Assignment 2

DUE DATE: Thursday 11^{th}, February 2021.

I pledge to the Honor Code and to obey all rules for taking and performing homework assignments as specified by the course instructor.

Full name Janyaporn Jittipakorn **Student ID.** 6104640435

All data are downloadable from yahoo finance

You should submit your answer with (i) the code file with the name (assignment1_yourname.r) and (ii) the report in .pdf file. You can upload your files on the BE-moodle

1.(90 points) Consider the stock price of Caterpillar (CAT) stock, Airports of Thailand Public Company Limited (AOT.BK) from January 3, 2000 to January 31, 2021. The data are downloadable from yahoo finance.

(a) Calculate the log returns and the simple returns, then plot these two series on the same figure.

(b) Compute the table.Stat sample mean, standard deviation, skewness, excess kurtosis, minimum, and maximum of each simple return series.

(c) Obtain the empirical density function of the simple returns of CAT Caterpillar stock. Are the daily simple returns normally distributed? Perform a normality test to justify your answer.

(d) Compute the sample mean, standard deviation, skewness, excess kurtosis, minimum, and maximum of each log return series.

(e) Test the t-test null hypothesis that the mean of the log returns of Caterpillar stock is zero. Do the same test for AOT stock.

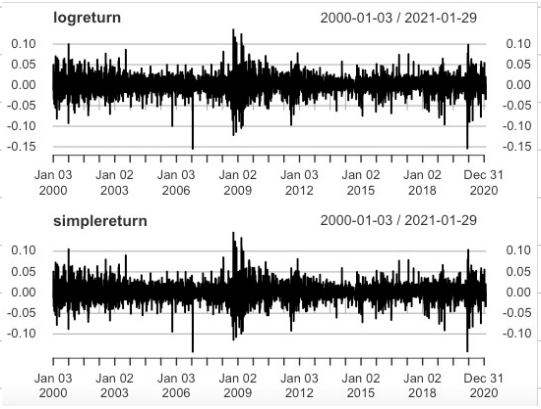
(f) Obtain the #2 empirical density plot of the daily log returns of Caterpillar stock and AOT stock.

(g) Construct a 95% confidence interval for the daily log returns of CAT stock.

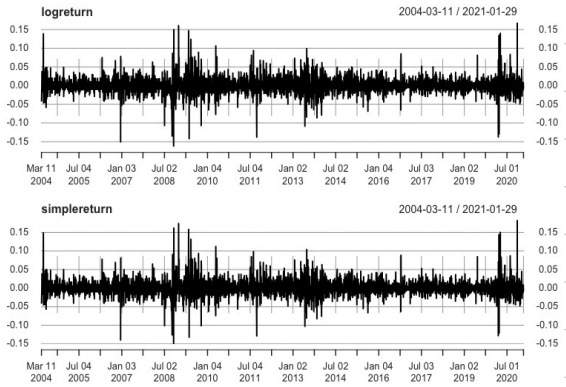
(h) Test $H_0 : m_3 = 0$ versus $H_a : m_3 \neq 0$, where m_3 denotes the skewness of the return.

(i) Test $H_0 : K = 3$ versus $H_a : K \neq 3$, where K denotes the kurtosis. (Excess kurtosis = 0.)

a.) CAT



AOT.BK



b.) simple return series

	CAT.Adjusted
Observations	5302.0000
NAs	1.0000
Minimum	-0.1452
Quartile 1	-0.0095
Median	0.0005
Arithmetic Mean	0.0007
Geometric Mean	0.0005
Quartile 3	0.0110
Maximum	0.1472
SE Mean	0.0003
LCL Mean (0.95)	0.0001
UCL Mean (0.95)	0.0013
Variance	0.0004
Stdev	0.0205
Skewness	0.0197
Kurtosis	4.5480

	AOT.BK.Adjusted
Observations	4158.0000
NAs	1.0000
Minimum	-0.1505
Quartile 1	-0.0093
Median	0.0000
Arithmetic Mean	0.0010
Geometric Mean	0.0007
Quartile 3	0.0103
Maximum	0.1834
SE Mean	0.0003
LCL Mean (0.95)	0.0003
UCL Mean (0.95)	0.0016
Variance	0.0005
Stdev	0.0213
Skewness	0.5443
Kurtosis	10.0827

c.)

```
        Jarque Bera Test

data:  newlogreturn
X-squared = 4906.1, df = 2, p-value < 2.2e-16
```

From JB test, p-value is less than $\alpha = 0.05$.
So, we reject H_0.
∴ simple return of CAT is not normal distributed at 95% CI

d.) log return series

	CAT.Adjusted
Observations	5302.0000
NAs	1.0000
Minimum	-0.1569
Quartile 1	-0.0095
Median	0.0005
Arithmetic Mean	0.0005
Geometric Mean	0.0003
Quartile 3	0.0110
Maximum	0.1373
SE Mean	0.0003
LCL Mean (0.95)	-0.0001
UCL Mean (0.95)	0.0010
Variance	0.0004
Stdev	0.0205
Skewness	-0.1836
Kurtosis	4.6982

	AOT.BK.Adjusted
Observations	4158.0000
NAs	1.0000
Minimum	-0.1632
Quartile 1	-0.0093
Median	0.0000
Arithmetic Mean	0.0007
Geometric Mean	0.0005
Quartile 3	0.0102
Maximum	0.1684
SE Mean	0.0003
LCL Mean (0.95)	0.0001
UCL Mean (0.95)	0.0014
Variance	0.0004
Stdev	0.0212
Skewness	0.1746
Kurtosis	9.6096

e) CAT

```
        One Sample t-test

data:  newlogreturn
t = 1.7296, df = 5301, p-value = 0.08377
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 -6.513168e-05  1.041069e-03
sample estimates:
   mean of x
0.0004879685
```

p-value = 0.08377 $>$ $\alpha = 0.05$

∴ We cannot reject H_0 which means mean of logreturn is equal to zero at 95% CI

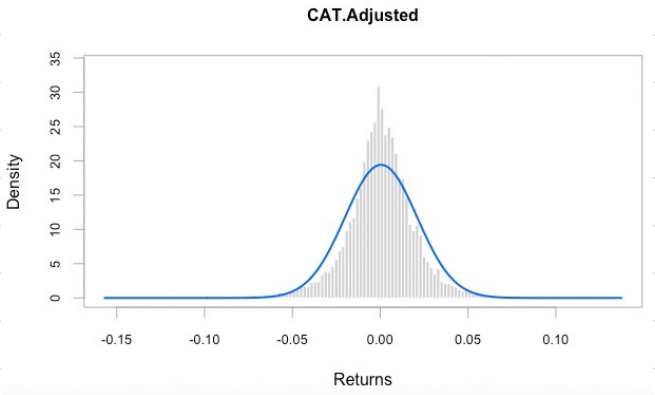
AOT.BK

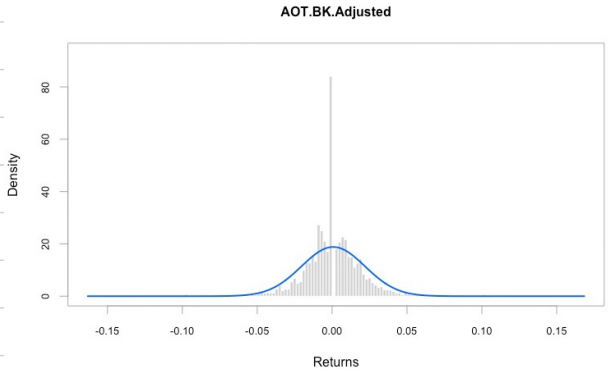
```
        One Sample t-test

data:  newlogreturn
t = 2.2696, df = 4157, p-value = 0.02328
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 0.0001016629 0.0013915769
sample estimates:
   mean of x
0.0007466199
```

p-value = 0.02328 $<$ $\alpha = 0.05$

∴ We reject H_0 which means mean of logreturn is not equal to zero at 95% CI

f.)





g.) 95% confidence interval for the daily log return of CAT is $(-6.513168e^{-5}, 1.041069e^{-3})$

h.) CAT

```
> #5 Test Skewness = 0
> T=length(newlogreturn)
> s3=skewness(newlogreturn)
> tst = s3/sqrt(6/T)
> tst
[1] -5.458812
> pv = 2*pnorm(tst)
> pv
[1] 4.793299e-08
```

since p-value $<$ $\alpha = 0.05$, We reject H_0.

∴ Skewness of logreturn is not equal to 0 at 95% CI

AOT.BK

```
> #5 Test Skewness = 0
> T=length(newlogreturn)
> s3=skewness(newlogreturn)
> tst = s3/sqrt(6/T)
> tst
[1] 4.596526
> pv = 2*(1-pnorm(tst))
> pv
[1] 4.29594e-06
```

since p-value $<$ $\alpha = 0.05$, We reject H_0

∴ Skewness of logreturn is not equal to 0 at 95% CI

i) CAT

```
> #6 Test excess kurtosis =0
> k4 = kurtosis(newlogreturn)
> tst = k4/sqrt(24/T)
> tst
[1] 69.83078
> pv = 2*(1-pnorm(tst))
> pv
[1] 0
```

since p-value $<$ $\alpha = 0.05$, We reject H_0

∴ the excess kurtosis is not equal to zero and kurtosis is not equal to 3 at 95% CI.

AOT.BK

```
> #6 Test excess kurtosis =0
> k4 = kurtosis(newlogreturn)
> tst = k4/sqrt(24/T)
> tst
[1] 126.4855
> pv = 2*(1-pnorm(tst))
> pv
[1] 0
```

since p-value $<$ $\alpha = 0.05$, We reject H_0

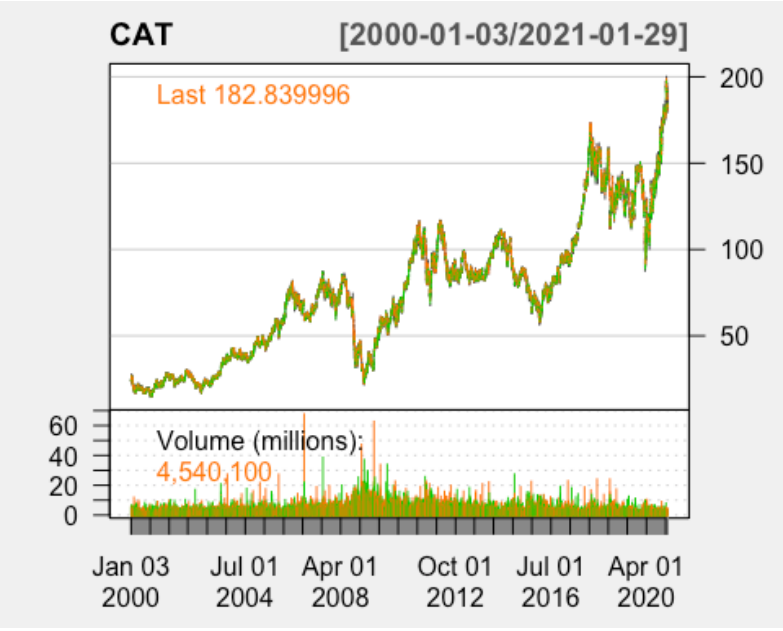
∴ the excess kurtosis is not equal to zero and kurtosis is not equal to 3 at 95% CI.

Lecture_2_updated.R

mew
2021-02-09

```
#EE435
setwd("/Users/mew/Desktop")
cat(rep("\n",50))  #clear R Console
#install.packages("quantmod")
#install.packages("fBasics")
#install.packages("sn")
#install.packages("PerformanceAnalytics")
#install.packages("car")
#install.packages("tseries")
#install.packages("forecast")
library(quantmod)
## Loading required package: xts
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
## Loading required package: TTR
## Registered S3 method overwritten by 'quantmod':
##   method           from
##   as.zoo.data.frame zoo
library(fBasics)
## Loading required package: timeDate
## Loading required package: timeSeries
##
## Attaching package: 'timeSeries'
## The following object is masked from 'package:zoo':
##
##     time<-
##
## Attaching package: 'fBasics'
## The following object is masked from 'package:TTR':
##
##     volatility
library(sn)
## Loading required package: stats4
##
## Attaching package: 'sn'
## The following object is masked from 'package:fBasics':
##
##     vech
```

```
## The following object is masked from 'package:stats':
##
##     sd
library(PerformanceAnalytics)
##
## Attaching package: 'PerformanceAnalytics'
## The following objects are masked from 'package:timeDate':
##
##     kurtosis, skewness
## The following object is masked from 'package:graphics':
##
##     legend
library(car)
## Loading required package: carData
##
## Attaching package: 'car'
## The following object is masked from 'package:fBasics':
##
##     densityPlot
library(tseries)
library(forecast)
getSymbols("CAT",from="2000-01-03",to="2021-01-31")
## '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"
dim(CAT)
## [1] 5303    6
head(CAT)
##            CAT.Open CAT.High  CAT.Low CAT.Close CAT.Volume CAT.Adjusted
## 2000-01-03 23.84375 24.50000 23.84375  24.31250    5055000     13.75500
## 2000-01-04 24.31250 24.87500 24.00000  24.00000    6181400     13.57821
## 2000-01-05 24.00000 25.09375 24.00000  24.56250    6398600     13.89644
## 2000-01-06 25.28125 26.12500 25.28125  25.81250    5140600     14.60364
## 2000-01-07 26.37500 27.56250 26.37500  26.65625    6360200     15.08100
## 2000-01-10 26.65625 27.28125 25.75000  25.78125    3682200     14.58597
tail(CAT)
##            CAT.Open CAT.High CAT.Low CAT.Close CAT.Volume CAT.Adjusted
## 2021-01-22   190.85   192.82  189.31    191.94    2027000       191.94
## 2021-01-25   190.56   191.37  186.97    187.34    3837100       187.34
## 2021-01-26   187.60   189.41  186.83    187.21    2506000       187.21
## 2021-01-27   184.20   185.55  179.34    180.63    4095300       180.63
## 2021-01-28   182.26   187.61  181.31    184.34    3445400       184.34
## 2021-01-29   183.50   188.82  180.73    182.84    4540100       182.84
da=CAT
chartSeries(CAT,theme="white")
```



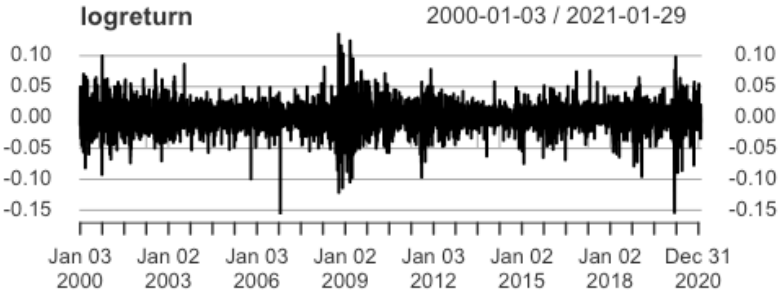

```
price=da[,6]
plot(price,type='l')
```

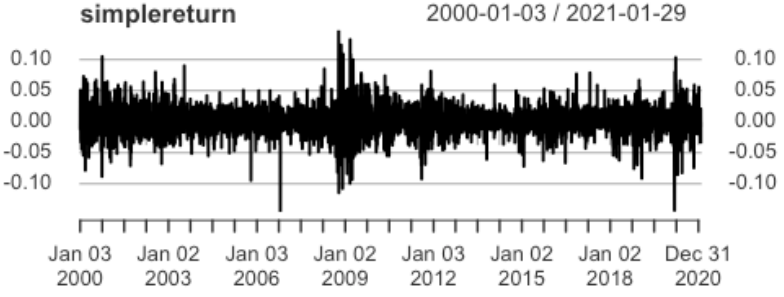

```
logprice=log(price)
plot(logprice,type='l')
```


```
logreturn=diff(log(price))
simplereturn <-exp(logreturn)-1
```

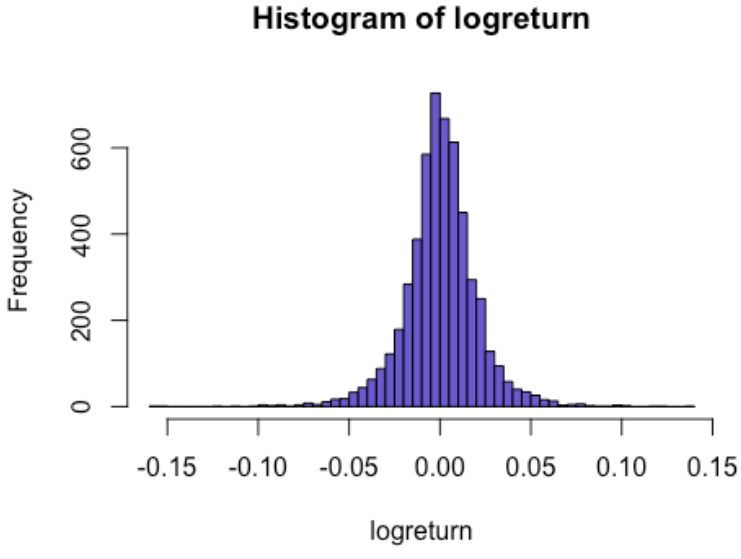
#1 Plot the series of log return and simple return

```
par(mfrow=c(2,1))
plot(logreturn,type='l')
plot(simplereturn)
```

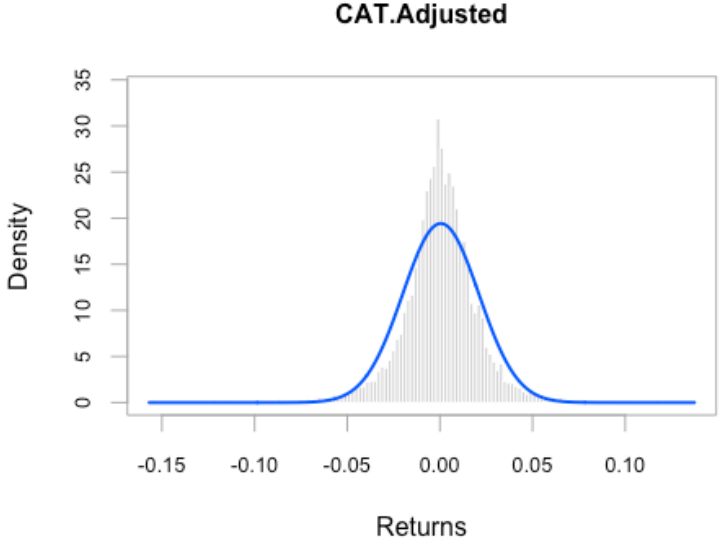




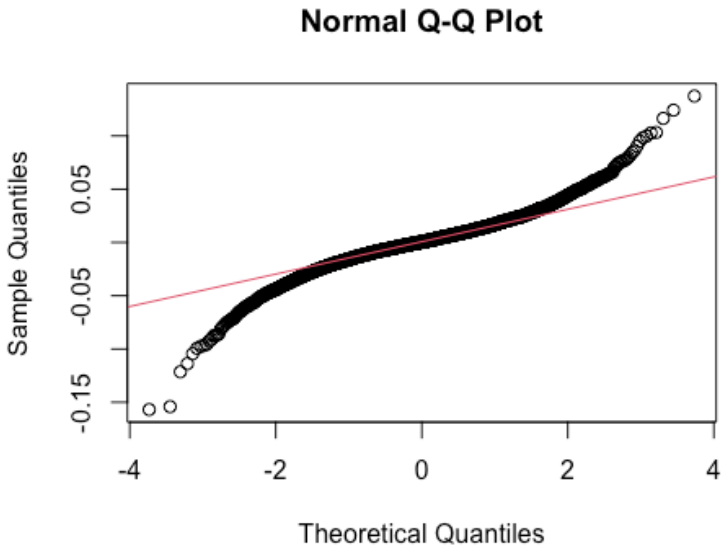

```
newlogreturn <- logreturn[2:nrow(logreturn),]
newsimplereturn <- simplereturn[2:nrow(logreturn),]


#2 Histogram and sample statistics
par(mfrow=c(1,1))
hist(logreturn, breaks=100, col="slateblue")
```




```
chart.Histogram(logreturn,methods = c("add.normal"))
```



```
table.Stats(logreturn)
##                  CAT.Adjusted
## Observations       5302.0000
## NAs                1.0000
## Minimum           -0.1569
## Quartile 1        -0.0095
## Median             0.0005
## Arithmetic Mean    0.0005
## Geometric Mean     0.0003
## Quartile 3         0.0110
## Maximum            0.1373
## SE Mean            0.0003
## LCL Mean (0.95)   -0.0001
## UCL Mean (0.95)    0.0010
## Variance           0.0004
## Stdev              0.0205
## Skewness          -0.1836
## Kurtosis           4.6982
table.Stats(simplereturn)
##                  CAT.Adjusted
## Observations       5302.0000
## NAs                1.0000
## Minimum           -0.1452
## Quartile 1        -0.0095
## Median             0.0005
## Arithmetic Mean    0.0007
## Geometric Mean     0.0005
## Quartile 3         0.0110
## Maximum            0.1472
## SE Mean            0.0003
## LCL Mean (0.95)    0.0001
## UCL Mean (0.95)    0.0013
## Variance           0.0004
## Stdev              0.0205
## Skewness           0.0197
## Kurtosis           4.5480
#3 QQ-plots and tests for normality
#
# use qqnorm function
par(mfrow=c(1,1))
qqnorm(newlogreturn)
qqline(newlogreturn, col = 2)
```




```
jarque.bera.test(newlogreturn)
##
##  Jarque Bera Test
##
## data:  newlogreturn
## X-squared = 4906.1, df = 2, p-value < 2.2e-16
#4 Test mean = 0
t.test(newlogreturn)
## Warning in tstat + c(-cint, cint): Recycling array of length 1 in array-vector arithmetic is
deprecated.
##   Use c() or as.vector() instead.
## Warning in cint * stderr: Recycling array of length 1 in vector-array arithmetic is deprecated.
##   Use c() or as.vector() instead.
##
##  One Sample t-test
##
## data:  newlogreturn
## t = 1.7296, df = 5301, p-value = 0.08377
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -6.513168e-05  1.041069e-03
## sample estimates:
##    mean of x
## 0.0004879685
#5 Test Skewness = 0
T=length(newlogreturn)
s3=skewness(newlogreturn)
```

```
tst = s3/sqrt(6/T)
tst
## [1] -5.458812
pv = 2*pnorm(tst)
pv
## [1] 4.793299e-08
#6 Test excess kurtosis =0
k4 = kurtosis(newlogreturn)
tst = k4/sqrt(24/T)
tst
## [1] 69.83078
pv = 2*(1-pnorm(tst))
pv
## [1] 0
getSymbols("AOT.BK",from="2000-01-03",to="2021-01-31")
## [1] "AOT.BK"
dim(AOT.BK)
## [1] 4159    6
head(AOT.BK)
##            AOT.BK.Open AOT.BK.High AOT.BK.Low AOT.BK.Close AOT.BK.Volume
## 2004-03-11       4.500       4.800      4.425        4.800      17414690
## 2004-03-12       4.700       4.775      4.600        4.600     668350000
## 2004-03-15       4.625       4.650      4.550        4.550     346345000
## 2004-03-16       4.525       4.575      4.500        4.525     136384000
## 2004-03-17       4.550       4.600      4.550        4.600      88608000
## 2004-03-18       4.650       4.925      4.650        4.775     434665000
##            AOT.BK.Adjusted
## 2004-03-11        2.668538
## 2004-03-12        2.557348
## 2004-03-15        2.529552
## 2004-03-16        2.515653
## 2004-03-17        2.557348
## 2004-03-18        2.654639
tail(AOT.BK)
##            AOT.BK.Open AOT.BK.High AOT.BK.Low AOT.BK.Close AOT.BK.Volume
## 2021-01-22       60.50       60.75       59.5        59.75      27812300
## 2021-01-25       59.75       60.50       59.5        59.75      10446500
## 2021-01-26       59.75       60.75       59.5        60.25      15439500
## 2021-01-27       60.25       60.75       60.0        60.25      12355000
## 2021-01-28       59.50       60.50       59.5        60.00      19675400
## 2021-01-29       60.25       60.50       59.5        59.50      23994200
##            AOT.BK.Adjusted
## 2021-01-22           59.75
## 2021-01-25           59.75
## 2021-01-26           60.25
## 2021-01-27           60.25
## 2021-01-28           60.00
## 2021-01-29           59.50
da=AOT.BK
chartSeries(AOT.BK,theme="white")
```

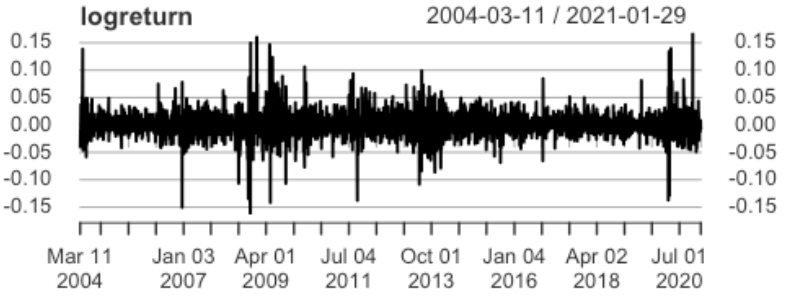

```
price=da[,6]
plot(price,type='l')
```

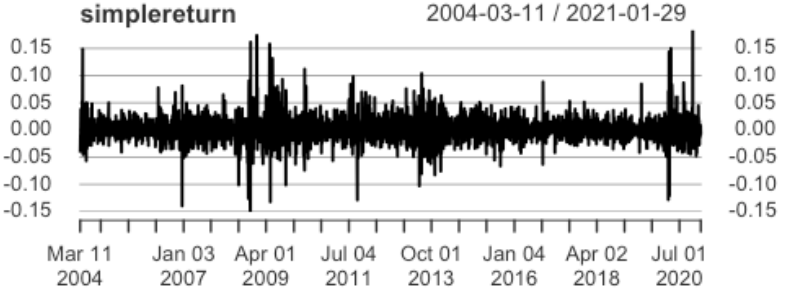

```
logprice=log(price)
plot(logprice,type='l')
```


```
logreturn=diff(log(price))
simplereturn <-exp(logreturn)-1
```

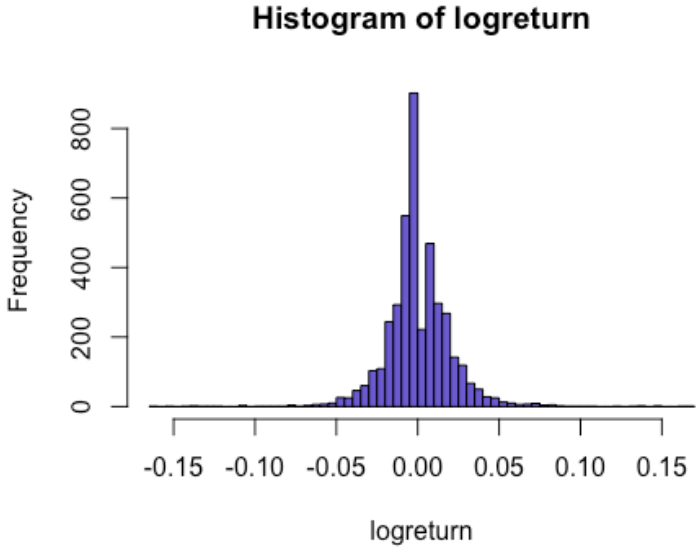
#1 Plot the series of log return and simple return

```
par(mfrow=c(2,1))
plot(logreturn,type='l')
plot(simplereturn)
```

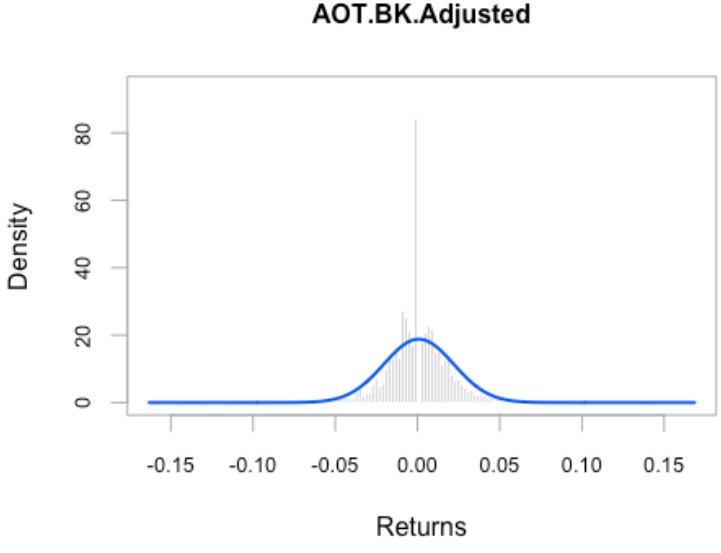




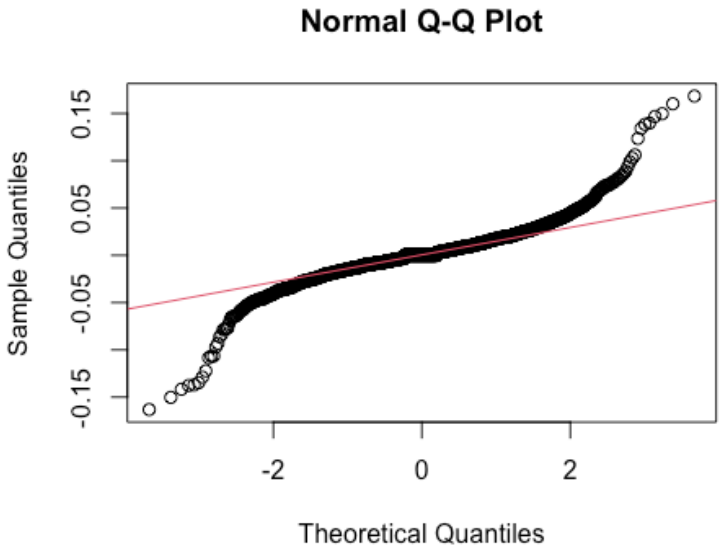

```
newlogreturn <- logreturn[2:nrow(logreturn),]
newsimplereturn <- simplereturn[2:nrow(logreturn),]


#2 Histogram and sample statistics
par(mfrow=c(1,1))
hist(logreturn, breaks=100, col="slateblue")
```




```
chart.Histogram(logreturn,methods = c("add.normal"))
```



```
table.Stats(logreturn)
##                   AOT.BK.Adjusted
## Observations          4158.0000
## NAs                   1.0000
## Minimum              -0.1632
## Quartile 1           -0.0093
## Median                0.0000
## Arithmetic Mean          0.0007
## Geometric Mean           0.0005
## Quartile 3            0.0102
## Maximum               0.1684
## SE Mean               0.0003
## LCL Mean (0.95)          0.0001
## UCL Mean (0.95)          0.0014
## Variance              0.0004
## Stdev                 0.0212
## Skewness              0.1746
## Kurtosis              9.6096
table.Stats(simplereturn)
##                   AOT.BK.Adjusted
## Observations          4158.0000
## NAs                   1.0000
## Minimum              -0.1505
## Quartile 1           -0.0093
## Median                0.0000
## Arithmetic Mean          0.0010
## Geometric Mean           0.0007
## Quartile 3            0.0103
## Maximum               0.1834
## SE Mean               0.0003
## LCL Mean (0.95)          0.0003
## UCL Mean (0.95)          0.0016
## Variance              0.0005
## Stdev                 0.0213
## Skewness              0.5443
## Kurtosis             10.0827
#3 QQ-plots and tests for normality
#
# use qqnorm function
par(mfrow=c(1,1))
qqnorm(newlogreturn)
qqline(newlogreturn, col = 2)
```




```
jarque.bera.test(newlogreturn)
##
##  Jarque Bera Test
##
## data:  newlogreturn
## X-squared = 16020, df = 2, p-value < 2.2e-16
#4 Test mean = 0
t.test(newlogreturn)
## Warning in tstat + c(-cint, cint): Recycling array of length 1 in array-vector arithmetic is
deprecated.
##   Use c() or as.vector() instead.


## Warning in tstat + c(-cint, cint): Recycling array of length 1 in vector-array arithmetic is
deprecated.
##   Use c() or as.vector() instead.
##
##  One Sample t-test
##
## data:  newlogreturn
## t = 2.2696, df = 4157, p-value = 0.02328
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  0.0001016629 0.0013915769
## sample estimates:
##    mean of x
## 0.0007466199
#5 Test Skewness = 0
```

```
T=length(newlogreturn)
s3=skewness(newlogreturn)
tst = s3/sqrt(6/T)
tst
## [1] 4.596526
pv = 2*pnorm(tst)
pv
## [1] 1.999996
#6 Test excess kurtosis =0
k4 = kurtosis(newlogreturn)
tst = k4/sqrt(24/T)
tst
## [1] 126.4855
pv = 2*(1-pnorm(tst))
pv
## [1] 0
```