

## Lab 7. Discrete volatility models

Let us first play around the simulated GARCH series. You need to load the "Finmetrics" or "Garch" module first: Files → Load modules.

```
> garch21 <- simulate.garch(model=list(a=1.5, arch=c(0.4,0.1),
  garch=0.3),n=1000,n.start=500,rseed=1996126)
  #simulate a GARCH(2,1) series of length 1000
  # component et contains the series and sigma.t contains Cond. SD.
> par(mfrow=c(3,2))
> tsplot(garch21$et)      # plot of the series
> tsplot(garch21$sigma.t) # plot of cond. SD
> tsplot(garch21$et/garch21$sigma.t)
> acf(garch21$et, lag=30) #acf of the series
> acf( (garch21$et)^2, lag=30) #acf of squared series
> aqqplot(garch21$et, dist='t', distpar=6.2) #comparing with t_6.2
> qqline(garch21$et)      #adding a line to the plot
```

Now, let us fit a GARCH(1,1) model to the daily log-returns of the SP500 index.

```
> return500 <- 100*diff(sp500)
> par(mfrow=c(3,2))
> tsplot(return500)
> acf(return500)
> acf(return500^2) #acf of the squared return
> aqqplot(return500, dist='t', distpar=5)
> qqline(return500)
> aqqplot(return500, dist='t', distpar=6)
> qqline(return500)
> garchfit <- garch(return500~1,~garch(1,1),cond.dist='t',dist.est=T)
  #fitting a GARCH(1,1) model
```

```
Call: garch(formula.mean = return500 ~ 1, formula.var = ~ garch(1, 1),
cond.dist = "t", dist.est = T)
```

Mean Equation: return500 ~ 1

Conditional Variance Equation: ~ garch(1, 1)

Conditional Distribution: t

with estimated parameter and standard error 0.4451982

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Estimated Coefficients:  
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	Value	Std.Error	t value	Pr(> t )
C	0.059501	0.010533	5.649	8.476e-009
A	0.005365	0.001468	3.654	1.305e-004
ARCH(1)	0.047170	0.005091	9.265	0.000e+000
GARCH(1)	0.948307	0.005243	180.874	0.000e+000

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AIC(5) = 13974.61  
BIC(5) = 14007.54

Normality Test:  
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Jarque-Bera P-value  
11092 0

Ljung-Box test for standardized residuals:  
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Statistic	P-value	Chi <sup>2</sup> -d.f.
32.22	0.001281	12

Ljung-Box test for squared standardized residuals:  
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Statistic	P-value	Chi <sup>2</sup> -d.f.
19.63	0.07445	12

Lagrange multiplier test:  
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Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7	Lag 8	Lag 9	Lag 10
1.651	1.114	-0.1819	0.5219	0.05381	-0.545	-0.1985	1.428	-0.4281	-0.3705
-0.7023	-0.01921	3.313							

TR <sup>2</sup>	P-value	F-stat	P-value
19.15	0.08498	1.747	0.1472

```
> tsplot(garchfit$sigma.t) #plot of residuals
> tsplot(garchfit$resid)   # residual series after removing mean effect
> tsplot(garchfit$resid/garchfit$sigma.t)
```

You can also fit other GARCH such as EGARCH, TGARCH, etc as follows.

```
> garch(return500~1,~egarch(1,1),cond.dist='t',dist.est=T)
> garch(return500~1,~tgarch(1,1),cond.dist='t',dist.est=T)
> fgarch(return500~1,~figarch(1,1))
```