STAT0017 ICA2

Hongwei Peng

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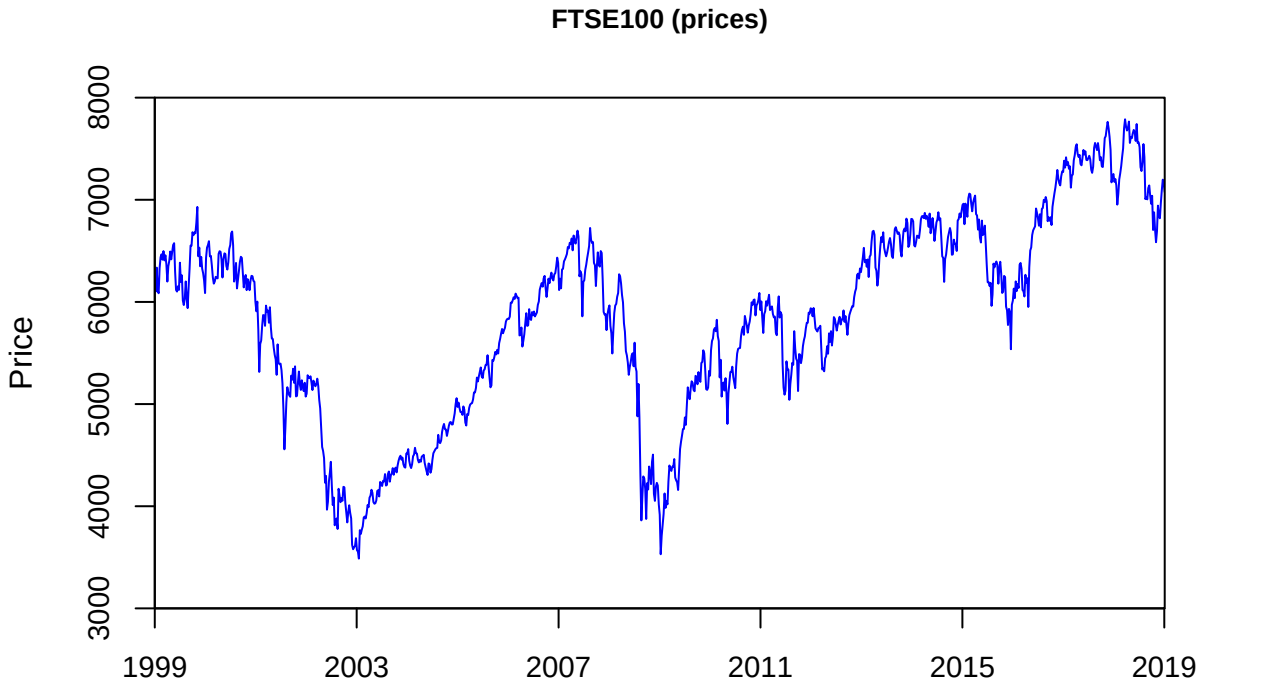
(a)

```
load("ICA2_data.RData")
library("fUnitRoots")
library(CDVine)
library(fGarch)
```

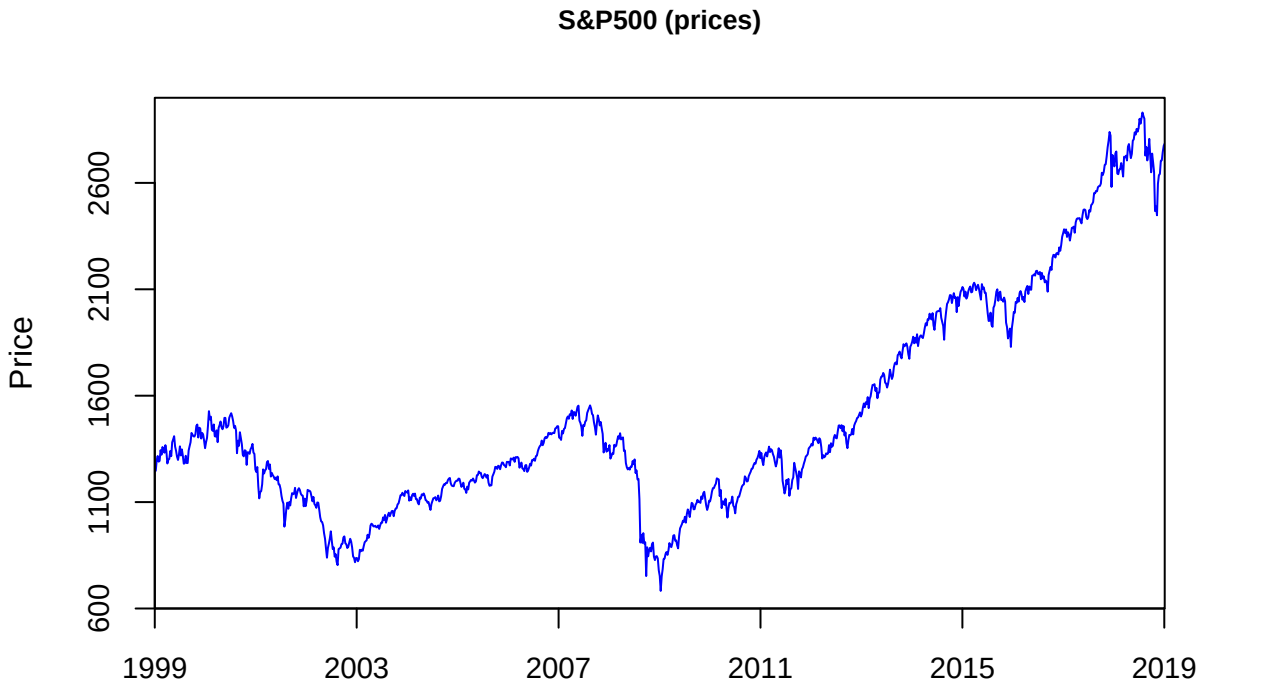
```
## Warning: package 'fGarch' was built under R version 3.5.2
```

```
library(goftest)
library(KScorrect)
library(stats)
```

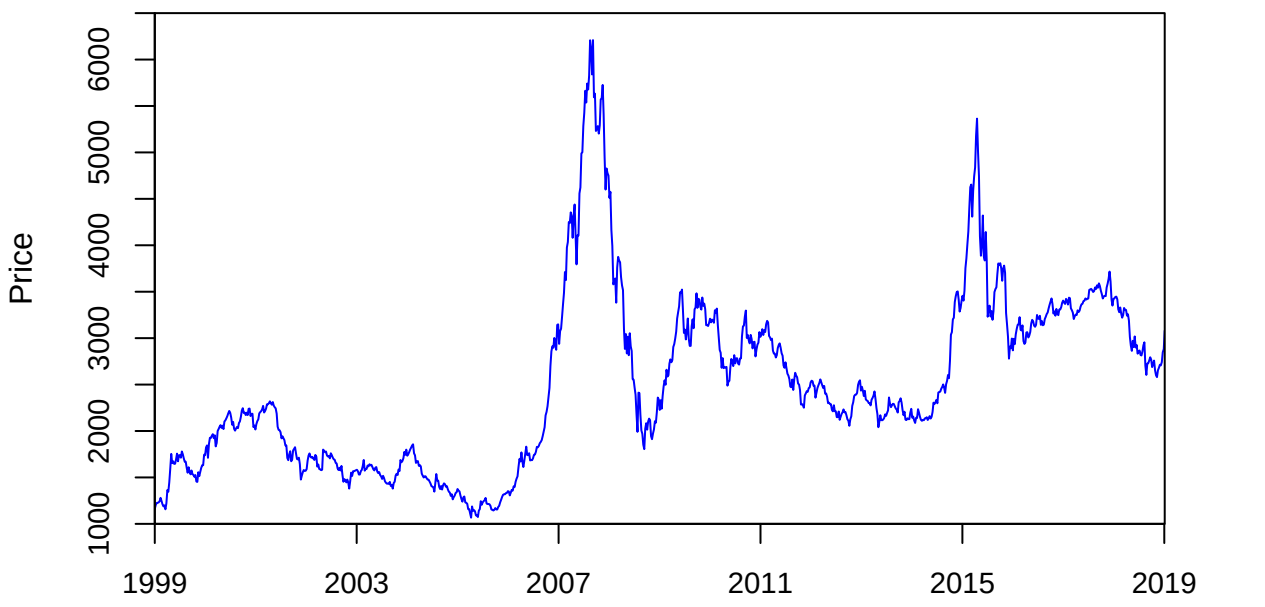
```
plot(data$ftse100~as.Date(data$date,"%d/%m/%y"),type="l",xaxt='n',yaxt='n',
     xlab="",ylab="Price",col="blue",main="FTSE100 (prices)",xaxs="i",
     yaxs="i",ylim=c(3000,8000),cex.main=0.8,cex.lab=1)
axis(2, at = seq(3000,8000,1000), tick=TRUE,cex.axis=0.9)
axis.Date(1, cex.axis=0.9,at=seq(as.Date("1999/02/25"), as.Date("2019/02/28"), "4 years"))
```




```
plot(data$sp500~as.Date(data$date,"%d/%m/%y"),type="l",xaxt='n',yaxt='n',
     xlab="",ylab="Price",col="blue",main="S&P500 (prices)",xaxs="i",
     yaxs="i",ylim=c(600,3000),cex.main=0.8,cex.lab=1)
axis(2, at = seq(600,3000,500), tick=TRUE,cex.axis=0.9)
axis.Date(1, cex.axis=0.9,at=seq(as.Date("1999/02/25"), as.Date("2019/02/28"), "4 years"))
```




```
plot(data$sse~as.Date(data$date,"%d/%m/%y"),type="l",xaxt='n',yaxt='n',
     xlab="",ylab="Price",col="blue",main="SSE (prices)",xaxs="i",
     yaxs="i",ylim=c(1000,6500),cex.main=0.8,cex.lab=1)
axis(2, at = seq(1000,6500,500), tick=TRUE,cex.axis=0.9)
axis.Date(1, cex.axis=0.9,at=seq(as.Date("1999/02/25"), as.Date("2019/02/28"), "4 years"))
```




```
unitrootTest(data$ftse100)
```

```
##
## Title:
##  Augmented Dickey-Fuller Test
```

```
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
##     DF: -0.0358
##   P VALUE:
##     t: 0.6707
##     n: 0.6738
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

```
unitrootTest(data$sp500)
```

```
##
## Title:
##  Augmented Dickey-Fuller Test
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
##     DF: 1.7922
##   P VALUE:
##     t: 0.9828
##     n: 0.983
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

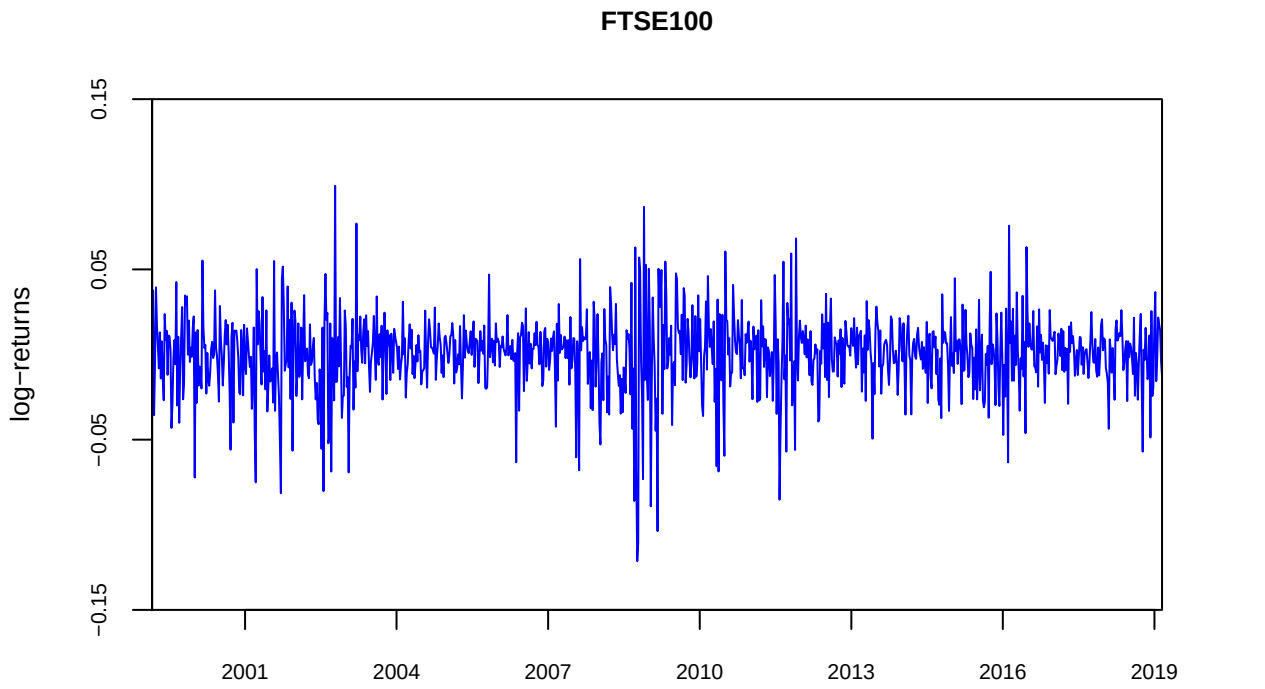
```
unitrootTest(data$sse)
```

```
##
## Title:
##  Augmented Dickey-Fuller Test
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
##     DF: -0.2252
##   P VALUE:
##     t: 0.6051
##     n: 0.6296
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

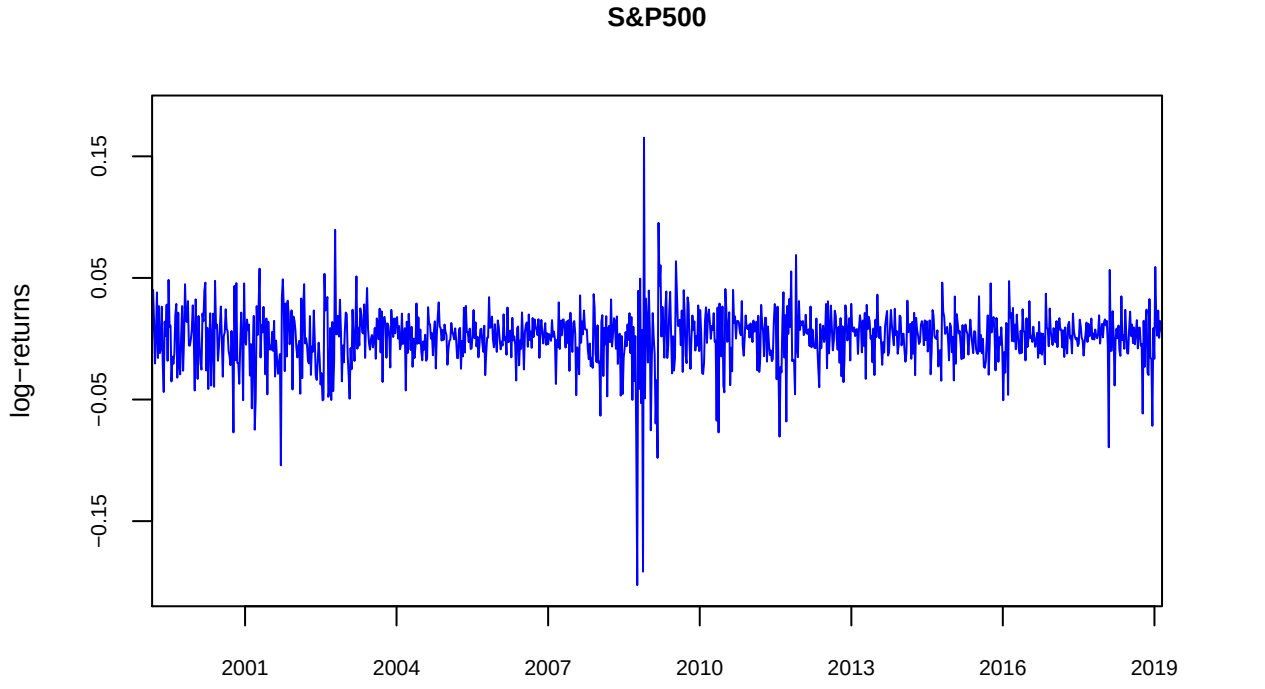
```
ret1<-diff(log(data$ftse100), lag=1,na=remove)
ret2<-diff(log(data$sp500), lag=1,na=remove)
ret3<-diff(log(data$sse), lag=1,na=remove)

plot(ret1~as.Date(data$date[2:length(data$date)],"%d/%m/%y"),type="l",yaxt='n',xaxt='n',
     xlab="",ylab="log-returns",main="FTSE100",xaxs="i",
     yaxs="i", col="blue",ylim=c(-0.15,0.15),cex.main=0.8,cex.lab=0.8)
```

```
axis(2, at = seq(-0.15,0.15,0.1), tick=TRUE,cex.axis=0.7)
axis.Date(1, cex.axis=0.7, at=seq(as.Date("1998/01/04"), as.Date("2019/02/28"), "3 years"))
```

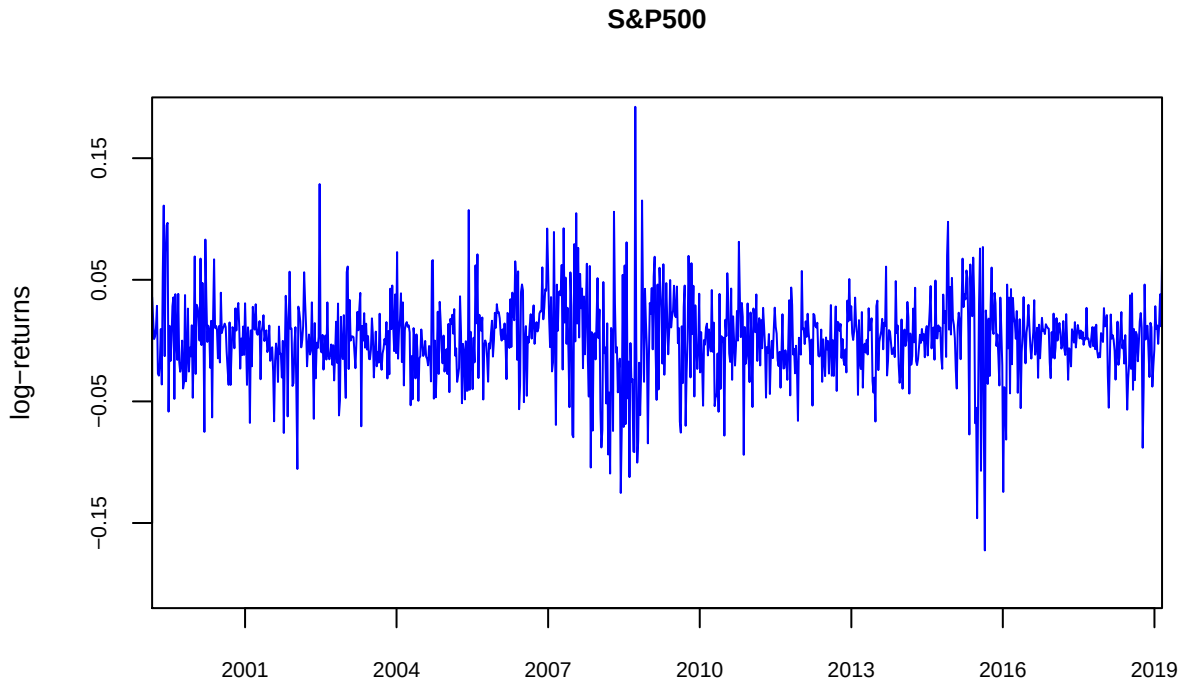



```
plot(ret2~as.Date(data$date[2:length(data$date)],"%d/%m/%y"),type="l",yaxt='n',xaxt='n',
     xlab="",ylab="log-returns",main="S&P500",xaxs="i",
     yaxs="i", col="blue",ylim=c(-0.22,0.2),cex.main=0.8,cex.lab=0.8)
axis(2, at = seq(-0.15,0.15,0.1), tick=TRUE,cex.axis=0.7)
axis.Date(1, cex.axis=0.7, at=seq(as.Date("1998/01/04"), as.Date("2019/02/28"), "3 years"))
```




```
plot(ret3~as.Date(data$date[2:length(data$date)],"%d/%m/%y"),type="l",yaxt='n',xaxt='n',
```

```
     xlab="",ylab="log-returns",main="S&P500",xaxs="i",
     yaxs="i", col="blue",ylim=c(-0.22,0.2),cex.main=0.8,cex.lab=0.8)
axis(2, at = seq(-0.15,0.15,0.1), tick=TRUE,cex.axis=0.7)
axis.Date(1, cex.axis=0.7, at=seq(as.Date("1998/01/04"), as.Date("2019/02/28"), "3 years"))
```




```
unitrootTest(ret1)
```

```
##
## Title:
##  Augmented Dickey-Fuller Test
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
##     DF: -23.8913
##   P VALUE:
##     t: < 2.2e-16
##     n: 0.0005934
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

```
unitrootTest(ret2)
```

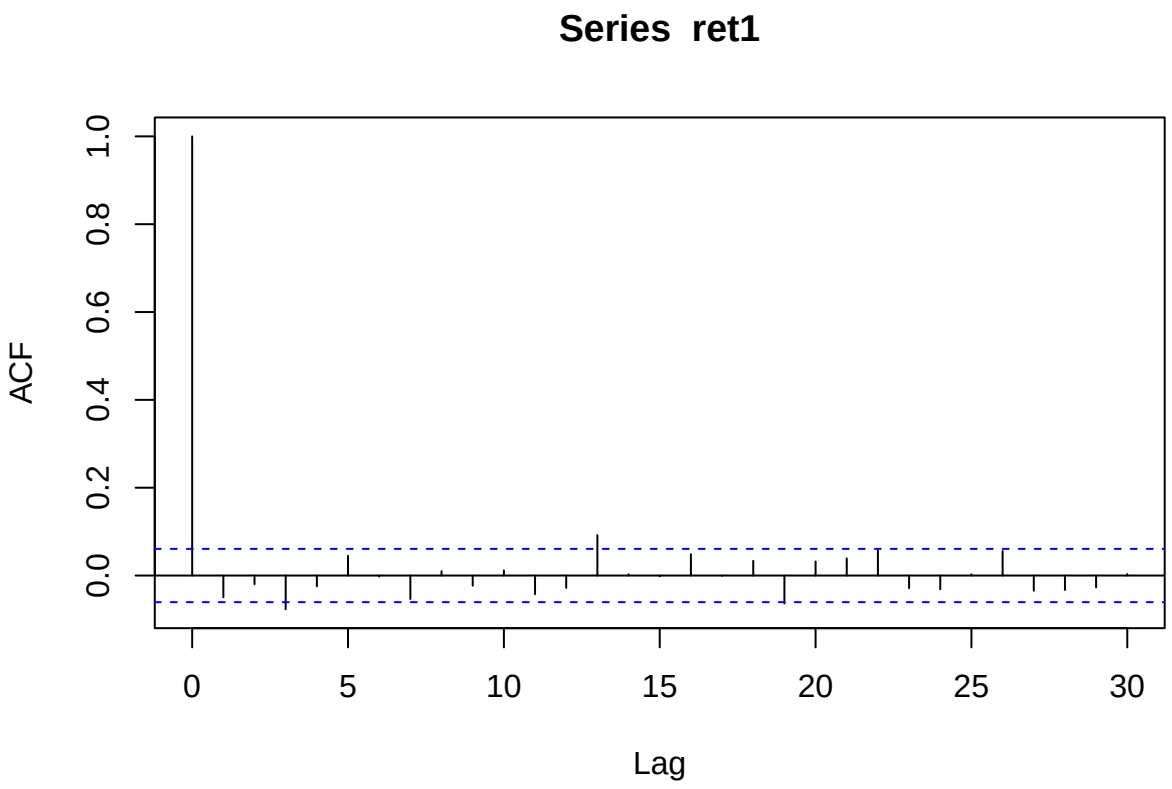
```
##
## Title:
##  Augmented Dickey-Fuller Test
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
```

```
##     DF: -22.442
##   P VALUE:
##     t: < 2.2e-16
##     n: 0.0008784
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

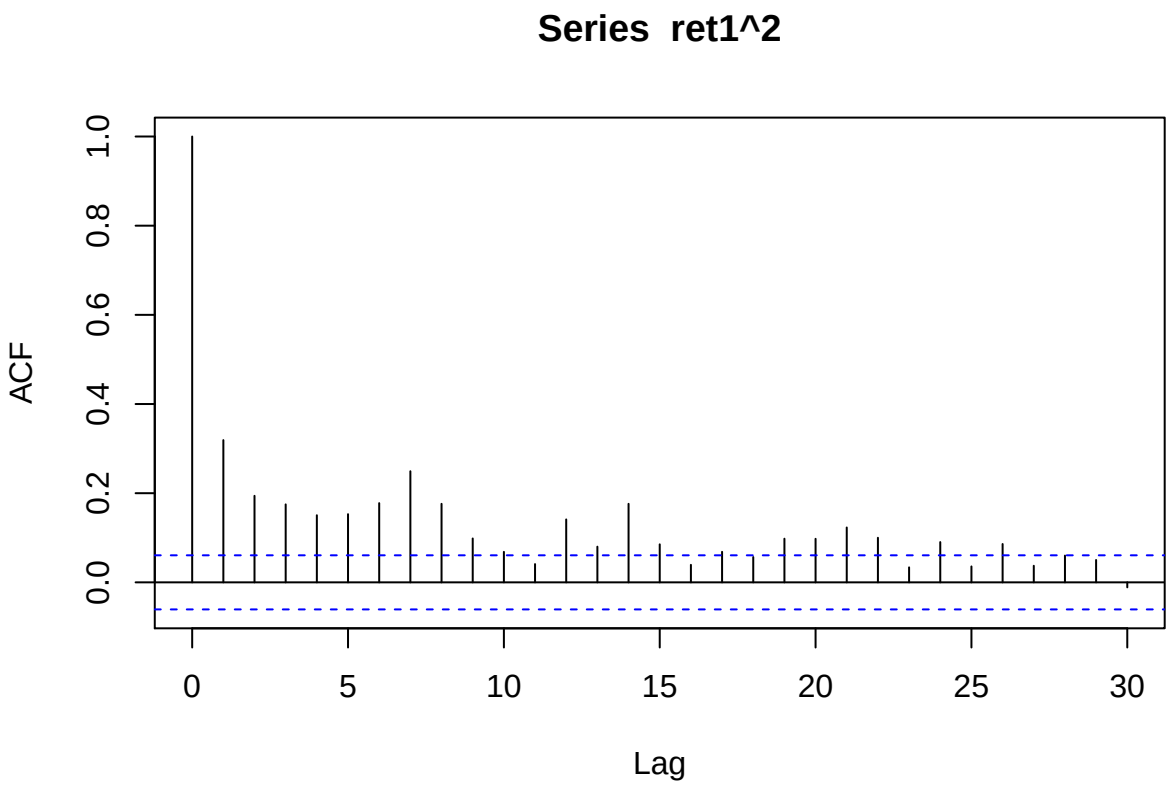
```
unitrootTest(ret3)
```

```
##
## Title:
##  Augmented Dickey-Fuller Test
##
## Test Results:
##   PARAMETER:
##     Lag Order: 1
##   STATISTIC:
##     DF: -21.4706
##   P VALUE:
##     t: < 2.2e-16
##     n: 0.001144
##
## Description:
##  Mon Apr 29 16:58:04 2019 by user:
```

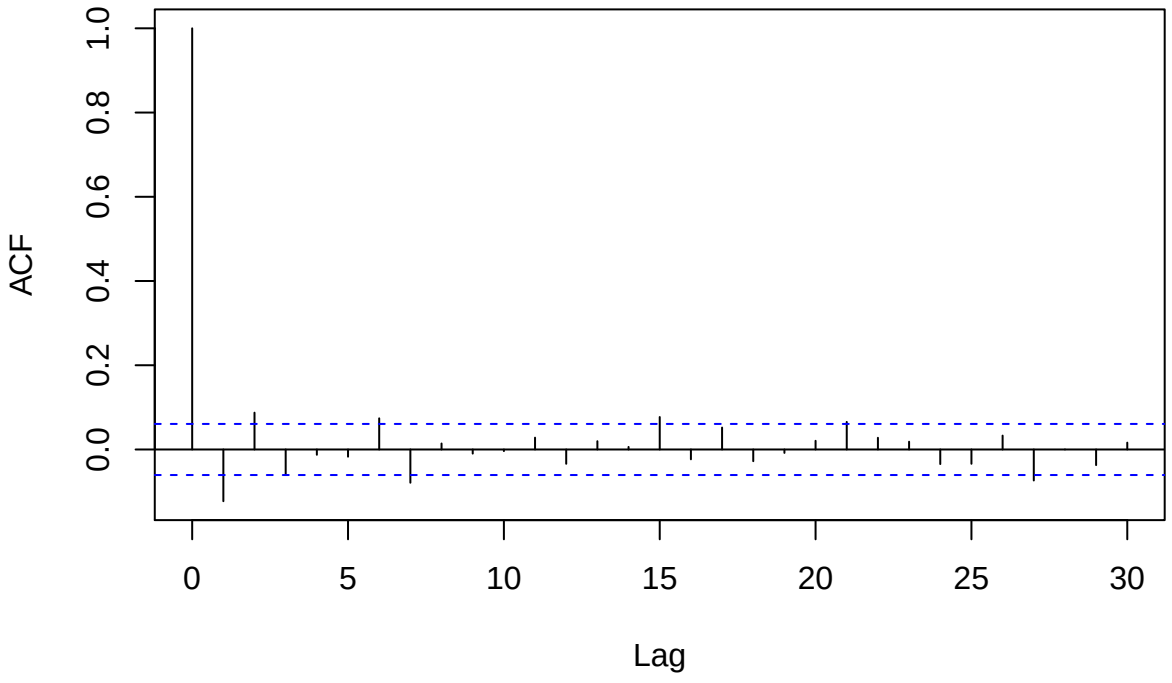
```
acf(ret1)
```



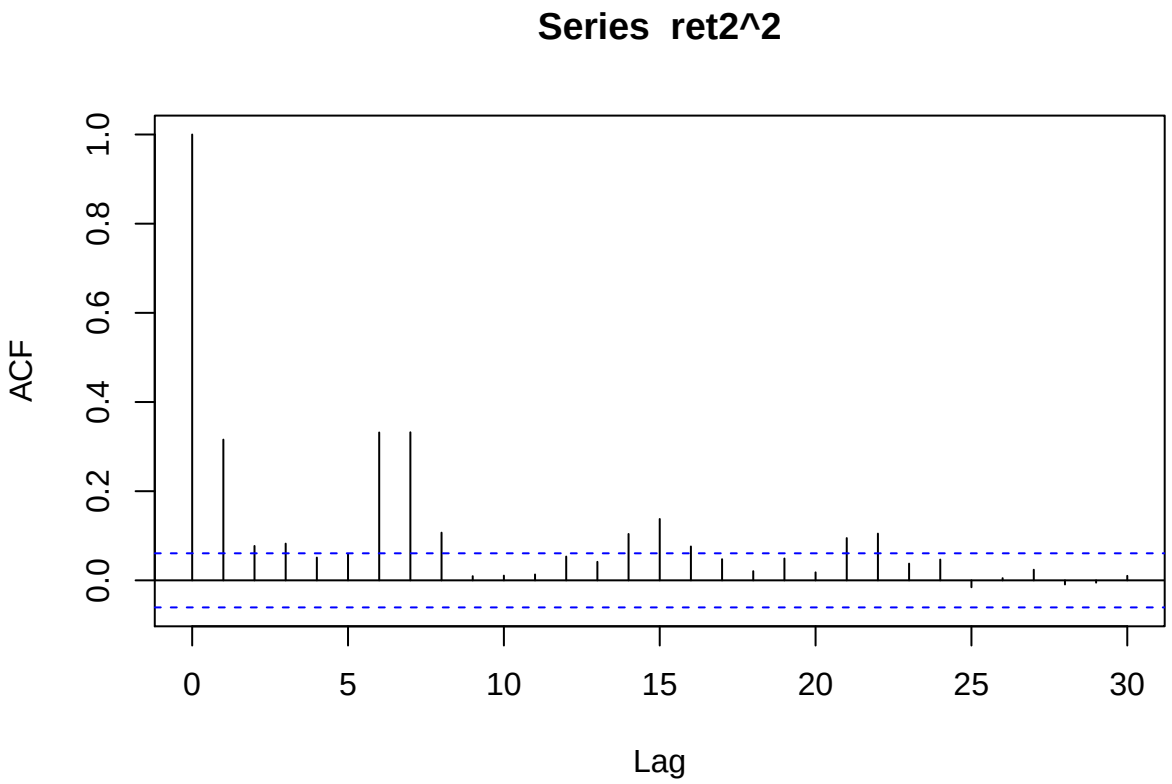
```
acf(ret1^2)
```



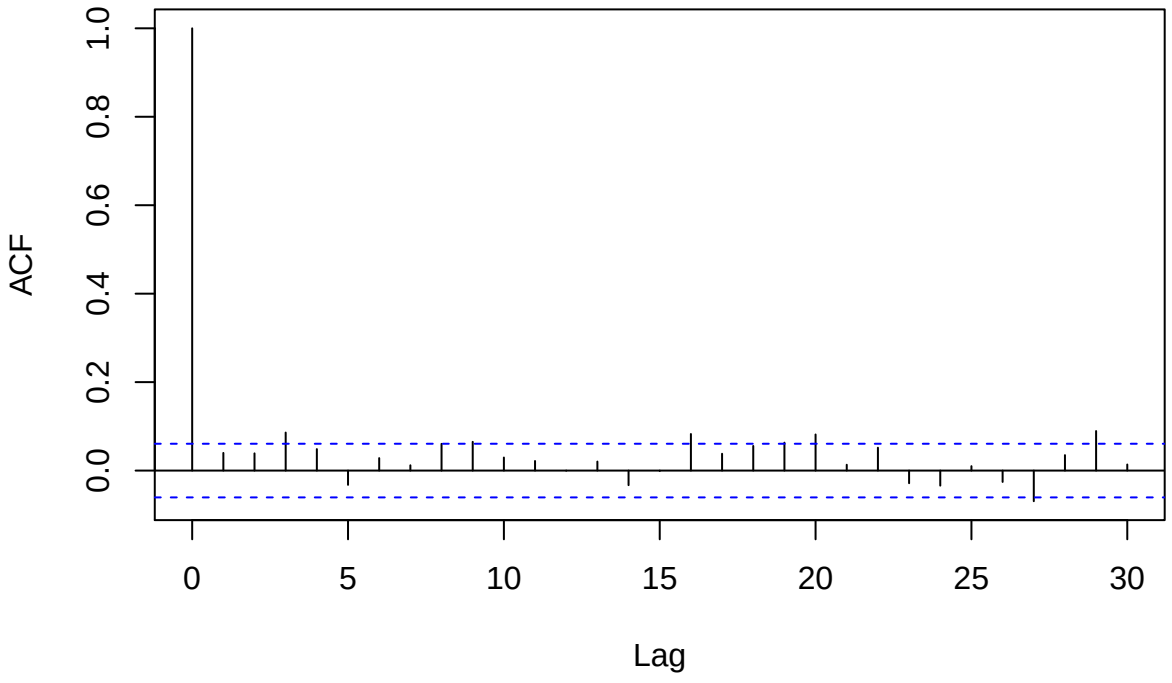

```
acf(ret2)
```



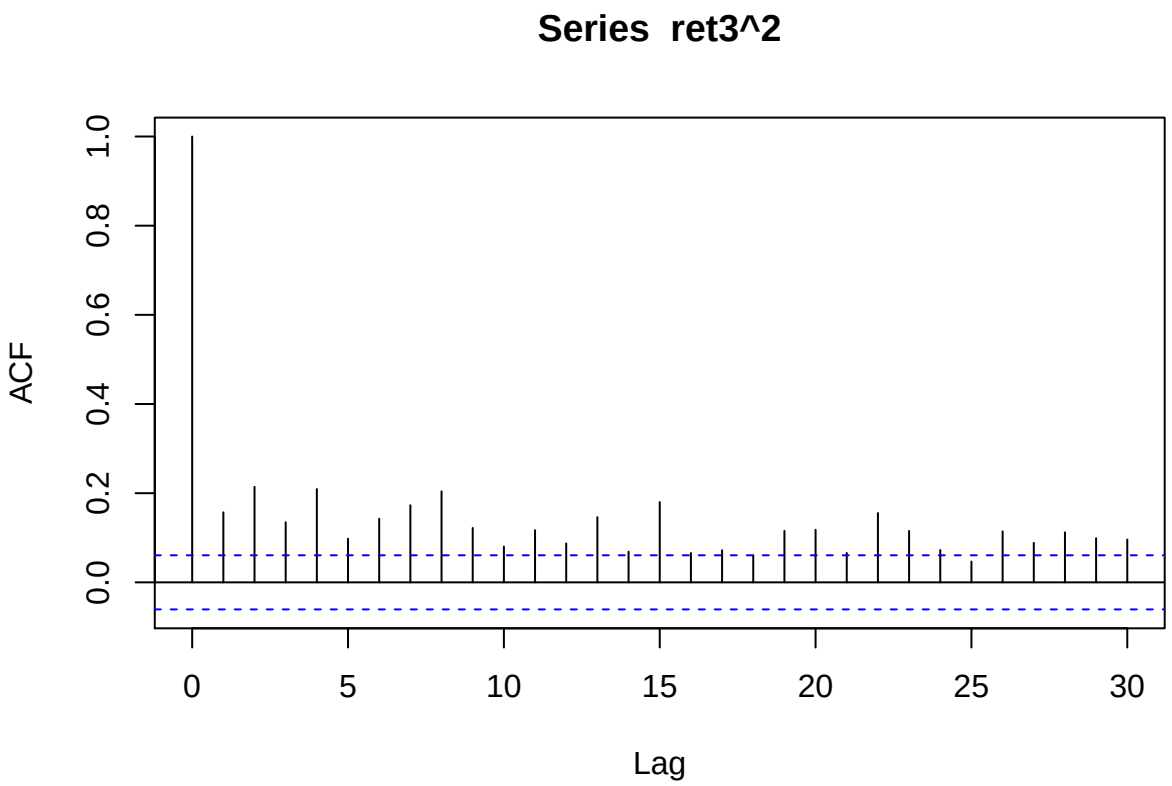
```
acf(ret2^2)
```



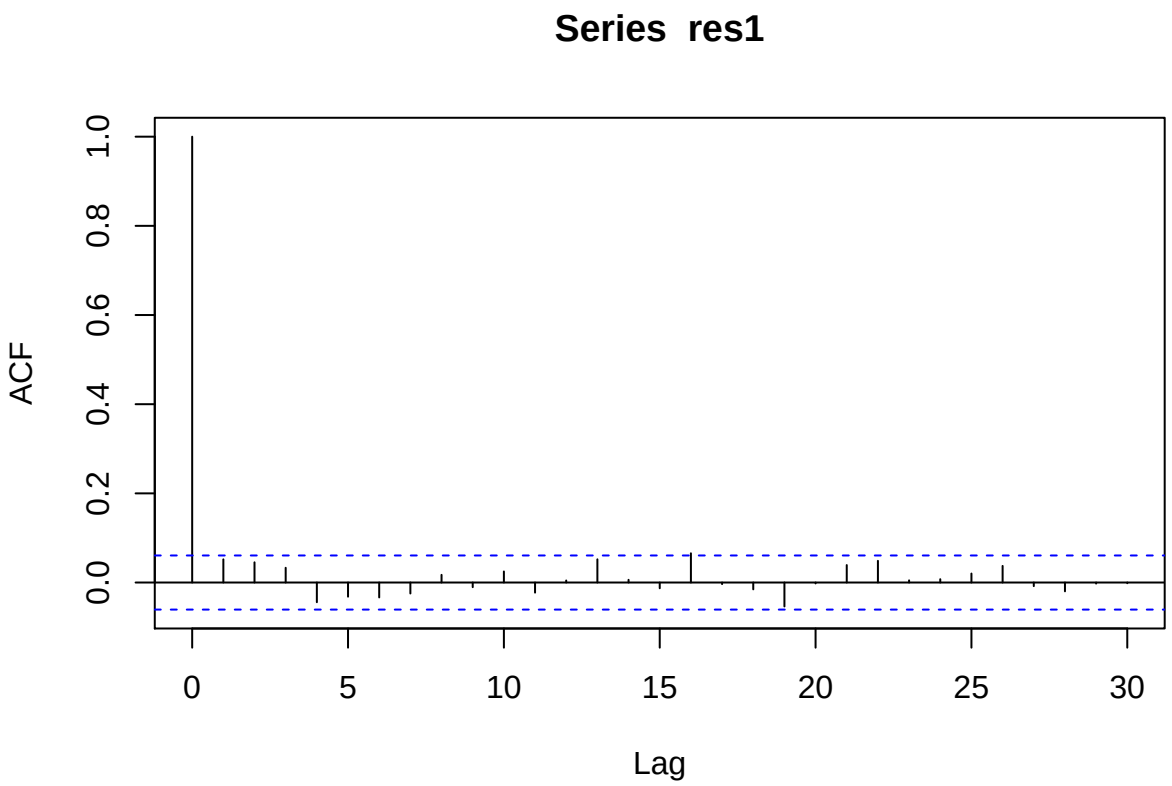

```
acf(ret3)
```



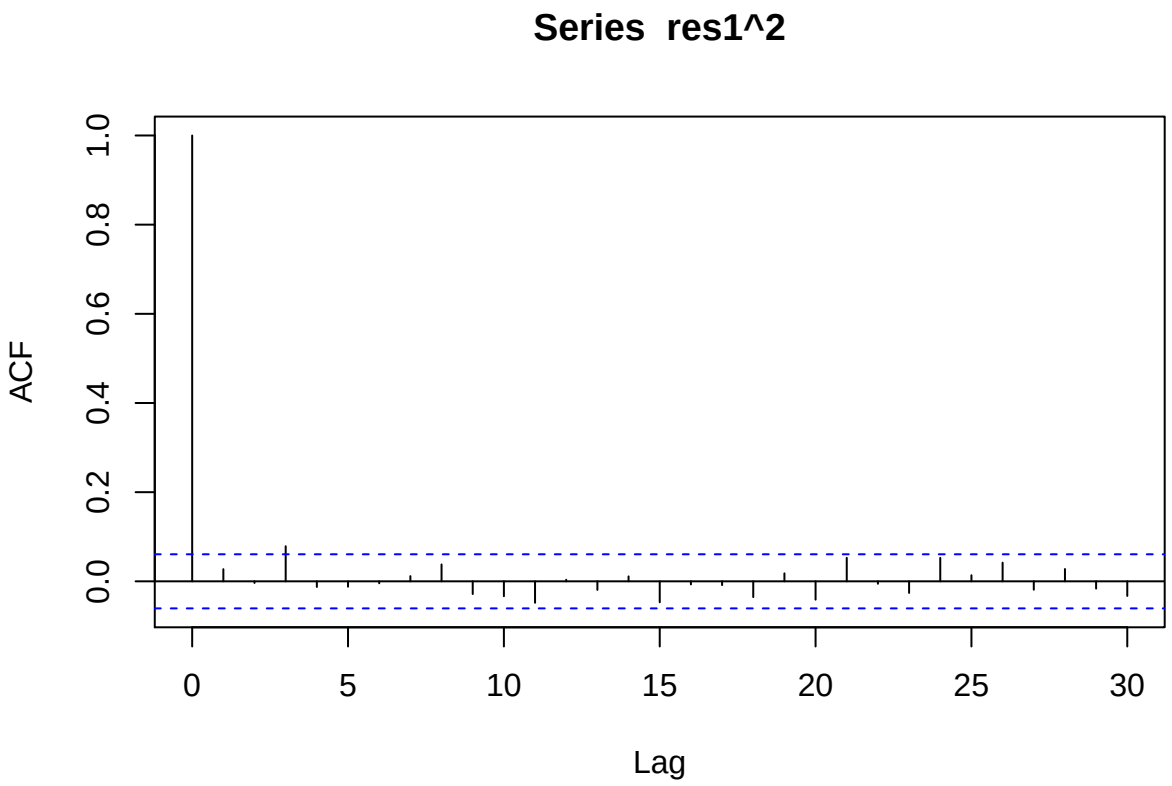
```r
acf(ret3^2)
```




```r
model1=garchFit(formula=~arma(3,0)+garch(1,1),data=ret1,trace=F,cond.dist="sstd")
res1 <- residuals(model1, standardize=TRUE)
acf(res1)
```




```
acf(res1^2)
```




```
Box.test(res1, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

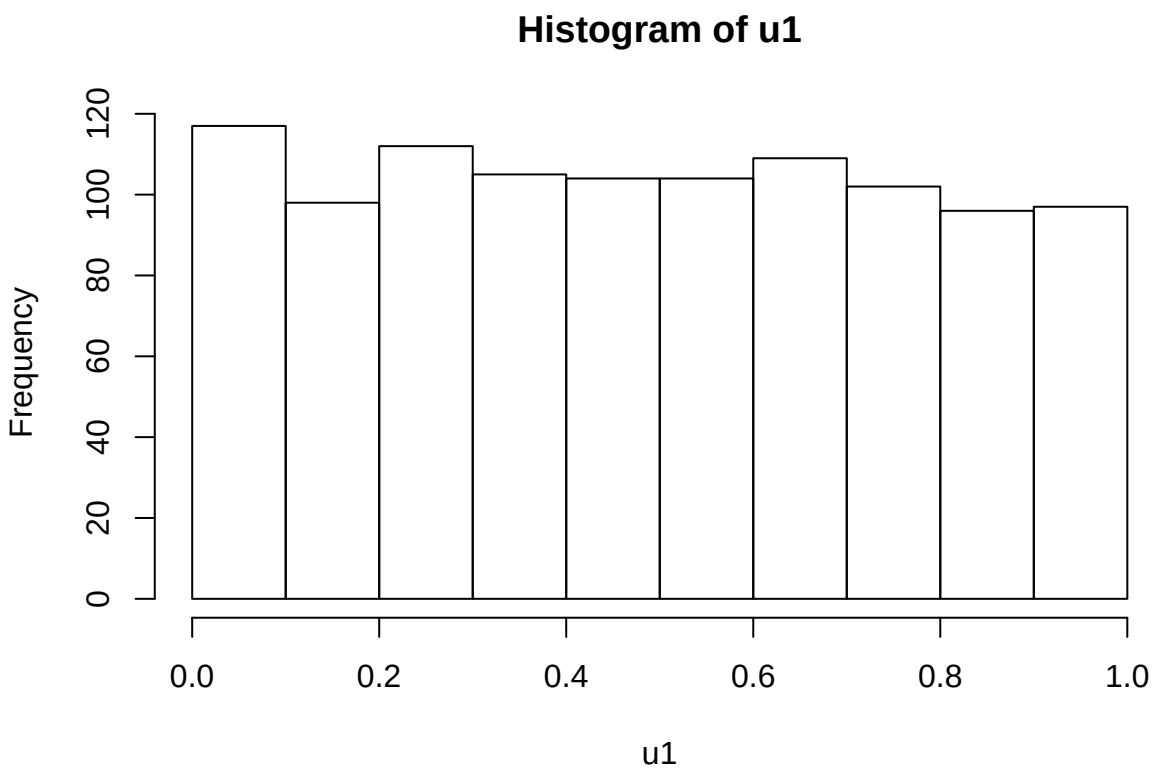
```
##
```

```
##  Box-Ljung test
##
## data:  res1
## X-squared = 12.138, df = 10, p-value = 0.2759
```

```
Box.test(res1^2, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

```
##
##  Box-Ljung test
##
## data:  res1^2
## X-squared = 11.352, df = 10, p-value = 0.3308
```

```
shape1<-coef(model1)[9]
skew1<-coef(model1)[8]
u1<-psstd(res1, mean=0, sd=1, nu=shape1, xi=skew1)
hist(u1)
```




```
#Kolmogorov-Smirnov test
KStest1<-LcKS(u1, cdf = "punif")
```

```
## Warning in ks.test(x, "punif", min = min.x, max = max.x): ties should not
## be present for the Kolmogorov-Smirnov test
```

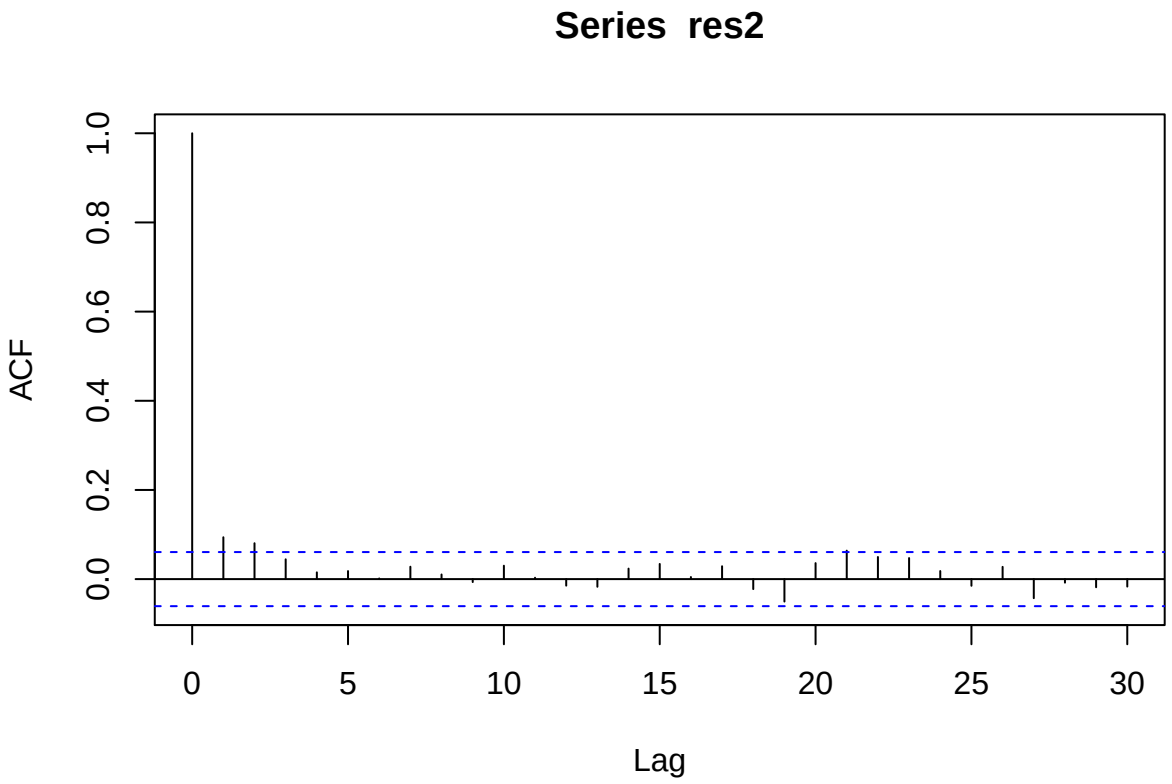
```
KStest1$p.value
```

```
## [1] 0.7518
```

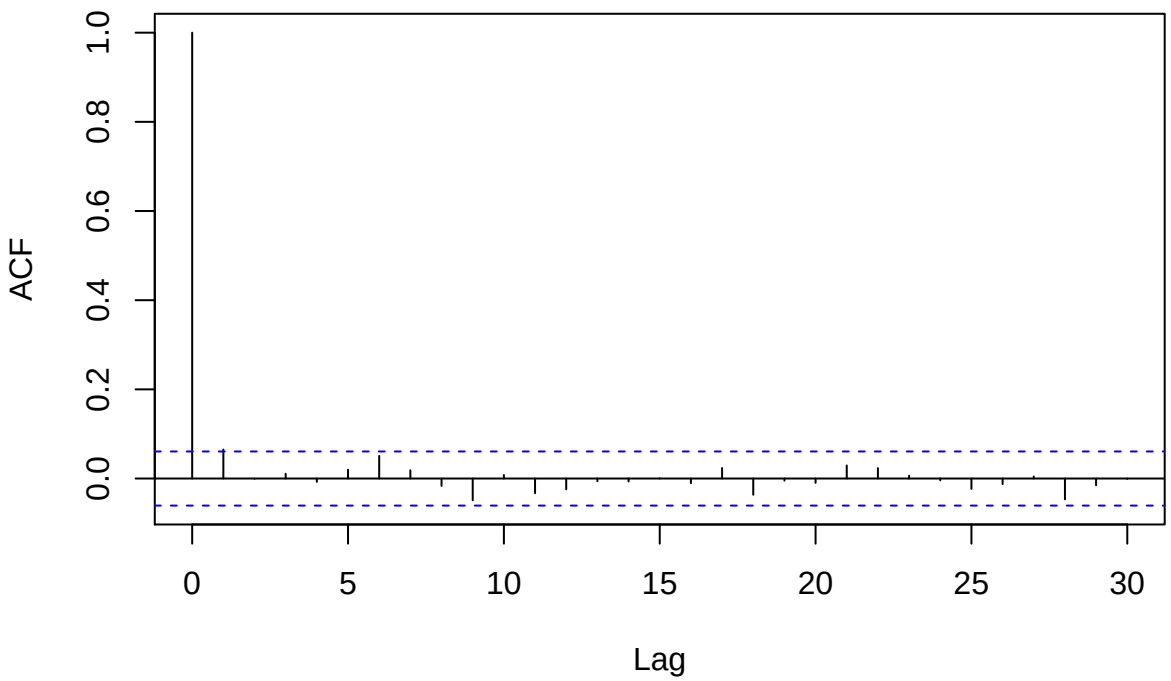
```
#Anderson-Darling test
ADtest1<-ad.test(u1, null="punif")
ADtest1$p.value
```

```
## [1] 0.4132992
```

```
model2=garchFit(formula=~arma(7,0)+garch(1,1),data=ret2,trace=F,cond.dist="sstd")
res2 <- residuals(model2, standardize=TRUE)
acf(res2)
```




```
acf(res2^2)
```



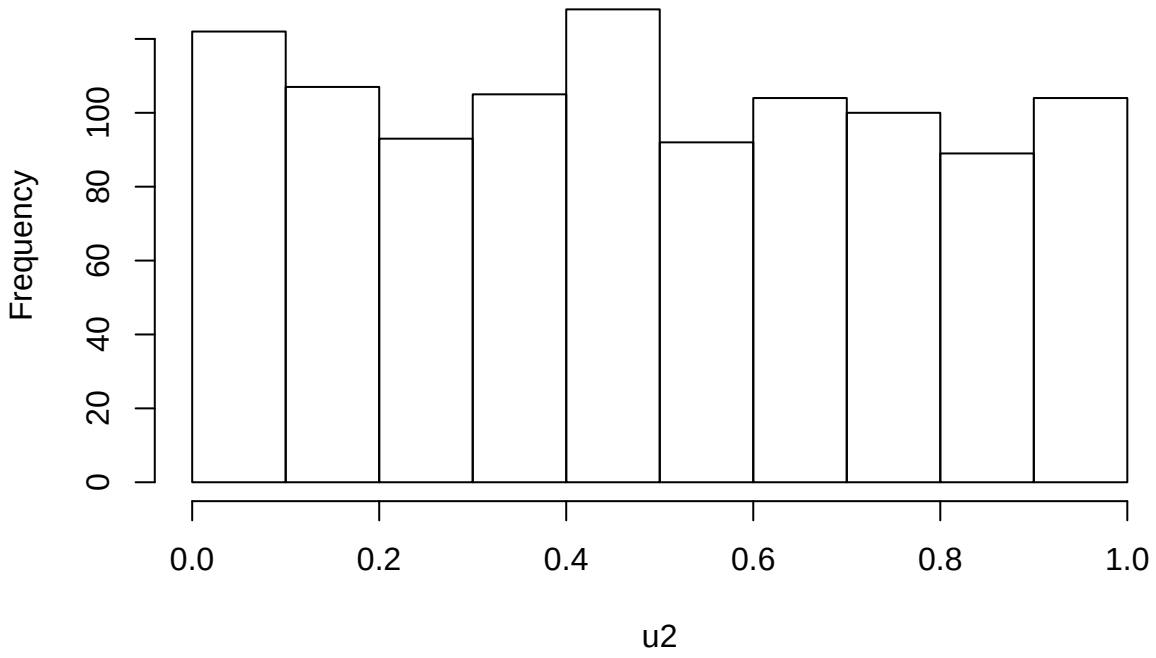

```
Box.test(res2, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

```
##
##  Box-Ljung test
##
## data:  res2
## X-squared = 20.636, df = 10, p-value = 0.02378
```

```
Box.test(res2^2, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

```
##
##  Box-Ljung test
##
## data:  res2^2
## X-squared = 10.966, df = 10, p-value = 0.3602
```

```
shape2<-coef(model2)[13]
skew2<-coef(model2)[12]
u2<-psstd(res2, mean=0, sd=1, nu=shape2, xi=skew2)
#u2<-pnorm(res2, mean=0, sd=1)
#u2<-pt(res2, df=3)
hist(u2)
```




```
#Kolmogorov-Smirnov test
KStest2<-LcKS(u2, cdf = "punif")
```

```
## Warning in ks.test(x, "punif", min = min.x, max = max.x): ties should not
## be present for the Kolmogorov-Smirnov test
```

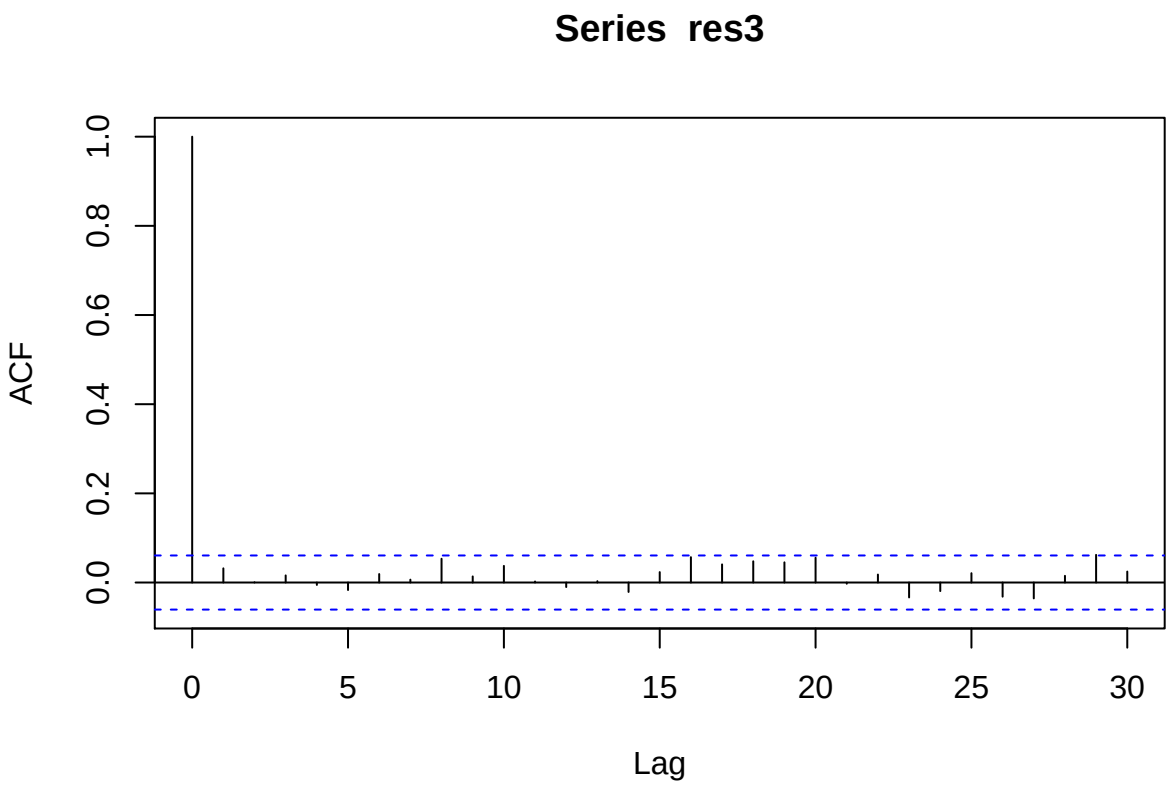
```
KStest2$p.value
```

```
## [1] 0.2576
```

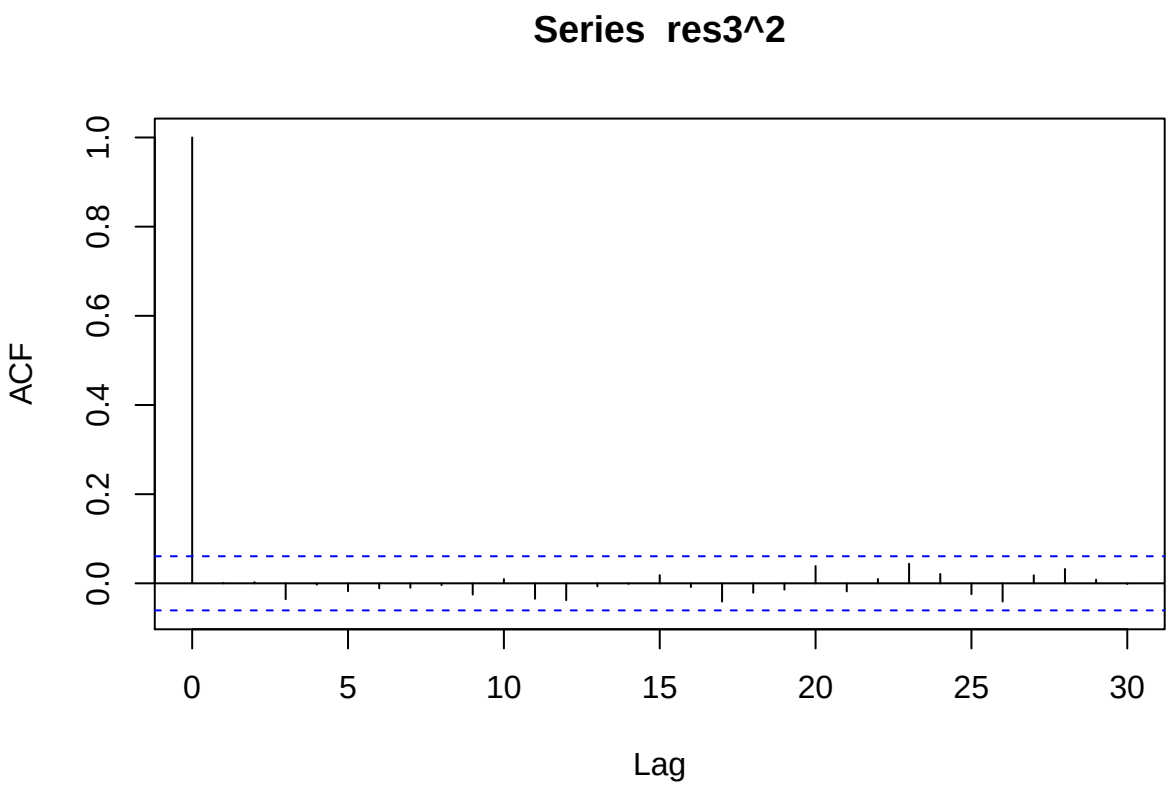
```
#Anderson-Darling test
ADtest2<-ad.test(u2, null="punif")
ADtest2$p.value
```

```
## [1] 0.1472603
```

```
model3=garchFit(formula=~arma(3,0)+garch(1,1),data=ret3,trace=F,cond.dist="sstd")
res3 <- residuals(model3, standardize=TRUE)
acf(res3)
```




```
acf(res3^2)
```




```
Box.test(res3, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

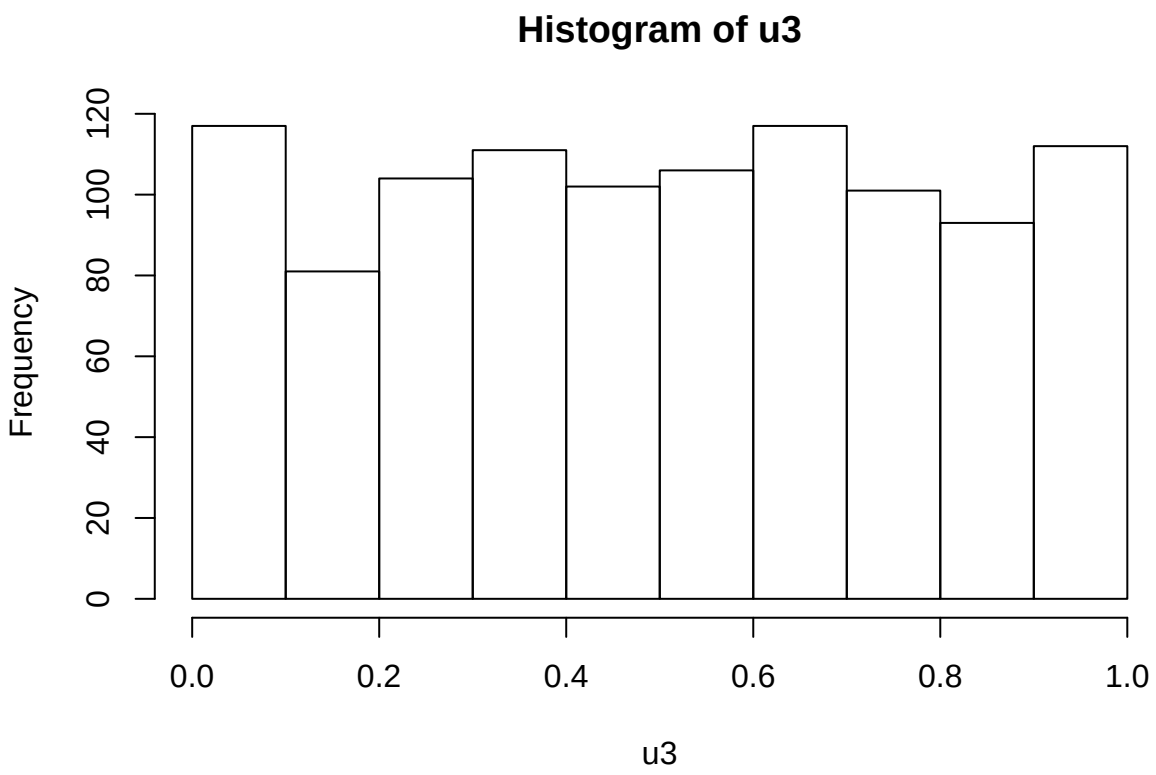
```
##
```

```
##  Box-Ljung test
##
## data:  res3
## X-squared = 6.758, df = 10, p-value = 0.7481
```

```
Box.test(res3^2, lag = 10, type = c("Ljung-Box"), fitdf = 0)
```

```
##
##  Box-Ljung test
##
## data:  res3^2
## X-squared = 2.6894, df = 10, p-value = 0.9878
```

```
shape3<-coef(model3)[9]
skew3<-coef(model3)[8]
u3<-psstd(res3, mean=0, sd=1, nu=shape3, xi=skew3)
hist(u3)
```




```
#Kolmogorov-Smirnov test
KStest3<-LcKS(u3, cdf = "punif")
```

```
## Warning in ks.test(x, "punif", min = min.x, max = max.x): ties should not
## be present for the Kolmogorov-Smirnov test
```

```
## Warning in ks.test(x.sim, "punif", min = min(x.sim), max = max(x.sim)):
## ties should not be present for the Kolmogorov-Smirnov test
```

```
KStest3$p.value
```

```
## [1] 0.8602
```

```
#Anderson-Darling test
ADtest3<-ad.test(u3, null="punif")
```

```
ADtest3$p.value
```

```
## [1] 0.8637571
```

(b)

(c)

(d)