

# 732A62 Lab 3

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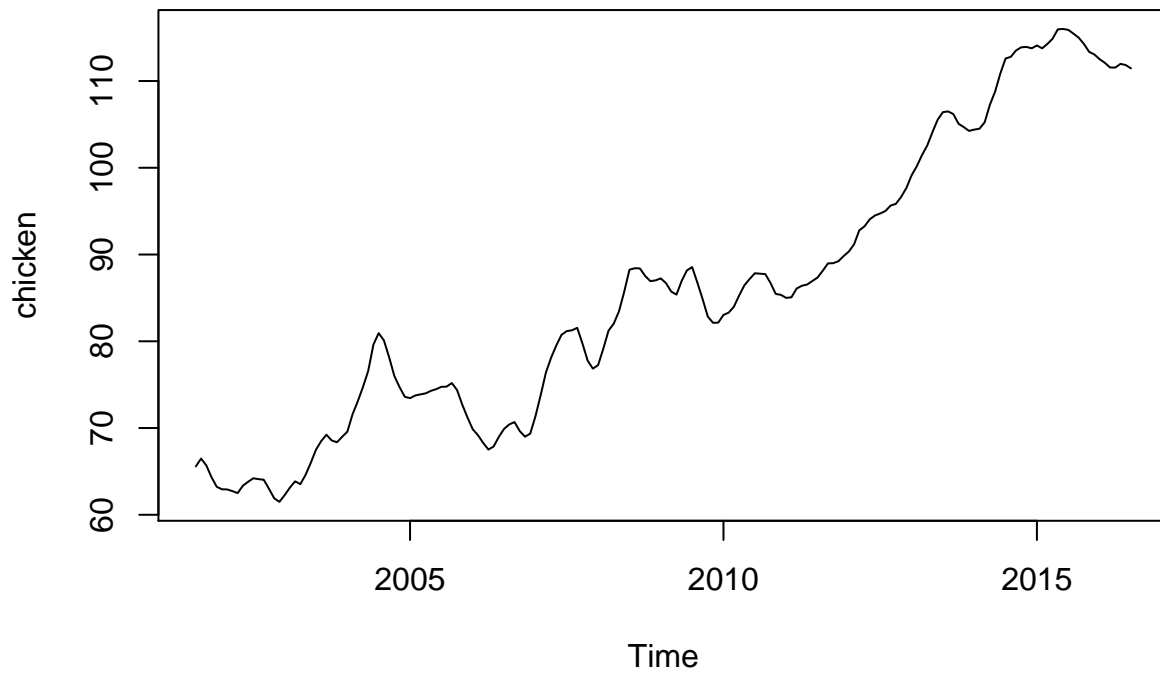
*2017-10-09*

## Assignment 1

1)

```
library(astsa)
library(TSA)
library(forecast)

plot(chicken)
```

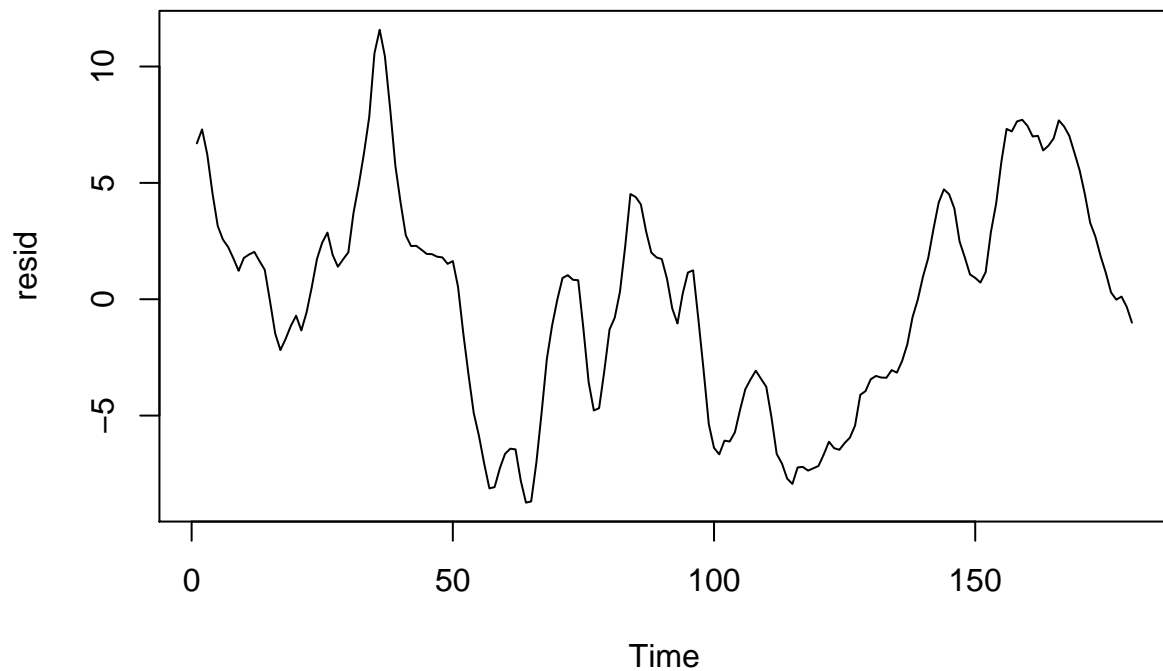


It looks like a linear, potentially quadratic, trend.

2)

```
lm_data <- data.frame(chicken=chicken, time=1:length(chicken))
lm_fit <- lm(chicken ~ time, lm_data)
```

```
z <- resid(lm_fit)
plot(z, type="l", ylab="resid", xlab="Time")
```



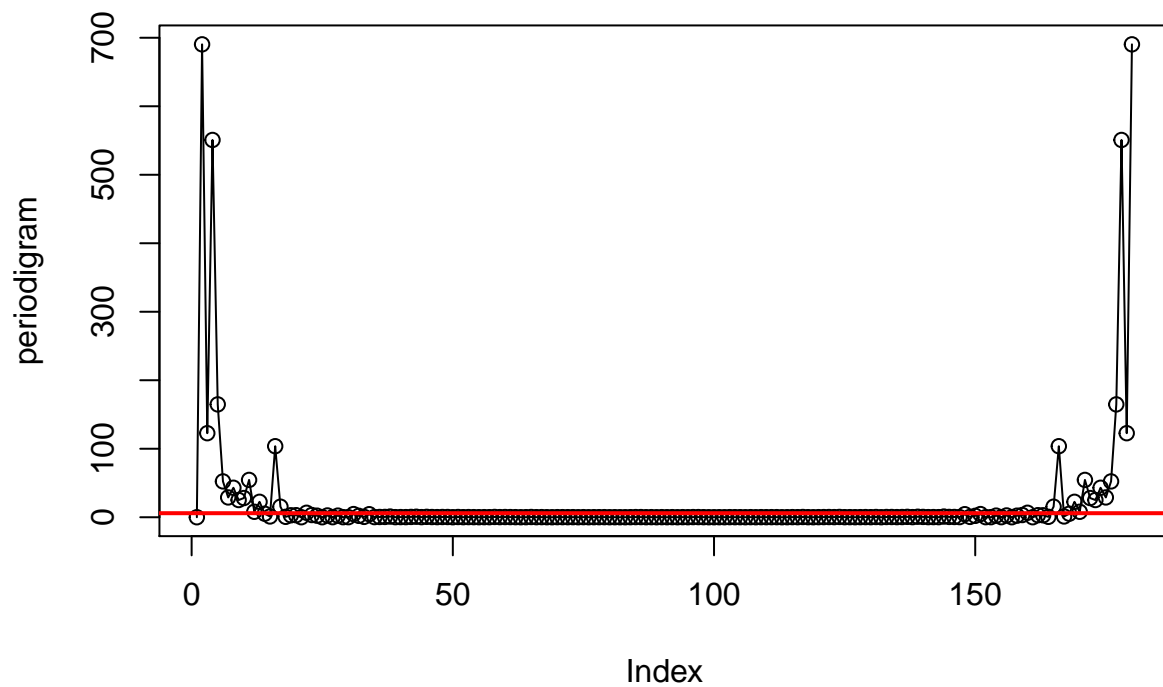
The residuals do not look stationary.

3)

```
denom <- sqrt(length(z)) *
  exp(complex(imaginary=2 * pi * 0:(length(z) - 1) / length(z)))
density <- fft(z) / denom
periodigram <- abs(density)^2

upper <- 2 * mean(periodigram) / qchisq(0.025, 2)
lower <- 2 * mean(periodigram) / qchisq(0.975, 2)

plot(periodigram, type="o")
abline(h=lower, col="red", lwd=2)
```



4)

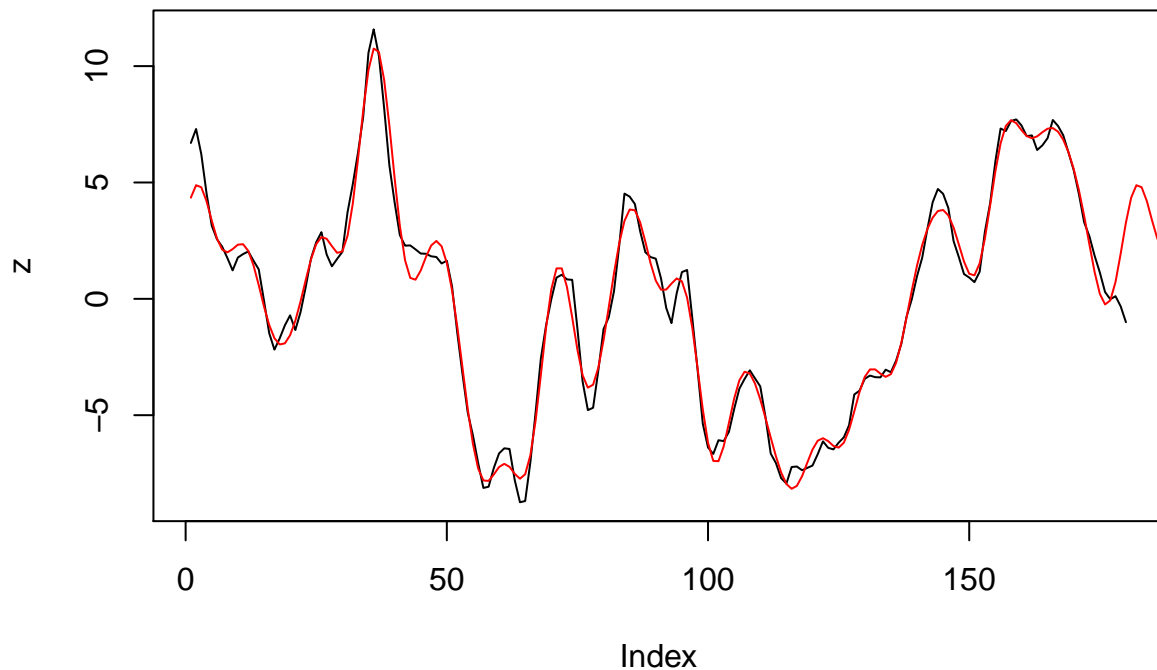
```
freq_density <- density
freq_density[periodigram < lower] <- 0

n <- length(z)
ts <- 1:(n + 36)

xs <- rep(0, n + 36)

for (t in ts) {
  xs[t] <- sum(freq_density * exp(complex(imaginary=2 * pi * (0:(n - 1)) / n * t))) / sqrt(n)
}

plot(z, type="l")
lines(Re(xs), col="red")
```



5)

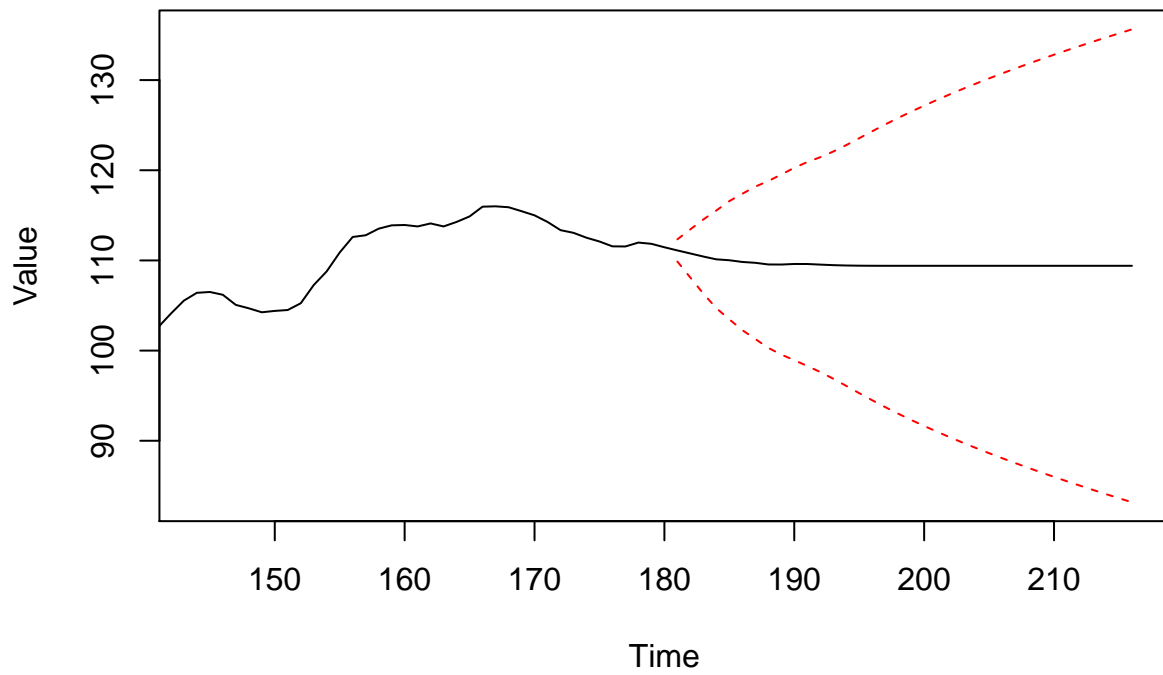
6)

```
fit_plot <- function(model, data) {
  nahead <- 36
  pred <- predict(model, n.ahead=nahead, se.fit=TRUE)
  upper_band <- pred$pred + 1.96 * pred$se
  lower_band <- pred$pred - 1.96 * pred$se

  n <- length(data)

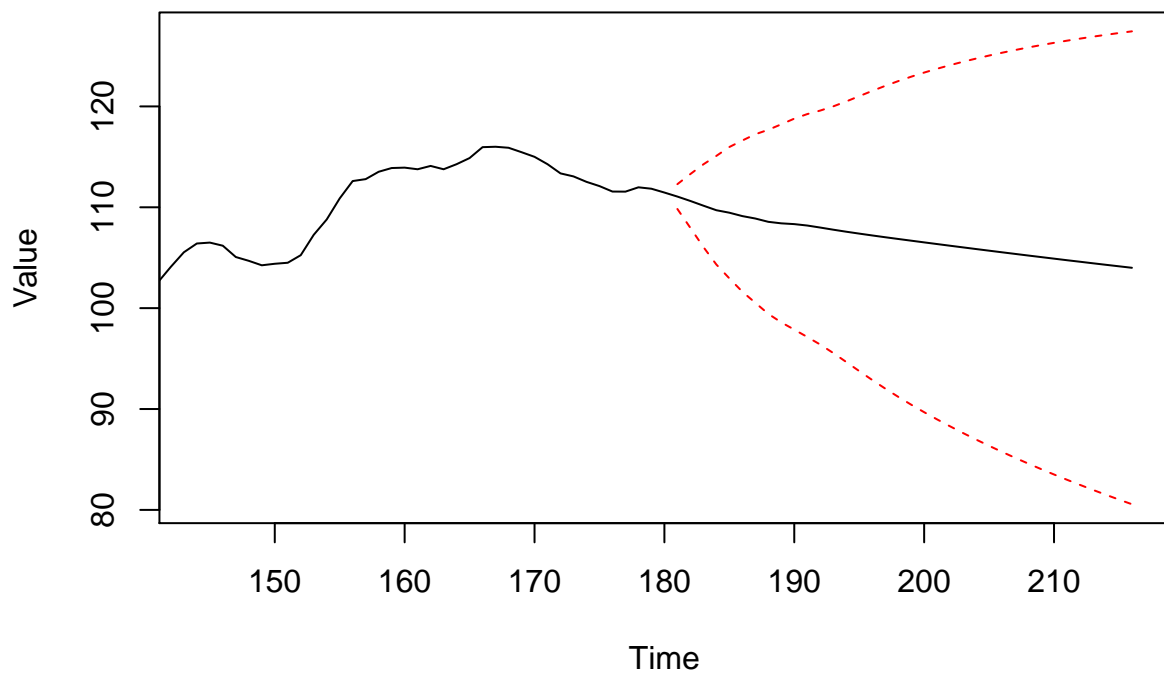
  plot(c(data, pred$pred), type="l",
       xlim=c(n - nahead, n + nahead),
       ylim=c(min(lower_band), max(upper_band)), ylab="Value", xlab="Time")
  lines(n + 1:nahead, upper_band, lty=2, col="red")
  lines(n + 1:nahead, lower_band, lty=2, col="red")
}

fit <- arima(chicken, order=c(2, 1, 0), seasonal=list(order=c(0, 0, 1), period=12))
fit_plot(fit, chicken)
```



7)

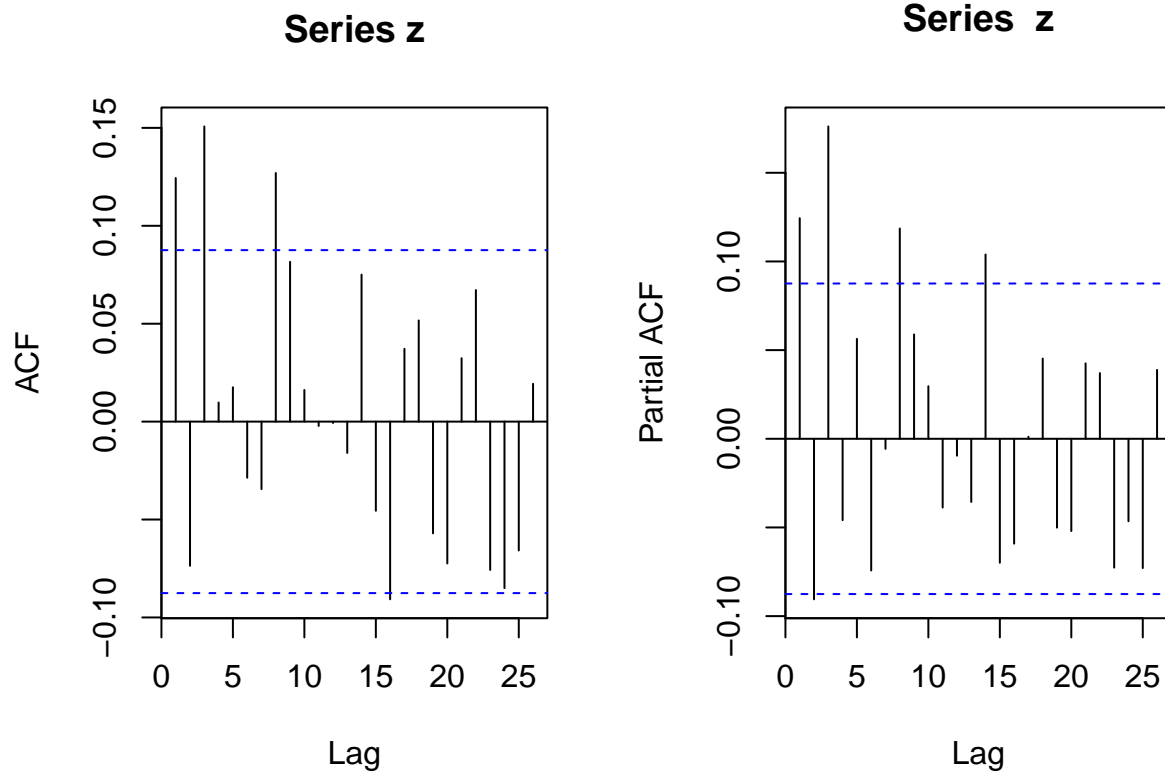
```
fit <- arima(chicken, order=c(3, 0, 0), seasonal=list(order=c(0, 0, 1), period=12))  
fit_plot(fit, chicken)
```



## Assignment 2

1)

```
ld_oil <-diff(log(oil))  
z <-ld_oil[1:(52*9 + 33)]  
  
old <- par(mfrow = c(1,2))  
acf(z)  
pacf(z)
```



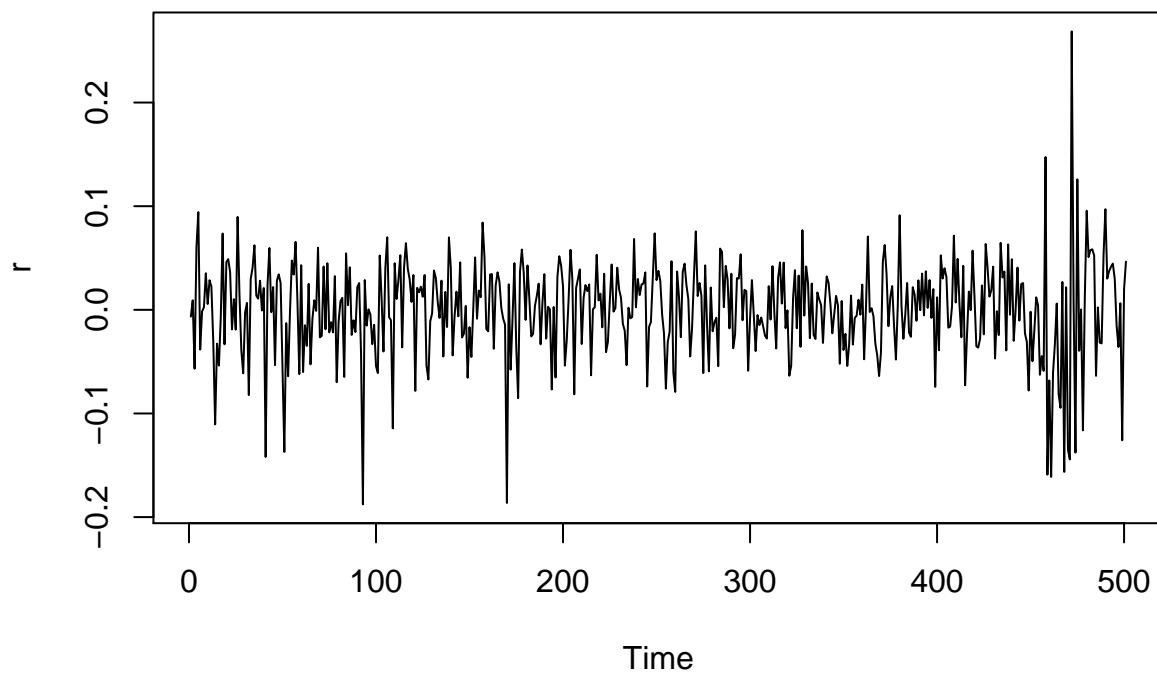
```
par(old)  
  
suggested_model <- Arima(z, order = c(3,0,0))  
  
summary(suggested_model)
```

```
## Series: z  
## ARIMA(3,0,0) with non-zero mean  
##  
## Coefficients:  
##          ar1      ar2      ar3      mean  
##      0.151  -0.1147  0.1777  0.0018  
## s.e.  0.044   0.0442  0.0442  0.0026  
##
```

```
## sigma^2 estimated as 0.002171: log likelihood=827.28
## AIC=-1644.55 AICc=-1644.43 BIC=-1623.47
##
## Training set error measures:
##           ME           RMSE           MAE  MPE MAPE           MASE
## Training set 2.381642e-05 0.04640656 0.03454024 -Inf Inf 0.7492286
##           ACF1
## Training set 0.008324494
r <- resid(suggested_model)
```

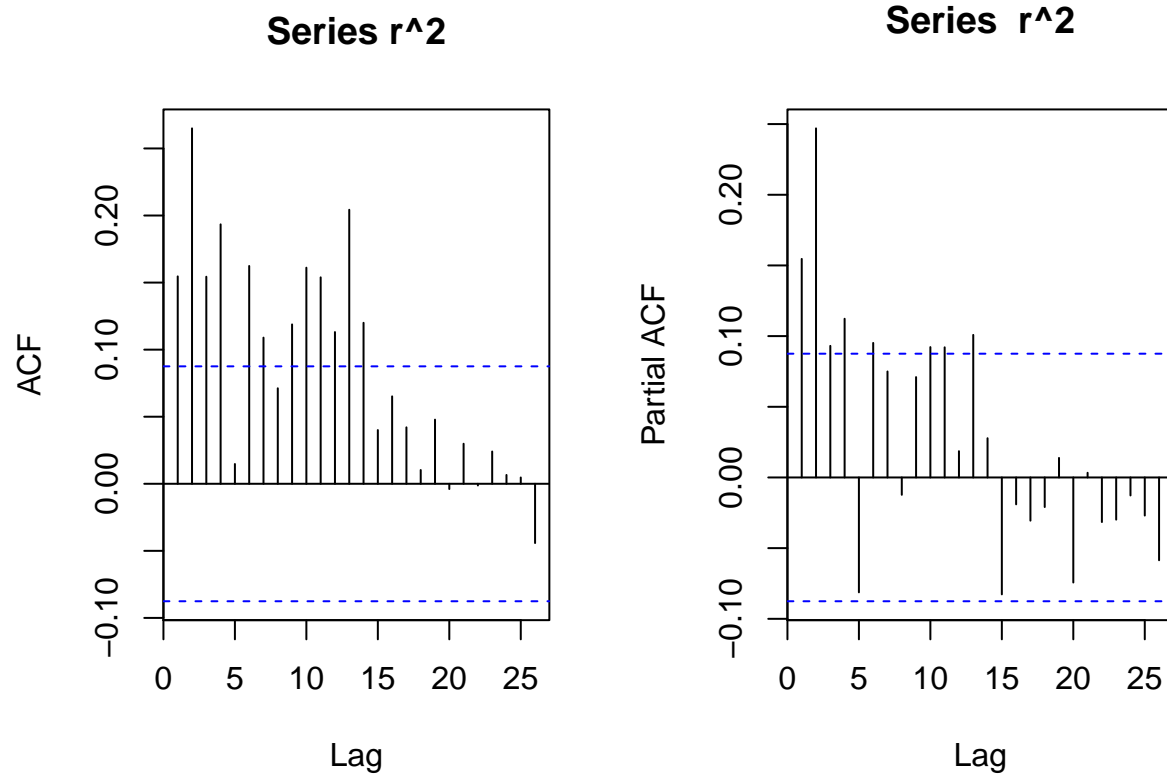
2)

```
plot(r)
```



```
old <- par(mfrow = c(1,2))
acf(r^2)
pacf(r^2)
```





```
par(old)
```

The time series of the residuals seem to have an increasing variance in the end of the residuals.

The ACF of the squared residuals trails off and in the PACF they cut off after 2 lags. Indicating a GARCH(p,q)  
 An  $p = 2$ ,  $q = 0$  maybe? ## 3)

```
helper <- function(data){
  old <- par(mfrow = c(3,1))
  acf(data)
  acf(data^2)
  qqnorm(data)
  qqline(data)
  par(old)
  jarque.bera.test(data)
  Box.test(data, type = "Ljung-Box")
}
```

4)

5)

6)