Assignment5_Hongvichny.R

29/04/2021

```
#EE 435 Assignment 5 Hongvichny Hor 6004820012
#install.packages("quantmod")
#install.packages("fBasics")
#install.packages("sn")
#install.packages("PerformanceAnalytics")
#install.packages("car")
#install.packages("tseries")
#install.packages("forecast")
#install.packages("fGarch")
library(fBasics)
## Warning: package 'fBasics' was built under R version 4.0.5
## Loading required package: timeDate
## Loading required package: timeSeries
library(quantmod)
## Warning: package 'quantmod' was built under R version 4.0.5
## Loading required package: xts
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following object is masked from 'package:timeSeries':
##
## time<-
## The following objects are masked from 'package:base':
##
## as.Date, as.Date.numeric
## Loading required package: TTR
##
## Attaching package: 'TTR'## The following object is masked from 'package:fBasics':
##
## volatility
## Registered S3 method overwritten by 'quantmod':
## method from
## as.zoo.data.frame zoo
library(sn)
## Warning: package 'sn' was built under R version 4.0.5
```

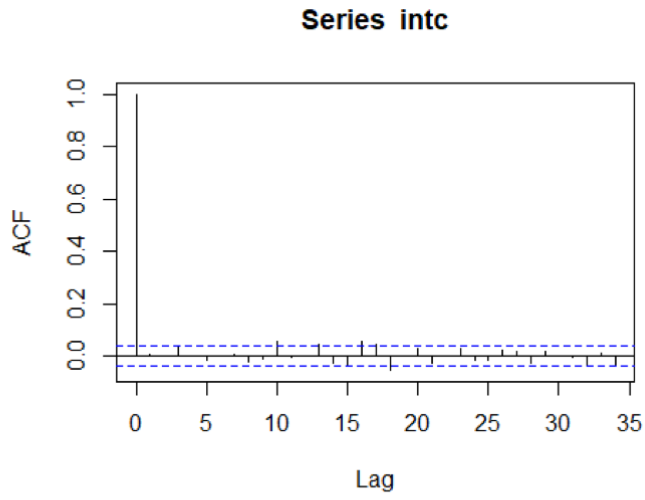
```
## Loading required package: stats4
##
## Attaching package: 'sn'
## The following objects are masked from 'package:fBasics':
##
## tr, vech
## The following object is masked from 'package:stats':
##
## sd
library(PerformanceAnalytics)
## Warning: package 'PerformanceAnalytics' was built under R version 4.0.5
##
## Attaching package: 'PerformanceAnalytics'
## The following objects are masked from 'package:timeDate':
##
## kurtosis, skewness
## The following object is masked from 'package:graphics':
##
## legend
library(car)
## Warning: package 'car' was built under R version 4.0.5
## Loading required package: carData
##
## Attaching package: 'car'
## The following object is masked from 'package:fBasics':
##
## densityPlot
library(tseries)## Warning: package 'tseries' was built under R version 4.0.5
library(forecast)
## Warning: package 'forecast' was built under R version 4.0.5
library(fGarch)
## Warning: package 'fGarch' was built under R version 4.0.5
getSymbols("CAT",from="2006-01-03",to="2017-04-13")
## 'getSymbols' currently uses auto.assign=TRUE by default, but will
## use auto.assign=FALSE in 0.5-0. You will still be able to use
## 'loadSymbols' to automatically load data. getOption("getSymbols.env")
## and getOption("getSymbols.auto.assign") will still be checked for
## alternate defaults.
##
## This message is shown once per session and may be disabled by setting
```

```
## options("getSymbols.warning4.0"=FALSE). See ?getSymbols for details.
## [1] "CAT"
rt=diff(log(as.numeric(CAT[,6])))
Box.test(rt, lag=10, type = 'Ljung')
##
## Box-Ljung test
##
## data: rt
## X-squared = 16.291, df = 10, p-value = 0.09159
```

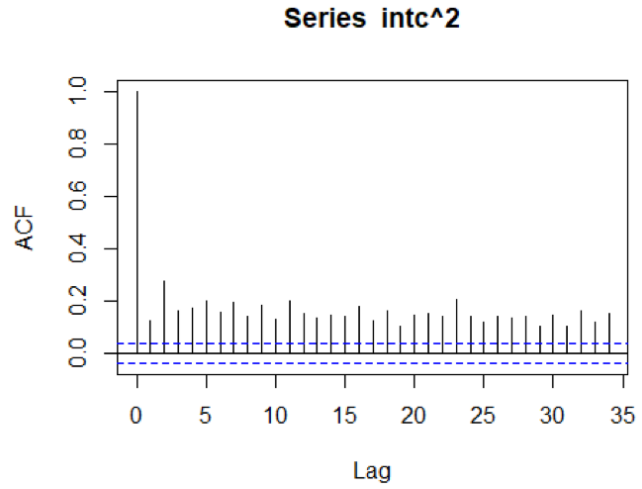
According to Ljung box test, p-value = 0.09159 > 0.05, H0 is not rejected at 95% confidence interval. It means there is no serial correlations in the log return series rt.

#Answer 1A

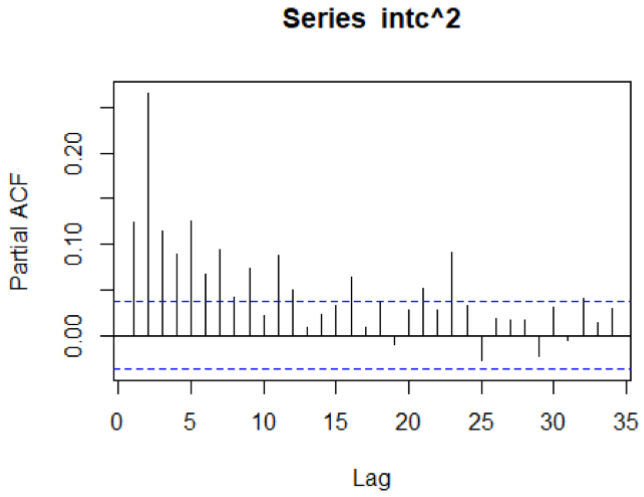
```
intc=rt
acf(intc)
```




```
acf(intc^2)
```




```
pacf(intc^2)
```




```
Box.test(intc^2, lag=10, type = 'Ljung')
##
## Box-Ljung test
##
## data: intc^2
## X-squared = 917.21, df = 10, p-value < 2.2e-16
# According to the Ljung Box test, p-value < 0.05, H0 is rejected at 95%
confidence interval. Hence, there is ARCH effect on rt.
#Answer 1b
m1=garchFit(~arma(1,0)+garch(1,1),data=rt,trace=F)
```

```
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m1)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(1, 0) + garch(1, 1), data = rt, trace = F)
##
## Mean and Variance Equation:## data ~ arma(1, 0) + garch(1, 1)
## <environment: 0x000000001f6b9588>
## [data = rt]
##
## Conditional Distribution:
## norm
##
## Coefficient(s):
## mu ar1 omega alpha1 beta1
## 4.8298e-04 1.6866e-02 4.4779e-06 4.9720e-02 9.3866e-01
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 4.830e-04 3.075e-04 1.571 0.116297
## ar1 1.687e-02 2.006e-02 0.841 0.400353
## omega 4.478e-06 1.278e-06 3.503 0.000461 ***
## alpha1 4.972e-02 8.191e-03 6.070 1.28e-09 ***
## beta1 9.387e-01 1.031e-02 91.048 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 7378.56 normalized: 2.599916
##
## Description:
## Wed Apr 28 19:12:30 2021 by user: HONGVICHNY
```

```
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 3298.441 0
## Shapiro-Wilk Test R W 0.9663735 0
## Ljung-Box Test R Q(10) 12.37554 0.2607088
## Ljung-Box Test R Q(15) 14.79514 0.4662719
## Ljung-Box Test R Q(20) 19.20107 0.5087928
## Ljung-Box Test R^2 Q(10) 0.980939 0.9998424
## Ljung-Box Test R^2 Q(15) 3.682825 0.9986048
## Ljung-Box Test R^2 Q(20) 6.9285 0.996913
## LM Arch Test R TR^2 2.723165 0.9972029
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -5.196308 -5.185823 -5.196314 -5.192526
#plot(m1)
#13
#0# Answer 1c
m2=garchFit(~garch(1,1),data=rt,cond.dist="std",trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m2)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~garch(1, 1), data = rt, cond.dist = "std",
## trace = F)
##
## Mean and Variance Equation:
## data ~ garch(1, 1)
## <environment: 0x000000001efe37d0>
## [data = rt]
##
## Conditional Distribution:
## std
```

```
##
## Coefficient(s):
## mu omega alpha1 beta1 shape
## 5.9780e-04 4.2035e-06 7.2376e-02 9.2033e-01 5.0958e+00
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 5.978e-04 2.702e-04 2.212 0.02695 *
## omega 4.203e-06 1.571e-06 2.675 0.00747 **
## alpha1 7.238e-02 1.374e-02 5.267 1.39e-07 ***
## beta1 9.203e-01 1.472e-02 62.503 < 2e-16 ***
## shape 5.096e+00 4.825e-01 10.561 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 7507.106 normalized: 2.64521
##
## Description:
## Wed Apr 28 20:10:57 2021 by user: HONGVICHNY
##
## ## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 4056.502 0
## Shapiro-Wilk Test R W 0.9639091 0
## Ljung-Box Test R Q(10) 14.77968 0.140303
## Ljung-Box Test R Q(15) 16.74279 0.3344718
## Ljung-Box Test R Q(20) 20.39783 0.433304
## Ljung-Box Test R^2 Q(10) 2.953085 0.9825066
## Ljung-Box Test R^2 Q(15) 5.482428 0.9871938
## Ljung-Box Test R^2 Q(20) 9.458146 0.9769677
## LM Arch Test R TR^2 4.273688 0.977976
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -5.286897 -5.276412 -5.286903 -5.283115
#plot(m2)
```

#13
#0
#Answer 1d
The fitted model is:
#Answer 1e
predict(m2,5)
meanForecast meanError standardDeviation
1 0.0005977987 0.01515760 0.01515760
2 0.0005977987 0.01524072 0.01524072
3 0.0005977987 0.01532280 0.01532280
4 0.0005977987 0.01540384 0.01540384
5 0.0005977987 0.01548387 0.01548387
#Answer 1f
95% confidence interval:
#Answer 1g
da=read.table("m-kovw-5116.txt", header = T)
head(da)
PERMNO date ko vwretd
1 11308 19520131 0.024390 0.017002
2 11308 19520229 0.009524 -0.025141
3 11308 19520331 0.016509 0.045870
4 11308 19520430 -0.016393 -0.049148
5 11308 19520529 0.028571 0.032847
6 11308 19520630 0.046296 0.039575
rt2=log(da$ko+1)
t.test(rt2)##
One Sample t-test
##
data: rt2
t = 4.9853, df = 779, p-value = 7.628e-07
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
0.00625636 0.01438347
sample estimates:
mean of x
0.01031992
Box.test(rt2,lag=10,type = 'Ljung')
##
Box-Ljung test
##

```
## data: rt2
## X-squared = 5.9201, df = 10, p-value = 0.8219
Box.test(rt2^2,lag=10,type='Ljung')
##
## Box-Ljung test
##
## data: rt2^2
## X-squared = 228.23, df = 10, p-value < 2.2e-16
#Answer 2a
m3=garchFit(~arma(1,0)+garch(1,1),data=rt2,trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m3)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(1, 0) + garch(1, 1), data = rt2, trace = F)
##
## Mean and Variance Equation:
## data ~ arma(1, 0) + garch(1, 1)
## <environment: 0x00000000216da830>
## [data = rt2]
##
## Conditional Distribution:
## norm ##
## Coefficient(s):
## mu ar1 omega alpha1 beta1
## 0.01124544 -0.02633742 0.00018112 0.09535029 0.84861593
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 1.125e-02 1.897e-03 5.929 3.05e-09 ***
## ar1 -2.634e-02 3.881e-02 -0.679 0.49740
## omega 1.811e-04 5.852e-05 3.095 0.00197 **
```

```
## alpha1 9.535e-02 1.915e-02 4.978 6.42e-07 ***
## beta1 8.486e-01 2.766e-02 30.675 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 1170.664 normalized: 1.500852
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 92.91946 0
## Shapiro-Wilk Test R W 0.9857081 6.655604e-07
## Ljung-Box Test R Q(10) 9.306169 0.5033144
## Ljung-Box Test R Q(15) 22.9901 0.0843502
## Ljung-Box Test R Q(20) 27.44814 0.1231201
## Ljung-Box Test R^2 Q(10) 12.63377 0.2448749
## Ljung-Box Test R^2 Q(15) 13.62088 0.5544545
## Ljung-Box Test R^2 Q(20) 15.19817 0.7649584
## LM Arch Test R TR^2 10.65102 0.5590389
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -2.988883 -2.959016 -2.988965 -2.977396
#Answer 2b
m4=garchFit(~arma(1,0)+garch(1,1),data=rt2,cond.dist='std',trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m4)##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(1, 0) + garch(1, 1), data = rt2, cond.dist =
"std",
## trace = F)
##
## Mean and Variance Equation:
## data ~ arma(1, 0) + garch(1, 1)
## <environment: 0x000000001fb82478>
```

[data = rt2]
##
Conditional Distribution:
std
##
Coefficient(s):
mu ar1 omega alpha1 beta1
shape
0.01124020 -0.01887601 0.00017395 0.09642927 0.85044151
7.47877780
##
Std. Errors:
based on Hessian
##
Error Analysis:
Estimate Std. Error t value Pr(>|t|)
mu 1.124e-02 1.810e-03 6.211 5.27e-10 ***
ar1 -1.888e-02 3.691e-02 -0.511 0.60904
omega 1.739e-04 6.596e-05 2.637 0.00836 **
alpha1 9.643e-02 2.338e-02 4.124 3.72e-05 ***
beta1 8.504e-01 3.267e-02 26.028 < 2e-16 ***
shape 7.479e+00 1.840e+00 4.066 4.79e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
##
Standardised Residuals Tests:
Statistic p-Value
Jarque-Bera Test R Chi^2 93.6433 0
Shapiro-Wilk Test R W 0.9857385 6.832848e-07
Ljung-Box Test R Q(10) 8.966733 0.5352637
Ljung-Box Test R Q(15) 22.44818 0.09657967 ## Ljung-Box Test R Q(20) 26.86769
0.1390276
Ljung-Box Test R^2 Q(10) 12.48941 0.2536355
Ljung-Box Test R^2 Q(15) 13.37442 0.5734021
Ljung-Box Test R^2 Q(20) 14.90709 0.7816987
LM Arch Test R TR^2 10.48089 0.5738501
##
Information Criterion Statistics:

```
## AIC BIC SIC HQIC
## -3.022725 -2.986885 -3.022843 -3.008941
#Answer 2c
m5=garchFit(~garch(1,1),data=rt2,trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m5)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~garch(1, 1), data = rt2, trace = F)
##
## Mean and Variance Equation:
## data ~ garch(1, 1)
## <environment: 0x0000000021632c90>
## [data = rt2]
##
## Conditional Distribution:
## norm
##
## Coefficient(s):
## mu omega alpha1 beta1
## 0.01098417 0.00018497 0.09479925 0.84780406
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 1.098e-02 1.846e-03 5.950 2.68e-09 ***
## omega 1.850e-04 5.899e-05 3.135 0.00172 **
## alpha1 9.480e-02 1.912e-02 4.958 7.11e-07 ***
## beta1 8.478e-01 2.787e-02 30.416 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## ## Log Likelihood:
## 1170.393 normalized: 1.500504
```

```
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 95.07163 0
## Shapiro-Wilk Test R W 0.9856773 6.481596e-07
## Ljung-Box Test R Q(10) 8.125181 0.6166108
## Ljung-Box Test R Q(15) 21.27199 0.128362
## Ljung-Box Test R Q(20) 25.62765 0.1784646
## Ljung-Box Test R^2 Q(10) 12.90586 0.228983
## Ljung-Box Test R^2 Q(15) 13.87463 0.5350581
## Ljung-Box Test R^2 Q(20) 15.35522 0.755734
## LM Arch Test R TR^2 10.96004 0.532346
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -2.990752 -2.966858 -2.990804 -2.981562
#Answer 2d
m6=garchFit(~garch(1,1),data=rt2,cond.dist='std',trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m6)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~garch(1, 1), data = rt2, cond.dist = "std",
## trace = F)
##
## Mean and Variance Equation:
## data ~ garch(1, 1)
## <environment: 0x000000001ef4b040>
## [data = rt2]
##
## Conditional Distribution:
## std
##
## Coefficient(s):
```

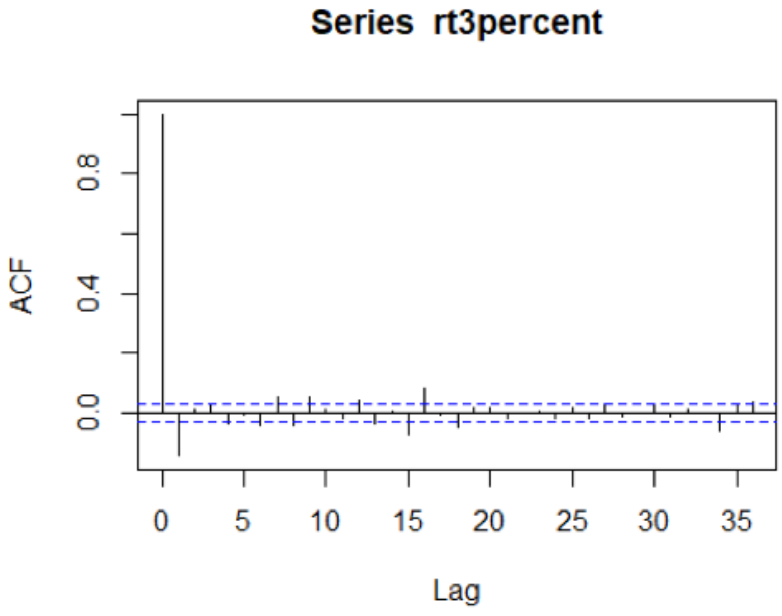
mu omega alpha1 beta1 shape ## 0.01105016 0.00017528 0.09632874 0.85006800
7.48604505
##
Std. Errors:
based on Hessian
##
Error Analysis:
Estimate Std. Error t value Pr(>|t|)
mu 1.105e-02 1.757e-03 6.291 3.16e-10 ***
omega 1.753e-04 6.627e-05 2.645 0.00817 **
alpha1 9.633e-02 2.337e-02 4.123 3.75e-05 ***
beta1 8.501e-01 3.277e-02 25.941 < 2e-16 ***
shape 7.486e+00 1.840e+00 4.069 4.72e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
Log Likelihood:
1184.68 normalized: 1.518821
##
Description:
Wed Apr 28 21:21:08 2021 by user: HONGVICHNY
##
##
Standardised Residuals Tests:
Statistic p-Value
Jarque-Bera Test R Chi^2 95.31715 0
Shapiro-Wilk Test R W 0.9857263 6.761141e-07
Ljung-Box Test R Q(10) 8.228765 0.6065024
Ljung-Box Test R Q(15) 21.34759 0.1260864
Ljung-Box Test R Q(20) 25.67699 0.1767469
Ljung-Box Test R^2 Q(10) 12.61146 0.2462139
Ljung-Box Test R^2 Q(15) 13.4693 0.5660982
Ljung-Box Test R^2 Q(20) 14.93694 0.7800047
LM Arch Test R TR^2 10.62989 0.560875
##
Information Criterion Statistics:
AIC BIC SIC HQIC
-3.024822 -2.994954 -3.024903 -3.013334
#Answer 2e.f
getSymbols("^GSPC",from="2005-01-2",to="2021-03-31")

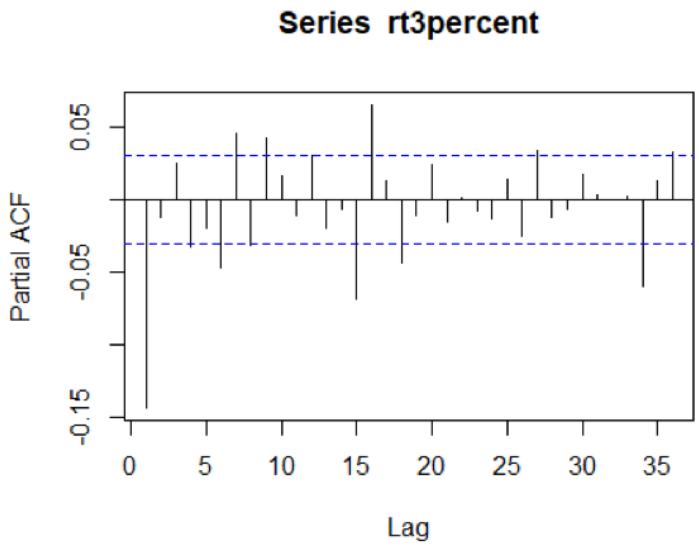
```
## [1] "^GSPC"
rt3=diff(log(as.numeric(GSPC[,6])))
rt3percent=rt3*100
t.test(rt3percent)##
## One Sample t-test
##
## data: rt3percent
## t = 1.4961, df = 4086, p-value = 0.1347
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
## -0.009051939 0.067374643
## sample estimates:
## mean of x
## 0.02916135
Box.test(rt3percent,lag=10,type='Ljung')
##
## Box-Ljung test
##
## data: rt3percent
## X-squared = 131.85, df = 10, p-value < 2.2e-16
```

#Answer 3A

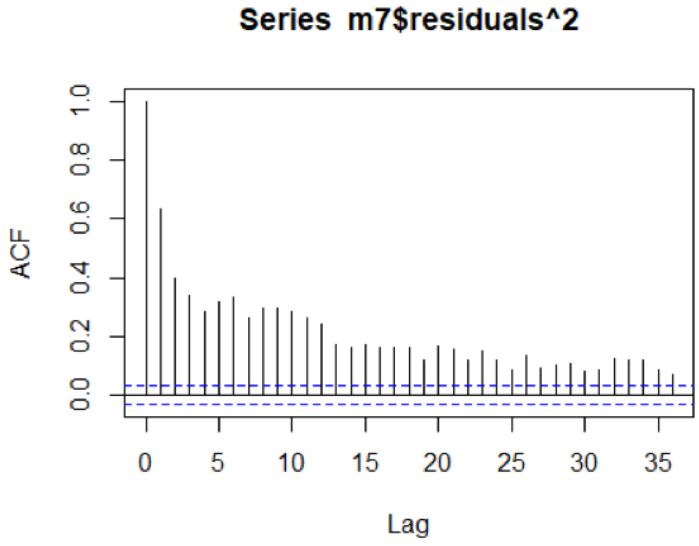
```
acf(rt3percent)
```




```
pacf(rt3percent)
```




```
m7=arima(rt3percent,order=c(0,1,0))
acf(m7$residuals^2)
```



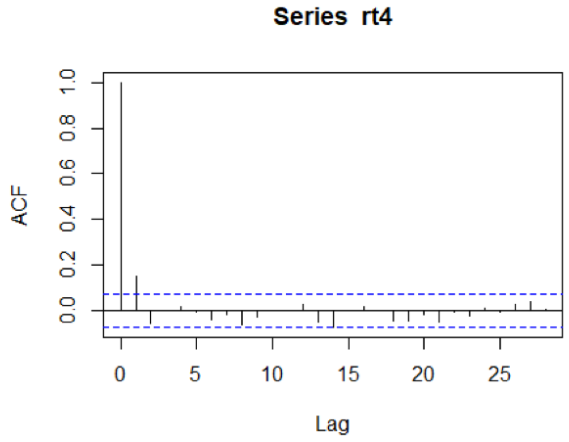

```
Box.test(m7$residuals^2,lag=10,type='Ljung')
##
## Box-Ljung test
##
```

```
## data: m7$residuals^2
## X-squared = 5312, df = 10, p-value < 2.2e-16
m8=garchFit(~arma(0,1)+garch(1,1),data=rt3percent,trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m8)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(0, 1) + garch(1, 1), data = rt3percent,
## trace = F)
##
## Mean and Variance Equation:
## data ~ arma(0, 1) + garch(1, 1)
## <environment: 0x0000000020fa82d8>
## [data = rt3percent]
##
## Conditional Distribution:
## norm
##
## Coefficient(s):
## mu ma1 omega alpha1 beta1
## 0.068986 -0.077582 0.027170 0.141814 0.837406
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.068986 0.010800 6.387 1.69e-10 ***
## ma1 -0.077582 0.017503 -4.433 9.31e-06 ***
## omega 0.027170 0.003504 7.754 8.88e-15 ***
## alpha1 0.141814 0.012017 11.801 < 2e-16 ***
## beta1 0.837406 0.011956 70.039 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

Log Likelihood:
-5392.874 normalized: -1.319519
Description:
Wed Apr 28 20:40:50 2021 by user: HONGVICHNY
##
##
Standardised Residuals Tests:
Statistic p-Value
Jarque-Bera Test R Chi^2 1134.026 0
Shapiro-Wilk Test R W 0.9717603 0
Ljung-Box Test R Q(10) 17.7885 0.05863789
Ljung-Box Test R Q(15) 26.08443 0.03714455
Ljung-Box Test R Q(20) 31.72122 0.04636094
Ljung-Box Test R^2 Q(10) 16.02024 0.09905437
Ljung-Box Test R^2 Q(15) 18.27301 0.2485849
Ljung-Box Test R^2 Q(20) 19.66181 0.4792555
LM Arch Test R TR^2 16.80097 0.1572388
##
Information Criterion Statistics:
AIC BIC SIC HQIC
2.641485 2.649211 2.641482 2.644220
#plot(m8)
#13
#0
#Answer 3B
m9=garchFit(~arma(0,1)+garch(1,1),data=rt3percent,cond.dist="std",trace=F)
Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
Consider formula(paste(x, collapse = " ")) instead.
summary(m9)
##
Title:
GARCH Modelling
##
Call:
garchFit(formula = ~arma(0, 1) + garch(1, 1), data = rt3percent,
cond.dist = "std", trace = F)
##
Mean and Variance Equation:
data ~ arma(0, 1) + garch(1, 1)

```
## <environment: 0x000000001eecaaa8>
## [data = rt3percent]
##
## Conditional Distribution:
## std
##
## Coefficient(s):## mu ma1 omega alpha1 beta1 shape
## 0.085537 -0.073712 0.016925 0.141240 0.856667 5.075507
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.085537 0.009733 8.789 < 2e-16 ***
## ma1 -0.073712 0.016039 -4.596 4.31e-06 ***
## omega 0.016925 0.003621 4.673 2.96e-06 ***
## alpha1 0.141240 0.014598 9.675 < 2e-16 ***
## beta1 0.856667 0.012848 66.675 < 2e-16 ***
## shape 5.075507 0.427751 11.866 < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## -5257.344 normalized: -1.286358
##
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 1431.666 0
## Shapiro-Wilk Test R W 0.969611 0
## Ljung-Box Test R Q(10) 17.95781 0.05567943
## Ljung-Box Test R Q(15) 26.2946 0.0350378
## Ljung-Box Test R Q(20) 31.68531 0.04676904
## Ljung-Box Test R^2 Q(10) 13.12031 0.217023
## Ljung-Box Test R^2 Q(15) 17.77068 0.2749137
## Ljung-Box Test R^2 Q(20) 20.51701 0.4260342
## LM Arch Test R TR^2 14.78812 0.2532284
##
```

Information Criterion Statistics:
AIC BIC SIC HQIC
2.575652 2.584923 2.575647 2.578935
#Answer 3C
predict(m9,5)
meanForecast meanError standardDeviation
1 0.11545471 0.9040206 0.9040206
2 0.08553707 0.9148267 0.9123965
3 0.08553707 0.9231321 0.9206790
4 0.08553707 0.9313464 0.9288705
5 0.08553707 0.9394718 0.9369735#Answer 3d
da4=read.table("m-deciles.txt",header=T)
rt4=log(da4$CAP9RET+1)
acf(rt4)



t.test(rt4)
##
One Sample t-test
##
data: rt4
t = 5.1808, df = 719, p-value = 2.873e-07
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
0.005946562 0.013203545
sample estimates:
mean of x
0.009575054
Box.test(rt4,lag=10,type='Ljung')
##
Box-Ljung test

```
##
## data: rt4
## X-squared = 24.257, df = 10, p-value = 0.006946#Answer 4a
Box.test(rt4^2,lag=10,type='Ljung')
##
## Box-Ljung test
##
## data: rt4^2
## X-squared = 19.824, df = 10, p-value = 0.03096
#Answer 4b
m10=garchFit(~arma(1,0)+garch(1,0),data=rt4,trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m10)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(1, 0) + garch(1, 0), data = rt4, trace = F)
##
## Mean and Variance Equation:
## data ~ arma(1, 0) + garch(1, 0)
## <environment: 0x000000001fdb6688>
## [data = rt4]
##
## Conditional Distribution:
## norm
##
## Coefficient(s):
## mu ar1 omega alpha1
## 0.01053 0.14707 0.00200 0.18152
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.0105300 0.0019275 5.463 4.68e-08 ***
```

```
## ar1 0.1470670 0.0424301 3.466 0.000528 ***
## omega 0.0020000 0.0001482 13.493 < 2e-16 ***
## alpha1 0.1815182 0.0651142 2.788 0.005309 **
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## ## Log Likelihood:
## 1158.628 normalized: 1.609206
##
## Description:
## Wed Apr 28 21:09:05 2021 by user: HONGVICHNY
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 647.6357 0
## Shapiro-Wilk Test R W 0.962804 1.502752e-12
## Ljung-Box Test R Q(10) 8.582995 0.572082
## Ljung-Box Test R Q(15) 12.95811 0.6055337
## Ljung-Box Test R Q(20) 15.77362 0.7305655
## Ljung-Box Test R^2 Q(10) 8.153476 0.6138486
## Ljung-Box Test R^2 Q(15) 12.29206 0.6568012
## Ljung-Box Test R^2 Q(20) 13.57787 0.851238
## LM Arch Test R TR^2 8.24593 0.7656286
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -3.207301 -3.181861 -3.207363 -3.197480
#Answer 4c
m11=garchFit(~arma(1,0)+garch(1,0),data=rt4,cond.dist="std",trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m11)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~arma(1, 0) + garch(1, 0), data = rt4, cond.dist =
"std",
```

```
## trace = F)
##
## Mean and Variance Equation:
## data ~ arma(1, 0) + garch(1, 0)
## <environment: 0x0000000020c5ee58>
## [data = rt4]
##
## Conditional Distribution:
## std
##
## Coefficient(s):## mu ar1 omega alpha1 shape
## 0.0116189 0.1076982 0.0019203 0.1900830 6.4225253
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.0116189 0.0017710 6.561 5.35e-11 ***
## ar1 0.1076982 0.0403169 2.671 0.00756 **
## omega 0.0019203 0.0001818 10.564 < 2e-16 ***
## alpha1 0.1900830 0.0713692 2.663 0.00774 **
## shape 6.4225253 1.3115905 4.897 9.74e-07 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 1187.516 normalized: 1.649328
##
## Description:
## Wed Apr 28 21:17:08 2021 by user: HONGVICHNY
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 680.4834 0
## Shapiro-Wilk Test R W 0.9612945 7.49198e-13
## Ljung-Box Test R Q(10) 9.486455 0.4866411
## Ljung-Box Test R Q(15) 13.8214 0.5391158
## Ljung-Box Test R Q(20) 17.0087 0.6524086
```

```
## Ljung-Box Test R^2 Q(10) 7.567444 0.671006
## Ljung-Box Test R^2 Q(15) 11.42176 0.7221637
## Ljung-Box Test R^2 Q(20) 12.79422 0.8860373
## LM Arch Test R TR^2 7.723697 0.8063327
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -3.284768 -3.252967 -3.284863 -3.272491
#Answer 4d
m12=garchFit(~garch(1,0),data=rt4,trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m12)
##
## Title:## GARCH Modelling
##
## Call:
## garchFit(formula = ~garch(1, 0), data = rt4, trace = F)
##
## Mean and Variance Equation:
## data ~ garch(1, 0)
## <environment: 0x000000001eeffd18>
## [data = rt4]
##
## Conditional Distribution:
## norm
##
## Coefficient(s):
## mu omega alpha1
## 0.012346 0.002016 0.194126
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.012346 0.001923 6.421 1.35e-10 ***
## omega 0.002016 0.000145 13.900 < 2e-16 ***
## alpha1 0.194126 0.062209 3.121 0.00181 **
```

```
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 1152.289 normalized: 1.600401
##
## Description:
## Wed Apr 28 21:20:05 2021 by user: HONGVICHNY
##
##
## Standardised Residuals Tests:
## Statistic p-Value
## Jarque-Bera Test R Chi^2 746.8024 0
## Shapiro-Wilk Test R W 0.9570702 1.171061e-13
## Ljung-Box Test R Q(10) 18.72223 0.04393591
## Ljung-Box Test R Q(15) 23.27998 0.07837365
## Ljung-Box Test R Q(20) 27.61004 0.1189566
## Ljung-Box Test R^2 Q(10) 7.012055 0.7243064
## Ljung-Box Test R^2 Q(15) 10.3604 0.7964784
## Ljung-Box Test R^2 Q(20) 11.97825 0.9168225
## LM Arch Test R TR^2 7.047101 0.8544853
##
## Information Criterion Statistics:
## AIC BIC SIC HQIC
## -3.192468 -3.173388 -3.192503 -3.185102#Answer 4e
m13=garchFit(~garch(1,0),data=rt4,cond.dist="std",trace=F)
## Warning: Using formula(x) is deprecated when x is a character vector of
length > 1.
## Consider formula(paste(x, collapse = " ")) instead.
summary(m13)
##
## Title:
## GARCH Modelling
##
## Call:
## garchFit(formula = ~garch(1, 0), data = rt4, cond.dist = "std",
## trace = F)
##
## Mean and Variance Equation:
## data ~ garch(1, 0)
```

```
## <environment: 0x000000001fe2a920>
## [data = rt4]
##
## Conditional Distribution:
## std
##
## Coefficient(s):
## mu omega alpha1 shape
## 0.013356 0.001928 0.204163 6.220222
##
## Std. Errors:
## based on Hessian
##
## Error Analysis:
## Estimate Std. Error t value Pr(>|t|)
## mu 0.013356 0.001685 7.927 2.22e-15 ***
## omega 0.001928 0.000185 10.421 < 2e-16 ***
## alpha1 0.204163 0.072375 2.821 0.00479 **
## shape 6.220223 1.236608 5.030 4.90e-07 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
## 1183.349 normalized: 1.64354
##
## Description:
## Wed Apr 28 21:30:01 2021 by user: HONGVICHNY
##
##
## Standardised Residuals Tests:## Statistic p-Value
## Jarque-Bera Test R Chi^2 746.3878 0
## Shapiro-Wilk Test R W 0.9574271 1.363165e-13
## Ljung-Box Test R Q(10) 18.51406 0.04688705
## Ljung-Box Test R Q(15) 22.99926 0.08415548
## Ljung-Box Test R Q(20) 27.3947 0.1245202
## Ljung-Box Test R^2 Q(10) 6.667871 0.7563837
## Ljung-Box Test R^2 Q(15) 10.0157 0.8187514
## Ljung-Box Test R^2 Q(20) 11.63085 0.928196
## LM Arch Test R TR^2 6.819315 0.8693193
##
```

Information Criterion Statistics:
AIC BIC SIC HQIC
-3.275969 -3.250529 -3.276031 -3.266148

#Answer 4f and 4g