Data Analysis

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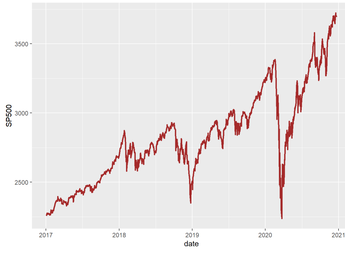
```
# Import library
library(tseries)
library(fBasics)
library(ggplot2)
library(FinTS)
library(fGarch)
```

Import file and convert data type to TimeSeries.

```
SP500 <- read.csv(file.choose(), header = TRUE)
SP500$date<-as.Date(SP500$date, format = "%d/%m/%Y")
ggplot(SP500, aes(x = date, y = close)) + geom_line(col="brown", lwd = 1) +ylab("SP500")
```




```
returnsSP500 <- diff(log(SP500$close))
SP500$returnsSP500 <-c(0,returnsSP500)
```

Descriptive Statistics

```
min(returnsSP500)
```

```
## [1] -0.1276521
```

```
max(returnsSP500)
```

```
## [1] 0.08968316
```

```
mean(returnsSP500)
```

```
## [1] 0.0004930478
```

```
sd(returnsSP500)
```

```
## [1] 0.01302506
```

```
summary(returnsSP500)
```

```
##       Min.    1st Qu.     Median       Mean    3rd Qu.       Max.
## -0.1276521 -0.0029192  0.0007995  0.0004930  0.0056255  0.0896832
```

```
summary(SP500$close)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2237    2585    2797    2826    3002    3722
```

```
# Stationary test
adf.test(returnsSP500)
```

```
## Warning in adf.test(returnsSP500): p-value smaller than printed p-value
```

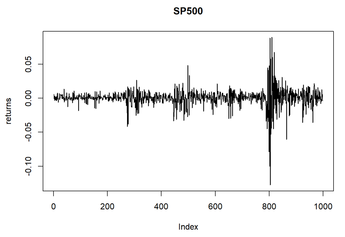
```
##
##  Augmented Dickey-Fuller Test
##
## data:  returnsSP500
## Dickey-Fuller = -9.0661, Lag order = 9, p-value = 0.01
## alternative hypothesis: stationary
```

```
test_out <- ArchTest(returnsSP500, lags = 1)
test_out
```

```
##
##  ARCH LM-test; Null hypothesis: no ARCH effects
##
## data:  returnsSP500
## Chi-squared = 259.22, df = 1, p-value < 2.2e-16
```

Data visualization

```
# Stock movement
plot(returnsSP500,type ='l',main="SP500",ylab="returns")
```




```
#Garch(1,1)
garch <- garchFit(formula = ~ garch(1,1), data = SP500$returns, trace = F, include.mean = F)
```

```
## Warning: Using formula(x) is deprecated when x is a character vector of length > 1.
##   Consider formula(paste(x, collapse = " ")) instead.
```

```
summary(garch)
```

```
##
## Title:
##  GARCH Modelling
##
## Call:
##  garchFit(formula = ~garch(1, 1), data = SP500$returns, include.mean = F,
##     trace = F)
##
## Mean and Variance Equation:
##  data ~ garch(1, 1)
## <environment: 0x000000001fc9c580>
##  [data = SP500$returns]
##
## Conditional Distribution:
##  norm
##
## Coefficient(s):
##      omega     alpha1      beta1
## 3.4193e-06  2.3874e-01  7.4806e-01
##
## Std. Errors:
##  based on Hessian
##
## Error Analysis:
##         Estimate  Std. Error  t value Pr(>|t|)
## omega  3.419e-06   7.058e-07    4.845 1.27e-06 ***
## alpha1 2.387e-01   3.450e-02    6.920 4.52e-12 ***
## beta1  7.481e-01   2.863e-02   26.132  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log Likelihood:
##  3373.373    normalized:  3.373373
##
## Description:
##  Thu Mar 31 16:21:37 2022 by user: tapiv
##
##
## Standardised Residuals Tests:
##                                 Statistic p-Value
##  Jarque-Bera Test   R     Chi^2  823.0697  0
##  Shapiro-Wilk Test  R     W      0.9470243 0
##  Ljung-Box Test     R     Q(10)  11.29822  0.3347608
##  Ljung-Box Test     R     Q(15)  13.76138  0.5436984
##  Ljung-Box Test     R     Q(20)  16.77128  0.6677714
##  Ljung-Box Test     R^2   Q(10)  11.65949  0.3084919
##  Ljung-Box Test     R^2   Q(15)  13.35567  0.5748472
##  Ljung-Box Test     R^2   Q(20)  14.51423  0.8034962
##  LM Arch Test       R     TR^2   12.31454  0.4207602
##
## Information Criterion Statistics:
##       AIC       BIC       SIC      HQIC
## -6.740746 -6.726023 -6.740764 -6.735150
```

```
vol <- garch@h.t
vol <- ts(vol)
```

```
# Return's volatility via Garch(1,1)
qplot(log(garch@sigma.t^2), geom = "density",
      ylab = ('density'),
      xlab = "",
      size=I(1),
      xlim=c(-20.5,20.5))
```