Problem Set 6

Philip Zhou

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1

a. The estimated coefficient is 0.999. The VaR for the next trading day is $ 1,000,000 × 0.06178949 = $ 61789.5 The expected shortfall is $ 1,000,000 × 0.07079003 = $ 70790.3. For 10-trading days, the VAR is $ 1,000,000 × 0.1953955 = $195,395.5

```
library (quantmod)
getSymbols("AMZN",from="2003-01-02", to="2015-04-30")
```

```
## [1] "AMZN"
```

```
adjclosed=diff(log(as.numeric(AMZN$AMZN.Adjusted)))
source("RMfit.R")
negadjclosed=-adjclosed
m1=RMfit(negadjclosed)
```

```
## Warning in sqrt(diag(solve(Hessian))):  NaNs produced
```

```
##
## Coefficient(s):
##       Estimate  Std. Error  t value Pr(>|t|)
## beta  0.999999          NA       NA       NA
##
##  Volatility prediction:
##      Orig      Vpred
## [1,] 3102 0.02656073
##
##  Risk measure based on RiskMetrics:
##       prob        VaR         ES
## [1,] 0.950 0.04368851 0.05478715
## [2,] 0.990 0.06178949 0.07079003
## [3,] 0.999 0.08207882 0.08943236
```

```
sqrt(10)*0.06178949
```

```
## [1] 0.1953955
```

b. The fitted model is:
$r_t = -.001299 + a_t, a_t = \sigma_t \epsilon_t, \epsilon_t \sim N(0,1)$

$\sigma_t^2 = 6.185 \times 10^{-5} + .04822 a_{t-1}^2 + .8649 \sigma_{t-1}^2$

The VAR is \$72,243.3 and the ES is \$82,955.8

```
library(fGarch)
m2=garchFit(~garch(1,1),data=negadjclosed,trace=F)
m2@fit$matcoef
```

```
##             Estimate   Std. Error   t value     Pr(>|t|)
## mu     -1.299307e-03 4.571000e-04 -2.842501 4.476107e-03
## omega   6.184594e-05 1.492769e-05  4.143035 3.427402e-05
## alpha1  4.821678e-02 1.262048e-02  3.820518 1.331720e-04
## beta1   8.648723e-01 3.077215e-02 28.105680 0.000000e+00
```

```
predict(m2,1)
```

```
##   meanForecast  meanError standardDeviation
## 1 -0.001299307 0.03161291        0.03161291
```

```
source("RMeasure.R")
RMeasure(-0.001299307,0.0316129)
```

```
##
##  Risk Measures for selected probabilities:
##        prob        VaR         ES
## [1,] 0.9500 0.05069929 0.06390903
## [2,] 0.9900 0.07224330 0.08295584
## [3,] 0.9990 0.09639190 0.10514417
## [4,] 0.9999 0.11626959 0.12383971
```

c. The fitted model is:
$r_t = -6.3885 \times 10^{-4} + a_t, a_t = \sigma_t \epsilon_t, \epsilon_t \sim t^*_{3.689}$
$\sigma_t^2 = 3.0968 \times 10^{-5} + .01520 a_{t-1}^2 + .9792 \sigma_{t-1}^2$

The VAR is \$56,720.4 and the ES is \$65,075.6

```
m3=garchFit(~garch(1,1),data=negadjclosed,trace=F,cond.dist="std")
m3@fit$matcoef
```

```
##             Estimate   Std. Error    t value     Pr(>|t|)
## mu     -6.388492e-04 3.438417e-04  -1.857975 6.317259e-02
## omega   3.096879e-06 1.073129e-06   2.885841 3.903691e-03
## alpha1  1.519663e-02 2.700987e-03   5.626325 1.840892e-08
## beta1   9.792202e-01 3.491603e-03 280.450067 0.000000e+00
## shape   3.688978e+00 2.318908e-01  15.908252 0.000000e+00
```

```
predict(m3,1)
```

```
##    meanForecast  meanError standardDeviation
## 1 -0.0006388492 0.02465635        0.02465635
```

```
RMeasure(-0.0006388537,0.02465634)
```

```
##
##  Risk Measures for selected probabilities:
##        prob        VaR         ES
## [1,] 0.9500 0.03991722 0.05022009
## [2,] 0.9900 0.05672037 0.06507557
## [3,] 0.9990 0.07555496 0.08238126
## [4,] 0.9999 0.09105848 0.09696277
```

2

The estimates and their standard errors are $(\xi, \sigma, \mu) = (0.3143\ ,\ 0.0165\ ,\ 0.0308)$ with standard errors (0.0727 , 0.0013 , 0.0015). The VaR is \$63,816.4 and 10-day VAR is \$131,585.3

```
require(evir)
source("evtVaR.R")
m4=gev(negadjclosed,block=21)
m4$par.ests
```

```
##         xi      sigma         mu
## 0.31426769 0.01647885 0.03076635
```

```
m4$par.ses
```

```
##          xi       sigma          mu
## 0.072726361 0.001271063 0.001538005
```

```
evtVaR(m4$par.ests[1],m4$par.ests[2],m4$par.ests[3])
```

```
##         mu
## 0.06382677
```

```
0.06381642*10^(0.31427501)
```

```
## [1] 0.1315853
```

3

For a threshold of 3.5%, we have a VaR = \$68,757.1 and ES = \$109,900.9.
For a threshold of 4.5%, we have a VaR = \$68,450.2 and ES = \$110,899.7.
The results are not sensitive to the choice of threshold.

```
m5=gpd(negadjclosed,0.035)
riskmeasures(m5,c(0.99))
```

```
##         p   quantile     sfall
## [1,] 0.99 0.06875713 0.1099009
```

```
m6=gpd(negadjclosed,0.045)
riskmeasures(m6,c(0.99))
```

```
##         p   quantile     sfall
## [1,] 0.99 0.06845018 0.1108997
```

4

For the Coke stock, we have VaR = $18,065.8 and ES = $20,697.3.
We have a sample correlation is 0.304. The VaR for the portfolio is $69,447.9.
If we use the time-varying correlation, we have a correlation of 0.0268. For the portfolio, we have VaR = $64,839.5

```
getSymbols("KO", from="2003-01-02", to="2015-04-30")
```

```
## [1] "KO"
```

```
koadj=diff(log(as.numeric(KO$KO.Adjusted)))
negkoadj=-koadj
cor(adjclosed,koadj)
```

```
## [1] 0.3039997
```

```
m7=RMfit(negkoadj)
```

```
##
## Coefficient(s):
##        Estimate  Std. Error  t value   Pr(>|t|)
## beta 0.95433411  0.00559023  170.715 < 2.22e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Volatility prediction:
##      Orig       Vpred
## [1,] 3102 0.007765728
##
##  Risk measure based on RiskMetrics:
##       prob        VaR         ES
## [1,] 0.950 0.01277349 0.01601847
## [2,] 0.990 0.01806578 0.02069733
## [3,] 0.999 0.02399790 0.02614791
```

```
sqrt(61789.5^2+18065.8^2+2*61789.5*18065.8*0.304)
```

```
## [1] 69447.91
```

```r
x1=negadjclosed+negkoadj
x2=negadjclosed-negkoadj
m8=RMfit(x1)
```

```
##
## Coefficient(s):
##        Estimate  Std. Error  t value   Pr(>|t|)
## beta 0.98795622  0.00138567  712.983 < 2.22e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Volatility prediction:
##      Orig      Vpred
## [1,] 3102 0.02588117
##
##  Risk measure based on RiskMetrics:
##       prob        VaR         ES
## [1,] 0.950 0.04257074 0.05338542
## [2,] 0.990 0.06020861 0.06897887
## [3,] 0.999 0.07997883 0.08714424
```

```r
m9=RMfit(x2)
```

```
## Warning in sqrt(diag(solve(Hessian))):  NaNs produced
```

```
##
## Coefficient(s):
##       Estimate  Std. Error  t value Pr(>|t|)
## beta  0.999999          NA       NA       NA
##
##  Volatility prediction:
##      Orig      Vpred
## [1,] 3102 0.02553869
##
##  Risk measure based on RiskMetrics:
##       prob        VaR         ES
## [1,] 0.950 0.04200741 0.05267899
## [2,] 0.990 0.05941188 0.06806608
## [3,] 0.999 0.07892049 0.08599107
```

```r
c1=(m8$volatility^2-m9$volatility^2)*.25
rho=c1/(m1$volatility*m7$volatility)
rho[length(rho)]
```

```
## [1] 0.02680474
```

```r
sqrt(61789.5^2+18065.8^2+2*61789.5*18065.8*0.02680454)
```

```
## [1] 64839.48
```

5

For the short position of Amazon stock, we have VaR = $61,789.5. For the portfolio, we havea VaR = $58,869.5. For the GARCH model, we have a VaR = $64,888.4. For the Coke stock, the VaR is $19,976.2. The VaR for the portfolio is $73,468.7.

```
RMfit(adjclosed)
```

```
## Warning in sqrt(diag(solve(Hessian))):  NaNs produced
```

```
##
## Coefficient(s):
##       Estimate  Std. Error  t value Pr(>|t|)
## beta  0.999999          NA       NA       NA
##
##  Volatility prediction:
##      Orig      Vpred
## [1,] 3102 0.02656073
##
##  Risk measure based on RiskMetrics:
##       prob        VaR         ES
## [1,] 0.950 0.04368851 0.05478715
## [2,] 0.990 0.06178949 0.07079003
## [3,] 0.999 0.08207882 0.08943236
```

```
sqrt(61789.49^2+18065.8^2-2*61789.49*18065.8*0.304)
```

```
## [1] 58869.5
```

```
m10=garchFit(~garch(1,1),data=negkoadj, trace=F, cond.dist='std')
m10@fit$matcoef
```

```
##              Estimate   Std. Error   t value     Pr(>|t|)
## mu     -4.134708e-04 1.501637e-04 -2.753467 5.896778e-03
## omega   1.909904e-06 6.349341e-07  3.008036 2.629423e-03
## alpha1  6.021607e-02 1.250106e-02  4.816879 1.458212e-06
## beta1   9.238080e-01 1.559007e-02 59.256184 0.000000e+00
## shape   5.207138e+00 4.707663e-01 11.060982 0.000000e+00
```

```
predict(m10,1)
```

```
##    meanForecast  meanError standardDeviation
## 1 -0.0004134708 0.00784988        0.00784988
```

```
RMeasure(predict(m10,1)$meanForecast,predict(m10,1)$meanError, cond.dist='std', df=5.207)
```

```
##
##  Risk Measures for selected probabilities:
##        prob        VaR         ES
## [1,] 0.9500 0.01189213 0.01711573
## [2,] 0.9900 0.01997615 0.02636175
## [3,] 0.9990 0.03481819 0.04412898
## [4,] 0.9999 0.05655147 0.07068112
```

```r
RMeasure(predict(m3,1)$meanForecast,predict(m3,1)$meanError, cond.dist='std', df=3.689)
```

```
##
##  Risk Measures for selected probabilities:
##        prob        VaR         ES
## [1,] 0.9500 0.03580724 0.05530110
## [2,] 0.9900 0.06488840 0.09286017
## [3,] 0.9990 0.12984853 0.18024858
## [4,] 0.9999 0.24720076 0.34036423
```

```r
sqrt(64888.39^2+19976.16^2+2*19976.16*64888.39*.304)
```

```
## [1] 73468.72
```