C183 - Project 5

```r
#Read the data:
stock <- read.csv("stockData.csv", sep=",", header=TRUE)
stock <- stock[-2:-1]

# Convert non-numeric columns to numeric
data <- apply(stock, 2, function(x) as.numeric(as.character(x)))


# Compute the mean returns, excluding missing values
R_ibar <- as.matrix(mean(data, na.rm = TRUE))
R_ibar
```

```
##          [,1]
## [1,] 221.7653
```

```r
#Compute the variance-covariance matrix:
var_covar <- cov(data)
head(var_covar)
```

```
##           X.GSPC       AAPL       CRM      NVDA         MU      MSFT        TSM
## X.GSPC 674127.40 40466.7263 45954.548 62439.008 16515.8109 73739.632 26471.9701
## AAPL    40466.73  2606.5756  2667.868  3889.241   950.7311  4573.326  1618.8881
## CRM     45954.55  2667.8684  3949.713  4165.847  1179.7398  5126.554  1887.8171
## NVDA    62439.01  3889.2415  4165.847  6387.132  1483.9941  6960.819  2477.8743
## MU      16515.81   950.7311  1179.740  1483.994   473.8072  1759.917   674.5854
## MSFT    73739.63  4573.3261  5126.554  6960.819  1759.9170  8343.204  2924.0764
##               DIS      GOOGL       NFLX         BIDU      META       ATVI
## X.GSPC 15027.6349 26885.3990 102691.188 -10621.93387 46450.990 13892.1344
## AAPL     777.5985  1618.3806   5605.970   -803.42387  2504.237   821.8546
## CRM     1338.2589  1837.1943   9506.052   -797.56734  4123.988  1008.9694
## NVDA    1180.4195  2549.4306   9139.725   -900.08624  4206.623  1233.2498
## MU       438.2748   651.4044   2875.662    -54.78558  1283.832   378.4163
## MSFT    1555.5404  2965.3087  11288.414  -1587.17030  5001.281  1494.0292
##               UNH        TMO        CVS       BMY        NVO        GILD
## X.GSPC 104727.311 134960.650 3975.17128 4929.0631 19699.9834 -1163.07224
## AAPL     6583.662   8471.130  332.56925  351.4200  1317.1251   -16.08951
## CRM      6403.491   9161.362   22.06426  228.2962  1083.2134  -176.19183
## NVDA     9718.426  12742.895  491.38051  485.0743  2009.5635   -25.61468
## MU       2414.002   3150.913   51.22528  101.4622   406.7044   -48.83014
## MSFT    11671.193  15244.534  455.39521  563.0904  2260.4389  -100.37221
##               JPM         V        GS        AXP         C        MA      TSLA
## X.GSPC 25005.8311 45174.349 55514.321 29613.0755 3822.2549 82105.481 83223.520
## AAPL    1392.5188  2681.132  3320.170  1754.1093  132.4391  4928.215  5393.493
## CRM     1737.2668  3333.664  3208.319  1858.1280  299.4084  6033.594  5422.380
## NVDA    2212.9222  3927.374  5293.562  2708.2750  259.5315  7156.763  8272.081
```

```
## MU       646.3674  1126.076  1333.688   718.2205  130.7546  2049.430  1959.755
## MSFT    2637.0911  5030.734  5847.501  3188.1649  310.7964  9181.061  9375.890
##              BABA        NKE       SBUX       LULU       MCD
## X.GSPC 15526.8925 27356.5299 16699.6113 97829.280 45191.151
## AAPL     633.0696  1635.9920   992.4103  6072.152  2730.104
## CRM     2275.8978  2070.6317  1216.6208  7404.528  3023.201
## NVDA     885.4465  2557.6591  1490.1324  9052.041  4060.152
## MU       634.4702   678.0262   399.7786  2326.627  1056.396
## MSFT    1617.7819  3044.5238  1852.1350 11176.670  5008.646
```

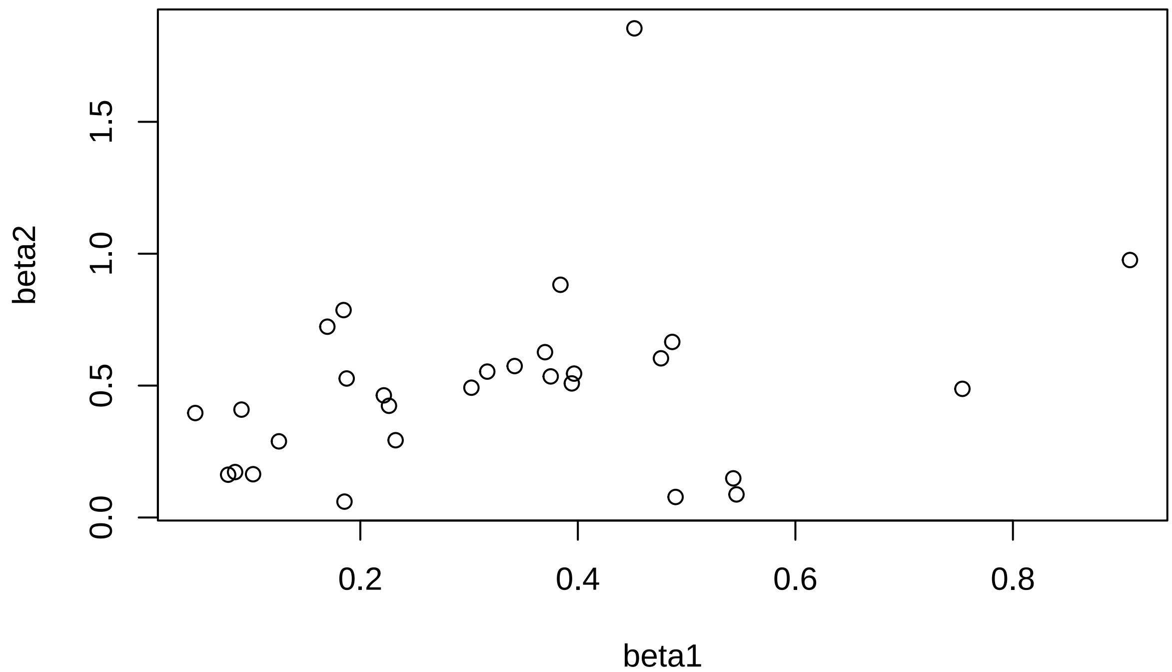
```
#Compute the inverse of the variance-covariance matrix:
var_covar_inv <- solve(var_covar)
head(var_covar_inv)
```

```
##              X.GSPC          AAPL          CRM          NVDA            MU
## X.GSPC  0.0012238809 -0.0002942541  0.000325381 -0.0026453678 -0.0021366793
## AAPL   -0.0002942541  0.0981735850 -0.007183490 -0.0176291005 -0.0134909708
## CRM     0.0003253810 -0.0071834899  0.024016484 -0.0032775494  0.0160146782
## NVDA   -0.0026453678 -0.0176291005 -0.003277549  0.0191130243 -0.0008236646
## MU     -0.0021366793 -0.0134909708  0.016014678 -0.0008236646  0.0798157559
## MSFT    0.0016268659 -0.0059780629  0.006827892 -0.0096328085 -0.0095968127
##              MSFT           TSM          DIS         GOOGL          NFLX
## X.GSPC  0.001626866  5.848827e-04 -0.002504835 -0.003874667 -9.150731e-05
## AAPL   -0.005978063 -2.802782e-02 -0.010684802  0.035951710  1.314004e-03
## CRM     0.006827892 -8.616771e-05 -0.004744500 -0.019537855 -4.107299e-03
## NVDA   -0.009632808  2.782738e-03  0.015391700  0.009927262 -2.980600e-05
## MU     -0.009596813 -1.056027e-02  0.006820705 -0.006219438 -2.997874e-03
## MSFT    0.055849317 -8.135525e-03 -0.009971003 -0.065060269 -4.222074e-04
##                BIDU          META          ATVI           UNH           TMO
## X.GSPC -0.0003795749 -0.0008279057  0.001529981 -0.0008211963 -0.0018235518
## AAPL    0.0056297921  0.0031076783 -0.012563239 -0.0032427135 -0.0032636436
## CRM    -0.0010734790 -0.0001379342  0.012244657  0.0014020524  0.0002196285
## NVDA    0.0006290649 -0.0008332128 -0.007254909  0.0040379069  0.0057784982
## MU     -0.0071242677  0.0039444366  0.014120816 -0.0008066192  0.0051850220
## MSFT    0.0047535830 -0.0013755616  0.011411980 -0.0008804607 -0.0064149741
##                CVS          BMY           NVO         GILD          JPM
## X.GSPC -0.003060896 -0.003680716  0.0023312464  0.003073939  0.002047096
## AAPL   -0.023365164 -0.007223028  0.0054586162 -0.003101417  0.051213196
## CRM    -0.000862313 -0.009370010 -0.0008032442  0.007657661  0.004374665
## NVDA    0.010264780  0.014093528 -0.0128282406 -0.006286344 -0.018167287
## MU      0.014345275 -0.009090373  0.0165834222 -0.008196501 -0.014199275
## MSFT    0.001683696  0.017486797 -0.0180799829 -0.003940768 -0.001776980
##                   V            GS          AXP            C           MA
## X.GSPC  0.0006379031 -0.0014327631 -0.001966852 -0.005457605 -0.001738860
## AAPL   -0.0125298432 -0.0123317938  0.009860860 -0.011253487 -0.008236364
## CRM     0.0046832481  0.0019997192 -0.002846809 -0.012396243 -0.004848593
## NVDA    0.0034278346  0.0051131899 -0.004091005  0.018865324  0.009152969
## MU      0.0077559689  0.0074790025 -0.008286039 -0.009190611 -0.007727400
## MSFT   -0.0057122731 -0.0007479259  0.016938061 -0.003386929 -0.014283778
##                TSLA          BABA           NKE          SBUX          LULU
## X.GSPC  0.0006106872  0.0001149341  0.0008001514  0.0007775781 -0.0008339921
## AAPL   -0.0076411932  0.0018519202  0.0077766709  0.0174929869 -0.0009034528
## CRM    -0.0009166118 -0.0043518055 -0.0024802888  0.0100299218 -0.0043550971
## NVDA   -0.0011714123  0.0006122022 -0.0078477971 -0.0043930145  0.0024230950
```

```
## MU     -0.0014041581 -0.0053060418  0.0017120428 -0.0069773412  0.0017187367
## MSFT   -0.0027485425 -0.0008076417  0.0101713661  0.0241053047 -0.0045350958
##                 MCD
## X.GSPC -0.001374544
## AAPL   -0.008930693
## CRM    -0.006288029
## NVDA    0.003091292
## MU      0.011723977
## MSFT   -0.003637221
```

```
#Create the vector R:
Rf <- 0.002
R <- R_ibar-Rf

#z <- var_covar_inv %*% R
#x <- z/sum(z)
#R_Gbar <- t(x) %*% R_ibar
#var_G <- t(x) %*% var_covar %*% x
#sd_G <- var_G^0.5
#slope <- (R_Gbar-Rf)/(sd_G)
```

```
stock <- read.csv("stockData.csv", sep=",", header=TRUE)
stock <- stock[,-1]


p1 <- stock[1:61,]
p2 <- stock[61:99,]


r1 <- (p1[-1,3:ncol(p1)]-p1[-nrow(p1),3:ncol(p1)])/p1[-nrow(p1),3:ncol(p1)]
r2 <- (p2[-1,3:ncol(p2)]-p2[-nrow(p2),3:ncol(p2)])/p2[-nrow(p2),3:ncol(p2)]


#Compute the variance covariance matrix of the returns for each period:
covmat1 <- var(r1)
covmat2 <- var(r2)

#Compute the betas in each period:
beta1 <- covmat1[1,-1] / covmat1[1,1]
beta2 <- covmat2[1,-1] / covmat2[1,1]

#Here is the plot of the betas in period 2 against the betas in perod 1:
plot(beta1, beta2)
```




```
#Correlation between the betas in the two periods:
cor(beta1, beta2)
```

```
## [1] 0.3073725
```

```
#Adjust betas using the Blume's technique:
q1 <- lm(beta2 ~ beta1)


beta3adj_blume <- q1$coef[1] + q1$coef[2]*beta2
```

```
p3 <- stock[61:99,]
r3 <- (p3[-1,3:ncol(p3)]-p3[-nrow(p3),3:ncol(p3)])/p3[-nrow(p3),3:ncol(p3)]

covmat3 <- var(r3)
beta3 <- covmat3[1,-1] / covmat3[1,1]

#Vasicek's method:
beta2 <- rep(0,60)

alpha2 <- rep(0,60)

sigma_e2 <- rep(0,60)

var_beta2 <- rep(0,60)
```

```r
for (i in 1:59) {
  q <- lm(data = r1, formula = unlist(r1[i + 1,]) ~ unlist(r1[ 1,]))
  beta2[i] <- q$coefficients[2]
  alpha2[i] <- q$coefficients[1]
  sigma_e2[i] <- summary(q)$sigma^2
  var_beta2[i] <- vcov(q)[2, 2]
}


#Adjusting the betas using the Vasicek's technique:
beta3adj_vasicek <- var_beta2*mean(beta2)/(var(beta2)+var_beta2) +
var(beta2)*beta2/(var(beta2)+var_beta2)

PRESS3 <- sum((beta3adj_vasicek-beta3)^2) / 60
```

```
## Warning in beta3adj_vasicek - beta3: longer object length is not a multiple of
## shorter object length
```

```r
cbind(beta3, beta3adj_vasicek)
```

```
## Warning in cbind(beta3, beta3adj_vasicek): number of rows of result is not a
## multiple of vector length (arg 1)
```

```
##             beta3 beta3adj_vasicek
##  [1,] 0.88223399    -0.0307158847
##  [2,] 0.97602978     0.1867601457
##  [3,] 0.48772697    -0.0801458020
##  [4,] 0.54543485    -0.0307437365
##  [5,] 0.60341689     0.2231983773
##  [6,] 0.72325422     0.2505335801
##  [7,] 0.55305523     0.2465760472
##  [8,] 0.66549050    -0.0950765320
##  [9,] 0.07772932    -0.0129854665
## [10,] 0.62666768     0.0787680945
## [11,] 0.14834149     0.0821494943
## [12,] 0.28867902    -0.1716280863
## [13,] 0.42340280    -0.0528213899
## [14,] 0.16217833     0.0425182440
## [15,] 0.16401413     0.3033870557
## [16,] 0.17228561    -0.0004830764
## [17,] 0.06018452     0.1478425761
## [18,] 0.29298028     0.0417884788
## [19,] 0.49206778    -0.0276238223
## [20,] 0.50833035     0.2673362368
## [21,] 0.46298479     0.2045518939
## [22,] 0.53482912     0.1152356817
## [23,] 0.57410062     0.0052112570
## [24,] 1.85421109     0.0788553725
## [25,] 0.08748041     0.0869193712
## [26,] 0.52689031    -0.1399299641
## [27,] 0.40898936     0.1608450616
## [28,] 0.78626585    -0.1439404050
```

```
## [29,] 0.39606783    -0.0607418836
## [30,] 0.88223399    -0.0957229957
## [31,] 0.97602978    -0.0509594974
## [32,] 0.48772697     0.2494088106
## [33,] 0.54543485     0.1222474303
## [34,] 0.60341689     0.0351829762
## [35,] 0.72325422     0.0666094811
## [36,] 0.55305523     0.0873662135
## [37,] 0.66549050     0.1367386848
## [38,] 0.07772932    -0.0442524285
## [39,] 0.62666768     0.1099532307
## [40,] 0.14834149    -0.0223324687
## [41,] 0.28867902     0.1179115006
## [42,] 0.42340280     0.2327856527
## [43,] 0.16217833     0.2101992552
## [44,] 0.16401413    -0.0163190272
## [45,] 0.17228561    -0.1922707558
## [46,] 0.06018452     0.1085256378
## [47,] 0.29298028     0.0016692125
## [48,] 0.49206778     0.0980138306
## [49,] 0.50833035     0.1367281598
## [50,] 0.46298479     0.3104647751
## [51,] 0.53482912     0.1794923716
## [52,] 0.57410062    -0.0426812652
## [53,] 1.85421109     0.1005738842
## [54,] 0.08748041     0.0329363092
## [55,] 0.52689031     0.0426578581
## [56,] 0.40898936     0.0164477289
## [57,] 0.78626585    -0.0760900020
## [58,] 0.39606783    -0.1218626892
## [59,] 0.88223399    -0.0046817898
## [60,] 0.97602978     0.0000000000
```