fit a BEKK model of order (1,1), enter:

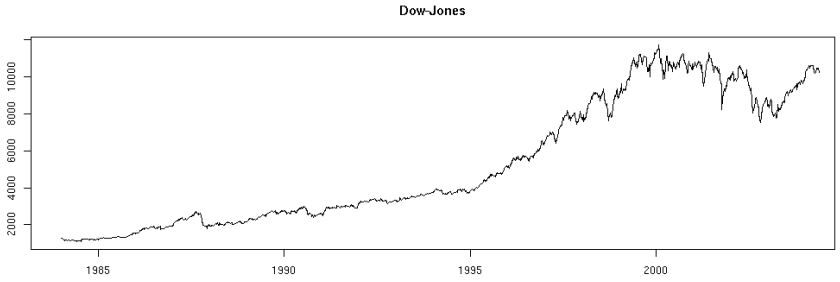
```
est = BEKK.est(e1, e2, order = c(0,1))
```

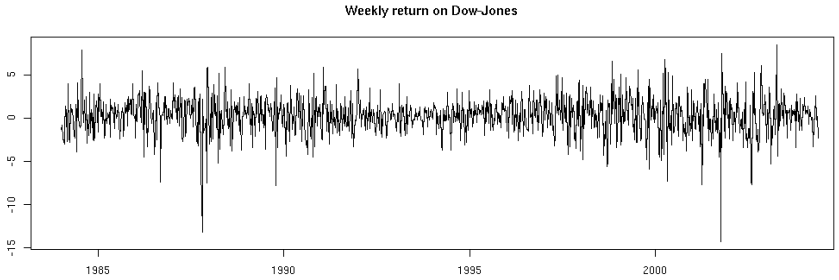
The command

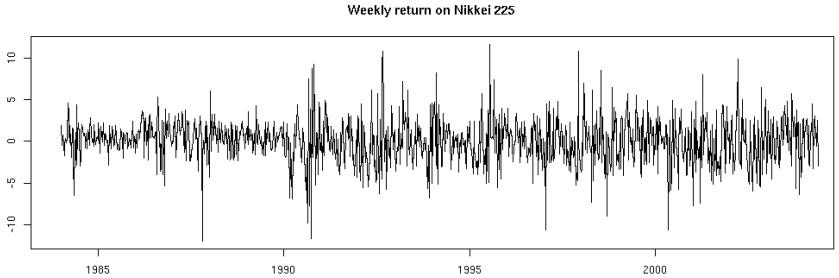
```
est = BEKK.est(e1, e2, order = c(1, 1),
      fixed = array(c(5,0,6,0,9,0,11,0)))
```

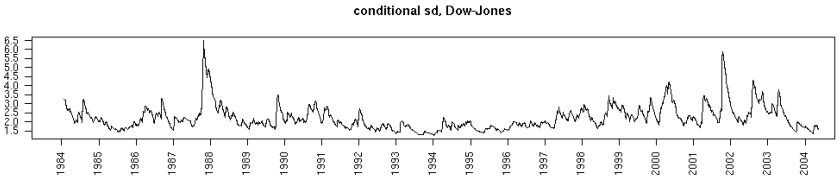
estimates a BEKK(1,1) with parameter matrices

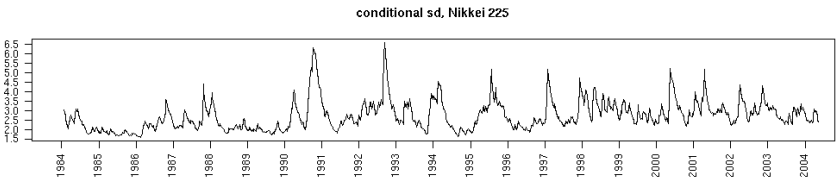
$$\mathtt{C} = \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{pmatrix}, \ \mathtt{A} = \begin{pmatrix} a_{11} & 0 \\ 0 & a_{22} \end{pmatrix}, \ \mathtt{B} = \begin{pmatrix} b_{11} & b_{12} \\ 0 & 0 \end{pmatrix}$$

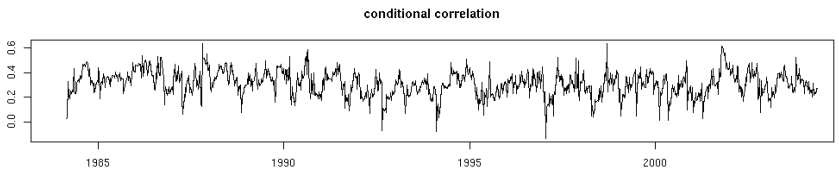












ESTIMATION RESULT:

$$\begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \begin{pmatrix} 0.235 \\ 0.026 \end{pmatrix} + \begin{pmatrix} -0.055 & -0.012 \\ 0.151 & -0.061 \end{pmatrix} \begin{pmatrix} X_{t-1} \\ Y_{t-1} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \end{pmatrix}$$

where the error term follows the MGARCH-BEKK of order (1,2) with equations $e_t = \mathtt{H}_t^{1/2} \cdot \nu_t$ and

$$\mathtt{H}_t = \mathtt{C}'\mathtt{C} + \mathtt{A}_1' e_{t-1} e_{t-1}' \mathtt{A}_1 + \mathtt{A}_2' e_{t-2} e_{t-2}' \mathtt{A}_2 + \mathtt{B}' \mathtt{H}_{t-1} \mathtt{B}$$

where $(\nu_{1t}, \nu_{2t})'$ is white noise, and estimated parameter matrices

$$\mathtt{C} = \begin{pmatrix} 0.488 & 0.291 \\ 0.000 & 0.593 \end{pmatrix},$$

$$\mathtt{A}_1 = \begin{pmatrix} 0.339 & 0.000 \\ 0.000 & 0.263 \end{pmatrix}, \quad \mathtt{A}_2 = \begin{pmatrix} 0.157 & 0.196 \\ 0.000 & -0.326 \end{pmatrix},$$

$$\mathtt{B} = \begin{pmatrix} 0.906 & 0.000 \\ 0.000 & 0.887 \end{pmatrix}.$$

Available Functionality

Elementary analysis: elem.an

elem.an computes daily and weekly returns of a time series of daily values, analyzes the return series and makes a list of missing days and weeks.

Usage:

```
elem.an(
  index.name, from.to = NULL,
  return.formula = 'simple', make.bootstrap.se = T,
  make.bull.indicator = F, make.weekly = T,
  save.data.files = T, save.statistics = F,
  verbose = T)
```

Combine daily time series: cdts

cdts combines daily time series in a daily or weekly returns format.

Usage:

```
cdts(
  file.names, return.formula = 'simple',
  from.to, daily.availability = 1,
  weekly.availability = 1, verbose = T)
```

Estimate a BEKK(p,q) model: mvBEKK.est

mvBEKK.est estimates a BEKK(p,q) model for given time series.

Usage:

```
mvBEKK.est(
  eps, order = c(1,1), params = NULL,
  fixed = NULL, method = 'BFGS', verbose = F)
```

Simulate a BEKK(p,q) model: mvBEKK.sim

mvBEKK.sim simulates an N dimensional BEKK(p,q) model for the given length, order list, and initial parameter list where N is also specified by the user.

Usage:

```
mvBEKK.sim(
  series.count, T, order = c(1,1), params = NULL)
```

Support diagnosis of BEKK(p,q) model fitting: `mvBEKK.diag`

`mvBEKK.diag` prints the results of an estimation of a BEKK(p,q) model in a fancy format.

Usage:

```
mvBEKK.diag(estimation)
```

Examples

A comprehensive example is to be found in the package manual on authors' websites.

Further Improvements and Functionality

- An optional parameter for switching between normal distribution and t-distribution is to be added (Currently only normal distribution is available.).
- `mvBEKK.diag` is to be improved for further diagnosis.
- DCC variant of MGARCH is to be implemented.
- `tseries` conventions to be implemented (like `ts` and/or `zoo` types for arguments, `summary` and `predict` functions implementations etc.)
- A bivariate asymmetric quadratic model is to be added. This model is (temporarily) implemented within `mtgarchBEKK` package and available on request.