Q5_GARCH

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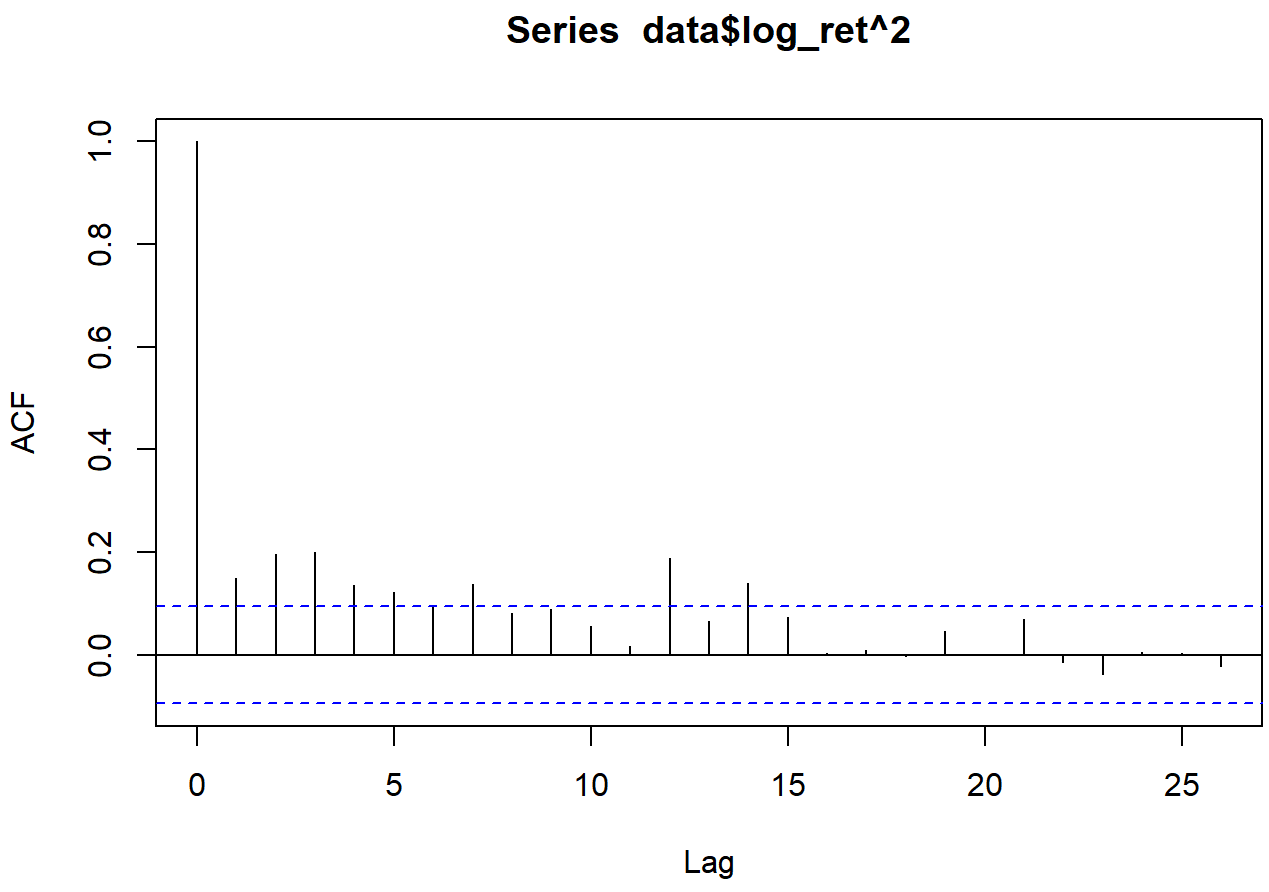
Read data and calculate log returns

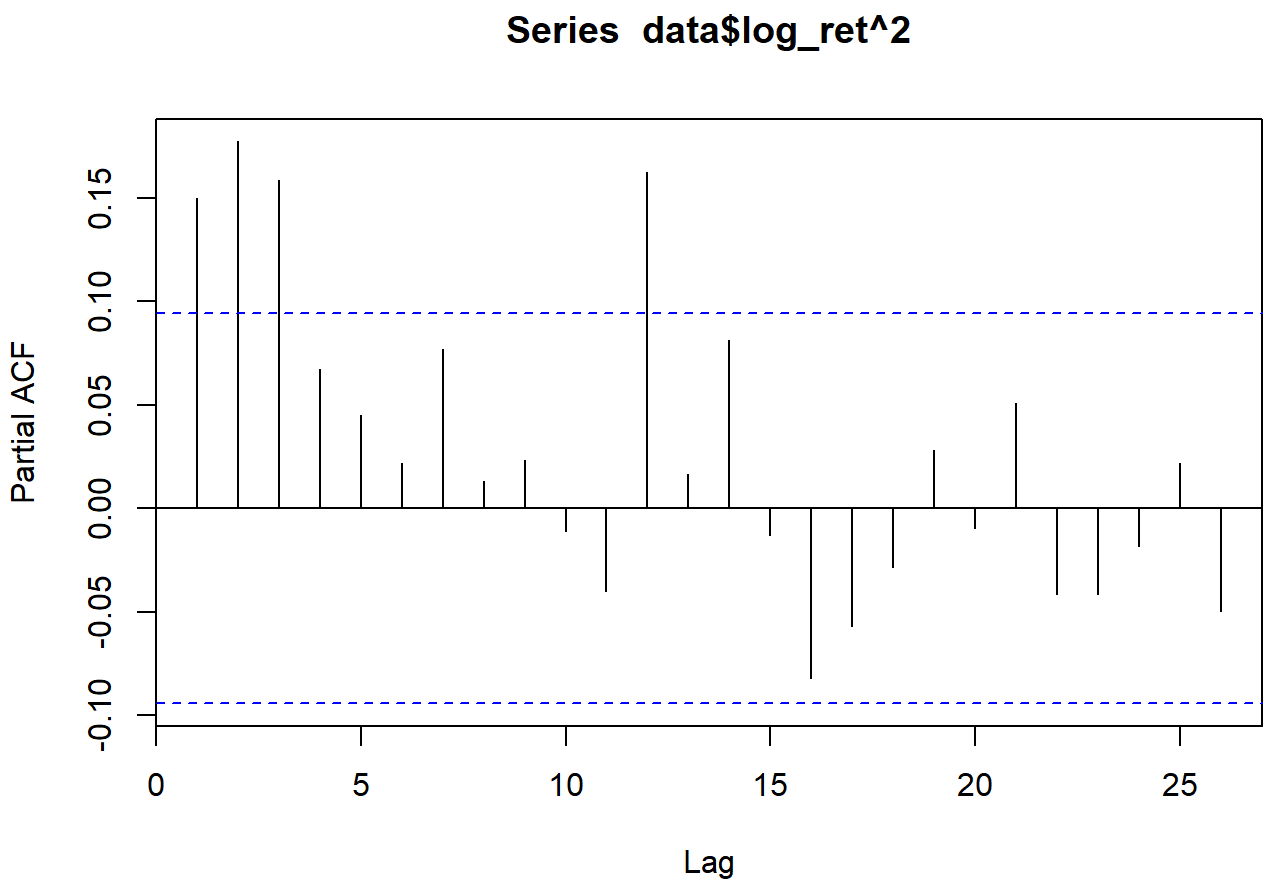
For ACF, PACF => we cannot trust the blue line as this is for non-linear relationship.

```
data = read.csv("m-intc7308.txt", sep="")
data$log_ret = log(1+data$rtn)

acf(data$log_ret^2)
```




```
pacf(data$log_ret^2)
```


Series data$log_ret^2
Partial ACF
0.15
0.10
0.05
0.00
-0.05
-0.10
0
5
10
15
20
25
Lag

GARCH(1,1) with normal innovation.

```
##
## Title:
##  GARCH Modelling
##
## Call:
##  garchFit(formula = ~garch(1, 1), data = data$log_ret, cond.dist = "norm",
##     trace = FALSE)
##
## Mean and Variance Equation:
##  data ~ garch(1, 1)
## <environment: 0x0000029a836ef448>
##  [data = data$log_ret]
##
## Conditional Distribution:
##  norm
##
## Coefficient(s):
##         mu       omega      alpha1       beta1
## 0.01073350  0.00095445  0.08741980  0.85118415
##
## Std. Errors:
##  based on Hessian
##
## Error Analysis:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu     0.0107335   0.0055289    1.941   0.0522 .
## omega  0.0009544   0.0003989    2.392   0.0167 *
## alpha1 0.0874198   0.0269810    3.240   0.0012 **
## beta1  0.8511841   0.0393702   21.620   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
##  299.9705    normalized:  0.6943761
##
## Description:
##  Tue Sep 24 00:03:52 2024 by user: kamin
##
##
## Standardised Residuals Tests:
##                                   Statistic      p-Value
##  Jarque-Bera Test   R    Chi^2  165.5739725 0.000000e+00
##  Shapiro-Wilk Test  R    W        0.9712087 1.626855e-07
##  Ljung-Box Test     R    Q(10)    8.2676358 6.027125e-01
##  Ljung-Box Test     R    Q(15)   14.4261292 4.934866e-01
##  Ljung-Box Test     R    Q(20)   15.1333124 7.687293e-01
##  Ljung-Box Test     R^2  Q(10)    0.9891847 9.998363e-01
##  Ljung-Box Test     R^2  Q(15)   11.3659702 7.262463e-01
##  Ljung-Box Test     R^2  Q(20)   12.6814451 8.906297e-01
```

```
##  LM Arch Test       R    TR^2    10.7019978 5.546153e-01
##
## Information Criterion Statistics:
##       AIC       BIC       SIC      HQIC
## -1.370234 -1.332563 -1.370403 -1.355361
```

Goodness of fit check

```
residual_norm=residuals(norm_model,standardize=T)
Box.test(residual_norm,10,type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residual_norm
## X-squared = 8.2676, df = 10, p-value = 0.6027
```

```
Box.test(residual_norm^2,10,type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residual_norm^2
## X-squared = 0.98918, df = 10, p-value = 0.9998
```

GARCH(1,1) with student-t innovation.

```
## [1] 0.0138819
```

```
##
## Title:
##  GARCH Modelling
##
## Call:
##  garchFit(formula = ~garch(1, 1), data = data$log_ret, cond.dist = "std",
##     trace = FALSE)
##
## Mean and Variance Equation:
##  data ~ garch(1, 1)
## <environment: 0x0000029a8235dfa8>
##  [data = data$log_ret]
##
## Conditional Distribution:
##  std
##
## Coefficient(s):
##        mu      omega     alpha1      beta1      shape
## 0.0159286  0.0011838  0.1054877  0.8180722  6.8330439
##
## Std. Errors:
##  based on Hessian
##
## Error Analysis:
##         Estimate  Std. Error  t value Pr(>|t|)
## mu      0.015929    0.005234    3.043 0.002340 **
## omega   0.001184    0.000586    2.020 0.043378 *
## alpha1  0.105488    0.037144    2.840 0.004512 **
## beta1   0.818072    0.057307   14.275  < 2e-16 ***
## shape   6.833044    1.905582    3.586 0.000336 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
##  313.2924    normalized:  0.7252139
##
## Description:
##  Tue Sep 24 00:03:52 2024 by user: kamin
##
##
## Standardised Residuals Tests:
##                                 Statistic      p-Value
##  Jarque-Bera Test   R    Chi^2  190.7259770 0.000000e+00
##  Shapiro-Wilk Test  R    W        0.9691568 6.728082e-08
##  Ljung-Box Test     R    Q(10)    8.1439993 6.147736e-01
##  Ljung-Box Test     R    Q(15)   14.4881496 4.888747e-01
##  Ljung-Box Test     R    Q(20)   15.2129524 7.640955e-01
##  Ljung-Box Test     R^2  Q(10)    1.1552437 9.996677e-01
##  Ljung-Box Test     R^2  Q(15)   11.4471943 7.202976e-01
##  Ljung-Box Test     R^2  Q(20)   12.6804190 8.906710e-01
##  LM Arch Test       R    TR^2    10.9399048 5.340758e-01
##
```

```
## Information Criterion Statistics:
##       AIC       BIC       SIC      HQIC
## -1.427280 -1.380191 -1.427544 -1.408689
```

Goodness of fit check

```
residual_t=residuals(t_model,standardize=T)
Box.test(residual_t,10,type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residual_t
## X-squared = 8.144, df = 10, p-value = 0.6148
```

```
Box.test(residual_t^2,10,type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residual_t^2
## X-squared = 1.1552, df = 10, p-value = 0.9997
```

As GARCH(1,1) with student-t innovation has lower AIC, we use the model for prediction.

```
#initial the process at the sample variance
nobs = length(data$log_ret)
e<-data$log_ret-mean(data$log_ret)
e2<-e^2

predvar = rep(NA, nobs)
predvar[1]<-var(data$log_ret)
omega = 0.001184
alpha1 = 0.105488
beta1 = 0.818072

#loop starting at 2 because of lagged equation
for (t in 2:nobs)
{
  #GARCH(1,1) equation
  predvar[t]<-omega+alpha1*e2[t-1]+beta1*predvar[t-1]
}
```

1-step and 5-step predictions

```
nstep = 5
predvar_5step = rep(NA, nstep)
predvar_5step[1] = predvar[nobs]
for (j in 1:(nstep-1))
{
  predvar_5step[j+1]<-omega+(alpha1+beta1)*predvar_5step[j]
}
cat("1-step pred: ", predvar_5step[1])
```

```
## 1-step pred:  0.01622689
```

```
cat("5-step pred: ", predvar_5step)
```

```
## 5-step pred:  0.01622689 0.0161705 0.01611843 0.01607034 0.01602592
```