TS_HW5

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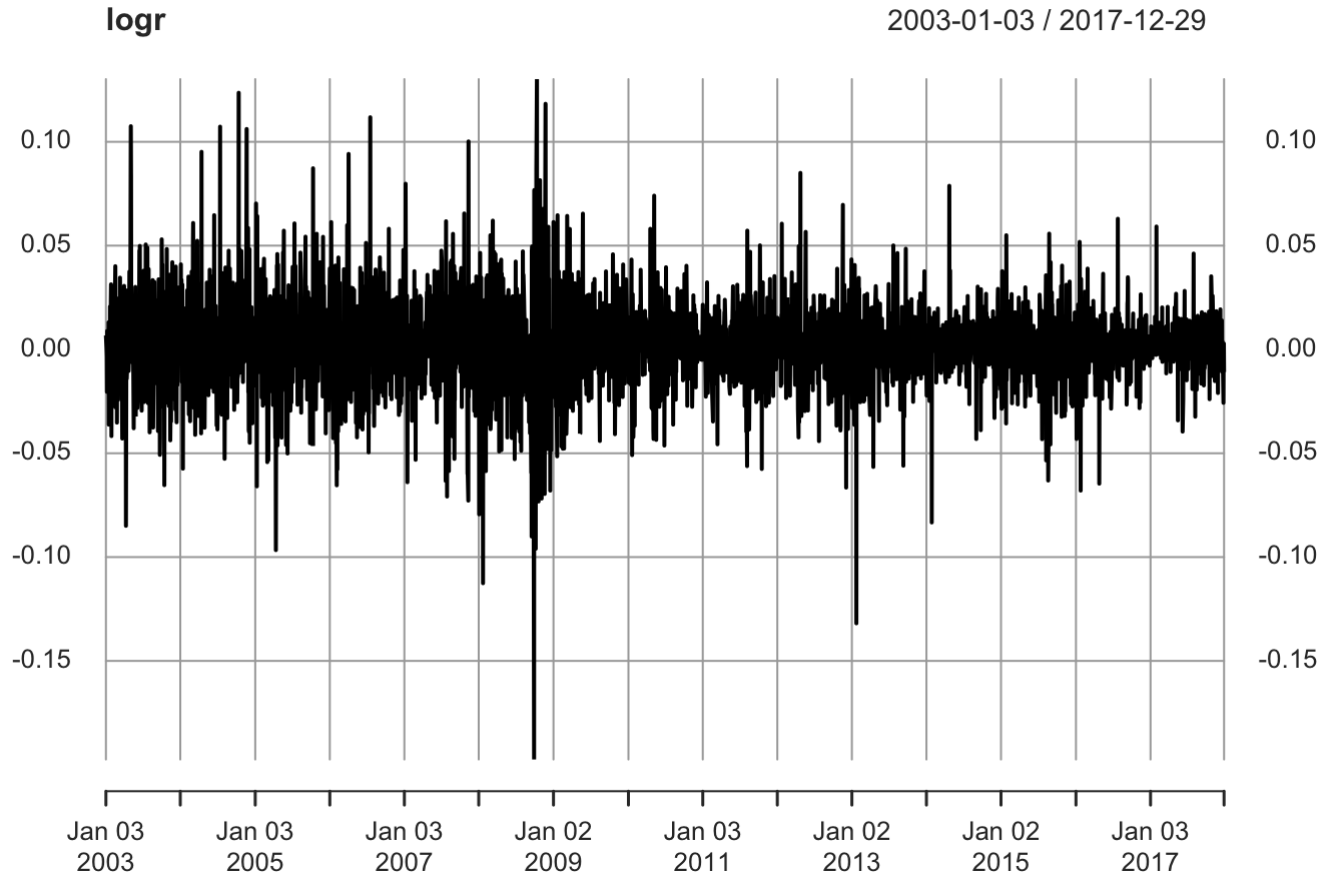
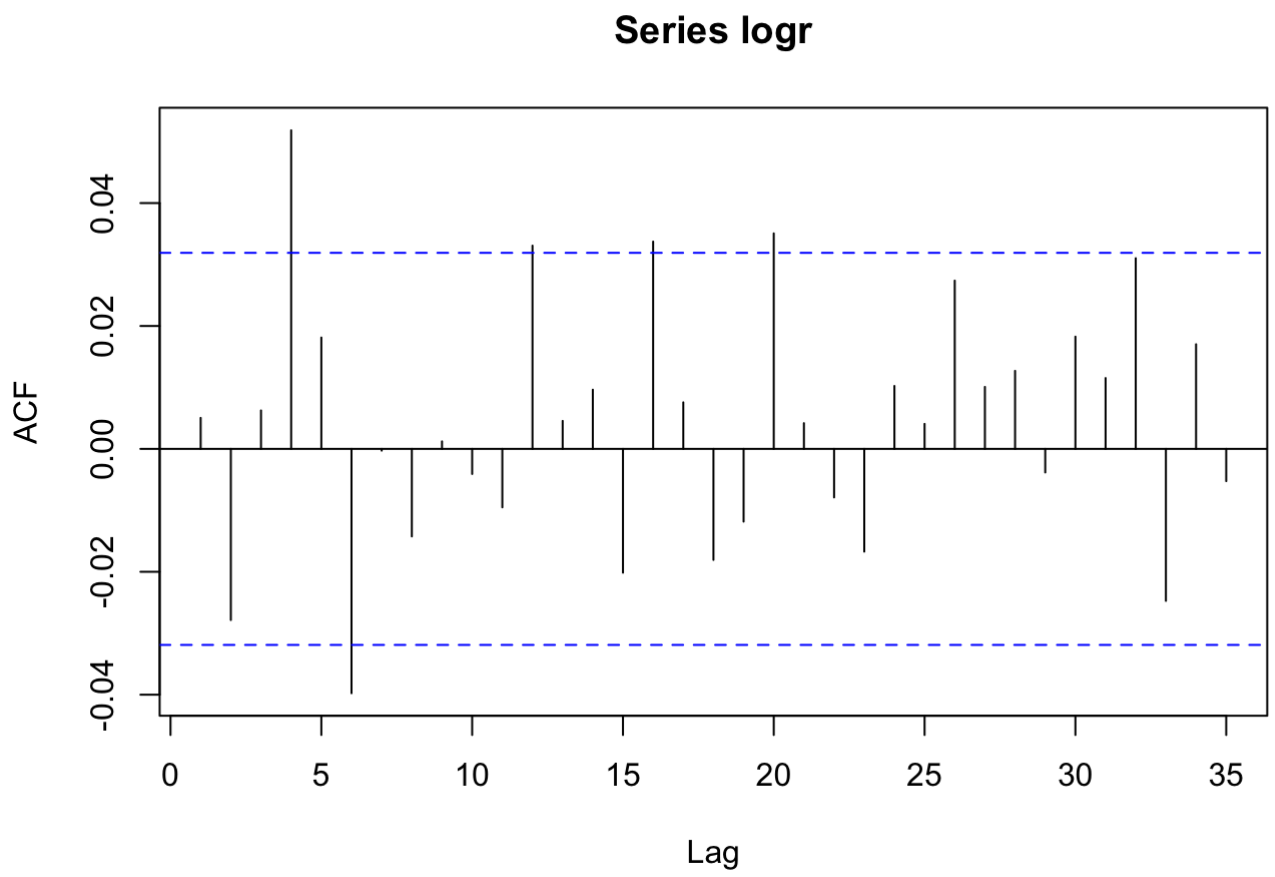
###(a)

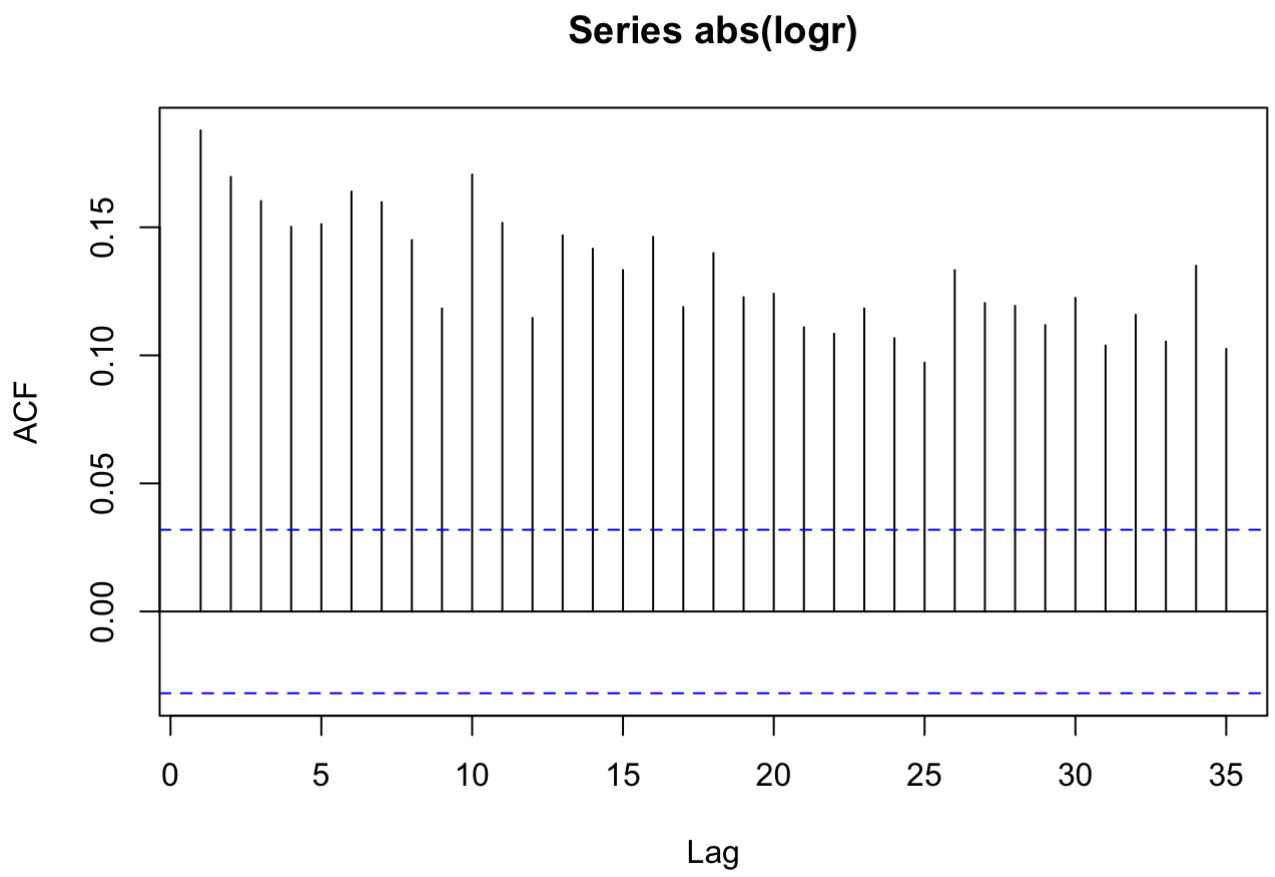
```
logr <-  diff(log(Pt))
logr <- logr[logr != ""]
plot(logr)
```



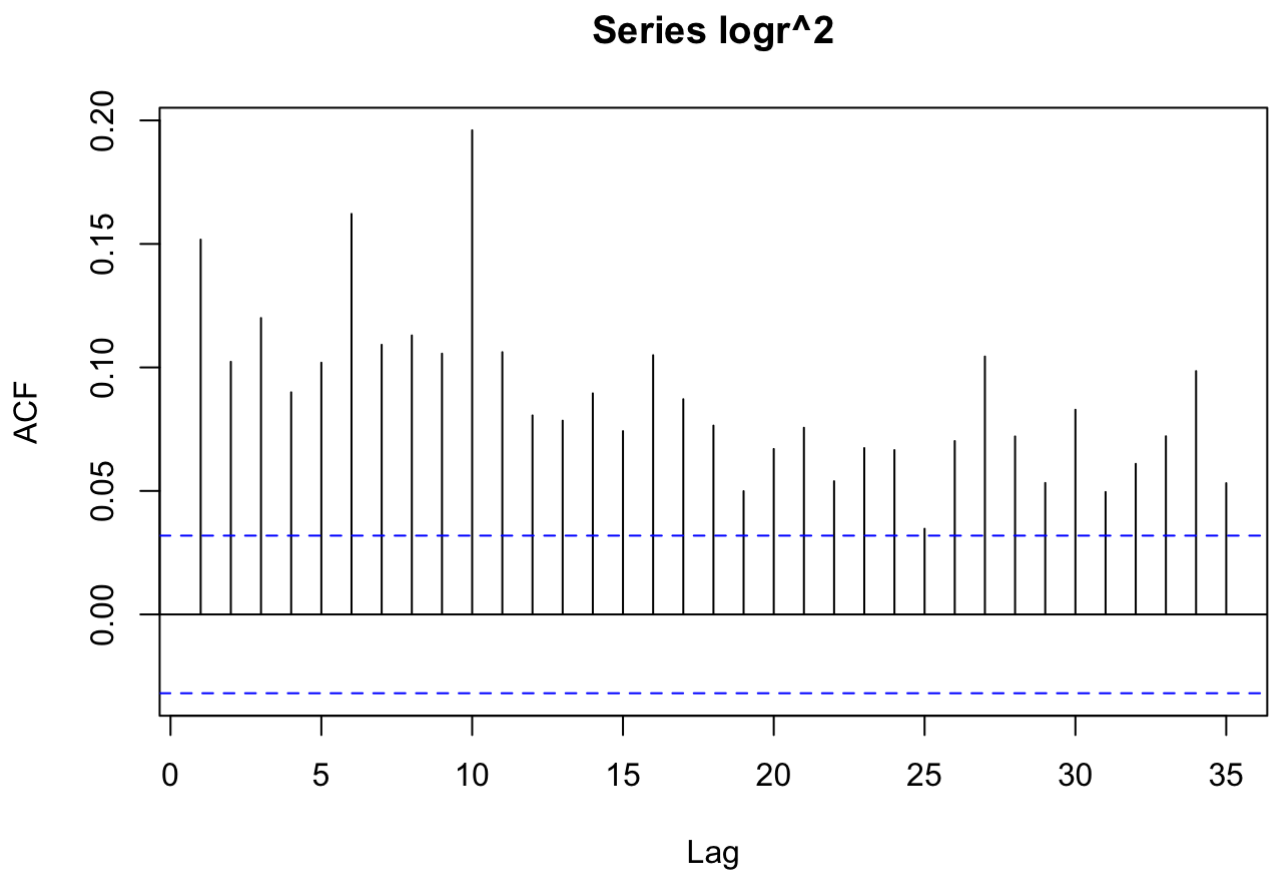

```
acf(logr)
```




```
acf(abs(logr))
```




```
acf(logr^2)
```



We from the plot we observed that the log return fluctuate around zero. Moreover, after checking the acf plot, we see that log returns appear not to be serially correlated. However, we also observed that the absolute value and squared log returns are significantly correlated, suggesting the log returns are dependent. Therefore, there might be a heteroskedasticity effect in our observations.

###(b)

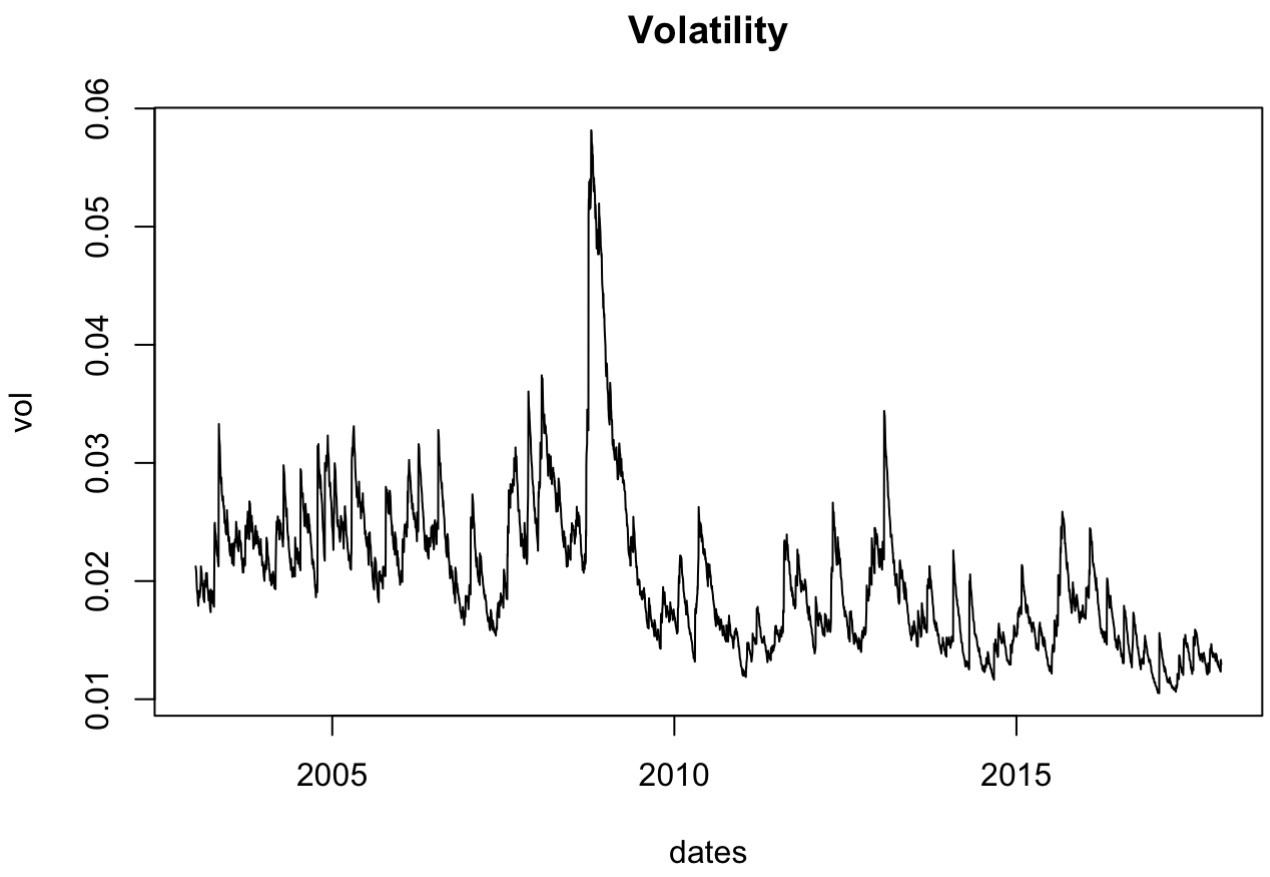
```
model_fit@fit$coef
```

```
##            mu           ma1           ma2           ma3           ma4
##  1.715053e-03  1.881278e-02 -4.937938e-03 -1.578339e-02  3.448696e-02
##         omega        alpha1         beta1
##  3.356877e-06  4.069972e-02  9.520639e-01
```

We observe that the mean mu of the model is 1.715053e-03. The coefficient for MA part is 1.881278e-02, -4.937938e-03, -1.578339e-02, 3.448696e-02 for theta1 to theta 4. ; The coefficients for the GARCH model: The omega is 3.356877e; the alpha is 4.069972e-02; the beta is 9.520639e-01.

###(c)

```
vol <- model_fit@sigma.t
dates <- index(logr)
plot(dates, vol, type = "l", main="Volatility")
```



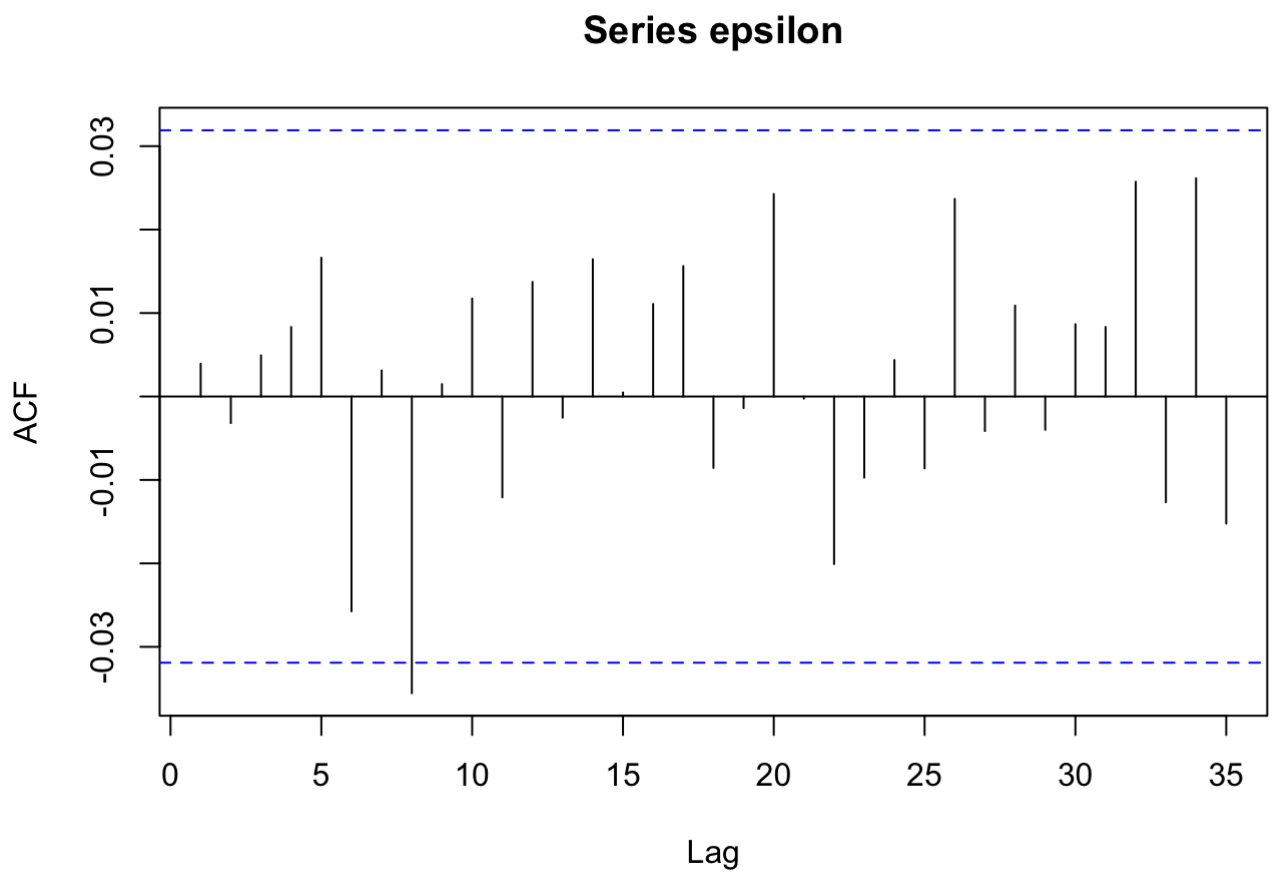

```
epsilon <- model_fit@residuals/model_fit@sigma.t
Box.test(epsilon)
```

```
##
##  Box-Pierce test
##
## data:  epsilon
## X-squared = 0.058316, df = 1, p-value = 0.8092
```

```
kurtosis(epsilon)
```

```
## [1] 3.599499
## attr(,"method")
## [1] "excess"
```

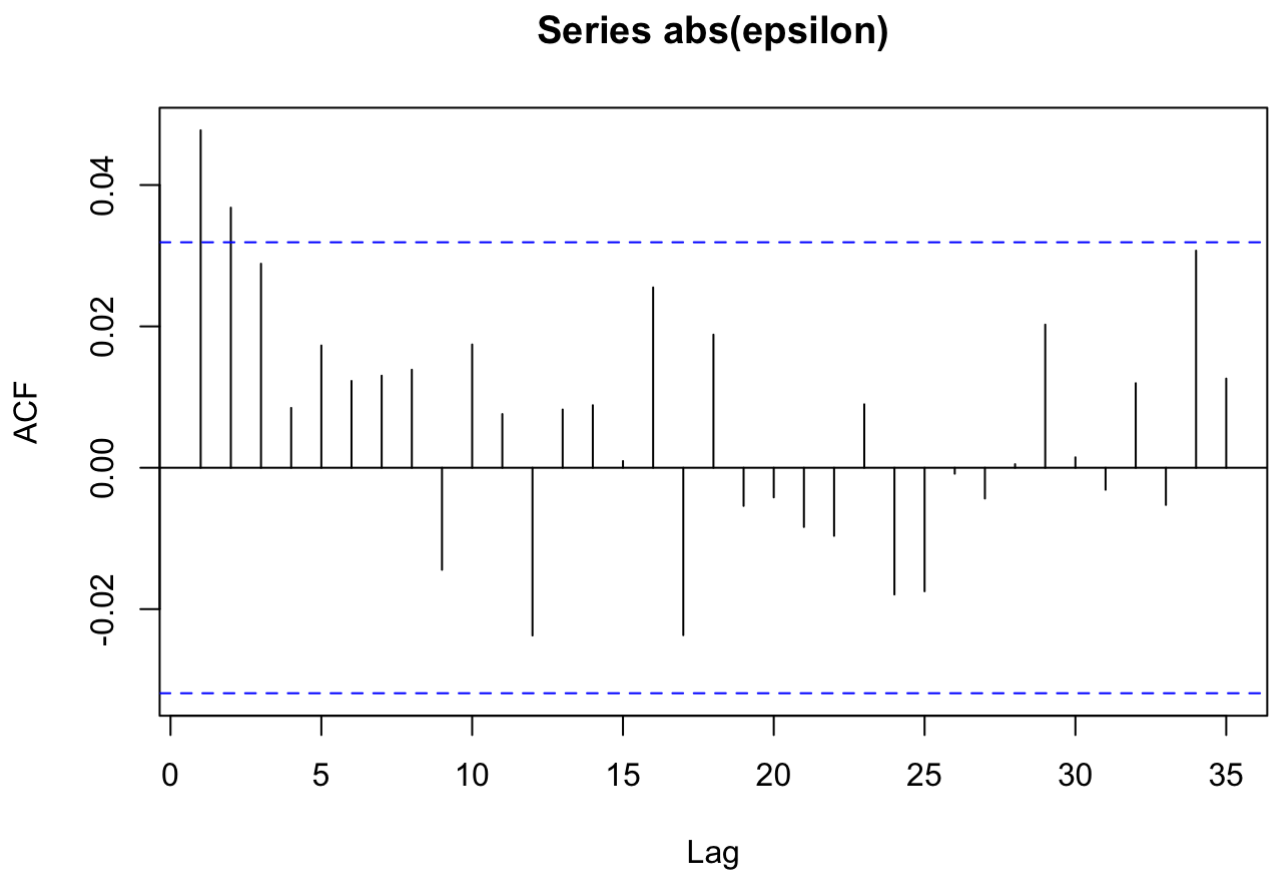
```
acf(epsilon)
```



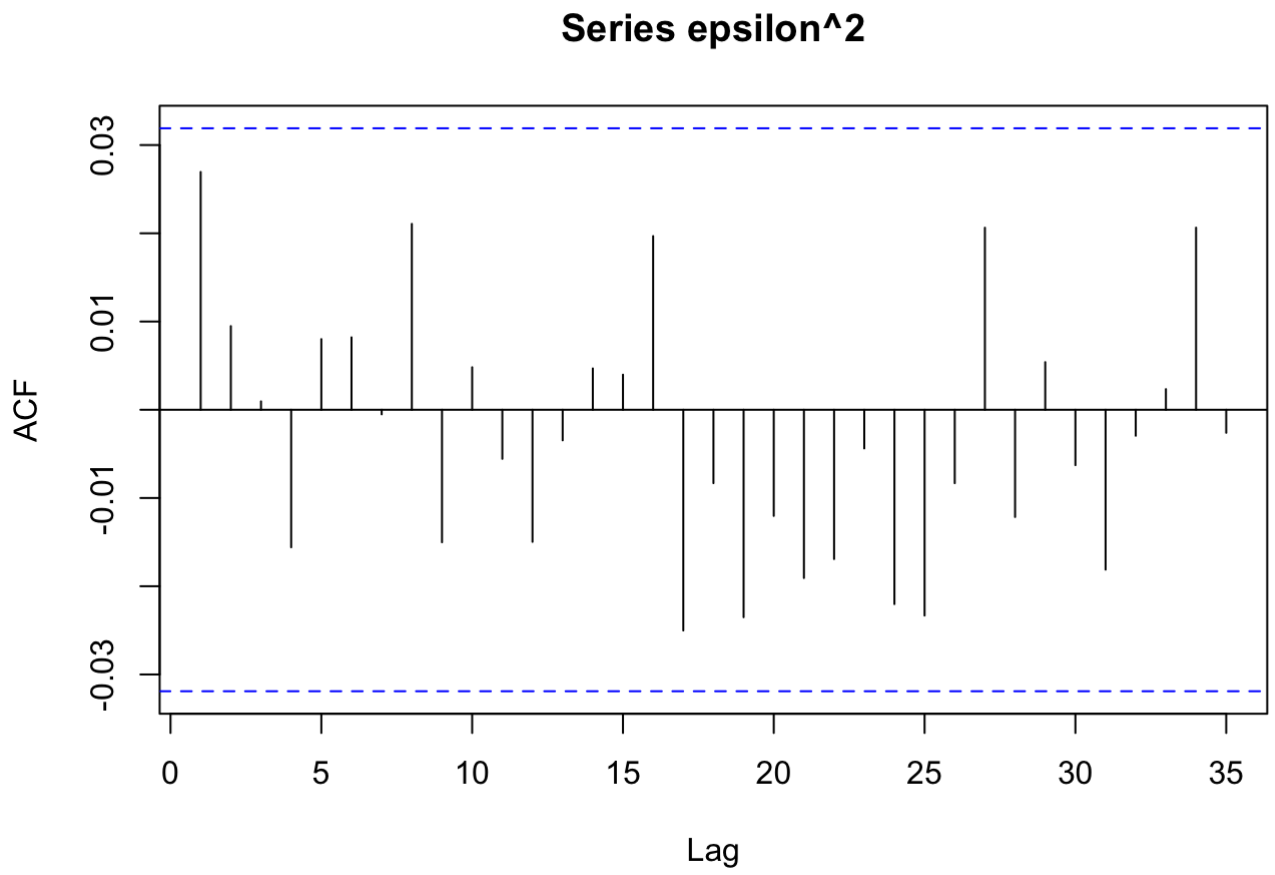

```
skewness(epsilon)
```

```
## [1] 0.1033716
## attr(,"method")
## [1] "moment"
```

```
acf(abs(epsilon))
```




```
acf(epsilon^2)
```



According to hte Box-Pierce test, we see that we fail to reject the null that the model is normally independently distributed. Moreover, from the output of skewness, kurtosis, acf of ϵ, ϵ^2, and $|\epsilon|$, we see that ϵ is also likely to be IID.

###(d)

```
4.069972e-02 + 9.520639e-01
```

```
## [1] 0.9927636
```

We observe that the sum of alpha and beta is almost 1, which violates our assumptions for the Garch model. Since the root is almost 1, it is reasonable to fit a IGarch Model.