Untitled

me

7/26/2020

```r
5+5
```

```
## [1] 10
```

```r
library(zoo)
```

```
##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
library(tseries)
```

```
## Warning: package 'tseries' was built under R version 4.0.2

## Registered S3 method overwritten by 'quantmod':
##    method           from
##    as.zoo.data.frame zoo
```

```r
library(FinTS)
```

```
## Warning: package 'FinTS' was built under R version 4.0.2
```

```r
library(rugarch)
```

```
## Warning: package 'rugarch' was built under R version 4.0.2

## Loading required package: parallel

##
## Attaching package: 'rugarch'

## The following object is masked from 'package:stats':
##
##     sigma
```
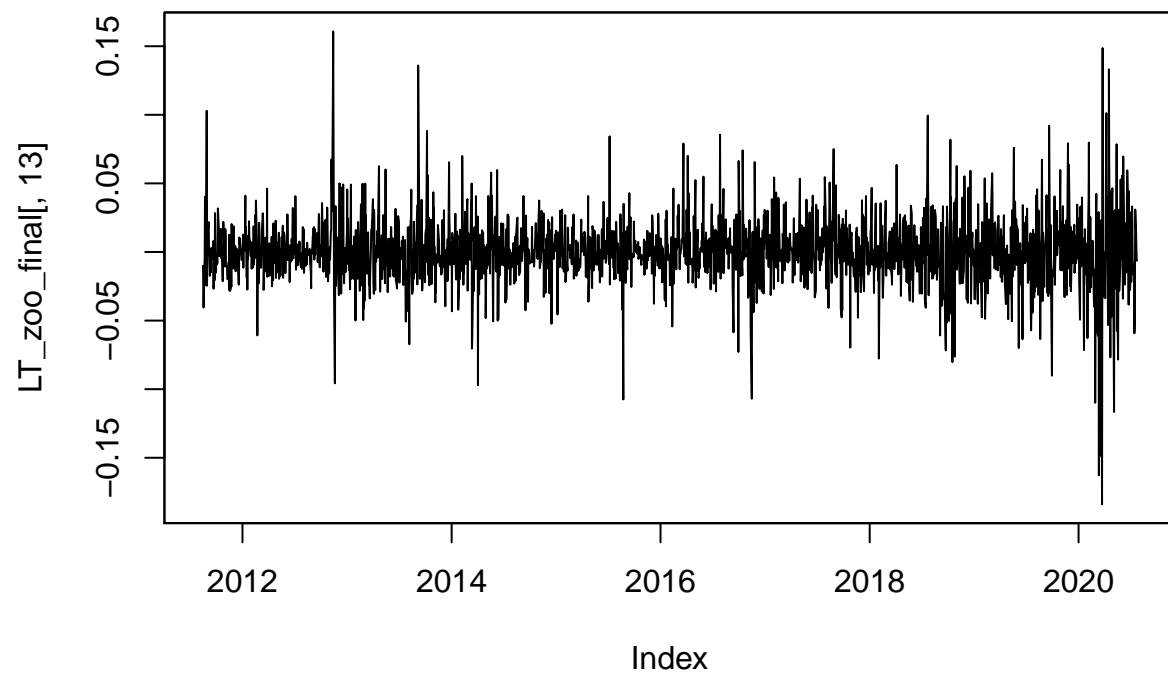
```
LT_zoo_final<-read.zoo("L&T housing Finance.csv",header=TRUE,sep=",",format="%d-%b-%y",FUN = as.Date)
plot(LT_zoo_final[,5])
```
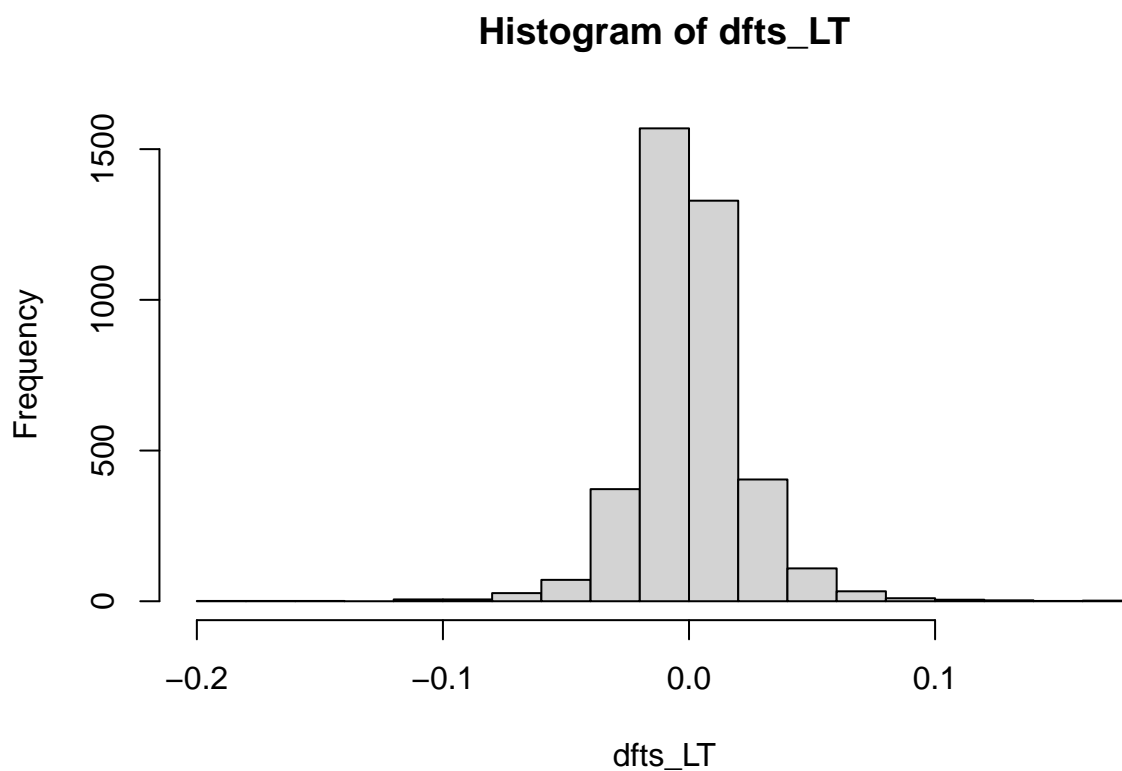

there is a trend in the closing price hence i am taking the differnce and considering the log return.

```
plot(LT_zoo_final[,13])
```

the return series seems to be constant at mean zero and volatility clustering is visible in graph

```
ret_LT<-LT_zoo_final[-1,13]
dfts_LT<- ts(ret_LT,start=c(2010,1),end=c(2020,300),frequency = 365)
hist(dfts_LT)
```

Histogram of dfts_LT

the return appears to be noormally distributed.

```
shapiro.test(dfts_LT)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  dfts_LT
## W = 0.92625, p-value < 2.2e-16
```

the series is staionary.

```
mean(dfts_LT)
```

```
## [1] 0.0006501557
```

```
adf.test(ret_LT)
```

```
## Warning in adf.test(ret_LT): p-value smaller than printed p-value
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  ret_LT
## Dickey-Fuller = -12.043, Lag order = 13, p-value = 0.01
## alternative hypothesis: stationary
```

since p value is smaller than 0.05 hence we are rejecting the null hypothesis hence the series is stationary. also the series is normal around mean 0.

```
acf(dfts_LT)
```

Series dfts_LT


```
acf(abs(dfts_LT))
```
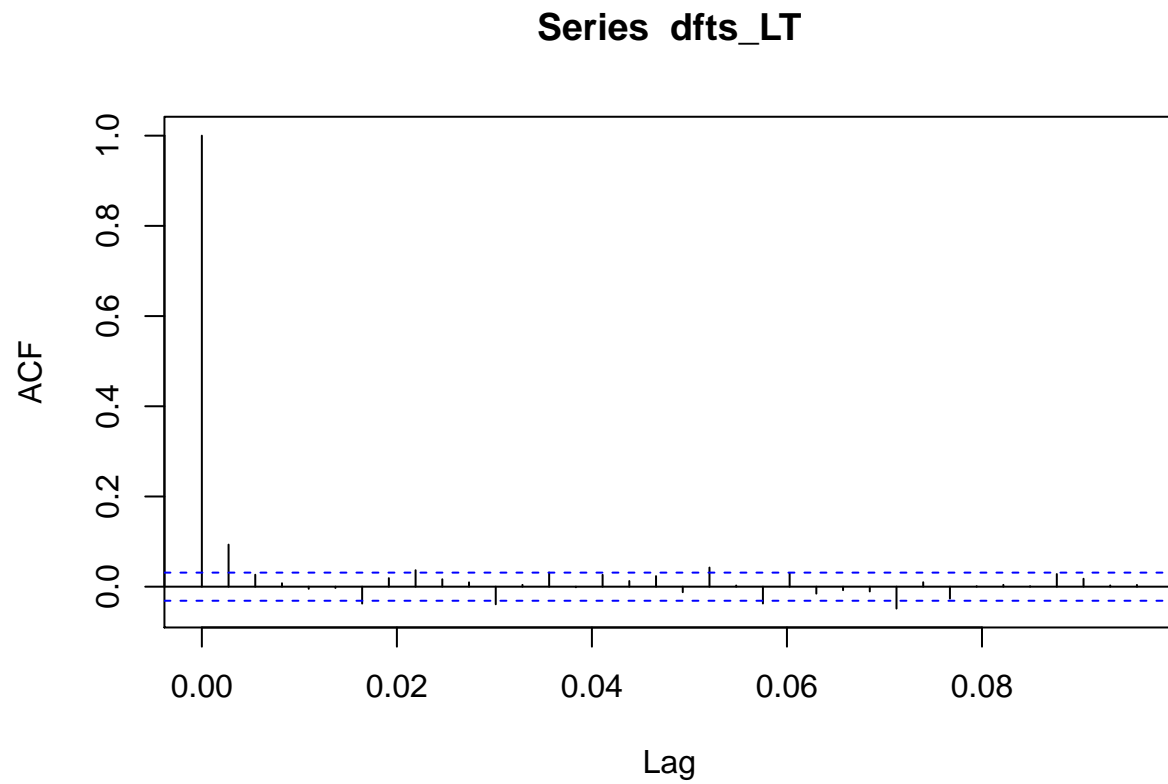
Series abs(dfts_LT)
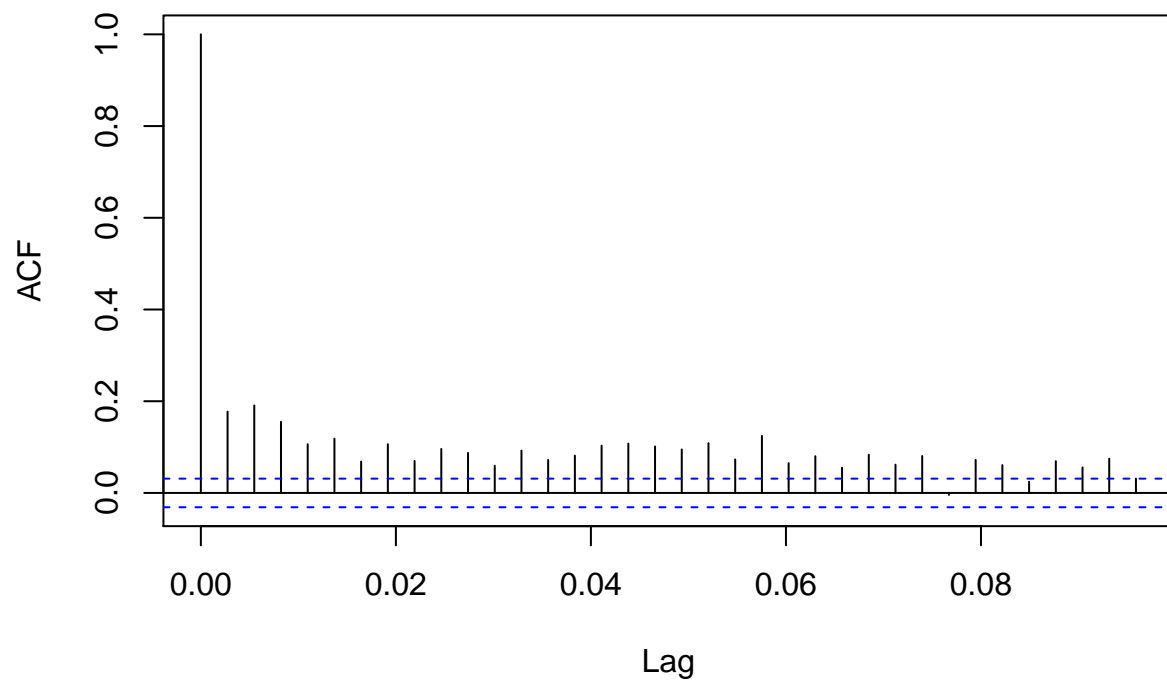

```
acf(dfts_LT^2)
```

Series dfts_LT^2
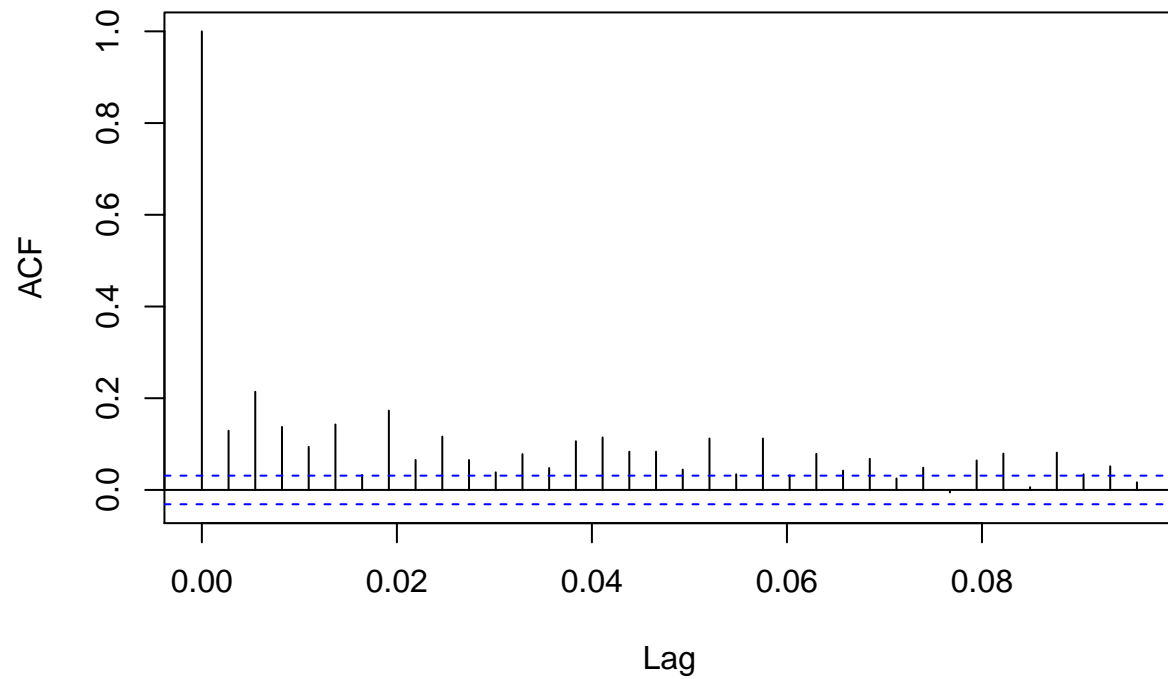
by acf function of return we can say there is no auto correlation and there will be no need of MA model also by looking at the acf of absolute return we can say that the large return are followed by large returns regardless of sign MA(1) may be

```r
pacf(dfts_LT)
```

Series dfts_LT
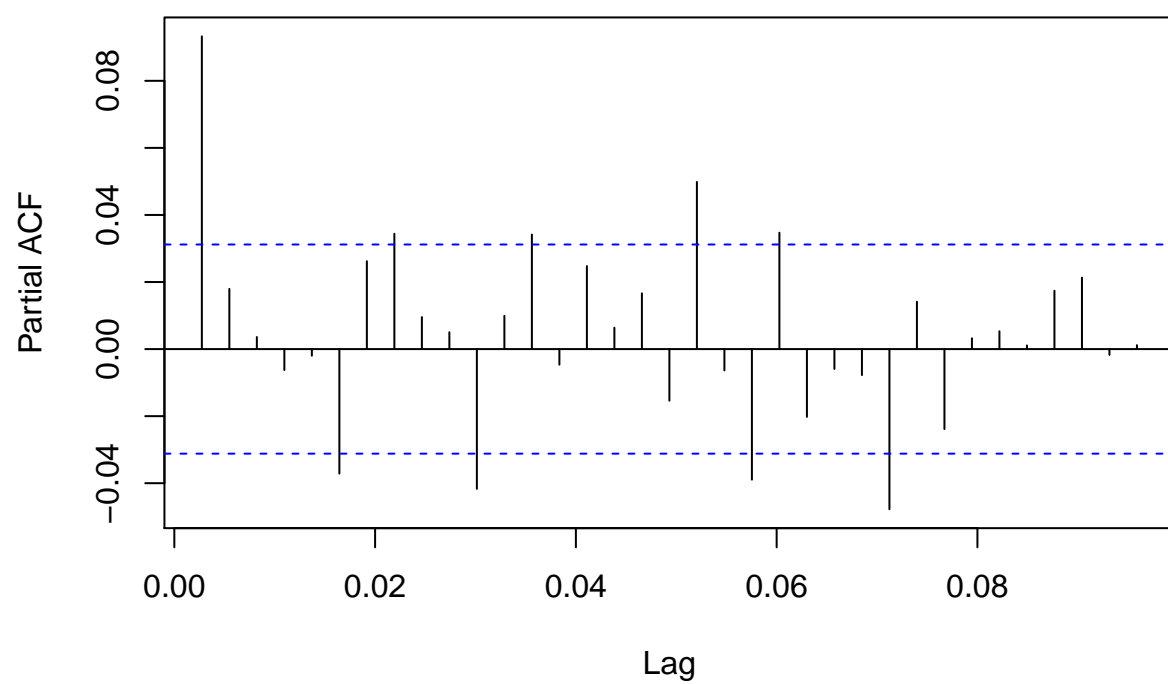

```
pacf(abs(dfts_LT))
```

Series abs(dfts_LT)
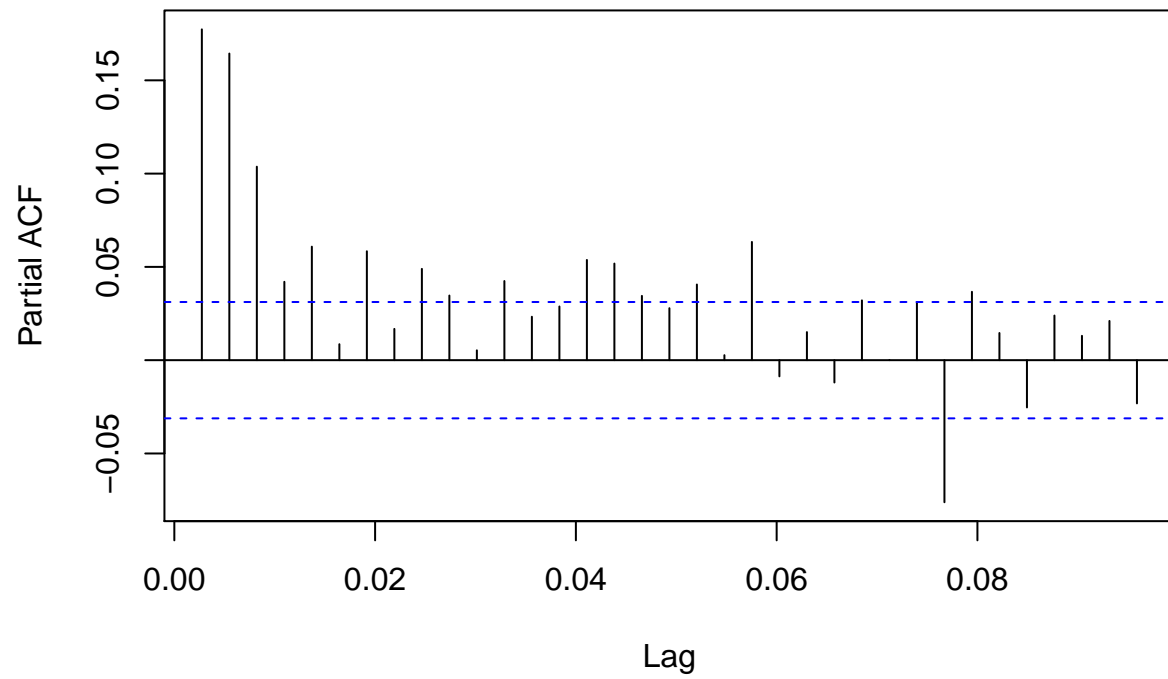

```
pacf(dfts_LT^2)
```

Series dfts_LT^2
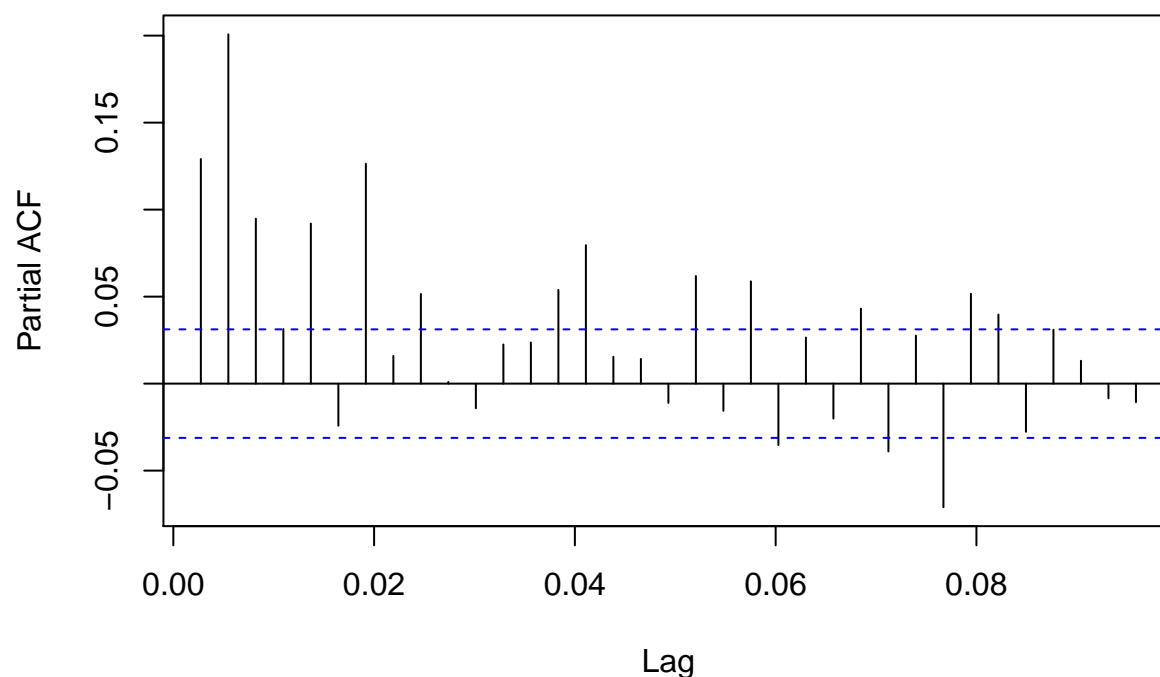
there seems to be no need of any AR model to predict the log return series. AR(1).

```r
Box.test(ret_LT,lag=12,type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  ret_LT
## X-squared = 51.847, df = 12, p-value = 6.599e-07
```

```r
ArchTest(ret_LT)
```

```
##
##  ARCH LM-test; Null hypothesis: no ARCH effects
##
## data:  ret_LT
## Chi-squared = 295.61, df = 12, p-value < 2.2e-16
```

since p value is less than 0.05 we are rejecting the null hypothesis and thus we can say there is arch effect in the series.

```r
arima001<-arima(ret_LT,order = c(0,0,1))
AIC(arima001)
```

```
## [1] -10158.81
```

```
"arima001"
```

```
## [1] "arima001"
```

```
arima010<-arima(ret_LT,order = c(0,1,0))
AIC(arima010)
```

```
## [1] -8674.839
```

```
"arima010"
```

```
## [1] "arima010"
```

```
arima100<-arima(ret_LT,order = c(1,0,0))
AIC(arima100);"arima100"
```

```
## [1] -10159.31
```

```
## [1] "arima100"
```

```
arima101<-arima(ret_LT,order = c(1,0,1))
AIC(arima101);"arima101"
```

```
## [1] -10161.29
```

```
## [1] "arima101"
```

```
arima110<-arima(ret_LT,order = c(1,1,0))
AIC(arima110);"arima110"
```

```
## [1] -9308.291
```

```
## [1] "arima110"
```

```
arima011<-arima(ret_LT,order = c(0,1,1))
AIC(arima011);"arima011"
```

```
## [1] -10137.74
```

```
## [1] "arima011"
```

```
arima111<-arima(ret_LT,order = c(1,1,1))
AIC(arima111);"arima111"
```

```
## [1] -10146.16
```

```
## [1] "arima111"
```

```r
arima200<-arima(ret_LT,order = c(2,0,0))
AIC(arima200);"arima200"
```

```
## [1] -10158.8
```

```
## [1] "arima200"
```

```r
arima210<-arima(ret_LT,order = c(2,1,0))
AIC(arima210);"arima210"
```

```
## [1] -9550.121
```

```
## [1] "arima210"
```

```r
arima201<-arima(ret_LT,order = c(2,0,1))
```

```
## Warning in arima(ret_LT, order = c(2, 0, 1)): possible convergence problem:
## optim gave code = 1
```

```r
AIC(arima201);"arima201"
```

```
## [1] -10159.14
```

```
## [1] "arima201"
```

```r
arima211<-arima(ret_LT,order = c(2,1,1))

AIC(arima211);"arima211"
```

```
## [1] -10145.69
```

```
## [1] "arima211"
```

```r
arima020<-arima(ret_LT,order = c(0,2,0))
AIC(arima020);"arima020"
```

```
## [1] -5745.348
```

```
## [1] "arima020"
```

```r
arima120<-arima(ret_LT,order = c(1,2,0))
AIC(arima120);"arima120"
```

```
## [1] -7213.363
```

```
## [1] "arima120"
```

```r
arima021<-arima(ret_LT,order = c(0,2,1))
AIC(arima021);"arima021"
```

```
## [1] -8659.563
```

```
## [1] "arima021"
```

```r
arima121<-arima(ret_LT,order = c(1,2,1))
AIC(arima121);"arima121"
```

```
## [1] -9291.916
```

```
## [1] "arima121"
```

```r
arima002<-arima(ret_LT,order = c(0,0,2))
AIC(arima002);"arima002"
```

```
## [1] -10157.96
```

```
## [1] "arima002"
```

```r
arima102<-arima(ret_LT,order = c(1,0,2))
AIC(arima102);"arima102"
```

```
## [1] -10159.3
```

```
## [1] "arima102"
```

```r
arima012<-arima(ret_LT,order = c(0,1,2))
AIC(arima012);"arima012"
```

```
## [1] -10145.64
```

```
## [1] "arima012"
```

```r
arima112<-arima(ret_LT,order = c(1,1,2))
AIC(arima112);"arima112"
```

```
## [1] -10141.96
```

```
## [1] "arima112"
```

```r
arima222<-arima(ret_LT,order = c(2,2,2))
AIC(arima222);"arima222"
```

```
## [1] -10084.88
```

```
## [1] "arima222"
```

```
arima220<-arima(ret_LT,order = c(2,2,0))
AIC(arima220);"arima220"
```

```
## [1] -7923.671
```

```
## [1] "arima220"
```

```
arima202<-arima(ret_LT,order = c(2,0,2))
AIC(arima202);"arima202"
```

```
## [1] -10157.6
```

```
## [1] "arima202"
```

```
arima022<-arima(ret_LT,order = c(0,2,2))
AIC(arima022);"arima022"
```

```
## [1] -10084
```

```
## [1] "arima022"
```

```
arima212<-arima(ret_LT,order = c(2,1,2))
AIC(arima212);"arima212"
```

```
## [1] -10142.31
```

```
## [1] "arima212"
```

ARMA(1,0,1)<-(1,0,0) is the best choice since there was not any reccomendation from acf and pacf function we will ignore these model for now .

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,0)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
## 
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
## 
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,0)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
## 
## Optimal Parameters
## -----------------------------------
##         Estimate  Std. Error   t value Pr(>|t|)
```

```
## mu       0.067208     0.000326 206.32303  0.00000
## ar1     -0.508998     0.006827 -74.55422  0.00000
## omega    0.000000     0.000003   0.11943  0.90494
## alpha1   0.999000     0.027706  36.05726  0.00000
##
## Robust Standard Errors:
##          Estimate  Std. Error    t value Pr(>|t|)
## mu       0.067208    0.001046  64.228361  0.00000
## ar1     -0.508998    0.023013 -22.118140  0.00000
## omega    0.000000    0.000005   0.069136  0.94488
## alpha1   0.999000    0.029493  33.871975  0.00000
##
## LogLikelihood : 1314.285
##
## Information Criteria
## ---------------------------------
##
## Akaike        -1.5316
## Bayes         -1.5189
## Shibata       -1.5316
## Hannan-Quinn  -1.5269
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                               statistic p-value
## Lag[1]                             1.09  0.2965
## Lag[2*(p+q)+(p+q)-1][2]           56.28  0.0000
## Lag[4*(p+q)+(p+q)-1][5]           90.22  0.0000
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                               statistic p-value
## Lag[1]                           0.7394  0.3899
## Lag[2*(p+q)+(p+q)-1][2]          2.0945  0.2476
## Lag[4*(p+q)+(p+q)-1][5]          3.0181  0.4037
## d.o.f=1
##
## Weighted ARCH LM Tests
## ---------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[2]     2.704 0.500 2.000  0.1001
## ARCH Lag[4]     2.802 1.397 1.611  0.2913
## ARCH Lag[6]     3.202 2.222 1.500  0.4339
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  25.9224
## Individual Statistics:
## mu      0.05949
## ar1     0.09513
## omega   1.49347
## alpha1 11.42401
```

```
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          1.07 1.24 1.6
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## -------------------------------------
##                    t-value       prob sig
## Sign Bias            13.18   7.702e-38 ***
## Negative Sign Bias   16.72   3.052e-58 ***
## Positive Sign Bias   10.45   7.876e-25 ***
## Joint Effect        526.39  9.100e-114 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -------------------------------------
##   group statistic p-value(g-1)
## 1    20      7242            0
## 2    30      7586            0
## 3    40      7669            0
## 4    50      7808            0
##
##
## Elapsed time : 0.997993
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(0,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
```

```
## Warning in .sgarchfit(spec = spec, data = data, out.sample = out.sample, :
## ugarchfit-->warning: solver failer to converge.
```

```
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(0,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
##
## Convergence Problem:
## Solver Message:
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
```

```
## *-----------------------------------*
## *          GARCH Model Fit          *
## *-----------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
##
## Optimal Parameters
## -----------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000612    0.000484   1.2634 0.206439
## ar1     0.057432    0.029936   1.9185 0.055047
## omega   0.000157    0.000026   5.9865 0.000000
## alpha1  0.223015    0.044341   5.0295 0.000000
## beta1   0.423046    0.080789   5.2364 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000612    0.000495   1.2373 0.215989
## ar1     0.057432    0.029172   1.9687 0.048982
## omega   0.000157    0.000033   4.7184 0.000002
## alpha1  0.223015    0.069098   3.2275 0.001249
## beta1   0.423046    0.089208   4.7422 0.000002
##
## LogLikelihood : 4274.761
##
## Information Criteria
## -----------------------------------
##
## Akaike        -4.9910
## Bayes         -4.9750
## Shibata       -4.9910
## Hannan-Quinn  -4.9851
##
## Weighted Ljung-Box Test on Standardized Residuals
## -----------------------------------
##                            statistic p-value
## Lag[1]                         1.130  0.2877
## Lag[2*(p+q)+(p+q)-1][2]        1.738  0.3168
## Lag[4*(p+q)+(p+q)-1][5]        3.237  0.3739
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## -----------------------------------
##                            statistic p-value
## Lag[1]                        0.9602  0.3271
## Lag[2*(p+q)+(p+q)-1][5]       1.2837  0.7928
## Lag[4*(p+q)+(p+q)-1][9]       1.7706  0.9306
## d.o.f=2
##
```

```
## Weighted ARCH LM Tests
## -----------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[3]    0.3737 0.500 2.000  0.5410
## ARCH Lag[5]    0.5888 1.440 1.667  0.8571
## ARCH Lag[7]    0.7085 2.315 1.543  0.9558
##
## Nyblom stability test
## -----------------------------------
## Joint Statistic:  1.1166
## Individual Statistics:
## mu     0.23104
## ar1    0.05652
## omega  0.22648
## alpha1 0.15724
## beta1  0.12510
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.28 1.47 1.88
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## -----------------------------------
##                    t-value    prob sig
## Sign Bias           1.2153 0.2244
## Negative Sign Bias  0.4617 0.6443
## Positive Sign Bias  0.7643 0.4448
## Joint Effect        1.5318 0.6750
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -----------------------------------
##   group statistic p-value(g-1)
## 1    20     108.8    1.306e-14
## 2    30     118.5    8.671e-13
## 3    40     127.4    2.566e-11
## 4    50     137.5    2.498e-10
##
##
## Elapsed time : 1.163993
```

```r
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,0)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,0)
## Mean Model   : ARFIMA(1,0,0)
```

```
## Distribution : norm
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000595    0.000470   1.2647 0.205962
## ar1     0.046435    0.028893   1.6071 0.108027
## omega   0.000271    0.000016  16.9023 0.000000
## alpha1  0.212705    0.044051   4.8286 0.000001
## alpha2  0.200278    0.040909   4.8957 0.000001
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000595    0.000495   1.2024 0.229193
## ar1     0.046435    0.028664   1.6200 0.105237
## omega   0.000271    0.000027   9.9740 0.000000
## alpha1  0.212705    0.078318   2.7159 0.006609
## alpha2  0.200278    0.070406   2.8446 0.004447
##
## LogLikelihood : 4277.724
##
## Information Criteria
## ------------------------------------
##
## Akaike       -4.9944
## Bayes        -4.9785
## Shibata      -4.9944
## Hannan-Quinn -4.9885
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                      1.579  0.2089
## Lag[2*(p+q)+(p+q)-1][2]     2.011  0.2095
## Lag[4*(p+q)+(p+q)-1][5]     3.530  0.3104
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                     0.8255  0.3636
## Lag[2*(p+q)+(p+q)-1][5]    2.3136  0.5464
## Lag[4*(p+q)+(p+q)-1][9]    3.0915  0.7438
## d.o.f=2
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[3]    0.03631 0.500 2.000  0.8489
## ARCH Lag[5]    0.95973 1.440 1.667  0.7449
## ARCH Lag[7]    1.16110 2.315 1.543  0.8860
##
## Nyblom stability test
```

```
## -----------------------------------
## Joint Statistic:  0.9376
## Individual Statistics:
## mu      0.17513
## ar1     0.03447
## omega   0.20129
## alpha1 0.20597
## alpha2 0.08386
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          1.28 1.47 1.88
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## -----------------------------------
##                   t-value   prob sig
## Sign Bias           1.1028 0.2703
## Negative Sign Bias  0.8086 0.4189
## Positive Sign Bias  0.6122 0.5405
## Joint Effect        1.3332 0.7213
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -----------------------------------
##   group statistic p-value(g-1)
## 1    20     103.1    1.460e-13
## 2    30     117.1    1.514e-12
## 3    40     134.3    2.176e-12
## 4    50     155.2    5.705e-13
##
##
## Elapsed time : 1.343
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(0,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
```

```
## Warning in .sgarchfit(spec = spec, data = data, out.sample = out.sample, :
## ugarchfit-->warning: solver failer to converge.
```

```
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(0,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
##
## Convergence Problem:
## Solver Message:
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000613    0.000502 1.221432 0.221923
## ar1     0.077103    0.026907 2.865502 0.004163
## omega   0.000032    0.000013 2.495879 0.012565
## alpha1  0.088188    0.029163 3.023930 0.002495
## alpha2  0.000000    0.025606 0.000009 0.999993
## beta1   0.617055    0.093278 6.615193 0.000000
## beta2   0.220015    0.149331 1.473333 0.140661
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000613    0.000502 1.222187 0.221637
## ar1     0.077103    0.026894 2.866870 0.004146
## omega   0.000032    0.000061 0.531186 0.595290
## alpha1  0.088188    0.120853 0.729710 0.465567
## alpha2  0.000000    0.075725 0.000003 0.999998
## beta1   0.617055    0.812446 0.759502 0.447552
## beta2   0.220015    0.977097 0.225172 0.821846
##
## LogLikelihood : 4268.83
##
## Information Criteria
## -----------------------------------
##
## Akaike        -4.9817
## Bayes         -4.9594
## Shibata       -4.9817
## Hannan-Quinn  -4.9734
##
## Weighted Ljung-Box Test on Standardized Residuals
## -----------------------------------
##                           statistic p-value
## Lag[1]                        0.7489  0.3868
## Lag[2*(p+q)+(p+q)-1][2]       1.6111  0.3782
## Lag[4*(p+q)+(p+q)-1][5]       2.8644  0.4662
## d.o.f=1
```

```
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                                statistic p-value
## Lag[1]                             1.086  0.2974
## Lag[2*(p+q)+(p+q)-1][11]           4.378  0.6758
## Lag[4*(p+q)+(p+q)-1][19]           7.458  0.7355
## d.o.f=4
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[5]      1.750 0.500 2.000  0.1859
## ARCH Lag[7]      3.493 1.473 1.746  0.2538
## ARCH Lag[9]      3.829 2.402 1.619  0.4234
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  5.0916
## Individual Statistics:
## mu     0.15697
## ar1    0.17148
## omega  0.21336
## alpha1 0.06715
## alpha2 0.05467
## beta1  0.12428
## beta2  0.12775
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.69 1.9 2.35
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value    prob sig
## Sign Bias           1.0096 0.3128
## Negative Sign Bias  1.3934 0.1637
## Positive Sign Bias  0.8079 0.4192
## Joint Effect        3.5804 0.3105
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
## 1    20    110.7     5.847e-15
## 2    30    121.1     3.155e-13
## 3    40    140.0     2.627e-13
## 4    50    144.3     2.502e-11
##
##
## Elapsed time : 0.96825
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000613    0.000502   1.2210 0.222072
## ar1     0.077109    0.027003   2.8556 0.004296
## omega   0.000032    0.000023   1.4280 0.153284
## alpha1  0.088175    0.030417   2.8989 0.003745
## beta1   0.617015    0.174771   3.5304 0.000415
## beta2   0.220097    0.192434   1.1438 0.252727
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000613    0.000506  1.21082  0.22596
## ar1     0.077109    0.029364  2.62597  0.00864
## omega   0.000032    0.000114  0.28436  0.77614
## alpha1  0.088175    0.145616  0.60553  0.54483
## beta1   0.617015    0.253365  2.43528  0.01488
## beta2   0.220097    0.618785  0.35569  0.72207
##
## LogLikelihood : 4268.83
##
## Information Criteria
## ------------------------------------
##
## Akaike       -4.9829
## Bayes        -4.9638
## Shibata      -4.9829
## Hannan-Quinn -4.9758
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                      0.7485  0.3870
## Lag[2*(p+q)+(p+q)-1][2]     1.6107  0.3783
## Lag[4*(p+q)+(p+q)-1][5]     2.8640  0.4663
## d.o.f=1
## H0 : No serial correlation
##
```

```
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                              statistic p-value
## Lag[1]                           1.087  0.2971
## Lag[2*(p+q)+(p+q)-1][8]          3.426  0.6075
## Lag[4*(p+q)+(p+q)-1][14]         5.356  0.7243
## d.o.f=3
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[4]    0.06857 0.500 2.000  0.7934
## ARCH Lag[6]    2.24991 1.461 1.711  0.4381
## ARCH Lag[8]    3.29130 2.368 1.583  0.4904
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  1.239
## Individual Statistics:
## mu     0.1569
## ar1    0.1715
## omega  0.2138
## alpha1 0.0670
## beta1  0.1245
## beta2  0.1280
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.49 1.68 2.12
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value    prob sig
## Sign Bias           1.0095  0.3129
## Negative Sign Bias  1.3937  0.1636
## Positive Sign Bias  0.8083  0.4190
## Joint Effect        3.5818  0.3103
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
## 1    20    110.7     5.847e-15
## 2    30    121.1     3.155e-13
## 3    40    140.0     2.627e-13
## 4    50    143.7     3.052e-11
##
##
## Elapsed time : 0.819993
```

```r
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
## 
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
## 
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : norm
## 
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000616    0.000477   1.2919 0.196396
## ar1     0.056330    0.029043   1.9395 0.052436
## omega   0.000240    0.000029   8.2300 0.000000
## alpha1  0.195406    0.043451   4.4972 0.000007
## alpha2  0.164282    0.051325   3.2008 0.001370
## beta1   0.110576    0.092433   1.1963 0.231588
## 
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000616    0.000489  1.25895 0.208047
## ar1     0.056330    0.028890  1.94979 0.051201
## omega   0.000240    0.000047  5.12772 0.000000
## alpha1  0.195406    0.069115  2.82726 0.004695
## alpha2  0.164282    0.085338  1.92506 0.054222
## beta1   0.110576    0.132606  0.83387 0.404355
## 
## LogLikelihood : 4279.017
## 
## Information Criteria
## -----------------------------------
## 
## Akaike       -4.9948
## Bayes        -4.9757
## Shibata      -4.9948
## Hannan-Quinn -4.9877
## 
## Weighted Ljung-Box Test on Standardized Residuals
## -----------------------------------
##                         statistic p-value
## Lag[1]                     0.9815  0.3218
## Lag[2*(p+q)+(p+q)-1][2]    1.4297  0.4771
## Lag[4*(p+q)+(p+q)-1][5]    2.7985  0.4837
## d.o.f=1
## H0 : No serial correlation
## 
## Weighted Ljung-Box Test on Standardized Squared Residuals
## -----------------------------------
##                         statistic p-value
## Lag[1]                     0.5678  0.4511
## Lag[2*(p+q)+(p+q)-1][8]    1.7476  0.8957
```

```
## Lag[4*(p+q)+(p+q)-1][14]    3.1086  0.9494
## d.o.f=3
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[4]     0.3549 0.500 2.000  0.5514
## ARCH Lag[6]     0.4682 1.461 1.711  0.9008
## ARCH Lag[8]     0.5085 2.368 1.583  0.9812
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  1.2291
## Individual Statistics:
## mu     0.16622
## ar1    0.05782
## omega  0.21149
## alpha1 0.17124
## alpha2 0.09298
## beta1  0.11060
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.49 1.68 2.12
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                   t-value    prob sig
## Sign Bias          1.0786 0.2809
## Negative Sign Bias 0.8013 0.4231
## Positive Sign Bias 0.5036 0.6146
## Joint Effect       1.2537 0.7402
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20     97.83    1.324e-12
## 2     30    113.49    6.093e-12
## 3     40    123.51    1.037e-10
## 4     50    140.11    1.037e-10
##
##
## Elapsed time : 1.122009
```

```r
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(0,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
```

```
## Warning in .sgarchfit(spec = spec, data = data, out.sample = out.sample, :
## ugarchfit-->warning: solver failer to converge.
```

```r
my_model_LT
```

```
##
```

```
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(0,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Convergence Problem:
## Solver Message:
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,0)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,0)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.000765    0.000505    1.5128 0.130342
## ar1      0.070225    0.025190    2.7878 0.005306
## omega    0.000367    0.000034   10.7693 0.000000
## alpha1   0.204628    0.058827    3.4784 0.000504
## skew     1.119668    0.036645   30.5547 0.000000
## shape    3.793486    0.372673   10.1791 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.000765    0.000488    1.5675 0.116991
## ar1      0.070225    0.021495    3.2670 0.001087
## omega    0.000367    0.000036   10.1156 0.000000
## alpha1   0.204628    0.071533    2.8606 0.004228
## skew     1.119668    0.038722   28.9154 0.000000
## shape    3.793486    0.337116   11.2528 0.000000
##
## LogLikelihood : 4379.536
##
## Information Criteria
## ------------------------------------
##
## Akaike        -5.1123
## Bayes         -5.0932
```

```
## Shibata       -5.1123
## Hannan-Quinn -5.1052
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                     0.4428  0.5058
## Lag[2*(p+q)+(p+q)-1][2]    1.0804  0.6908
## Lag[4*(p+q)+(p+q)-1][5]    3.2467  0.3718
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                    0.02726  0.8689
## Lag[2*(p+q)+(p+q)-1][2]   2.92215  0.1473
## Lag[4*(p+q)+(p+q)-1][5]   7.33418  0.0430
## d.o.f=1
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale  P-Value
## ARCH Lag[2]      5.776 0.500 2.000 0.016244
## ARCH Lag[4]      9.093 1.397 1.611 0.008427
## ARCH Lag[6]      9.987 2.222 1.500 0.013883
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  1.7312
## Individual Statistics:
## mu     0.3504
## ar1    0.2732
## omega  0.4229
## alpha1 0.3953
## skew   0.1794
## shape  0.3658
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.49 1.68 2.12
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value    prob sig
## Sign Bias            1.350 0.1771
## Negative Sign Bias   1.054 0.2921
## Positive Sign Bias   0.162 0.8713
## Joint Effect         2.221 0.5279
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
```

```
## 1    20     7.773       0.9888
## 2    30    16.884       0.9639
## 3    40    23.868       0.9729
## 4    50    34.733       0.9384
##
##
## Elapsed time : 1.591997
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000813    0.000494   1.6468 0.099608
## ar1     0.072547    0.024666   2.9411 0.003270
## omega   0.000124    0.000044   2.8469 0.004415
## alpha1  0.180462    0.054705   3.2988 0.000971
## beta1   0.555789    0.128328   4.3310 0.000015
## skew    1.133749    0.037615  30.1407 0.000000
## shape   3.965729    0.398564   9.9500 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000813    0.000495   1.6405 0.100893
## ar1     0.072547    0.021200   3.4220 0.000622
## omega   0.000124    0.000062   2.0073 0.044722
## alpha1  0.180462    0.069694   2.5893 0.009616
## beta1   0.555789    0.179956   3.0885 0.002012
## skew    1.133749    0.039854  28.4476 0.000000
## shape   3.965729    0.358611  11.0586 0.000000
##
## LogLikelihood : 4392.533
##
## Information Criteria
## ------------------------------------
##
## Akaike        -5.1263
## Bayes         -5.1040
## Shibata       -5.1263
## Hannan-Quinn  -5.1180
##
```

```
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                     0.4988  0.4800
## Lag[2*(p+q)+(p+q)-1][2]    1.1307  0.6596
## Lag[4*(p+q)+(p+q)-1][5]    2.4769  0.5730
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                         statistic p-value
## Lag[1]                     0.2320  0.6300
## Lag[2*(p+q)+(p+q)-1][5]    0.6754  0.9276
## Lag[4*(p+q)+(p+q)-1][9]    1.3928  0.9639
## d.o.f=2
##
## Weighted ARCH LM Tests
## ------------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[3]    0.4087 0.500 2.000  0.5226
## ARCH Lag[5]    0.8641 1.440 1.667  0.7737
## ARCH Lag[7]    1.1878 2.315 1.543  0.8812
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  2.097
## Individual Statistics:
## mu     0.2933
## ar1    0.2286
## omega  0.3721
## alpha1 0.3216
## beta1  0.3014
## skew   0.3256
## shape  0.2895
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.69 1.9 2.35
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value   prob sig
## Sign Bias           1.1782 0.2389
## Negative Sign Bias  0.7603 0.4472
## Positive Sign Bias  0.3373 0.7359
## Joint Effect        1.4769 0.6876
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
## 1    20      4.50       0.9997
## 2    30     17.94       0.9456
```

```
## 3     40     28.45        0.8936
## 4     50     31.93        0.9719
##
##
## Elapsed time : 2.060997
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,0)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,0)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000710    0.000490   1.4485 0.147482
## ar1     0.069505    0.024827   2.7996 0.005117
## omega   0.000306    0.000029  10.4123 0.000000
## alpha1  0.178493    0.054134   3.2972 0.000976
## alpha2  0.167582    0.050412   3.3243 0.000887
## skew    1.125224    0.037178  30.2661 0.000000
## shape   3.979253    0.401070   9.9216 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000710    0.000478   1.4838 0.137852
## ar1     0.069505    0.021234   3.2733 0.001063
## omega   0.000306    0.000032   9.6318 0.000000
## alpha1  0.178493    0.061019   2.9252 0.003442
## alpha2  0.167582    0.054077   3.0989 0.001942
## skew    1.125224    0.038922  28.9100 0.000000
## shape   3.979253    0.361976  10.9931 0.000000
##
## LogLikelihood : 4391.129
##
## Information Criteria
## ------------------------------------
##
## Akaike       -5.1246
## Bayes        -5.1024
## Shibata      -5.1247
## Hannan-Quinn -5.1164
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
```

```
##                           statistic p-value
## Lag[1]                      0.3108  0.5772
## Lag[2*(p+q)+(p+q)-1][2]     0.7304  0.8845
## Lag[4*(p+q)+(p+q)-1][5]     2.2401  0.6415
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                           statistic p-value
## Lag[1]                      0.1229  0.7260
## Lag[2*(p+q)+(p+q)-1][5]     1.5885  0.7181
## Lag[4*(p+q)+(p+q)-1][9]     2.6634  0.8130
## d.o.f=2
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[3]     0.3343 0.500 2.000  0.5631
## ARCH Lag[5]     2.1223 1.440 1.667  0.4448
## ARCH Lag[7]     2.4019 2.315 1.543  0.6327
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  2.1103
## Individual Statistics:
## mu     0.2685
## ar1    0.2312
## omega  0.4077
## alpha1 0.2303
## alpha2 0.3538
## skew   0.3121
## shape  0.3120
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:         1.69 1.9 2.35
## Individual Statistic:    0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                      t-value    prob sig
## Sign Bias             1.0724 0.2837
## Negative Sign Bias    1.2127 0.2254
## Positive Sign Bias    0.1255 0.9001
## Joint Effect          1.8018 0.6145
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20     3.565       1.0000
## 2     30    18.147       0.9412
## 3     40    15.686       0.9997
## 4     50    32.629       0.9653
```

```
##
##
## Elapsed time : 1.768996

spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(0,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT


##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(0,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## -----------------------------------
##          Estimate  Std. Error    t value Pr(>|t|)
## mu      0.000927    0.000546     1.6977 0.089570
## ar1     0.076181    0.021991     3.4642 0.000532
## omega   0.000001    0.000000    28.4084 0.000000
## beta1   0.992975    0.000372 2667.4657 0.000000
## beta2   0.004153    0.000536     7.7530 0.000000
## skew    1.119364    0.037521    29.8330 0.000000
## shape   3.553275    0.318034    11.1726 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error    t value Pr(>|t|)
## mu      0.000927    0.000584     1.5892 0.112014
## ar1     0.076181    0.024200     3.1480 0.001644
## omega   0.000001    0.000000    24.3052 0.000000
## beta1   0.992975    0.000421 2355.9950 0.000000
## beta2   0.004153    0.000567     7.3301 0.000000
## skew    1.119364    0.042388    26.4074 0.000000
## shape   3.553275    0.390237     9.1054 0.000000
##
## LogLikelihood : 4366.008
##
## Information Criteria
## -----------------------------------
##
## Akaike        -5.0953
## Bayes         -5.0730
## Shibata       -5.0953
## Hannan-Quinn -5.0870
##
## Weighted Ljung-Box Test on Standardized Residuals
## -----------------------------------
##                            statistic p-value
## Lag[1]                         1.339  0.2473
```

```
## Lag[2*(p+q)+(p+q)-1][2]      2.237  0.1444
## Lag[4*(p+q)+(p+q)-1][5]      3.945  0.2344
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                          statistic   p-value
## Lag[1]                       50.16 1.414e-12
## Lag[2*(p+q)+(p+q)-1][5]      76.18 0.000e+00
## Lag[4*(p+q)+(p+q)-1][9]      84.96 0.000e+00
## d.o.f=2
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale   P-Value
## ARCH Lag[3]      25.57 0.500 2.000 4.258e-07
## ARCH Lag[5]      35.92 1.440 1.667 1.944e-09
## ARCH Lag[7]      36.72 2.315 1.543 2.664e-09
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  61.7706
## Individual Statistics:
## mu     0.2950
## ar1    0.4703
## omega 16.6375
## beta1  0.4902
## beta2  0.4902
## skew   0.1874
## shape  0.3946
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        1.69 1.9 2.35
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                     t-value       prob sig
## Sign Bias             0.226 8.212e-01
## Negative Sign Bias    4.018 6.130e-05 ***
## Positive Sign Bias    5.534 3.607e-08 ***
## Joint Effect         48.430 1.725e-10 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
## 1    20    12.10        0.8814
## 2    30    22.74        0.7883
## 3    40    32.57        0.7569
## 4    50    39.06        0.8445
##
##
```

```
## Elapsed time : 1.444995

spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error   t value Pr(>|t|)
## mu      0.000874    0.000489  1.786262 0.074057
## ar1     0.068724    0.023445  2.931225 0.003376
## omega   0.000045    0.000026  1.711098 0.087063
## alpha1  0.080410    0.030705  2.618770 0.008825
## alpha2  0.031911    0.025027  1.275054 0.202290
## beta1   0.000000    0.086724  0.000005 0.999996
## beta2   0.790606    0.038274 20.656548 0.000000
## skew    1.129509    0.037273 30.303463 0.000000
## shape   3.938386    0.387438 10.165192 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error   t value Pr(>|t|)
## mu      0.000874    0.000488  1.788415 0.073709
## ar1     0.068724    0.022558  3.046556 0.002315
## omega   0.000045    0.000050  0.898644 0.368842
## alpha1  0.080410    0.055472  1.449570 0.147179
## alpha2  0.031911    0.048269  0.661109 0.508543
## beta1   0.000000    0.126173  0.000003 0.999998
## beta2   0.790606    0.155110  5.097077 0.000000
## skew    1.129509    0.039707 28.446227 0.000000
## shape   3.938386    0.371290 10.607315 0.000000
##
## LogLikelihood : 4392.035
##
## Information Criteria
## ------------------------------------
##
## Akaike       -5.1234
## Bayes        -5.0947
## Shibata      -5.1234
## Hannan-Quinn -5.1128
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
```

```
##                                  statistic p-value
## Lag[1]                               1.302  0.2538
## Lag[2*(p+q)+(p+q)-1][2]              2.318  0.1257
## Lag[4*(p+q)+(p+q)-1][5]              3.761  0.2661
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                                  statistic p-value
## Lag[1]                               1.793  0.1805
## Lag[2*(p+q)+(p+q)-1][11]             5.868  0.4539
## Lag[4*(p+q)+(p+q)-1][19]             8.648  0.6019
## d.o.f=4
##
## Weighted ARCH LM Tests
## ------------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[5]     2.006 0.500 2.000  0.1567
## ARCH Lag[7]     3.477 1.473 1.746  0.2557
## ARCH Lag[9]     3.631 2.402 1.619  0.4551
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  2.525
## Individual Statistics:
## mu     0.2261
## ar1    0.3109
## omega  0.2900
## alpha1 0.1677
## alpha2 0.2015
## beta1  0.2760
## beta2  0.2333
## skew   0.2677
## shape  0.2227
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        2.1 2.32 2.82
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                     t-value     prob sig
## Sign Bias             1.179 0.23875
## Negative Sign Bias    1.648 0.09944    *
## Positive Sign Bias    1.032 0.30230
## Joint Effect          5.216 0.15668
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
## 1    20     8.638       0.9790
## 2    30    13.167       0.9948
```

```
## 3    40     38.784       0.4796
## 4    50     37.071       0.8945
##
##
## Elapsed time : 2.485992
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(1,2)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
```

```
## Warning in .sgarchfit(spec = spec, data = data, out.sample = out.sample, :
## ugarchfit-->warning: solver failer to converge.
```

```
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(1,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Convergence Problem:
## Solver Message:
```

```
spec_of_garch_LT<- ugarchspec(variance.model = list(garchOrder=c(2,1)),mean.model =list(armaOrder=c(1,0
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : sGARCH(2,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## -----------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.000763    0.000491   1.5525 0.120536
## ar1     0.071499    0.024572   2.9098 0.003617
## omega   0.000207    0.000068   3.0277 0.002465
## alpha1  0.169869    0.052999   3.2052 0.001350
## alpha2  0.102666    0.080833   1.2701 0.204050
## beta1   0.284713    0.205866   1.3830 0.166664
```

```
## skew    1.130440    0.037598  30.0668 0.000000
## shape    3.996384    0.403277   9.9098 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.000763    0.000487  1.56610 0.117325
## ar1      0.071499    0.021243  3.36576 0.000763
## omega    0.000207    0.000094  2.19969 0.027829
## alpha1   0.169869    0.057160  2.97184 0.002960
## alpha2   0.102666    0.104290  0.98443 0.324906
## beta1    0.284713    0.281881  1.01005 0.312472
## skew     1.130440    0.040078 28.20571 0.000000
## shape    3.996384    0.359668 11.11133 0.000000
##
## LogLikelihood : 4393.18
##
## Information Criteria
## ---------------------------------
##
## Akaike       -5.1259
## Bayes        -5.1004
## Shibata      -5.1259
## Hannan-Quinn -5.1164
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                          statistic p-value
## Lag[1]                       0.3448  0.5571
## Lag[2*(p+q)+(p+q)-1][2]      0.8379  0.8319
## Lag[4*(p+q)+(p+q)-1][5]      2.1306  0.6734
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                          statistic p-value
## Lag[1]                       0.1326  0.7158
## Lag[2*(p+q)+(p+q)-1][8]      0.7286  0.9891
## Lag[4*(p+q)+(p+q)-1][14]     2.0602  0.9900
## d.o.f=3
##
## Weighted ARCH LM Tests
## ---------------------------------
##            Statistic Shape Scale P-Value
## ARCH Lag[4]   0.0532 0.500 2.000  0.8176
## ARCH Lag[6]   0.2805 1.461 1.711  0.9500
## ARCH Lag[8]   0.3122 2.368 1.583  0.9935
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  2.3241
## Individual Statistics:
## mu      0.2652
## ar1     0.2279
```

```
## omega  0.3983
## alpha1 0.2836
## alpha2 0.3715
## beta1  0.2993
## skew   0.3486
## shape  0.2957
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          1.89 2.11 2.59
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value   prob sig
## Sign Bias          1.0784 0.2810
## Negative Sign Bias 0.9879 0.3234
## Positive Sign Bias 0.1876 0.8512
## Joint Effect       1.4835 0.6861
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ----------------------------------
##    group statistic p-value(g-1)
## 1     20    2.606      1.0000
## 2     30   11.870      0.9979
## 3     40   16.341      0.9995
## 4     50   32.162      0.9698
##
##
## Elapsed time : 3.998
```

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="eGARCH",garchOrder=c(1,1)),mean.model = list(ar
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : eGARCH(1,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.000789    0.000434  1.81683 0.069244
## ar1      0.072742    0.021324  3.41126 0.000647
## omega   -1.144660    0.647472 -1.76789 0.077079
## alpha1  -0.023610    0.028679 -0.82327 0.410357
## beta1    0.853174    0.083032 10.27522 0.000000
```

```
## gamma1  0.284346    0.079616  3.57145 0.000355
## skew     1.134137    0.036736 30.87285 0.000000
## shape    3.979434    0.396459 10.03743 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.000789    0.000416  1.89810 0.057683
## ar1      0.072742    0.017036  4.26982 0.000020
## omega   -1.144660    1.261303 -0.90752 0.364131
## alpha1  -0.023610    0.033564 -0.70344 0.481782
## beta1    0.853174    0.162164  5.26117 0.000000
## gamma1   0.284346    0.140800  2.01950 0.043435
## skew     1.134137    0.038876 29.17351 0.000000
## shape    3.979434    0.350628 11.34945 0.000000
##
## LogLikelihood : 4397.777
##
## Information Criteria
## ---------------------------------
##
## Akaike       -5.1312
## Bayes        -5.1058
## Shibata      -5.1313
## Hannan-Quinn -5.1218
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                           statistic p-value
## Lag[1]                        1.059  0.3033
## Lag[2*(p+q)+(p+q)-1][2]       1.847  0.2701
## Lag[4*(p+q)+(p+q)-1][5]       3.000  0.4314
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                           statistic p-value
## Lag[1]                        0.2798  0.5969
## Lag[2*(p+q)+(p+q)-1][5]       0.7422  0.9147
## Lag[4*(p+q)+(p+q)-1][9]       2.0050  0.9044
## d.o.f=2
##
## Weighted ARCH LM Tests
## ---------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[3]    0.05946 0.500 2.000  0.8074
## ARCH Lag[5]    1.00700 1.440 1.667  0.7308
## ARCH Lag[7]    1.91089 2.315 1.543  0.7362
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  2.8802
## Individual Statistics:
## mu      0.2882
```

```
## ar1    0.2858
## omega  0.2152
## alpha1 0.9880
## beta1  0.2200
## gamma1 0.6411
## skew   0.3692
## shape  0.2086
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:         1.89 2.11 2.59
## Individual Statistic:    0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value    prob sig
## Sign Bias           0.9758 0.3293
## Negative Sign Bias  0.7299 0.4656
## Positive Sign Bias  0.5182 0.6044
## Joint Effect        2.2833 0.5157
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20    7.726        0.9892
## 2     30   17.936        0.9456
## 3     40   30.601        0.8295
## 4     50   41.221        0.7774
##
##
## Elapsed time : 1.763997
```

this model is rejected since there is no leverage effect.

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(1,1)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## ------------------------------------
## GARCH Model  : gjrGARCH(1,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##          Estimate  Std. Error   t value Pr(>|t|)
## mu       0.001033    0.000505    2.0466 0.040697
```

```
## ar1     0.069303    0.022692    3.0541 0.002257
## omega   0.000001    0.000001    1.1834 0.236641
## alpha1  0.014400    0.003130    4.6010 0.000004
## beta1   0.989979    0.000417 2373.1610 0.000000
## gamma1 -0.014165    0.005694   -2.4876 0.012859
## skew    1.134564    0.038823   29.2243 0.000000
## shape   3.752190    0.501981    7.4748 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error    t value Pr(>|t|)
## mu      0.001033    0.000539    1.91604 0.055359
## ar1     0.069303    0.024166    2.86775 0.004134
## omega   0.000001    0.000005    0.21812 0.827336
## alpha1  0.014400    0.006998    2.05770 0.039619
## beta1   0.989979    0.000266 3718.02486 0.000000
## gamma1 -0.014165    0.009683   -1.46282 0.143515
## skew    1.134564    0.053372   21.25779 0.000000
## shape   3.752190    2.034840    1.84397 0.065187
##
## LogLikelihood : 4387.81
##
## Information Criteria
## ---------------------------------
##
## Akaike       -5.1196
## Bayes        -5.0941
## Shibata      -5.1196
## Hannan-Quinn -5.1102
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                         statistic p-value
## Lag[1]                      1.759 0.18474
## Lag[2*(p+q)+(p+q)-1][2]     3.480 0.01319
## Lag[4*(p+q)+(p+q)-1][5]     5.400 0.07697
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                         statistic  p-value
## Lag[1]                      48.24 3.774e-12
## Lag[2*(p+q)+(p+q)-1][5]     62.19 0.000e+00
## Lag[4*(p+q)+(p+q)-1][9]     67.18 0.000e+00
## d.o.f=2
##
## Weighted ARCH LM Tests
## ---------------------------------
##             Statistic Shape Scale  P-Value
## ARCH Lag[3]     11.93 0.500 2.000 5.512e-04
## ARCH Lag[5]     18.71 1.440 1.667 4.513e-05
## ARCH Lag[7]     19.37 2.315 1.543 9.253e-05
##
## Nyblom stability test
```

```
## -----------------------------------
## Joint Statistic:  328.8651
## Individual Statistics:
## mu      0.06815
## ar1     0.36858
## omega  33.01721
## alpha1  0.12167
## beta1   0.17204
## gamma1  0.16287
## skew    0.32744
## shape   0.14329
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          1.89 2.11 2.59
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## -----------------------------------
##                     t-value       prob sig
## Sign Bias            0.5377 5.909e-01
## Negative Sign Bias   3.3919 7.099e-04 ***
## Positive Sign Bias   4.2305 2.455e-05 ***
## Joint Effect        31.0162 8.434e-07 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -----------------------------------
##   group statistic p-value(g-1)
## 1    20     21.00       0.3365
## 2    30     19.58       0.9054
## 3    40     46.92       0.1797
## 4    50     44.79       0.6445
##
##
## Elapsed time : 2.653998
```

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(1,2)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *-----------------------------------*
## *          GARCH Model Fit          *
## *-----------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(1,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Convergence Problem:
## Solver Message:
```

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```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(2,1)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(2,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error     t value Pr(>|t|)
## mu      0.001016    0.000510     1.99436 0.046113
## ar1     0.064837    0.024110     2.68923 0.007162
## omega   0.000001    0.000001     0.96774 0.333177
## alpha1  0.013574    0.007948     1.70783 0.087667
## alpha2  0.000000    0.010214     0.00000 1.000000
## beta1   0.991444    0.000290 3421.77075 0.000000
## gamma1  0.159525    0.003386    47.11427 0.000000
## gamma2 -0.174462    0.000785  -222.16132 0.000000
## skew    1.138457    0.039542    28.79112 0.000000
## shape   3.821576    0.573914     6.65879 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error     t value Pr(>|t|)
## mu      0.001016    0.000616     1.64979 0.098987
## ar1     0.064837    0.027528     2.35535 0.018505
## omega   0.000001    0.000006     0.14773 0.882555
## alpha1  0.013574    0.033336     0.40718 0.683874
## alpha2  0.000000    0.042037     0.00000 1.000000
## beta1   0.991444    0.000443 2236.70850 0.000000
## gamma1  0.159525    0.010856    14.69484 0.000000
## gamma2 -0.174462    0.000630  -277.10473 0.000000
## skew    1.138457    0.058633    19.41673 0.000000
## shape   3.821576    2.987533     1.27917 0.200836
##
## LogLikelihood : 4393.135
##
## Information Criteria
## -----------------------------------
##
## Akaike       -5.1235
## Bayes        -5.0917
## Shibata      -5.1235
## Hannan-Quinn -5.1117
##
## Weighted Ljung-Box Test on Standardized Residuals
```

```
## ------------------------------------
##                         statistic  p-value
## Lag[1]                      2.974 0.084596
## Lag[2*(p+q)+(p+q)-1][2]     4.578 0.001169
## Lag[4*(p+q)+(p+q)-1][5]     6.409 0.032671
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                          statistic  p-value
## Lag[1]                       31.51 1.984e-08
## Lag[2*(p+q)+(p+q)-1][8]      47.75 2.192e-12
## Lag[4*(p+q)+(p+q)-1][14]     50.90 2.078e-11
## d.o.f=3
##
## Weighted ARCH LM Tests
## ------------------------------------
##             Statistic Shape Scale  P-Value
## ARCH Lag[4]     7.242 0.500 2.000 0.007123
## ARCH Lag[6]     7.560 1.461 1.711 0.029565
## ARCH Lag[8]     7.807 2.368 1.583 0.068270
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  352.0509
## Individual Statistics:
## mu      0.05894
## ar1     0.29288
## omega  40.78036
## alpha1  0.14762
## alpha2  0.18165
## beta1   0.19707
## gamma1  0.18855
## gamma2  0.18714
## skew    0.38635
## shape   0.20879
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        2.29 2.54 3.05
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value      prob sig
## Sign Bias           0.1285 8.978e-01
## Negative Sign Bias  0.7564 4.495e-01
## Positive Sign Bias  4.3759 1.283e-05 ***
## Joint Effect       25.0857 1.482e-05 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##   group statistic p-value(g-1)
```

```
## 1    20        6.65          0.9959
## 2    30       10.26          0.9995
## 3    40       27.84          0.9085
## 4    50       25.44          0.9978
##
##
## Elapsed time : 7.127001
```

```r
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(2,2)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(2,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.001187    0.000126   9.4439  0.00000
## ar1     0.070110    0.010252   6.8385  0.00000
## omega   0.000001    0.000001   0.9483  0.34298
## alpha1  0.019326    0.000867  22.2948  0.00000
## alpha2  0.003138    0.000016 193.6857  0.00000
## beta1   0.501790    0.000611 820.8856  0.00000
## beta2   0.484405    0.001499 323.1059  0.00000
## gamma1  0.033767    0.001465  23.0444  0.00000
## gamma2 -0.057938    0.000755 -76.7754  0.00000
## skew    1.134118    0.032794  34.5830  0.00000
## shape   3.723429    0.324133  11.4873  0.00000
##
## Robust Standard Errors:
##         Estimate  Std. Error   t value Pr(>|t|)
## mu      0.001187    0.000386   3.07748 0.002088
## ar1     0.070110    0.043188   1.62337 0.104511
## omega   0.000001    0.000012   0.11915 0.905154
## alpha1  0.019326    0.002159   8.95056 0.000000
## alpha2  0.003138    0.000029 107.80242 0.000000
## beta1   0.501790    0.000993 505.26088 0.000000
## beta2   0.484405    0.008359  57.94782 0.000000
## gamma1  0.033767    0.001713  19.71466 0.000000
## gamma2 -0.057938    0.002237 -25.90104 0.000000
## skew    1.134118    0.066543  17.04328 0.000000
## shape   3.723429    0.909329   4.09470 0.000042
##
## LogLikelihood : 4390.719
##
```

```
## Information Criteria
## ---------------------------------
##
## Akaike       -5.1195
## Bayes        -5.0845
## Shibata      -5.1196
## Hannan-Quinn -5.1065
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                             statistic p-value
## Lag[1]                          1.618 0.20341
## Lag[2*(p+q)+(p+q)-1][2]         3.330 0.01804
## Lag[4*(p+q)+(p+q)-1][5]         5.259 0.08641
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                             statistic  p-value
## Lag[1]                          29.16 6.668e-08
## Lag[2*(p+q)+(p+q)-1][11]        47.09 2.976e-11
## Lag[4*(p+q)+(p+q)-1][19]        50.36 7.264e-10
## d.o.f=4
##
## Weighted ARCH LM Tests
## ---------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[5]     0.3517 0.500 2.000  0.5532
## ARCH Lag[7]     0.5455 1.473 1.746  0.8849
## ARCH Lag[9]     0.7603 2.402 1.619  0.9607
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  245.5898
## Individual Statistics:
## mu      0.3456
## ar1     0.2557
## omega  19.9165
## alpha1  0.1883
## alpha2  0.1976
## beta1   0.1480
## beta2   0.1430
## gamma1  0.2098
## gamma2  0.2730
## skew    0.4331
## shape   0.1060
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          2.49 2.75 3.27
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## ---------------------------------
```

```
##                    t-value      prob sig
## Sign Bias           0.415 0.6781661
## Negative Sign Bias  2.055 0.0400457   **
## Positive Sign Bias  3.696 0.0002256  ***
## Joint Effect        20.686 0.0001223  ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20      9.90       0.9554
## 2     30     12.12       0.9975
## 3     40     23.07       0.9800
## 4     50     34.62       0.9402
##
##
## Elapsed time : 4.739013
```

sGARCH(0,2) Akaike -4.5795 sstd sGARCH(2,0) Akaike -4.6343 sstd sGARCH(2,1) Akaike -4.6599 sstd sGARCH(2,2) Akaike -4.6650 sstd sGARCH(1,1) Akaike -4.6611 sstd sGARCH(1,2) Akaike -4.6657 sstd gjrGARCH(2,1) Akaike -4.6685 sstd gjrGARCH(1,1) Akaike -4.6703 sstd gjrGARCH(1,2) Akaike -4.6730 sstd gjrGARCH(2,2) Akaike -4.6742 sstd

so we are taking (1,2) instead of (2,2) because many terme in it are not significant

```r
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(1,3)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *           GARCH Model Fit       *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(1,3)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## -----------------------------------
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.001002    0.000496   2.0206 0.043321
## ar1      0.068221    0.022856   2.9848 0.002838
## omega    0.000003    0.000001   2.4388 0.014734
## alpha1   0.035149    0.006150   5.7155 0.000000
## beta1    0.134265    0.006487  20.6981 0.000000
## beta2    0.392030    0.005198  75.4221 0.000000
## beta3    0.445062    0.004263 104.4113 0.000000
## gamma1  -0.025375    0.013065  -1.9422 0.052115
## skew     1.134488    0.037318  30.4002 0.000000
## shape    3.802105    0.360754  10.5393 0.000000
##
```

```
## Robust Standard Errors:
##          Estimate  Std. Error  t value Pr(>|t|)
## mu       0.001002    0.000522    1.9211 0.054717
## ar1      0.068221    0.023034    2.9617 0.003059
## omega    0.000003    0.000002    1.1354 0.256213
## alpha1   0.035149    0.013164    2.6700 0.007584
## beta1    0.134265    0.009667   13.8892 0.000000
## beta2    0.392030    0.005323   73.6454 0.000000
## beta3    0.445062    0.001196  372.0647 0.000000
## gamma1  -0.025375    0.022260   -1.1399 0.254312
## skew     1.134488    0.040282   28.1633 0.000000
## shape    3.802105    0.393369    9.6655 0.000000
##
## LogLikelihood : 4389.106
##
## Information Criteria
## ---------------------------------
##
## Akaike        -5.1188
## Bayes         -5.0869
## Shibata       -5.1188
## Hannan-Quinn  -5.1070
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                             statistic p-value
## Lag[1]                          1.794 0.18044
## Lag[2*(p+q)+(p+q)-1][2]         3.428 0.01470
## Lag[4*(p+q)+(p+q)-1][5]         5.386 0.07788
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                             statistic   p-value
## Lag[1]                          29.85 4.673e-08
## Lag[2*(p+q)+(p+q)-1][11]        46.44 4.544e-11
## Lag[4*(p+q)+(p+q)-1][19]        49.36 1.335e-09
## d.o.f=4
##
## Weighted ARCH LM Tests
## ---------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[5]    0.5495 0.500 2.000  0.4585
## ARCH Lag[7]    0.8048 1.473 1.746  0.8124
## ARCH Lag[9]    0.9863 2.402 1.619  0.9332
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  93.1594
## Individual Statistics:
## mu     0.09787
## ar1    0.37615
## omega  5.61479
```

```
## alpha1 0.10599
## beta1  0.15753
## beta2  0.15784
## beta3  0.15837
## gamma1 0.15470
## skew   0.31131
## shape  0.12551
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          2.29 2.54 3.05
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                      t-value       prob sig
## Sign Bias             0.9691 0.3326233
## Negative Sign Bias   3.1047 0.0019359 ***
## Positive Sign Bias   2.9164 0.0035868 ***
## Joint Effect        19.5202 0.0002134 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20    12.64        0.8567
## 2     30    14.32        0.9896
## 3     40    27.66        0.9128
## 4     50    31.87        0.9724
##
##
## Elapsed time : 3.796001
```

```r
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(3,1)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## ------------------------------------
## GARCH Model  : gjrGARCH(3,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##          Estimate  Std. Error    t value Pr(>|t|)
## mu       0.000954    0.000327   2.917866 0.003524
## ar1      0.063416    0.022260   2.848911 0.004387
## omega    0.000001    0.000001   1.616038 0.106086
## alpha1   0.012018    0.003844   3.126464 0.001769
```

```
## alpha2  0.000000     0.038529     0.000001 0.999999
## alpha3  0.000000     0.044948     0.000001 0.999999
## beta1   0.993397     0.000820 1210.942981 0.000000
## gamma1  0.176610     0.000990  178.350844 0.000000
## gamma2 -0.048113     0.004169  -11.541650 0.000000
## gamma3 -0.144040     0.003578  -40.260104 0.000000
## skew    1.143089     0.030641   37.306096 0.000000
## shape   3.963093     0.473081    8.377197 0.000000
##
## Robust Standard Errors:
##          Estimate  Std. Error   t value Pr(>|t|)
## mu      0.000954    0.002897    0.32941 0.741845
## ar1     0.063416    0.050715    1.25045 0.211135
## omega   0.000001    0.000003    0.31643 0.751675
## alpha1  0.012018    0.037353    0.32175 0.747643
## alpha2  0.000000    0.231181    0.00000 1.000000
## alpha3  0.000000    0.261977    0.00000 1.000000
## beta1   0.993397    0.004584  216.70656 0.000000
## gamma1  0.176610    0.005890   29.98556 0.000000
## gamma2 -0.048113    0.024916   -1.93104 0.053478
## gamma3 -0.144040    0.017625   -8.17231 0.000000
## skew    1.143089    0.152989    7.47172 0.000000
## shape   3.963093    2.901808    1.36573 0.172023
##
## LogLikelihood : 4397.704
##
## Information Criteria
## ---------------------------------
##
## Akaike        -5.1265
## Bayes         -5.0883
## Shibata       -5.1266
## Hannan-Quinn -5.1123
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                          statistic   p-value
## Lag[1]                       3.638 0.0564701
## Lag[2*(p+q)+(p+q)-1][2]      5.304 0.0002138
## Lag[4*(p+q)+(p+q)-1][5]      7.106 0.0175208
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                          statistic   p-value
## Lag[1]                       37.94 7.288e-10
## Lag[2*(p+q)+(p+q)-1][11]     57.20 3.941e-14
## Lag[4*(p+q)+(p+q)-1][19]     61.17 8.932e-13
## d.o.f=4
##
## Weighted ARCH LM Tests
## ---------------------------------
##             Statistic Shape Scale P-Value
```

```
## ARCH Lag[5]    0.4281 0.500 2.000  0.5129
## ARCH Lag[7]    0.8721 1.473 1.746  0.7933
## ARCH Lag[9]    1.5645 2.402 1.619  0.8405
##
## Nyblom stability test
## -----------------------------------
## Joint Statistic:  352.593
## Individual Statistics:
## mu      0.05672
## ar1     0.28967
## omega  48.59588
## alpha1  0.15962
## alpha2  0.18816
## alpha3  0.20461
## beta1   0.17454
## gamma1  0.19180
## gamma2  0.19083
## gamma3  0.19158
## skew    0.40980
## shape   0.19717
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:         2.69 2.96 3.51
## Individual Statistic:    0.35 0.47 0.75
##
## Sign Bias Test
## -----------------------------------
##                    t-value      prob sig
## Sign Bias           0.4466 6.552e-01
## Negative Sign Bias  0.6008 5.481e-01
## Positive Sign Bias  4.7319 2.408e-06 ***
## Joint Effect       27.7099 4.179e-06 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -----------------------------------
##   group statistic p-value(g-1)
## 1    20    4.406        0.9998
## 2    30   17.445        0.9548
## 3    40   27.095        0.9249
## 4    50   30.993        0.9792
##
##
## Elapsed time : 10.171
```

```r
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(2,3)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
```

```
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(2,3)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Convergence Problem:
## Solver Message:
```

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(3,2)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(3,2)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## -----------------------------------
##         Estimate  Std. Error     t value Pr(>|t|)
## mu      0.001003    0.000482    2.082159 0.037328
## ar1     0.063491    0.024091    2.635489 0.008402
## omega   0.000001    0.000000   16.954286 0.000000
## alpha1  0.020915    0.000689   30.361910 0.000000
## alpha2  0.000058    0.008532    0.006805 0.994570
## alpha3  0.000041    0.007534    0.005482 0.995626
## beta1   0.394564    0.000399  988.297737 0.000000
## beta2   0.592488    0.002257  262.560779 0.000000
## gamma1  0.162475    0.001257  129.222067 0.000000
## gamma2 -0.053456    0.006587   -8.115346 0.000000
## gamma3 -0.132414    0.000546 -242.536679 0.000000
## skew    1.140339    0.037897   30.090295 0.000000
## shape   3.912920    0.360636   10.850041 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error     t value Pr(>|t|)
## mu      0.001003    0.000504    1.990725 0.046511
## ar1     0.063491    0.024641    2.576626 0.009977
## omega   0.000001    0.000000    9.416683 0.000000
## alpha1  0.020915    0.003015    6.936393 0.000000
## alpha2  0.000058    0.008448    0.006873 0.994516
## alpha3  0.000041    0.007073    0.005839 0.995341
## beta1   0.394564    0.000522  755.392371 0.000000
## beta2   0.592488    0.002802  211.485181 0.000000
## gamma1  0.162475    0.000411  395.659575 0.000000
## gamma2 -0.053456    0.007961   -6.714858 0.000000
## gamma3 -0.132414    0.001935  -68.429630 0.000000
```

```
## skew    1.140339    0.041576  27.427841 0.000000
## shape   3.912920    0.352966  11.085839 0.000000
##
## LogLikelihood : 4395.481
##
## Information Criteria
## ---------------------------------
##
## Akaike       -5.1227
## Bayes        -5.0813
## Shibata      -5.1228
## Hannan-Quinn -5.1074
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                          statistic  p-value
## Lag[1]                       2.948 0.085999
## Lag[2*(p+q)+(p+q)-1][2]      4.619 0.001065
## Lag[4*(p+q)+(p+q)-1][5]      6.417 0.032448
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                          statistic  p-value
## Lag[1]                       25.96 3.481e-07
## Lag[2*(p+q)+(p+q)-1][14]     44.67 1.077e-09
## Lag[4*(p+q)+(p+q)-1][24]     49.80 1.708e-08
## d.o.f=5
##
## Weighted ARCH LM Tests
## ---------------------------------
##             Statistic Shape Scale P-Value
## ARCH Lag[6]    0.2357 0.500 2.000  0.6273
## ARCH Lag[8]    0.5323 1.480 1.774  0.8922
## ARCH Lag[10]   1.0158 2.424 1.650  0.9342
##
## Nyblom stability test
## ---------------------------------
## Joint Statistic:  230.9085
## Individual Statistics:
## mu      0.05955
## ar1     0.28414
## omega  20.49630
## alpha1  0.13273
## alpha2  0.17170
## alpha3  0.18120
## beta1   0.16803
## beta2   0.16820
## gamma1  0.17193
## gamma2  0.17303
## gamma3  0.16815
## skew    0.37563
## shape   0.16733
```

```
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          2.89 3.15 3.69
## Individual Statistic:     0.35 0.47 0.75
##
## Sign Bias Test
## -------------------------------------
##                    t-value      prob sig
## Sign Bias          0.01682 9.866e-01
## Negative Sign Bias 0.65317 5.137e-01
## Positive Sign Bias 3.91795 9.283e-05 ***
## Joint Effect      20.78570 1.166e-04 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## -------------------------------------
##   group statistic p-value(g-1)
## 1    20     11.68       0.8990
## 2    30     17.06       0.9612
## 3    40     29.15       0.8746
## 4    50     33.80       0.9517
##
##
## Elapsed time : 5.876993
```

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(3,3)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
##
## *---------------------------------*
## *          GARCH Model Fit        *
## *---------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(3,3)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## -----------------------------------
##         Estimate  Std. Error     t value Pr(>|t|)
## mu      0.000530    0.000456    1.161636 0.245384
## ar1     0.055797    0.021936    2.543678 0.010969
## omega   0.000009    0.000002    3.701944 0.000214
## alpha1  0.030182    0.003360    8.982847 0.000000
## alpha2  0.000000    0.017878    0.000002 0.999999
## alpha3  0.000000    0.015133    0.000000 1.000000
## beta1   0.527362    0.000407 1295.181143 0.000000
## beta2   0.145327    0.001459   99.624414 0.000000
## beta3   0.262306    0.001984  132.204228 0.000000
## gamma1  0.157617    0.010851   14.525269 0.000000
## gamma2  0.144342    0.012985   11.115758 0.000000
```

```
## gamma3 -0.262287     0.000891 -294.400176 0.000000
## skew     1.119412     0.036398   30.755182 0.000000
## shape    4.055594     0.335250   12.097223 0.000000
##
## Robust Standard Errors:
##          Estimate   Std. Error      t value Pr(>|t|)
## mu       0.000530     0.000474     1.118218 0.263474
## ar1      0.055797     0.022451     2.485269 0.012945
## omega    0.000009     0.000003     2.599090 0.009347
## alpha1   0.030182     0.004086     7.386280 0.000000
## alpha2   0.000000     0.021046     0.000002 0.999999
## alpha3   0.000000     0.017641     0.000000 1.000000
## beta1    0.527362     0.000313 1682.915179 0.000000
## beta2    0.145327     0.003701    39.262023 0.000000
## beta3    0.262306     0.001019   257.289229 0.000000
## gamma1   0.157617     0.005471    28.808692 0.000000
## gamma2   0.144342     0.014042    10.279502 0.000000
## gamma3  -0.262287     0.001029  -254.944764 0.000000
## skew     1.119412     0.038984    28.714363 0.000000
## shape    4.055594     0.327123    12.397752 0.000000
##
## LogLikelihood : 4387.786
##
## Information Criteria
## ---------------------------------
##
## Akaike        -5.1125
## Bayes         -5.0680
## Shibata       -5.1127
## Hannan-Quinn  -5.0961
##
## Weighted Ljung-Box Test on Standardized Residuals
## ---------------------------------
##                           statistic   p-value
## Lag[1]                        4.931 2.638e-02
## Lag[2*(p+q)+(p+q)-1][2]       6.281 1.985e-05
## Lag[4*(p+q)+(p+q)-1][5]       7.780 9.417e-03
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ---------------------------------
##                           statistic   p-value
## Lag[1]                        22.62 1.978e-06
## Lag[2*(p+q)+(p+q)-1][17]      43.43 1.484e-08
## Lag[4*(p+q)+(p+q)-1][29]      49.75 2.094e-07
## d.o.f=6
##
## Weighted ARCH LM Tests
## ---------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[7]     0.1426 0.500 2.000  0.7057
## ARCH Lag[9]     0.6289 1.485 1.796  0.8696
## ARCH Lag[11]    1.2523 2.440 1.677  0.9059
```

```
## 
## Nyblom stability test
## -----------------------------------
## Joint Statistic:  24.4062
## Individual Statistics:
## mu     0.1594
## ar1    0.4324
## omega  1.7146
## alpha1 0.1266
## alpha2 0.1583
## alpha3 0.1910
## beta1  0.1690
## beta2  0.1714
## beta3  0.1723
## gamma1 0.1604
## gamma2 0.1569
## gamma3 0.1421
## skew   0.3474
## shape  0.1763
## 
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:          3.08 3.34 3.9
## Individual Statistic:     0.35 0.47 0.75
## 
## Sign Bias Test
## -----------------------------------
##                    t-value       prob sig
## Sign Bias           0.2944 0.7684637
## Negative Sign Bias  0.6573 0.5110458
## Positive Sign Bias  3.4846 0.0005053 ***
## Joint Effect       18.0790 0.0004236 ***
## 
## 
## Adjusted Pearson Goodness-of-Fit Test:
## -----------------------------------
##   group statistic p-value(g-1)
## 1    20     7.819       0.9884
## 2    30    21.443       0.8425
## 3    40    22.279       0.9855
## 4    50    30.175       0.9842
## 
## 
## Elapsed time : 9.422992
```

going further is not leading any good results

```
spec_of_garch_LT<-ugarchspec(variance.model =list(model="gjrGARCH",garchOrder=c(3,1)),mean.model = list
my_model_LT<-ugarchfit(spec=spec_of_garch_LT,data=ret_LT,out.sample = 500)
my_model_LT
```

```
## 
## *---------------------------------*
## *          GARCH Model Fit        *
```

```
## *--------------------------------*
##
## Conditional Variance Dynamics
## -----------------------------------
## GARCH Model  : gjrGARCH(3,1)
## Mean Model   : ARFIMA(1,0,0)
## Distribution : sstd
##
## Optimal Parameters
## ------------------------------------
##         Estimate  Std. Error      t value Pr(>|t|)
## mu      0.000954    0.000327     2.917866 0.003524
## ar1     0.063416    0.022260     2.848911 0.004387
## omega   0.000001    0.000001     1.616038 0.106086
## alpha1  0.012018    0.003844     3.126464 0.001769
## alpha2  0.000000    0.038529     0.000001 0.999999
## alpha3  0.000000    0.044948     0.000001 0.999999
## beta1   0.993397    0.000820  1210.942981 0.000000
## gamma1  0.176610    0.000990   178.350844 0.000000
## gamma2 -0.048113    0.004169   -11.541650 0.000000
## gamma3 -0.144040    0.003578   -40.260104 0.000000
## skew    1.143089    0.030641    37.306096 0.000000
## shape   3.963093    0.473081     8.377197 0.000000
##
## Robust Standard Errors:
##         Estimate  Std. Error   t value Pr(>|t|)
## mu      0.000954    0.002897   0.32941 0.741845
## ar1     0.063416    0.050715   1.25045 0.211135
## omega   0.000001    0.000003   0.31643 0.751675
## alpha1  0.012018    0.037353   0.32175 0.747643
## alpha2  0.000000    0.231181   0.00000 1.000000
## alpha3  0.000000    0.261977   0.00000 1.000000
## beta1   0.993397    0.004584 216.70656 0.000000
## gamma1  0.176610    0.005890  29.98556 0.000000
## gamma2 -0.048113    0.024916  -1.93104 0.053478
## gamma3 -0.144040    0.017625  -8.17231 0.000000
## skew    1.143089    0.152989   7.47172 0.000000
## shape   3.963093    2.901808   1.36573 0.172023
##
## LogLikelihood : 4397.704
##
## Information Criteria
## ------------------------------------
##
## Akaike       -5.1265
## Bayes        -5.0883
## Shibata      -5.1266
## Hannan-Quinn -5.1123
##
## Weighted Ljung-Box Test on Standardized Residuals
## ------------------------------------
##                       statistic  p-value
## Lag[1]                    3.638 0.0564701
## Lag[2*(p+q)+(p+q)-1][2]   5.304 0.0002138
```

```
## Lag[4*(p+q)+(p+q)-1][5]      7.106 0.0175208
## d.o.f=1
## H0 : No serial correlation
##
## Weighted Ljung-Box Test on Standardized Squared Residuals
## ------------------------------------
##                             statistic   p-value
## Lag[1]                          37.94 7.288e-10
## Lag[2*(p+q)+(p+q)-1][11]        57.20 3.941e-14
## Lag[4*(p+q)+(p+q)-1][19]        61.17 8.932e-13
## d.o.f=4
##
## Weighted ARCH LM Tests
## ------------------------------------
##              Statistic Shape Scale P-Value
## ARCH Lag[5]     0.4281 0.500 2.000  0.5129
## ARCH Lag[7]     0.8721 1.473 1.746  0.7933
## ARCH Lag[9]     1.5645 2.402 1.619  0.8405
##
## Nyblom stability test
## ------------------------------------
## Joint Statistic:  352.593
## Individual Statistics:
## mu      0.05672
## ar1     0.28967
## omega  48.59588
## alpha1  0.15962
## alpha2  0.18816
## alpha3  0.20461
## beta1   0.17454
## gamma1  0.19180
## gamma2  0.19083
## gamma3  0.19158
## skew    0.40980
## shape   0.19717
##
## Asymptotic Critical Values (10% 5% 1%)
## Joint Statistic:        2.69 2.96 3.51
## Individual Statistic:   0.35 0.47 0.75
##
## Sign Bias Test
## ------------------------------------
##                    t-value      prob sig
## Sign Bias           0.4466 6.552e-01
## Negative Sign Bias  0.6008 5.481e-01
## Positive Sign Bias  4.7319 2.408e-06 ***
## Joint Effect       27.7099 4.179e-06 ***
##
##
## Adjusted Pearson Goodness-of-Fit Test:
## ------------------------------------
##    group statistic p-value(g-1)
## 1     20     4.406       0.9998
## 2     30    17.445       0.9548
```

```
## 3    40    27.095         0.9249
## 4    50    30.993         0.9792
##
##
## Elapsed time : 6.320003
```

```r
back_testing<-ugarchroll(spec_of_garch_LT,ret_LT,n.ahead=1,n.start = 2000,refit.every  =30,refit.window
```

```
##
## Iter: 1 fn: -5023.2196    Pars:    4.993e-04  5.821e-02  1.317e-05  3.797e-02  1.354e-08  1.183e-11  9
## Iter: 2 fn: -5023.2196    Pars:    4.992e-04  5.820e-02  1.317e-05  3.797e-02  1.351e-08  8.533e-16  9
## Iter: 3 fn: -5023.2196    Pars:    4.993e-04  5.820e-02  1.317e-05  3.797e-02  1.351e-08  2.548e-16  9
## Iter: 4 fn: -5023.2196    Pars:    4.993e-04  5.820e-02  1.317e-05  3.797e-02  1.351e-08  2.214e-16  9
## solnp--> Completed in 4 iterations
##
## Iter: 1 fn: -5014.9800    Pars:    0.00059160111  0.05790410750  0.00001161126  0.03958245825  0.00000
## Iter: 2 fn: -5014.9800    Pars:    0.00059160111  0.05790410750  0.00001161126  0.03958245825  0.00000
## solnp--> Completed in 2 iterations
##
## Iter: 1 fn: -4997.4099    Pars:    0.0006767004  0.0548740817  0.0000123802  0.0436199545  0.000000235
## Iter: 2 fn: -4997.4099    Pars:    6.767e-04  5.487e-02  1.238e-05  4.361e-02  9.912e-09  2.697e-12  9
## Iter: 3 fn: -4997.4099    Pars:    6.767e-04  5.487e-02  1.238e-05  4.361e-02  9.912e-09  2.697e-12  9
## solnp--> Completed in 3 iterations
##
## Iter: 1 fn: -4982.1370    Pars:    0.0007629200018  0.0495050756343  0.0000109168954  0.0376035543855
## Iter: 2 fn: -4982.1370    Pars:    7.629e-04  4.950e-02  1.092e-05  3.760e-02  9.651e-09  3.525e-11  9
## Iter: 3 fn: -4982.1370    Pars:    7.629e-04  4.950e-02  1.092e-05  3.760e-02  9.651e-09  3.525e-11  9
## solnp--> Completed in 3 iterations
##
## Iter: 1 fn: -4953.0579    Pars:    0.0006006073277  0.0526367770131  0.0000106095125  0.0377947188657
## Iter: 2 fn: -4953.0579    Pars:    0.0006006073277  0.0526367770131  0.0000106095125  0.0377947188657
## solnp--> Completed in 2 iterations
##
## Iter: 1 fn: -4910.8614    Pars:    0.00055561111  0.04515577736  0.00001158362  0.04121526381  0.00000
## Iter: 2 fn: -4910.8614    Pars:    0.0005556184546  0.0451556335504  0.0000115834053  0.0412150276547
## Iter: 3 fn: -4910.8614    Pars:    0.0005556184546  0.0451556335504  0.0000115834053  0.0412150276547
## solnp--> Completed in 3 iterations
##
## Iter: 1 fn: -4880.0984    Pars:    0.00063291226  0.04767755780  0.00001221280  0.04228984550  0.00000
## Iter: 2 fn: -4880.0984    Pars:    0.00063291226  0.04767755780  0.00001221280  0.04228984550  0.00000
## solnp--> Completed in 2 iterations
##
## Iter: 1 fn: -4852.6915    Pars:    0.0006535851752  0.0523427924861  0.0000130225823  0.0425814848666
## Iter: 2 fn: -4852.6915    Pars:    0.0006535851752  0.0523427924861  0.0000130225823  0.0425814848666
## solnp--> Completed in 2 iterations
```

```r
report(back_testing)
```

```
## VaR Backtest Report
## ===========================================
## Model:               gjrGARCH-sstd
## Backtest Length: 211
## Data:
```

```
## 
## ===============================================
## alpha:               1%
## Expected Exceed: 2.1
## Actual VaR Exceed:   6
## Actual %:            2.8%
## 
## Unconditional Coverage (Kupiec)
## Null-Hypothesis: Correct Exceedances
## LR.uc Statistic: 4.834
## LR.uc Critical:      3.841
## LR.uc p-value:       0.028
## Reject Null:     YES
## 
## Conditional Coverage (Christoffersen)
## Null-Hypothesis: Correct Exceedances and
##                  Independence of Failures
## LR.cc Statistic: 5.187
## LR.cc Critical:      5.991
## LR.cc p-value:       0.075
## Reject Null:     NO
```
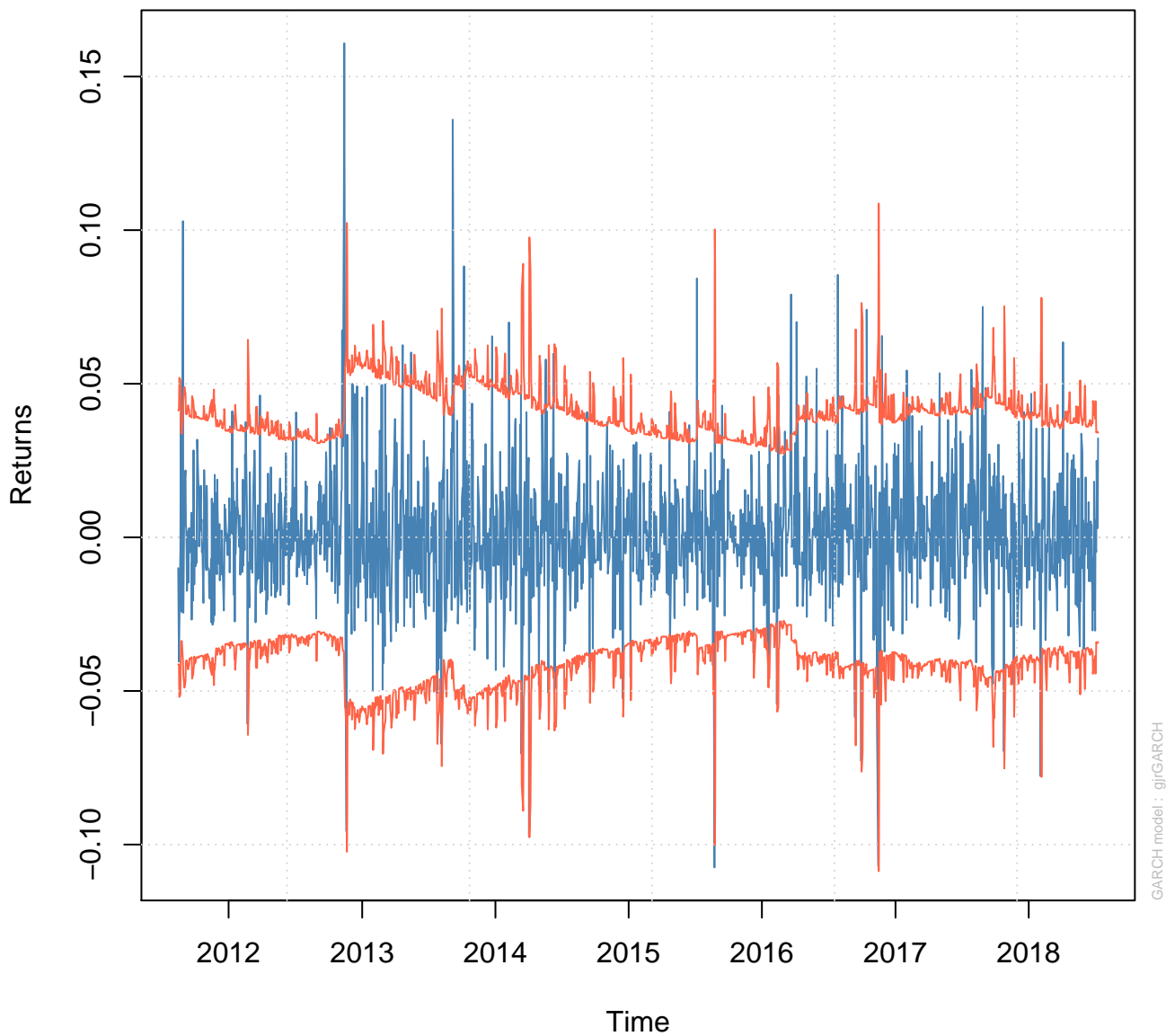
```r
forecast<- ugarchforecast(my_model_LT,data=ret_LT,out.sample = 500,n.ahead =100,n.roll = 100)
```

Series with 2 Conditional SD Superimposed

GARCH model : gjrGARCH

Series with with 1% VaR Limits

GARCH model : gjrGARCH
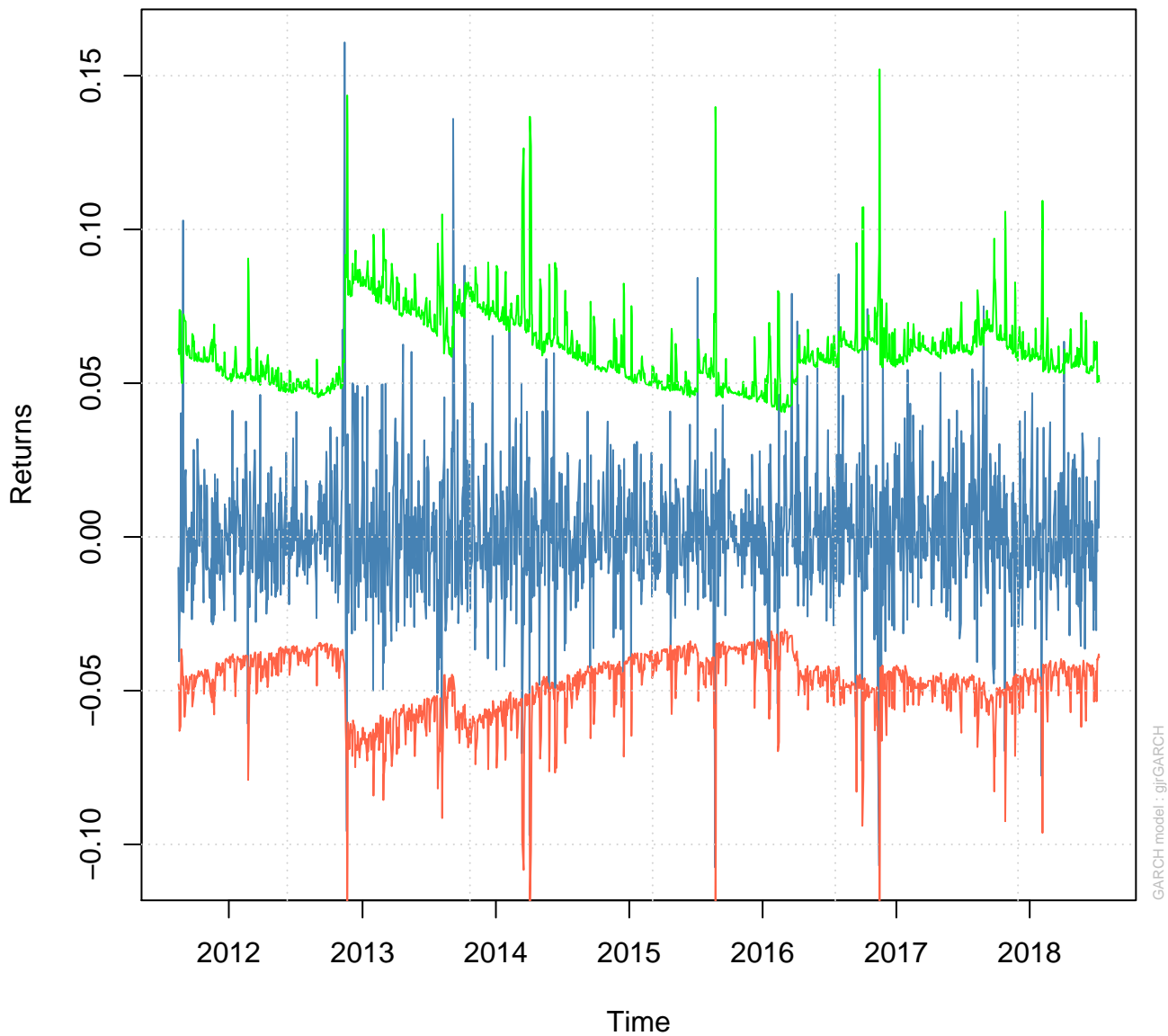
Conditional SD (vs |returns|)

GARCH model : gjrGARCH
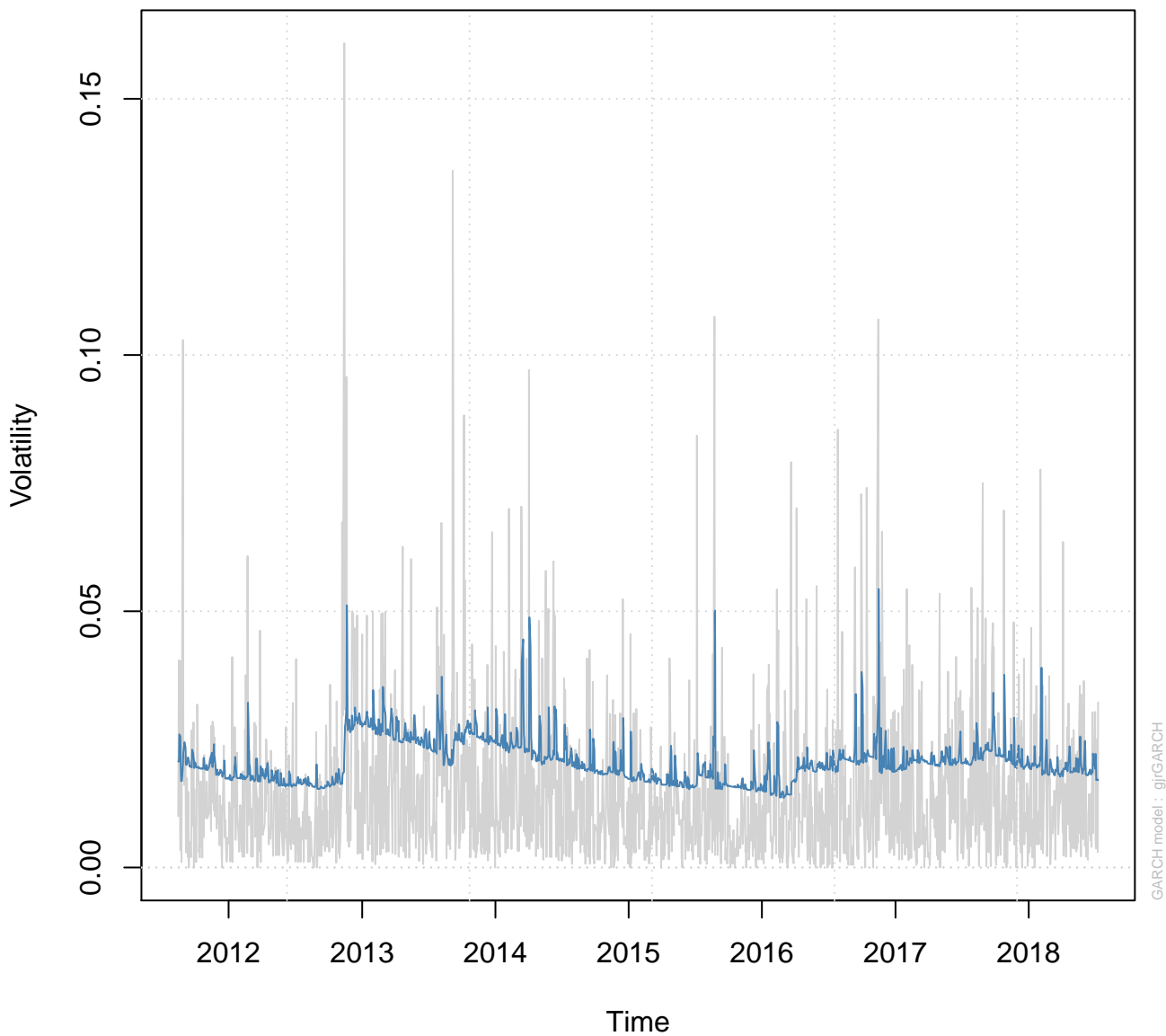
ACF of Observations

GARCH model : gjrGARCH
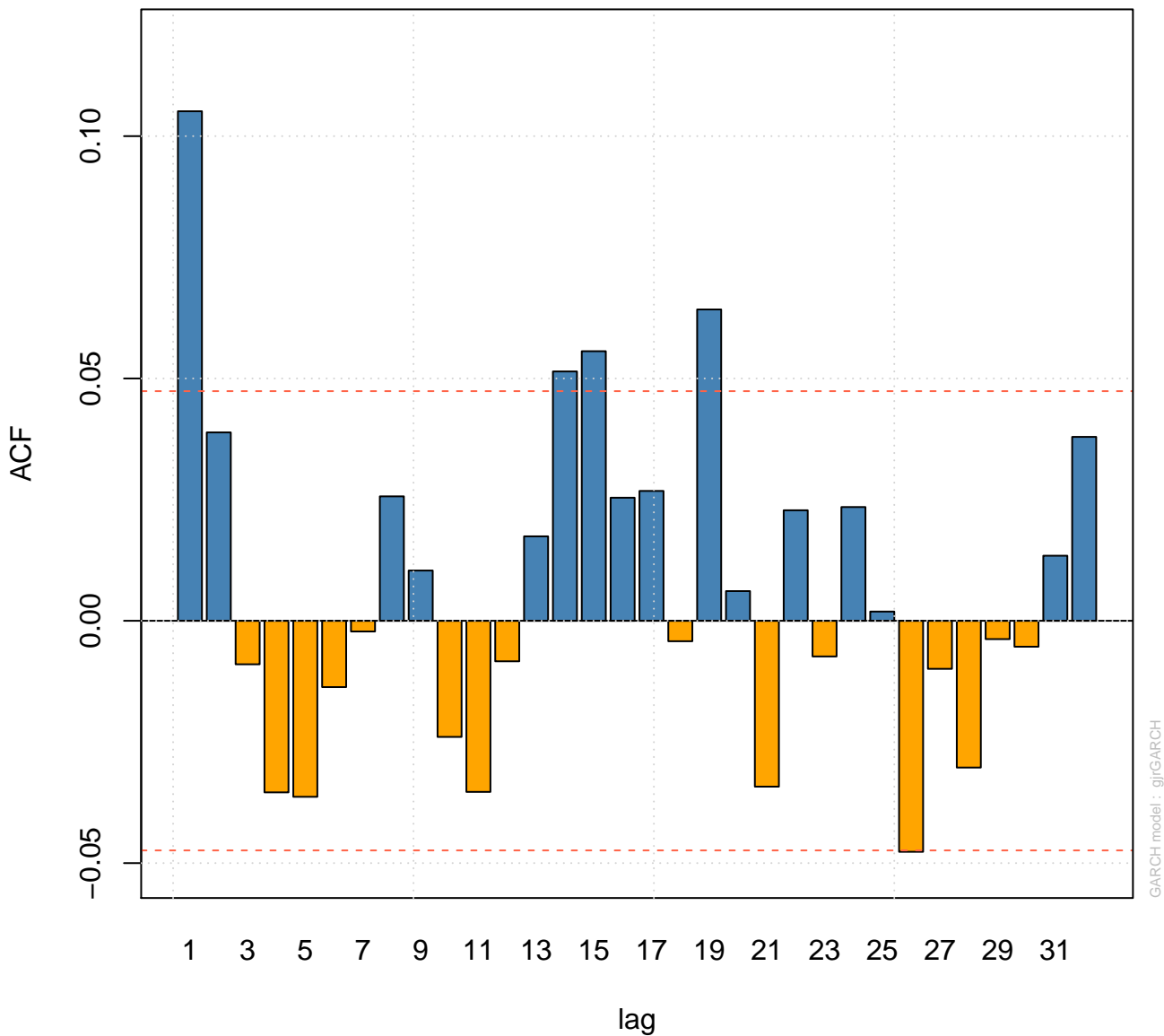
ACF of Squared Observations
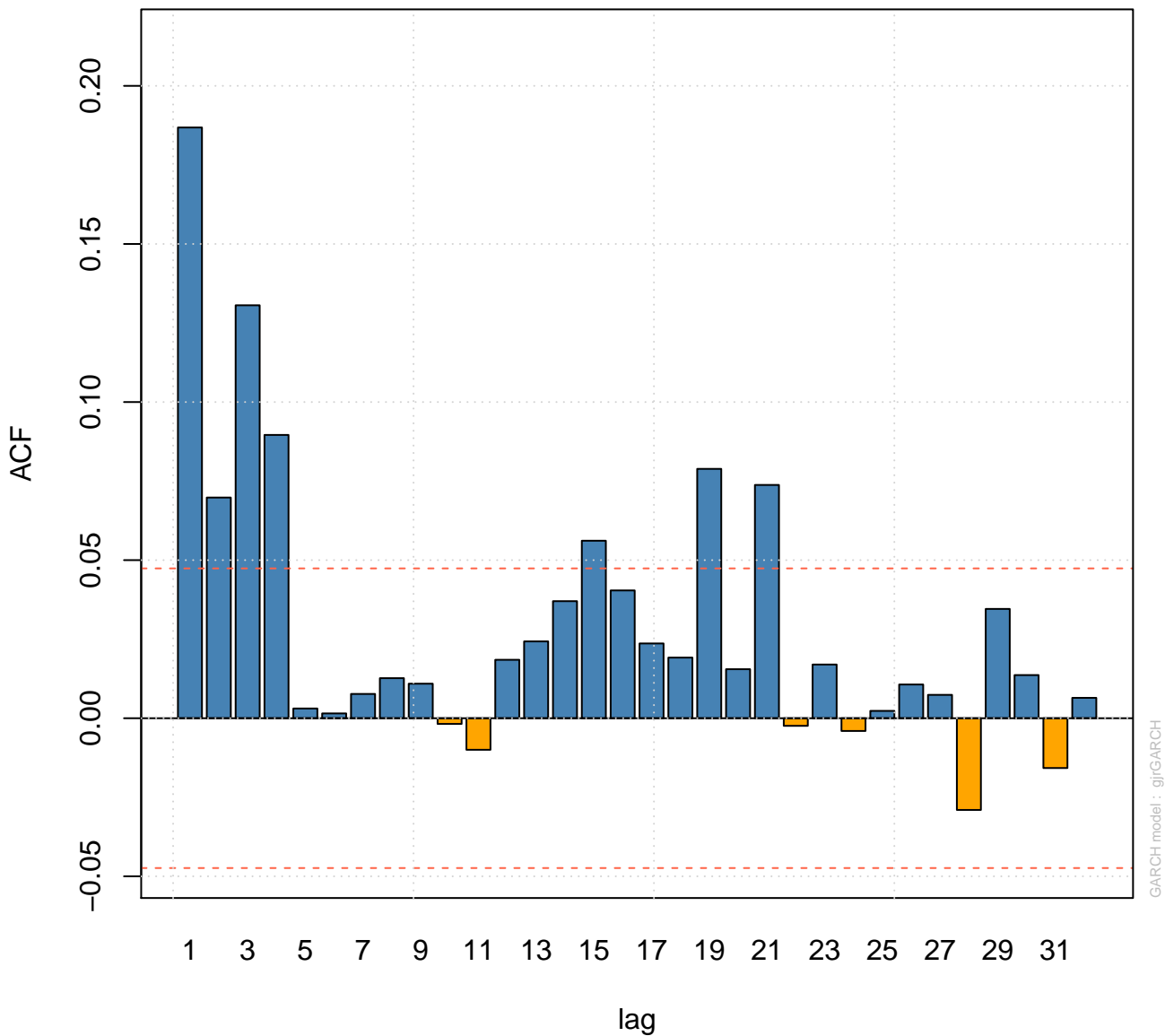
ACF of Absolute Observations
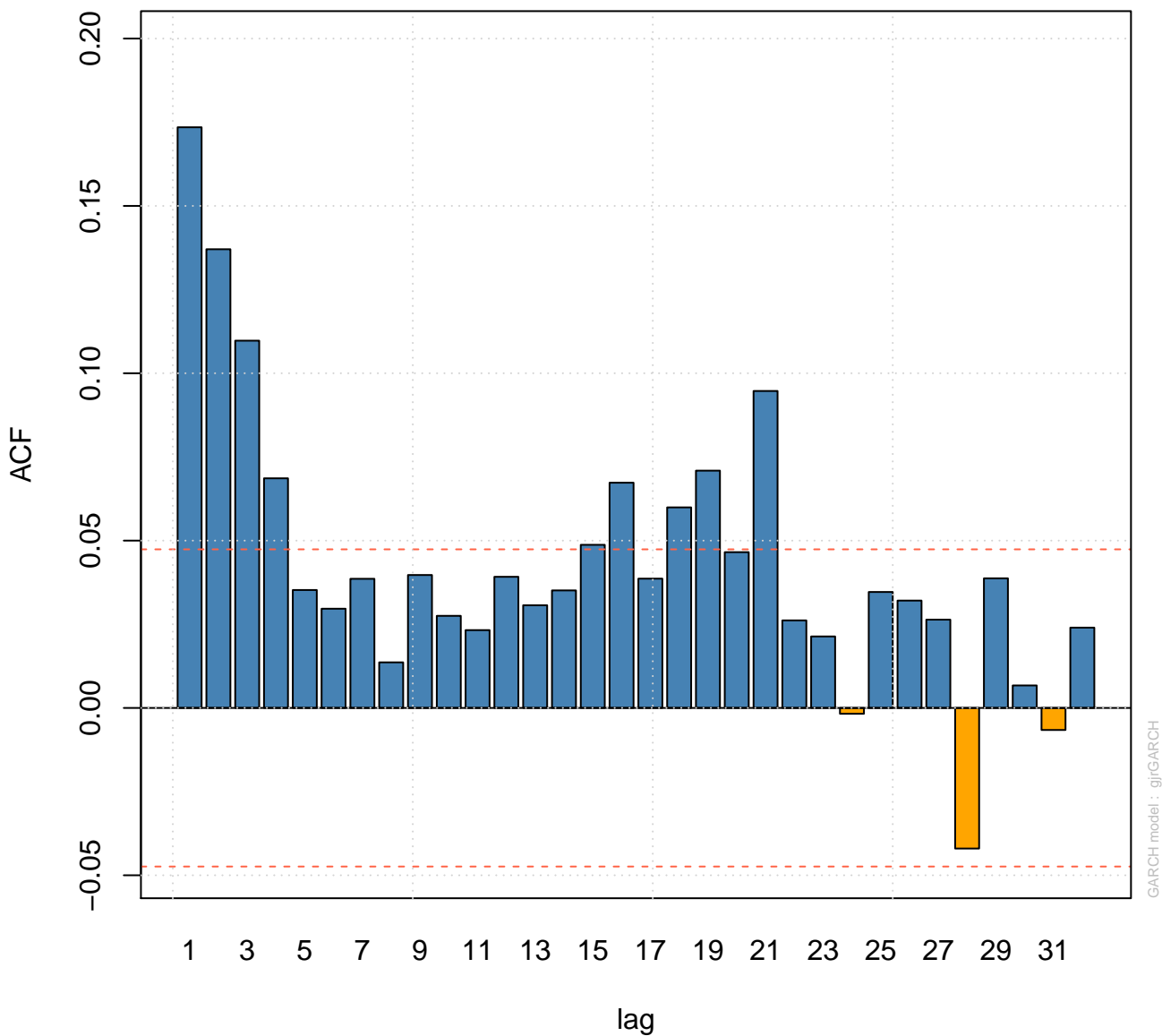
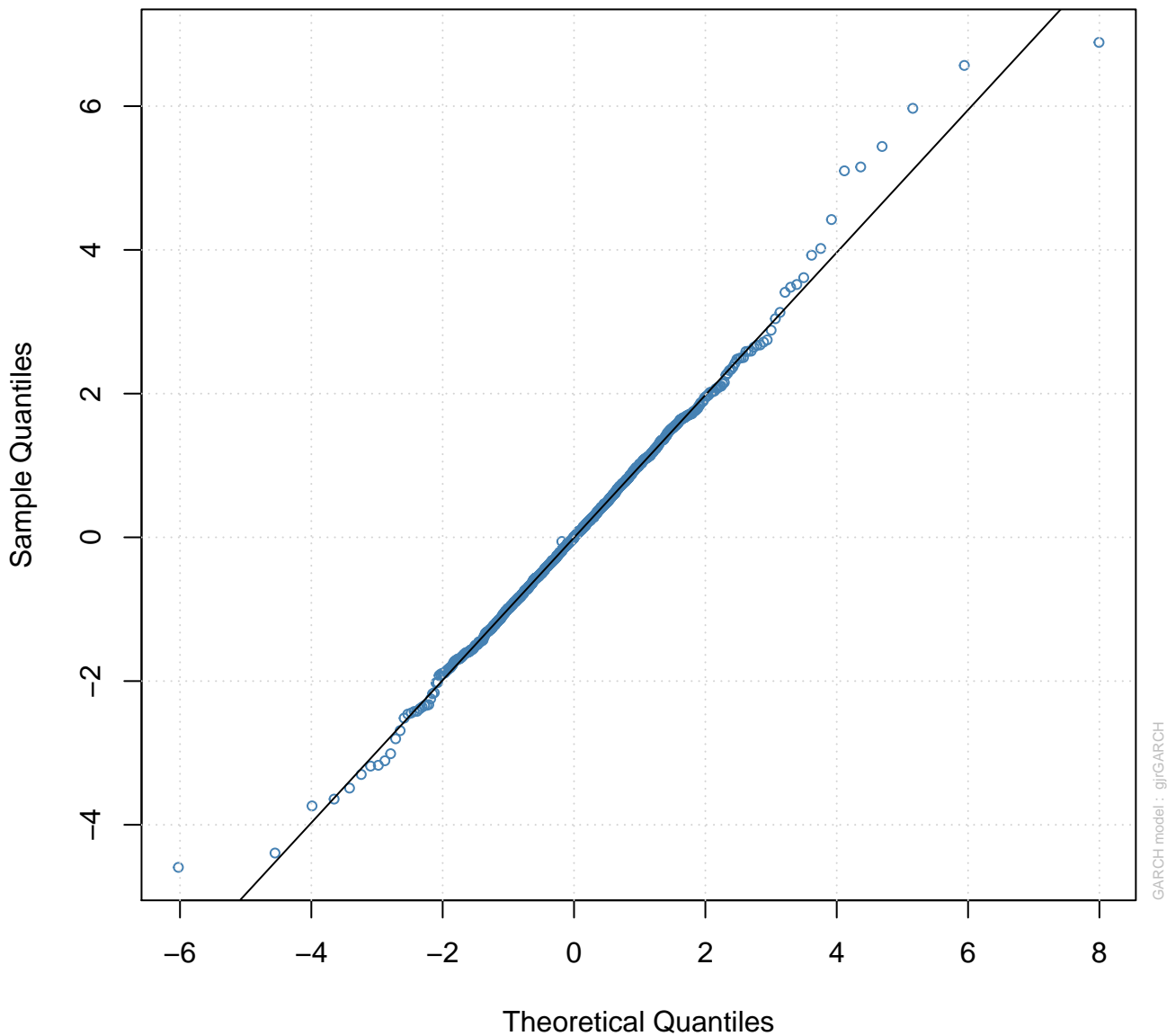**Cross–Correlations of Squared vs Actual Observations**

GARCH model : gjrGARCH
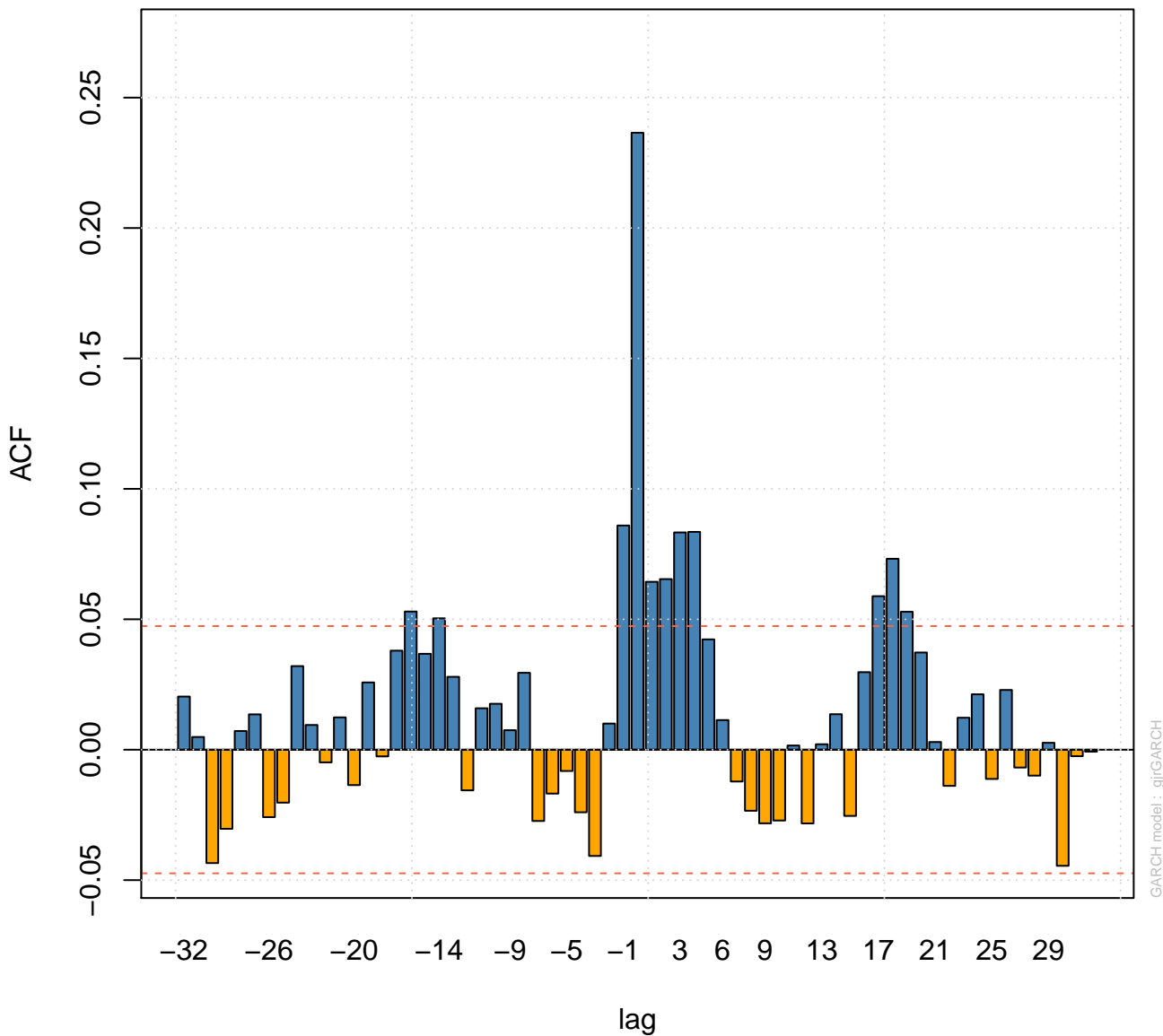
Empirical Density of Standardized Residuals

Median: −0.06 | Mean: 0.00226

- normal Density
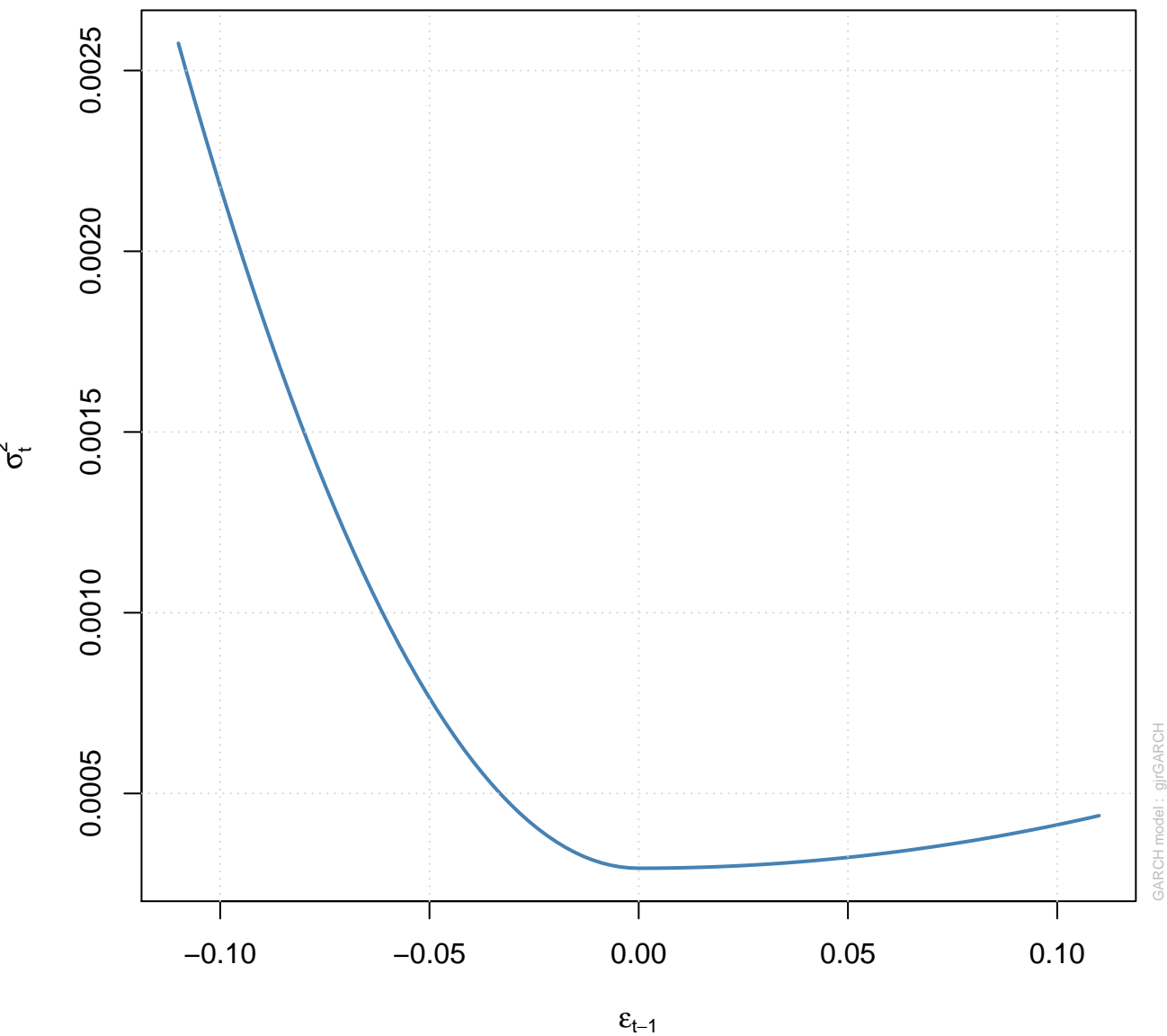- sstd (0,1) Fitted Density

Probability

zseries

GARCH model : gjrGARCH

sstd − QQ Plot

Theoretical Quantiles

Sample Quantiles

GARCH model : gjrGARCH
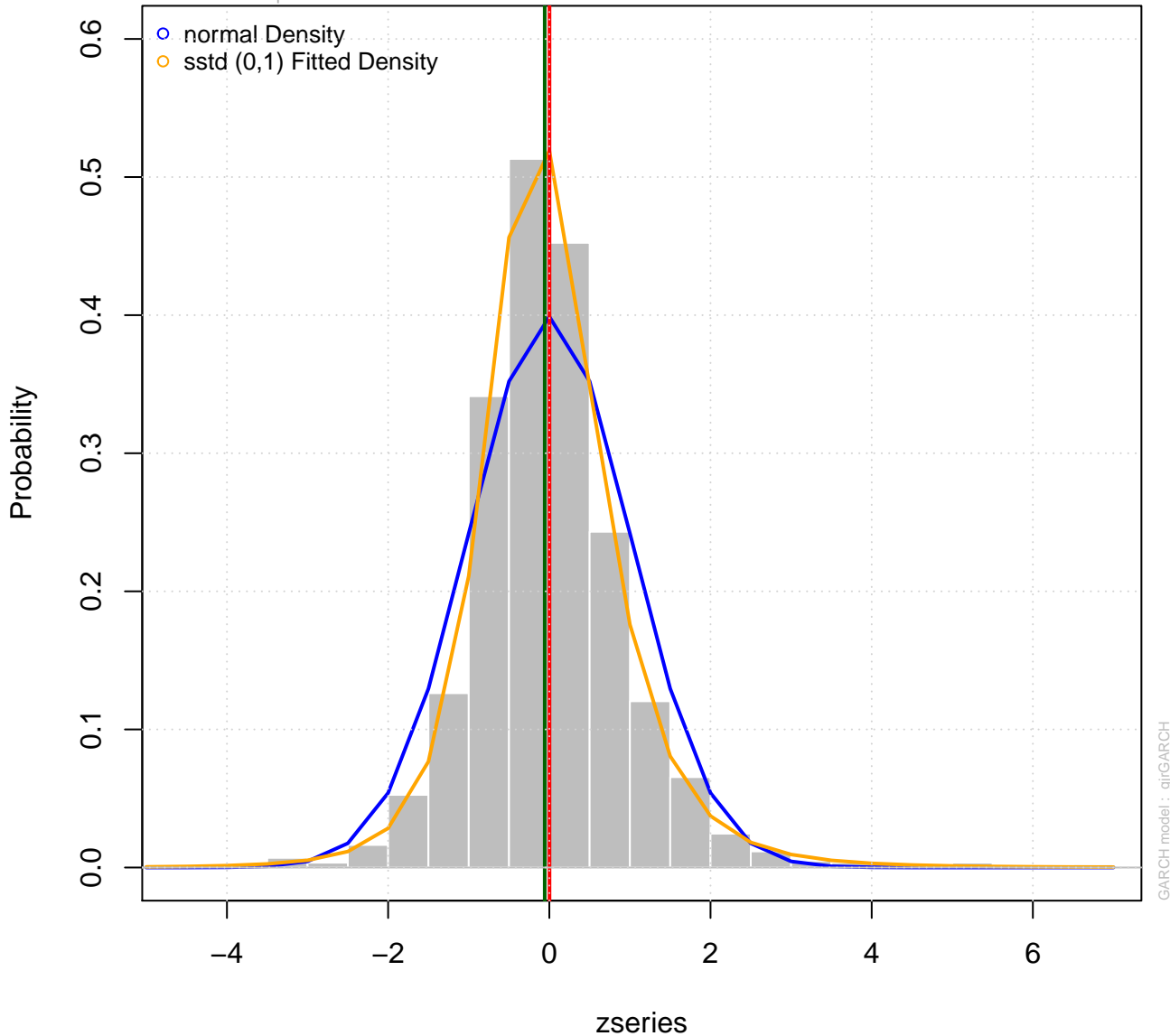
ACF of Standardized Residuals
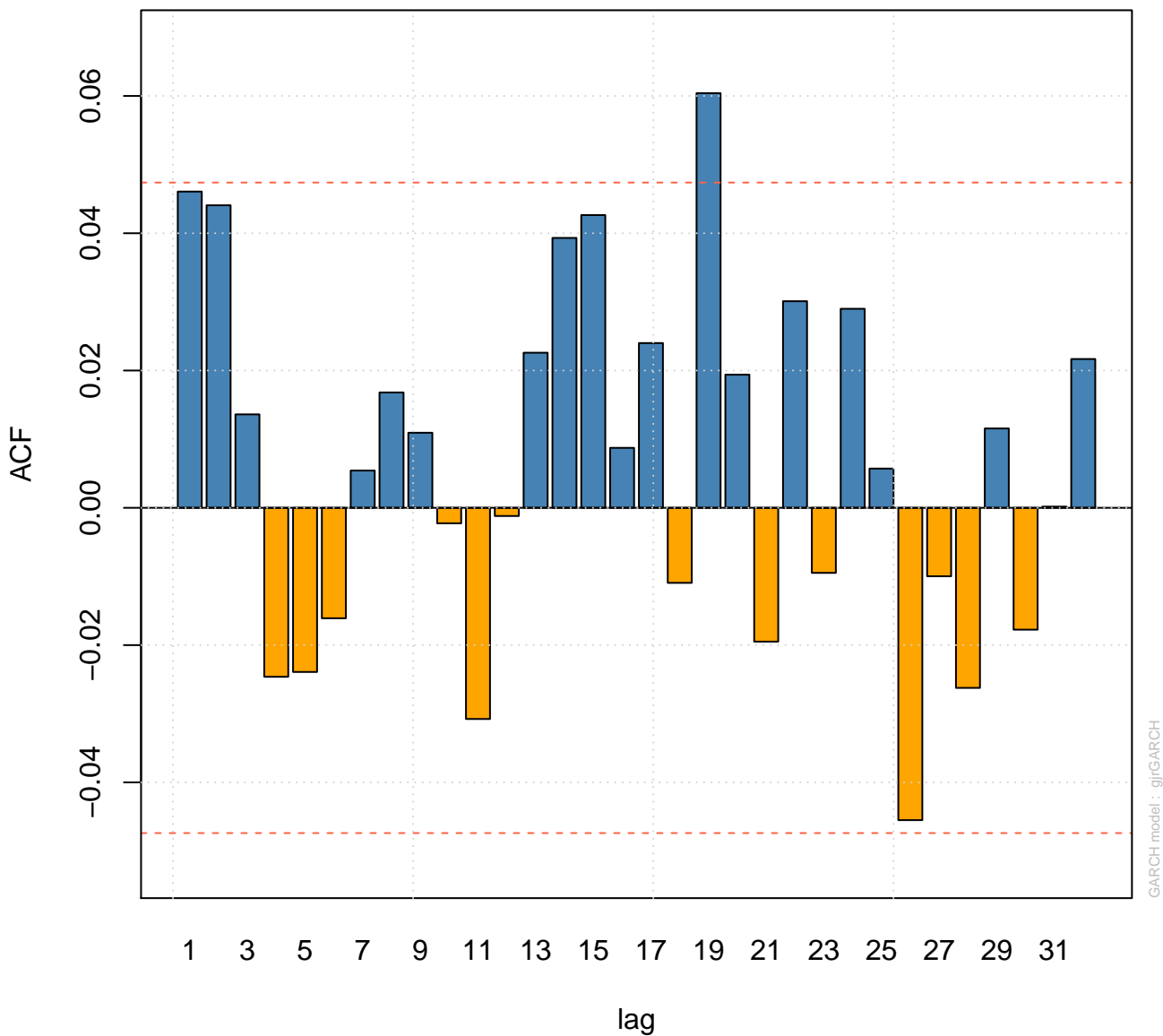
ACF of Squared Standardized Residuals

News Impact Curve
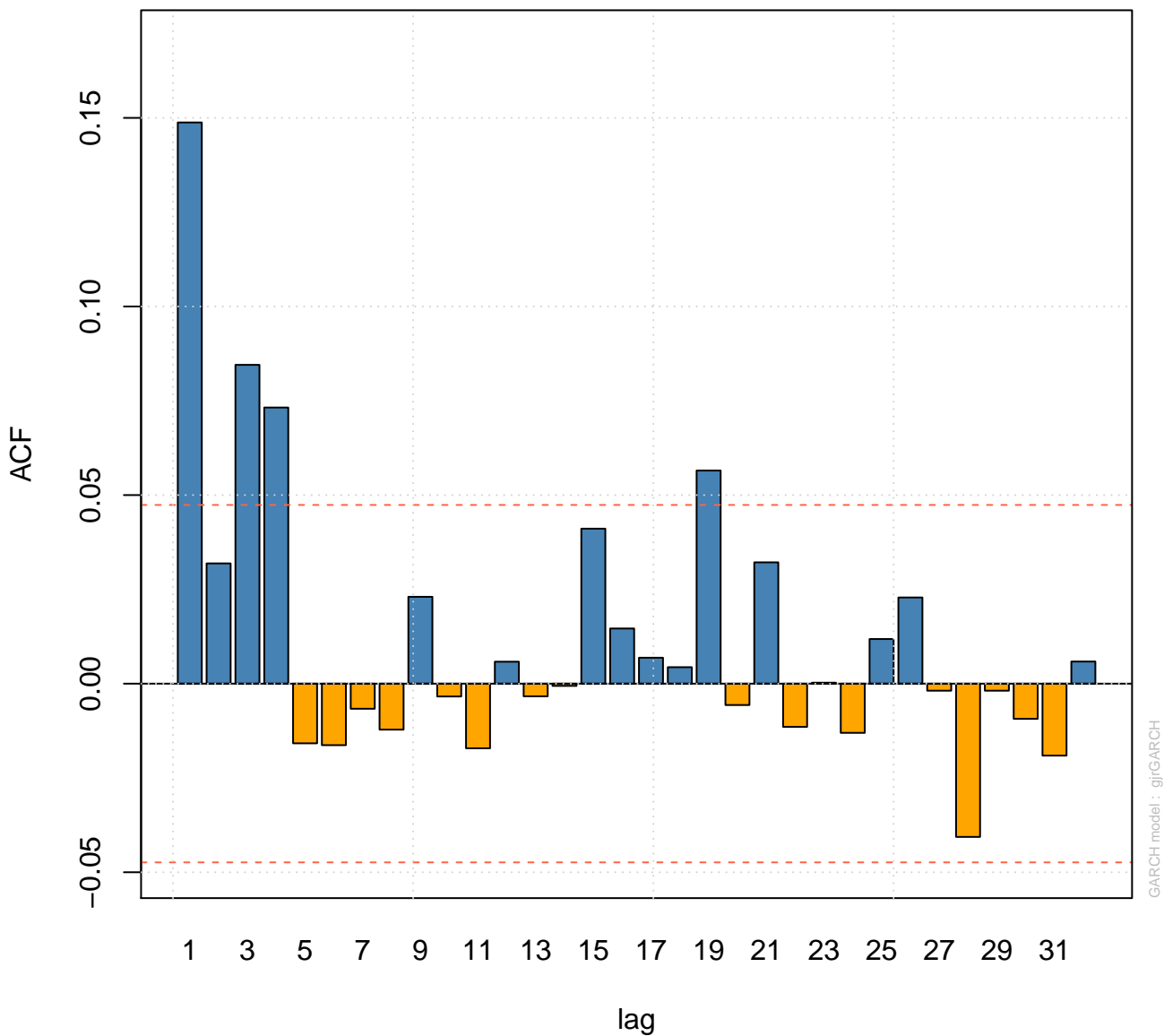
GARCH model : gjrGARCH

Forecast Series
w/th unconditional 1−Sigma bands

Horizon: 100

○ Actual
○ Forecast

Series

Time/Horizon

GARCH model : gjrGARCH
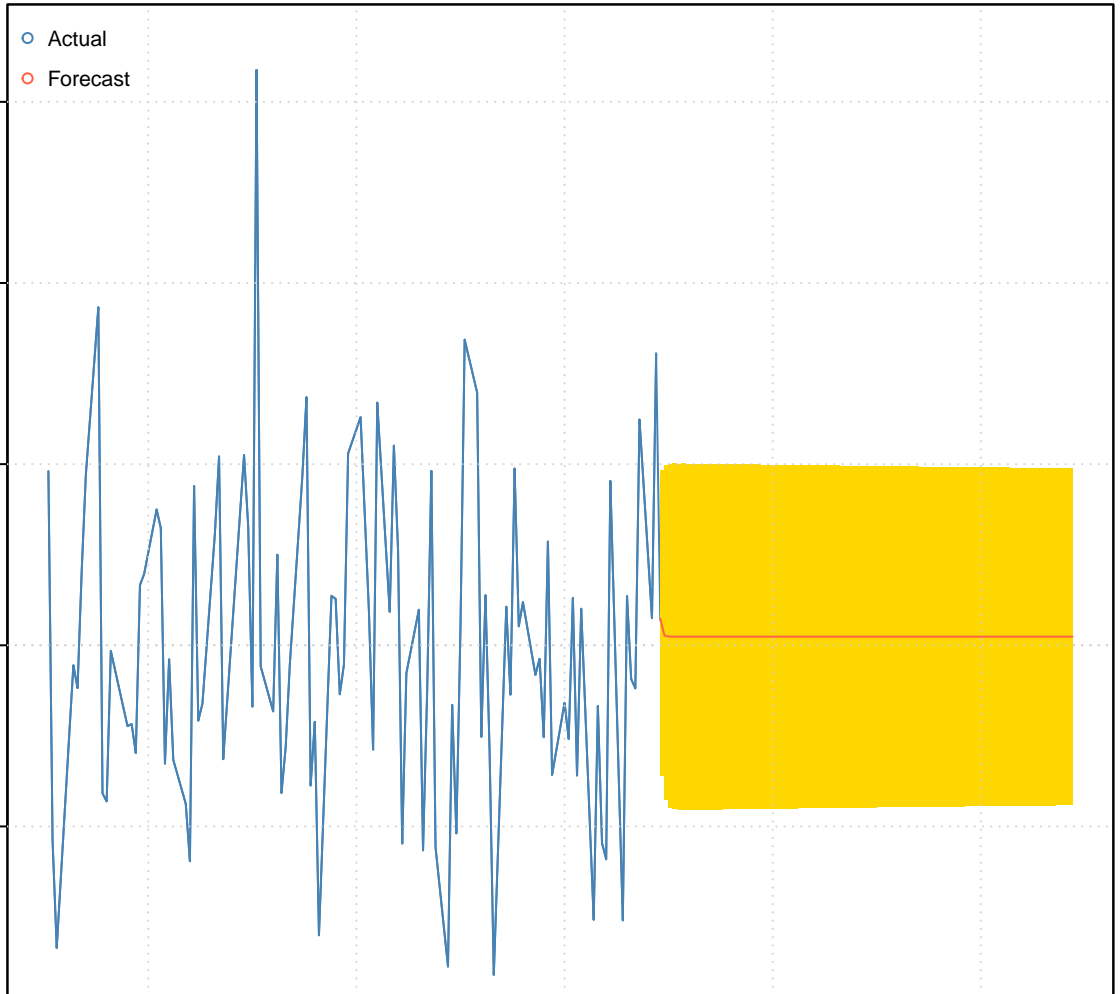
Rolling Forecast vs Actual Series
w/th conditional 2−Sigma bands

Horizon: 100

Series

Time/Horizon

- Actual
- Forecast

GARCH model : gjrGARCH
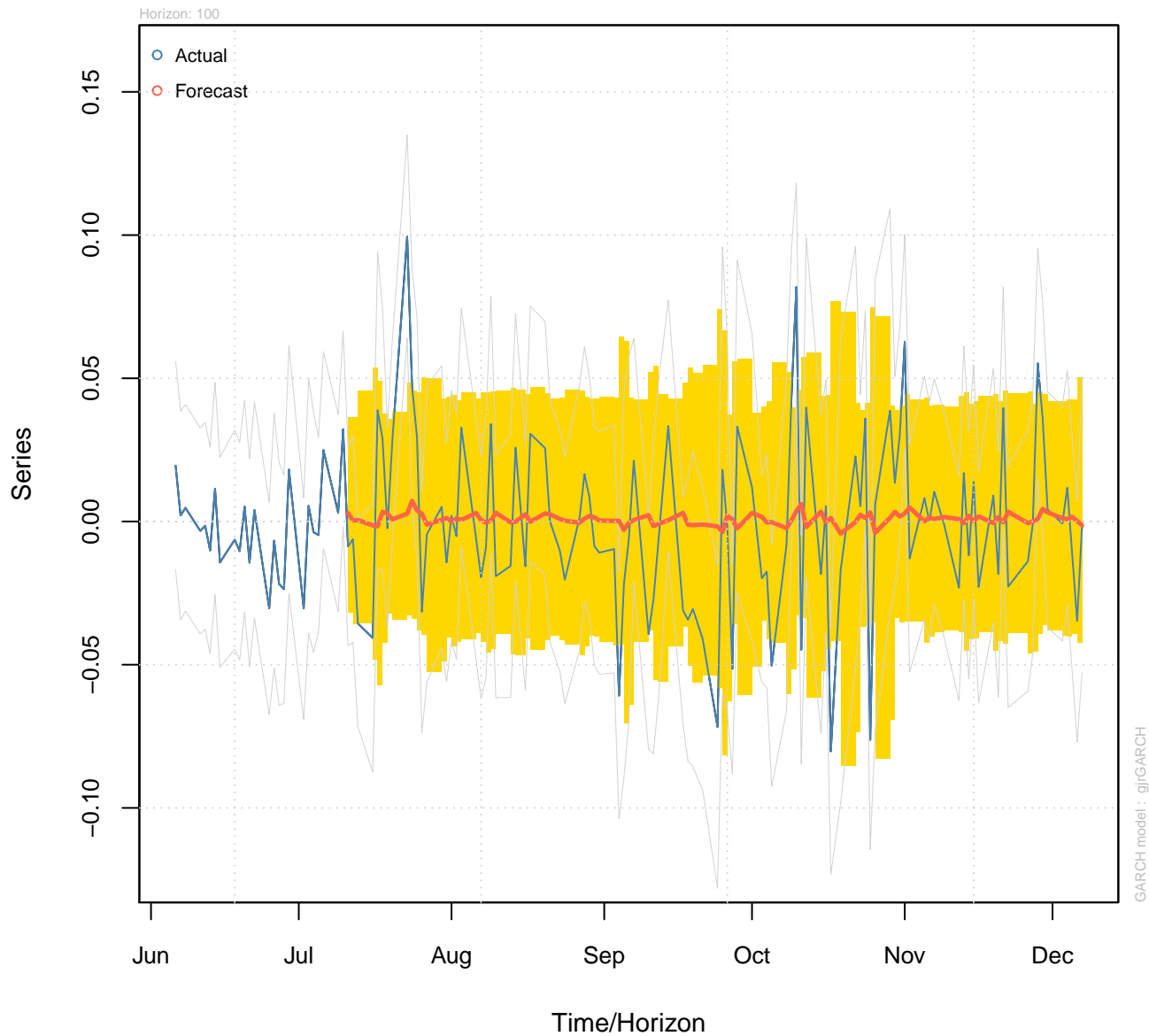
Forecast Unconditional Sigma
(n.roll = 0)

Horizon: 100

○ Actual
○ Forecast

Sigma

Time/Horizon

GARCH model : gjrGARCH
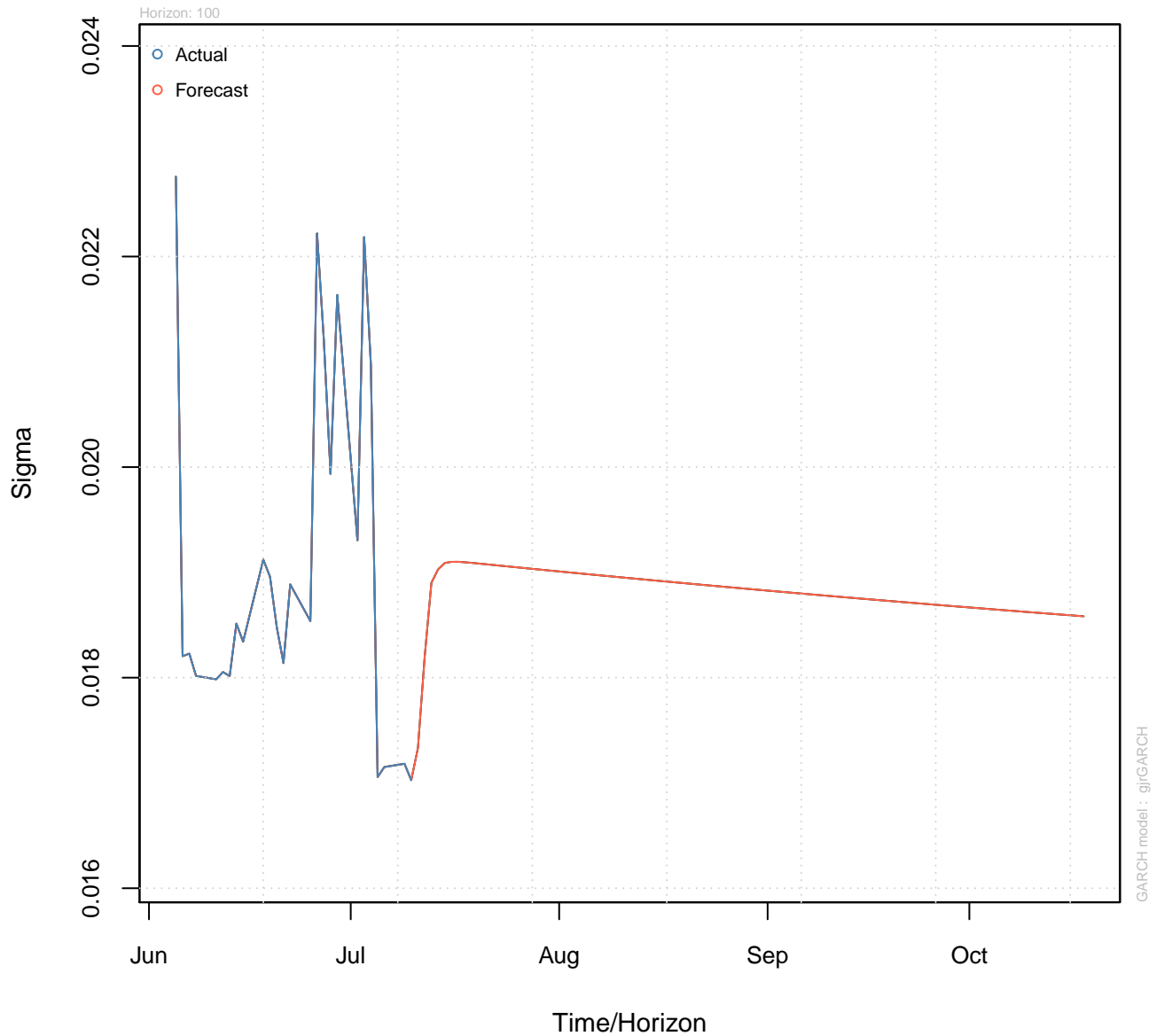
Forecast Rolling Sigma vs |Series|

Horizon: 100

- Actual
- Forecast
- |Series|

Sigma

Jun Jul Aug Sep Oct Nov Dec

Time/Horizon

GARCH model : gjrGARCH