MATH10282 Introduction to Statistics
Semester 2, 2018/19
Solutions to coursework assignment using R

The data for this question are contained in `https://minerva.it.manchester.ac.uk/~saralees/data.txt`. The data consist of daily closing stock prices of the company Coca Cola.

(a) Read the data into R as

```
z=scan("https://minerva.it.manchester.ac.uk/~saralees/data.txt",list(a=0))
x=z$a
```

`x` will contain the data.

[1]

(b) Use the following R command

```
x=diff(log(x))
```

[1]

(c) Use the following R command

```
hist(x,xlab="Log returns",ylab="Histogram and fitted PDF",
 main="",freq=F,xlim=c(-0.15,0.1),ylim=c(0,30))
```

You will get the plot

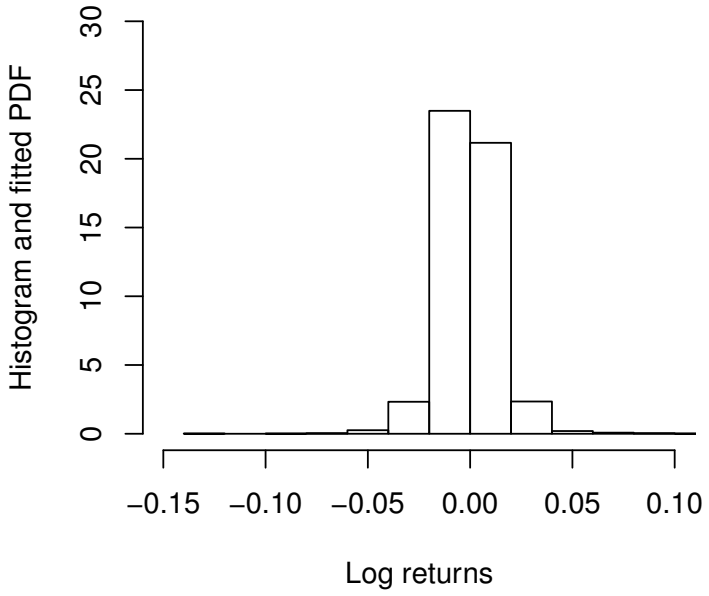

Figure 1: The histogram.

The shape is symmetric. But the tails appear heavier than that of a normal distribution. So, a normal distribution may not be an appropriate choice.

[1]

(d) An appropriate distribution to fit is the scaled Student' t distribution given by the PDF

$$f(x) = \frac{K(\nu)}{\sigma}\left[1 + \frac{(x-\mu)^2}{\sigma^2\nu}\right]^{-(1+\nu)/2}$$

for $-\infty < x < \infty$, $-\infty < \mu < \infty$, $\sigma > 0$ and $\nu > 0$, where $K(\nu) = \sqrt{\nu}B\left(\nu/2, 1/2\right)$ and $B(\cdot,\cdot)$ denotes the beta function defined by

$$B(a,b) = \int_0^1 t^{a-1}(1-t)^{b-1}dt.$$

There are several R packages which contain functions for computing this distribution. One R package is metRology. Install the package using

```
install.packages("metRology")
library("metRology")
```

Now use the following R commands to fit the distribution

```
est=fitdist(x,dist="t.scaled",start=c(1,0,1))
est
```

You will get the output

```
Fitting of the distribution ' t.scaled ' by maximum likelihood
Parameters:
       estimate   Std. Error
1  3.0448663048 0.2139152343
2 -0.0002416764 0.0002051701
3  0.0084289210 0.0002197112
```

The MLEs of ν, μ and σ are 3.0449, -0.0002 and 0.0084, respectively.

[5]

(e) You can superimpose the fitted PDF on top of the histogram by using the following R commands

```
hist(x,xlab="Log returns",ylab="Histogram and fitted PDF",
 main="",freq=F,xlim=c(-0.15,0.1),ylim=c(0,30))
par(new=TRUE)
plot(seq(-0.15,0.1,0.001),fitted,type="l",xlim=c(-0.15,0.1),
 ylim=c(0,30),xlab="",ylab="")
```

You will get the plot

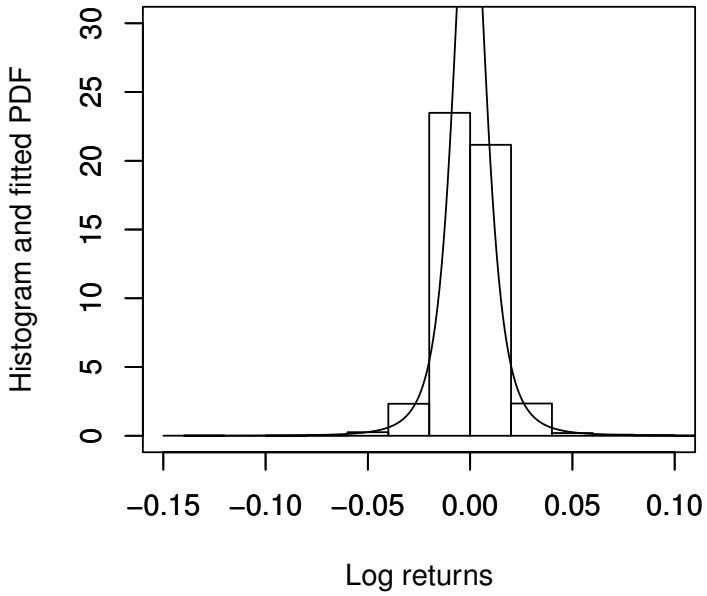

Figure 2: The histogram and the fitted PDF of the scaled Student't t distribution.

The fitted PDF captures the histogram well especially at its tails.

[1]

(f) The following R commands will perform the Kolmogorov Smirnov test:

```
p1=est$estimate[1]
p2=est$estimate[2]
p3=est$estimate[3]
ks.test(x,"pt.scaled",p1,p2,p3)
```

You will get the following output

```
        One-sample Kolmogorov-Smirnov test

data:  x
D = 0.012522, p-value = 0.8254
alternative hypothesis: two-sided

Warning message:
In ks.test(x, "pt.scaled", p1, p2, p3) :
  ties should not be present for the Kolmogorov-Smirnov test
```

Since the p-value is well above 0.05 the distribution does an adequate fit. [1]

[Total 10 marks]