R Code for Lecture 8

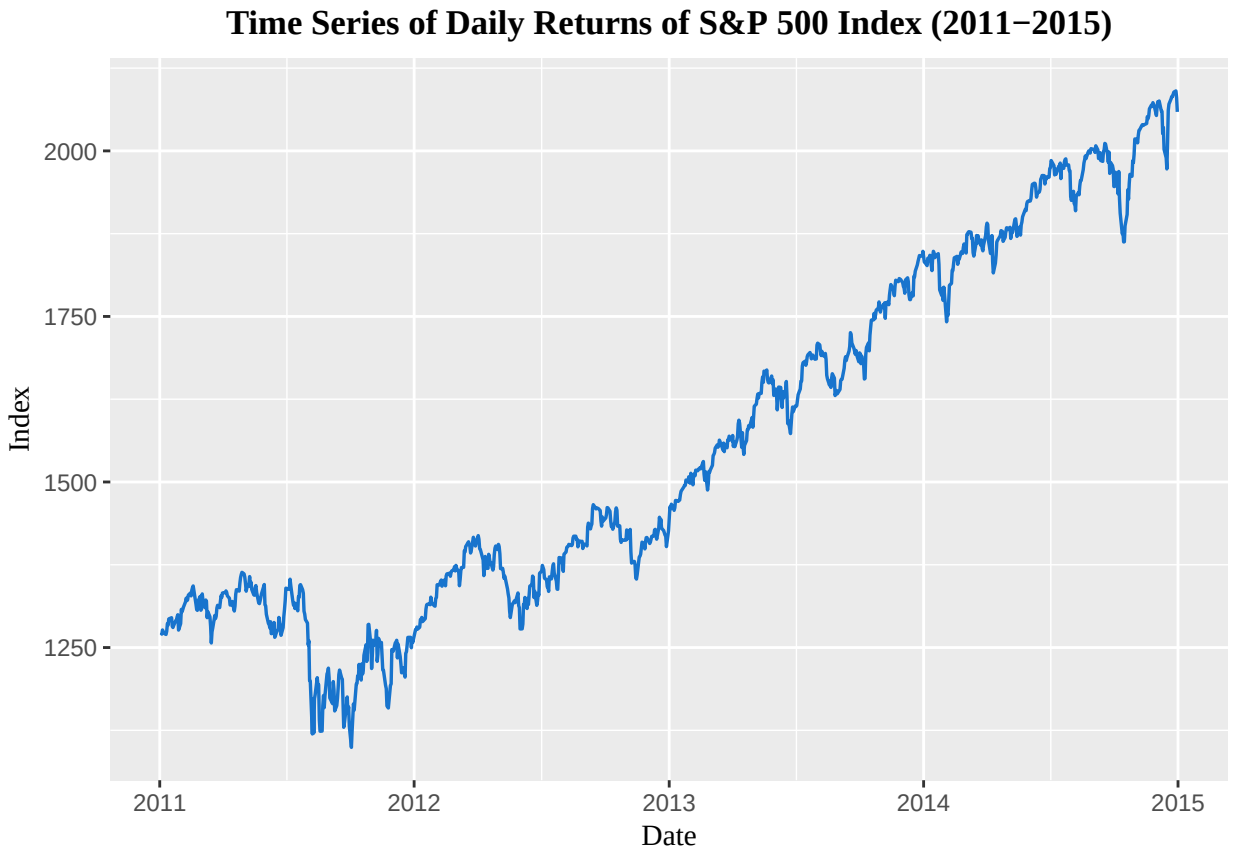
```
library(ggplot2)
library(TSA)
library(vars)
library(readr)
library(dplyr)
```

1. Daily Data of S&P 500, S&P 400 (MidCap) and S&P 600 (SmallCap)

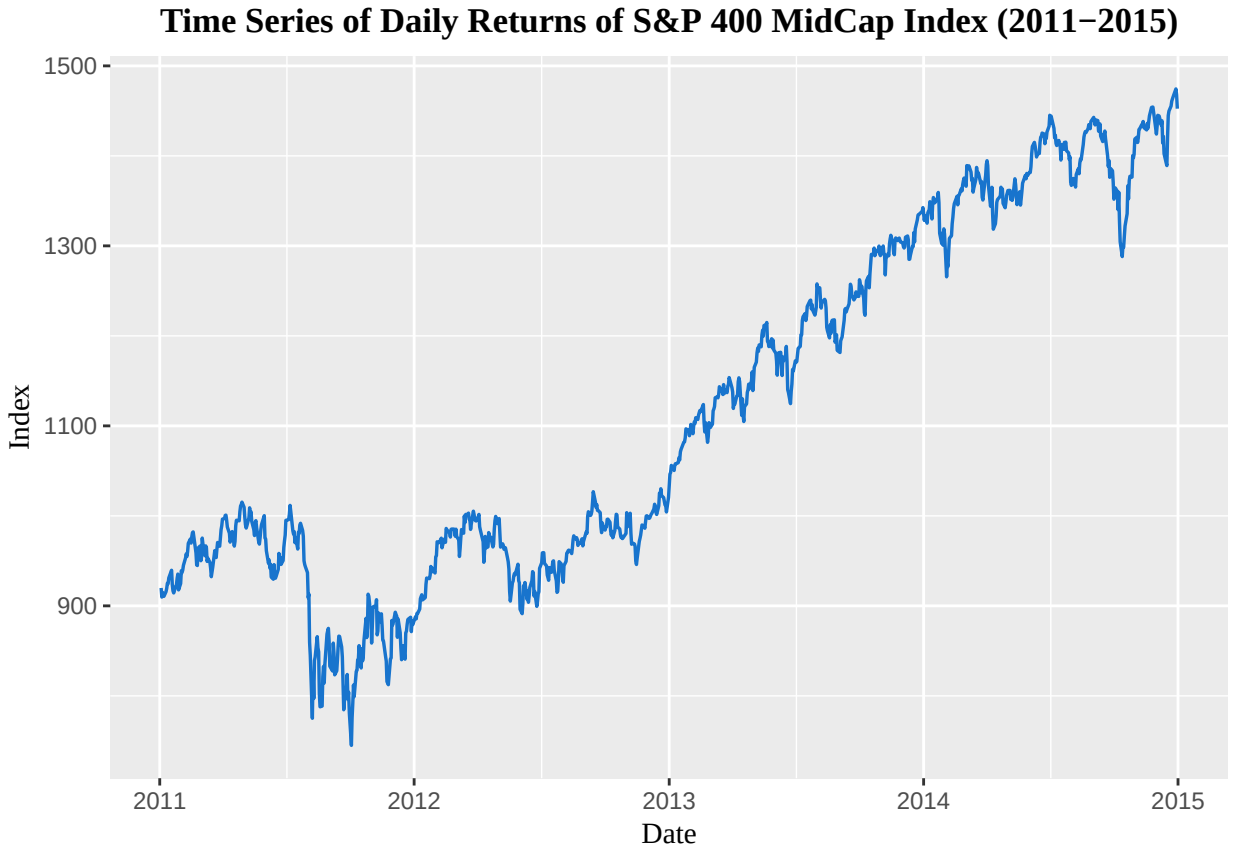
```
setwd("/Users/ouyangfu/Dropbox/Teaching/financial econometrics/2018/data")
rm(list = ls())

data.prepare <- function(data.name) {
  data <- read_csv(data.name, col_names = T, na = "null") %>%
    rename(index = `Adj Close`) %>%
    mutate(lindex = lag(index, n = 1L), ret = (index-lindex)/lindex) %>%
    select(Date, ret, index)

  if (data.name == "sp500day.csv") {
    data$Date <- as.Date(strptime(as.character(data$Date), "%m/%d/%Y"))
  } else {
    data$Date <- as.Date(strptime(as.character(data$Date), "%Y-%m-%d"))
  }

  data <- arrange(data, Date)
  data <- filter(data, (Date >= as.Date("2011-01-01")) & (Date <= as.Date("2014-12-31")))
}

sp500 <- data.prepare("sp500day.csv"); sp500 <-rename(sp500, R_LC = ret)
sp400 <- data.prepare("sp400day.csv"); sp400 <- rename(sp400, R_MC = ret)
sp600 <- data.prepare("sp600day.csv"); sp600 <- rename(sp600, R_SC = ret)
```

2. Time Series of Daily Returns of S&P 500, S&P 400 (MidCap) and S&P 600 (SmallCap)

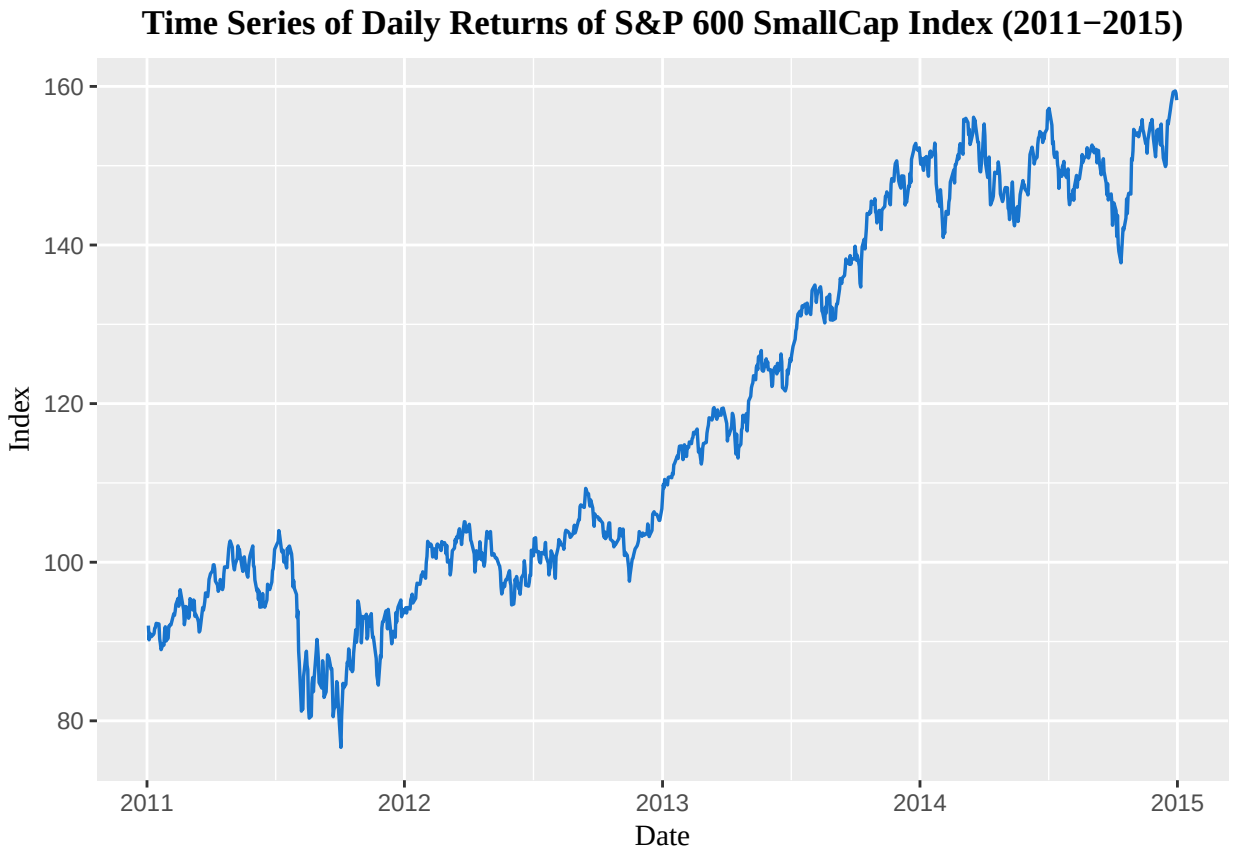
```
fig11 <- ggplot(sp500, aes(Date)) +
  geom_line(aes(y = index), size = 0.6, color = "dodgerblue3") +
  labs(title = "Time Series of Daily Returns of S&P 500 Index (2011-2015)",
       x = "Date", y = "Index") +
  theme(axis.title = element_text(family = "serif"),
        plot.title = element_text(hjust = 0.5, family = "serif", face = "bold"))
fig11
```




```
fig12 <- ggplot(sp400, aes(Date)) +
  geom_line(aes(y = index), size = 0.6, color = "dodgerblue3") +
  labs(title = "Time Series of Daily Returns of S&P 400 MidCap Index (2011-2015)",
       x = "Date", y = "Index") +
  theme(axis.title = element_text(family = "serif"),
        plot.title = element_text(hjust = 0.5, family = "serif", face = "bold"))
fig12
```

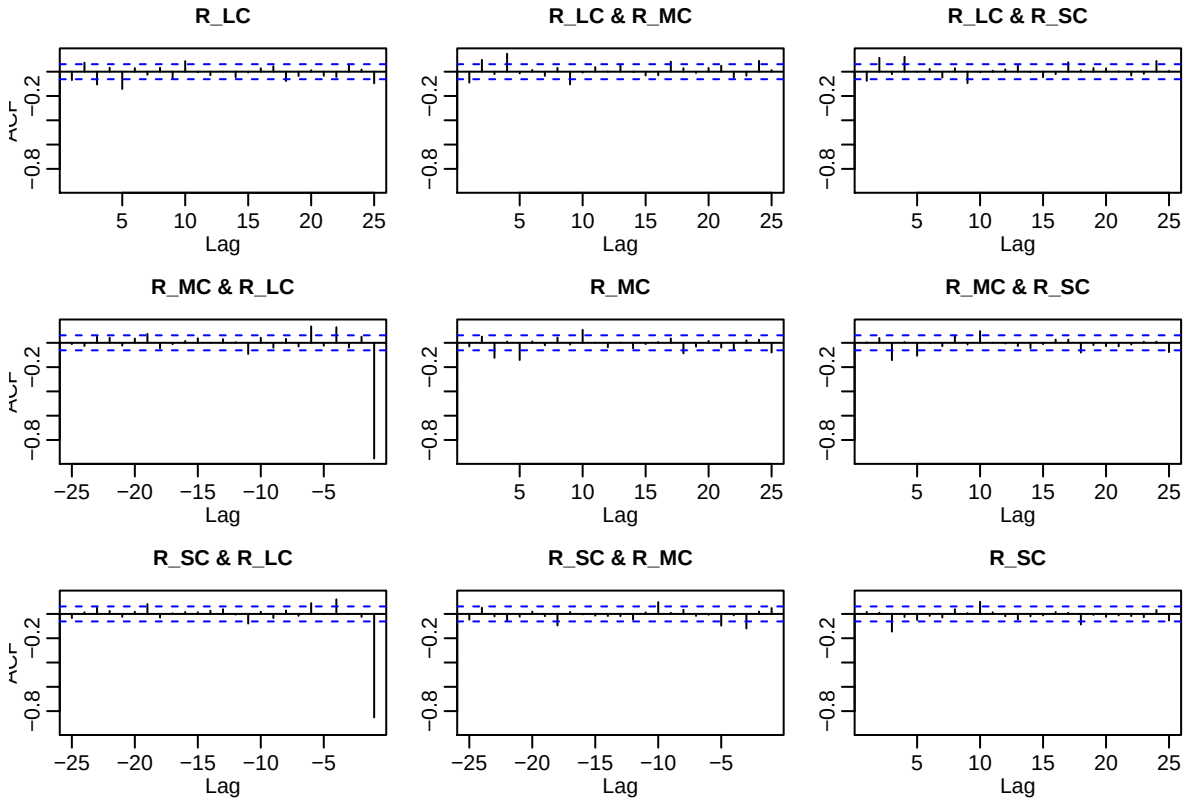



```
fig13 <- ggplot(sp600, aes(Date)) +
  geom_line(aes(y = index), size = 0.6, color = "dodgerblue3") +
  labs(title = "Time Series of Daily Returns of S&P 600 SmallCap Index (2011-2015)",
       x = "Date", y = "Index") +
  theme(axis.title = element_text(family = "serif"),
        plot.title = element_text(hjust = 0.5, family = "serif", face = "bold"))
fig13
```



3. Auto-Correlation and Cross Correlation Functions

```
data <- inner_join(inner_join(sp500, sp400, by = "Date"), sp600, by = "Date")
data <- select(data, starts_with("R"))
ACF <- acf(data, na.action = na.pass, plot = F)
plot(ACF)
```



4. LSE of Vector Autoregressive Model using S&P 500/400/600 Data

```
SPvar <- VAR(data, p = 2)
summary(SPvar)
```

```
##
## VAR Estimation Results:
## ========================
## Endogenous variables: R_LC, R_MC, R_SC
## Deterministic variables: const
## Sample size: 1004
## Log Likelihood: 11411.067
## Roots of the characteristic polynomial:
## 0.4577 0.4577 0.4167 0.341 0.341 0.06778
## Call:
## VAR(y = data, p = 2)
##
##
## Estimation results for equation R_LC:
## =====================================
## R_LC = R_LC.l1 + R_MC.l1 + R_SC.l1 + R_LC.l2 + R_MC.l2 + R_SC.l2 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## R_LC.l1 -0.0605982  0.0315769  -1.919   0.0553 .
## R_MC.l1 -0.2235136  0.1061730  -2.105   0.0355 *
## R_SC.l1  0.0337213  0.0622328   0.542   0.5880
## R_LC.l2 -0.1481371  0.1041119  -1.423   0.1551
```

```
## R_MC.l2 -0.0505158  0.0646956  -0.781   0.4351
## R_SC.l2  0.1325179  0.0612454   2.164   0.0307 *
## const   -0.0004785  0.0003066  -1.561   0.1189
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.00968 on 997 degrees of freedom
## Multiple R-Squared: 0.02694, Adjusted R-squared: 0.02109
## F-statistic: 4.601 on 6 and 997 DF,  p-value: 0.0001281
##
##
## Estimation results for equation R_MC:
## =====================================
## R_MC = R_LC.l1 + R_MC.l1 + R_SC.l1 + R_LC.l2 + R_MC.l2 + R_SC.l2 + const
##
##           Estimate Std. Error  t value Pr(>|t|)
## R_LC.l1 -1.1489433  0.0114654 -100.209   <2e-16 ***
## R_MC.l1 -0.0282938  0.0385510   -0.734    0.463
## R_SC.l1  0.0032806  0.0225965    0.145    0.885
## R_LC.l2 -0.0466944  0.0378026   -1.235    0.217
## R_MC.l2 -0.0252823  0.0234907   -1.076    0.282
## R_SC.l2 -0.0091004  0.0222380   -0.409    0.682
## const    0.0000495  0.0001113    0.445    0.657
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.003515 on 997 degrees of freedom
## Multiple R-Squared: 0.9108,  Adjusted R-squared: 0.9103
## F-statistic:  1697 on 6 and 997 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation R_SC:
## =====================================
## R_SC = R_LC.l1 + R_MC.l1 + R_SC.l1 + R_LC.l2 + R_MC.l2 + R_SC.l2 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## R_LC.l1 -1.0834725  0.0195900 -55.307  < 2e-16 ***
## R_MC.l1  0.4268166  0.0658687   6.480 1.44e-10 ***
## R_SC.l1 -0.3296444  0.0386086  -8.538  < 2e-16 ***
## R_LC.l2  0.0300506  0.0645900   0.465  0.64185
## R_MC.l2  0.0837491  0.0401365   2.087  0.03718 *
## R_SC.l2 -0.1237928  0.0379961  -3.258  0.00116 **
## const    0.0001875  0.0001902   0.986  0.32453
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.006005 on 997 degrees of freedom
## Multiple R-Squared: 0.7581,  Adjusted R-squared: 0.7566
## F-statistic: 520.7 on 6 and 997 DF,  p-value: < 2.2e-16
##
##
```

```
##
## Covariance matrix of residuals:
##            R_LC       R_MC       R_SC
## R_LC  9.370e-05 -2.210e-06 -4.756e-06
## R_MC -2.210e-06  1.235e-05  1.223e-05
## R_SC -4.756e-06  1.223e-05  3.606e-05
##
## Correlation matrix of residuals:
##          R_LC     R_MC     R_SC
## R_LC  1.00000 -0.06497 -0.08181
## R_MC -0.06497  1.00000  0.57964
## R_SC -0.08181  0.57964  1.00000
```