Project 7

Juwon Lee, Economics and Statistics, UCLA

2023-05-10

tinytex::install_tinytex()

a.

```
hw <- read.csv("/Users/user/Desktop/Yonsei/Junior/3-2/Statistical Models in Finance/stockData.csv",sep=

r_hw7 <- (hw[-1, 3:ncol(hw)]-hw[-nrow(hw),3:ncol(hw)])/hw[-nrow(hw),3:ncol(hw)]

covmat_hw7 <- cov(r_hw7)
beta_hw7 <- covmat_hw7[1,-1] / covmat_hw7[1,1]

r_tech <- data.frame(r_hw7$AAPL, r_hw7$IBM, r_hw7$GOOGL, r_hw7$META, r_hw7$NFLX, r_hw7$AMZN, r_hw7$TSLA)

r_custom <- data.frame(r_hw7$BABA, r_hw7$NKE, r_hw7$MCD, r_hw7$WMT, r_hw7$KO, r_hw7$PEP, r_hw7$XOM, r_hw
                       r_hw7$SHEL, r_hw7$GE, r_hw7$JNJ, r_hw7$PFE, r_hw7$PKX, r_hw7$BIDU)

r_finance <- data.frame(r_hw7$BRK.A, r_hw7$BRK.B, r_hw7$V, r_hw7$JPM, r_hw7$MA, r_hw7$C.PJ, r_hw7$MS, r
                        r_hw7$BA)
```

Tech group (7) = AAPL, IBM, GOOGL, META, NFLX, AMZN, TSLA
Customer Item group (14) = BABA, NKE, MCD, WMT, KO, PEP, XOM, CVX, SHEL, GE, JNJ, PFE, PKX, BIDU
Financial group (9) = BRK.A, BRK.B, V, JPM, MA, C.PJ, MS, HSBC, BA

```
r_group <- cbind(r_hw7$X.GSPC, r_tech, r_custom, r_finance)

rrr_hw7 <- r_group[,-c(1,which(beta_hw7<0)+1)]

b_hw7 <- rep(0, 7)

tech <- (rrr_hw7[,1] + rrr_hw7[,2] + rrr_hw7[,3] + rrr_hw7[,4] +rrr_hw7[,5] + rrr_hw7[,6] + rrr_hw7[,7]

lm_tech <- lm(data=r_hw7, formula=tech~r_hw7[,1])

b_tech <- lm_tech$coefficients[2]

custom <- (rrr_hw7[,8] + rrr_hw7[,9] + rrr_hw7[,10] + rrr_hw7[,11] +rrr_hw7[,12] + rrr_hw7[,13] + rrr_h
           + rrr_hw7[,15] + rrr_hw7[,16] + rrr_hw7[,17] + rrr_hw7[,18] + rrr_hw7[,19] + rrr_hw7[,20] + 

lm_custom <- lm(data=r_hw7, formula=custom~r_hw7[,1])

b_custom <- lm_custom$coefficients[2]
```

```r
finance <- (rrr_hw7[,22] + rrr_hw7[,23] + rrr_hw7[,24] + rrr_hw7[,25] +rrr_hw7[,26] + rrr_hw7[,27] + rrr
            + rrr_hw7[,29] + rrr_hw7[,30]) / 9

lm_finance <- lm(data=r_hw7, formula=finance~r_hw7[,1])

b_finance <- lm_tech$coefficients[2]

b_tech ; b_custom ; b_finance
```

```
## r_hw7[, 1]
##    1.19856
```

```
## r_hw7[, 1]
##  0.9369151
```

```
## r_hw7[, 1]
##    1.19856
```

```r
cov(tech, custom) ; cov(tech, finance) ; cov(custom, finance)
```

```
## [1] 0.001214162
```

```
## [1] 0.0013123
```

```
## [1] 0.001017524
```

Thus, $b_t = 1.19856, b_c = 0.9369151, b_f = 1.19856$. And we know correlation between group. Then if we know about beta, then we can know A and C (N1 = 7, N2 = 14, N3 = 9, sigma_i = for stock, rho_ii = for industry), then we can figure phi, then z_i can be computed. Then we can find mean and sd, and add it to plot of project 6.

```r
cor_11 <- (sum(cor(r_tech)) - length(r_tech)) / (length(r_tech) * (length(r_tech) - 1))
cor_22 <- (sum(cor(r_custom)) - length(r_custom)) / (length(r_custom) * (length(r_custom) - 1))
cor_33 <- (sum(cor(r_finance)) - length(r_finance)) / (length(r_finance) * (length(r_finance) - 1))

A1 <- c(1 + 7 * cor_11 / (1 - cor_11), 14 * cor(custom, tech) / (1 - cor_22), 9 * cor(finance, tech) /

A2 <- c(7 * cor(tech, custom) / (1 - cor_11), 1 + (14 * cor_22) / (1 - cor_22), 9 * cor(finance, custom)

A3 <- c(7 * cor(tech, finance) / (1 - cor_11), (14 * cor(custom, finance) / (1 - cor_22)), 1 + (9 * cor

length(r_tech)
```

```
## [1] 7
```

```r
mean_tech <- rep(0, length(r_tech))
sd_tech <- rep(0, length(r_tech))

for (i in 1:length(r_tech)) {
  mean_tech[i] <- mean(r_tech[,i])
  sd_tech[i] <- sd(r_tech[,i])
}

mean_custom <- rep(0, length(r_custom))
sd_custom <- rep(0, length(r_custom))

for (i in 1:length(r_custom)) {
  mean_custom[i] <- mean(r_custom[,i])
```

```r
  sd_custom[i] <- sd(r_custom[,i])
}

mean_finance <- rep(0, length(r_finance))
sd_finance <- rep(0, length(r_finance))

for (i in 1:length(r_finance)) {
  mean_finance[i] <- mean(r_finance[,i])
  sd_finance[i] <- sd(r_finance[,i])
}

rf_hw7 <- 0.001

c_tech <- sum((mean_tech - rf_hw7) / (sd_tech * (1 - cor_11)))
c_custom <- sum((mean_custom - rf_hw7) / (sd_custom) * (1 - cor_22))
c_finance <- sum((mean_finance - rf_hw7) / (sd_finance) * (1 - cor_33))

A <- cbind(A1, A2, A3)
C <- c(c_tech, c_custom, c_finance)

phi <- solve(A) %*% C

phi
```

```
##          [,1]
## A1 -0.7292934
## A2  0.4445712
## A3  0.4516039
```

```r
C_tech <- t(c(cor_11, cor(tech, custom), cor(tech, finance))) %*% phi
C_custom <- t(c(cor(custom, tech), cor_22, cor(custom, finance))) %*% phi
C_finance <- t(c(cor(finance, tech), cor(finance, custom), cor_33)) %*% phi

z_tech <- 1 / (sd_tech * (1 - cor_11)) * ((mean_tech - rf_hw7) / sd_tech - C_tech)
```

```
## Warning in (mean_tech - rf_hw7)/sd_tech - C_tech: Recycling array of length 1 in vector-array arithme
##   Use c() or as.vector() instead.
```

```r
z_custom <- 1 / (sd_custom * (1 - cor_22)) * ((mean_custom - rf_hw7) / sd_custom - C_custom)
```

```
## Warning in (mean_custom - rf_hw7)/sd_custom - C_custom: Recycling array of length 1 in vector-array a
##   Use c() or as.vector() instead.
```

```r
z_finance <- 1 / (sd_finance * (1 - cor_33)) * ((mean_finance - rf_hw7) / sd_finance - C_finance)
```

```
## Warning in (mean_finance - rf_hw7)/sd_finance - C_finance: Recycling array of length 1 in vector-arra
##   Use c() or as.vector() instead.
```

```r
sumofz <- sum(z_tech, z_custom, z_finance)

x_tech <- z_tech / sumofz
x_custom <- z_custom / sumofz
x_finance <- z_finance / sumofz
```

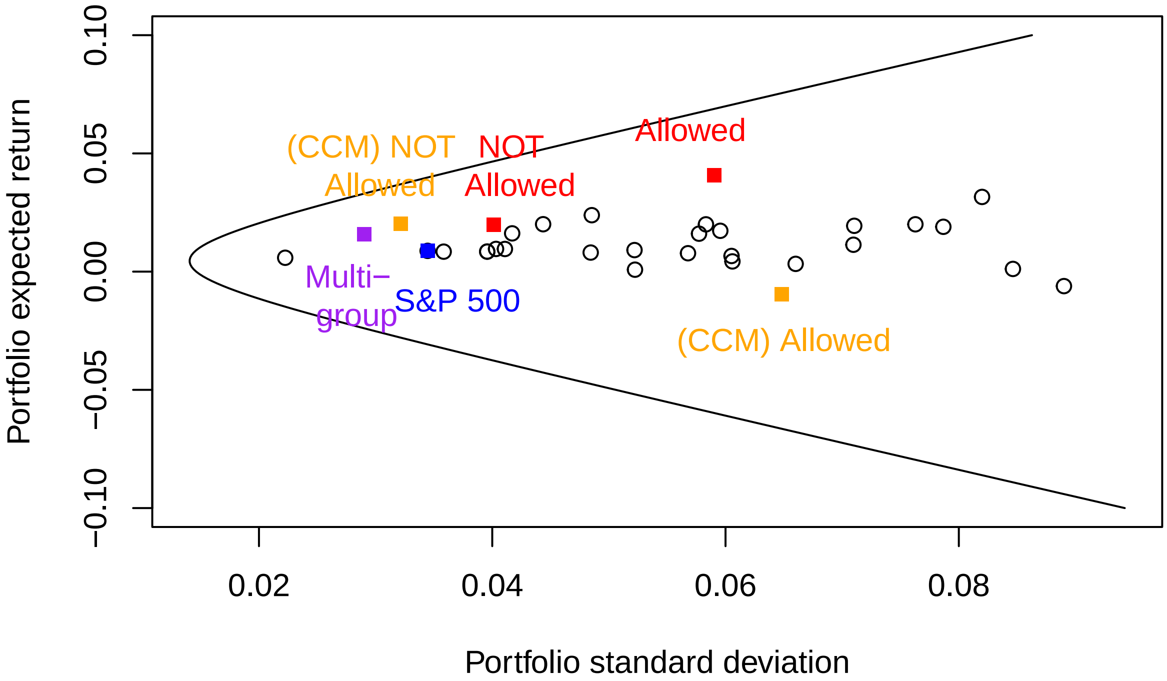
Thus, we find the percentage of investment.

```r
x <- c(x_tech, x_custom, x_finance)

meanofmodel <- t(colMeans(r_group)[-1]) %*% x
varofmodel <- t(x) %*% cov(r_group[-1]) %*% x
```

Now, if we plot this,

```
## Warning in C2_plot_hw6 * x_plot_hw6: Recycling array of length 1 in array-vector arithmetic is depre
##   Use c() or as.vector() instead.

## Warning in 2 * A2_plot_hw6 * x_plot_hw6: Recycling array of length 1 in array-vector arithmetic is de
##   Use c() or as.vector() instead.

## Warning in C2_plot_hw6 * x_plot_hw6 * x_plot_hw6 - 2 * A2_plot_hw6 * x_plot_hw6 + : Recycling array
##   Use c() or as.vector() instead.

## Warning in (C2_plot_hw6 * x_plot_hw6 * x_plot_hw6 - 2 * A2_plot_hw6 * x_plot_hw6 + : Recycling array
##   Use c() or as.vector() instead.

##  [1] 17 18 20 11  8 27  7 15 16 14 28 23 25 24 29 26 30
```

```r
plot(sigma_squared_hw6^0.5, x_plot_hw6, type='l',  ylab="Portfolio expected return", xlab="Portfolio st
points(variances_hw6^0.5, means_hw6)
points(var(r_hw6$X.GSPC)^0.5, mean(r_hw6$X.GSPC), col='blue', pch=15)
points(var_with_short_hw6^0.5, mean_with_short_hw6, col='red', pch=15)
points(var_no_short_hw6^0.5, mean_no_short_hw6, col='red', pch=15)
points(var_no_short_ccm_hw6^0.5, mean_no_short_ccm_hw6, col='orange', pch=15)
points(var_with_short_ccm_hw6^0.5, mean_with_short_ccm_hw6, col='orange', pch=15)
text(0.03, 0.045, "(CCM) NOT \n Allowed", col='orange')
text(0.065, -0.03, "(CCM) Allowed", col='orange')
text(0.037, -0.012, "S&P 500", col='blue')
text(0.057, 0.06, "Allowed", col='red')
text(0.042, 0.045, "NOT \n Allowed", col='red')

points(varofmodel^0.5, meanofmodel, col='purple', pch=15)
text(0.028, -0.01, "Multi- \n group", col='purple')
```


(CCM) NOT
Allowed
NOT
Allowed
Allowed
Multi−
group
S&P 500
(CCM) Allowed
Portfolio expected return
Portfolio standard deviation
0.10
0.05
0.00
−0.05
−0.10
0.02
0.04
0.06
0.08

b.

```
x
```

1.

```
##  [1] -0.0098907522 -0.0596325069 -0.0067588022 -0.0086729077 -0.0024577277
##  [6]  0.0131392321 -0.0180147001  0.0178304756  0.0535193494  0.1089227552
## [11]  0.0308468204  0.0654208387  0.0600563004 -0.0119424255  0.0194469902
## [16]  0.0120731400 -0.0191072748  0.0574045269  0.0304320917 -0.0065240156
## [21] -0.0115923411  0.0594126947  0.0595053921  0.1463714271  0.0807237583
## [26]  0.1486643923  0.1288632308  0.0227583263  0.0007115743  0.0384901372
```

```
x_short_hw6
```

```
##  [1]  0.297016862  0.035138516  0.063938097  0.446916117  0.068021331
##  [6]  0.401806800  0.152961167  0.101763286  0.201319172  0.115733013
## [11]  0.078989914  0.149730809  0.088305173  0.092541568  0.054263273
## [16]  0.040250236  0.037221152 -0.003435238 -0.091747468 -0.097041021
## [21] -0.036853616 -0.063986891 -0.084155621 -0.054486457 -0.063831010
## [26] -0.236946025 -0.098618806 -0.304682916 -0.149341739 -0.140789677
```

```
x_no_short_hw6
```

```
##  [1] 0.280812095 0.031000551 0.040878374 0.275329947 0.038492745 0.196668269
##  [7] 0.050778414 0.020061146 0.037821624 0.020760467 0.007396367
```

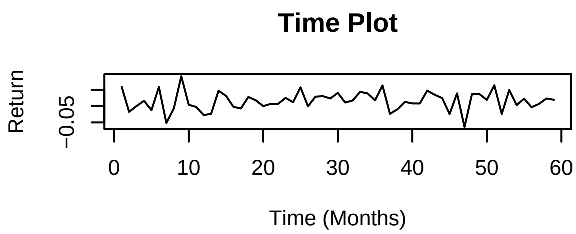
```
x_with_short_ccm_hw6
```

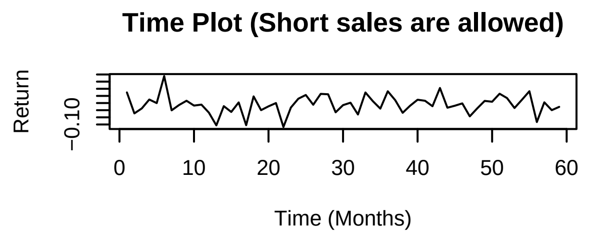
```
##  [1] -0.093059110 -0.003840417 -0.121156110 -0.079273322 -0.024540984
##  [6] -0.078613259  0.034238891  0.028983448 -0.050787526 -0.168779438
## [11]  0.021862820 -0.058652449 -0.032749741  0.137979205  0.074114766
## [16]  0.096489733  0.001666268  0.010075507 -0.126902240  0.018572175
## [21] -0.091769058 -0.085834891  0.169048916  0.208369206  0.155033852
## [26]  0.272719238  0.091321699  0.164007909  0.259532611  0.271942302
```

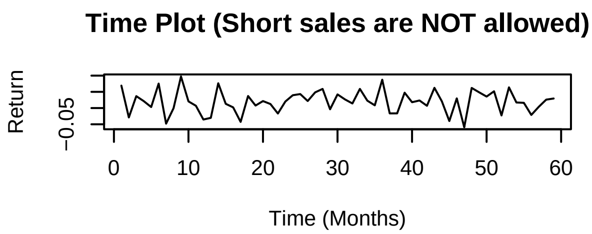
```
x_no_short_ccm_hw6
```

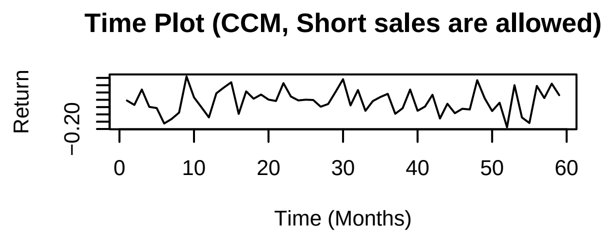
```
##  [1] 0.02452945 0.01369970 0.07678845 0.08596666 0.04208463 0.13481408
##  [7] 0.17564721 0.08843561 0.08812549 0.07654005 0.08755993 0.09208872
## [13] 0.01372001
```

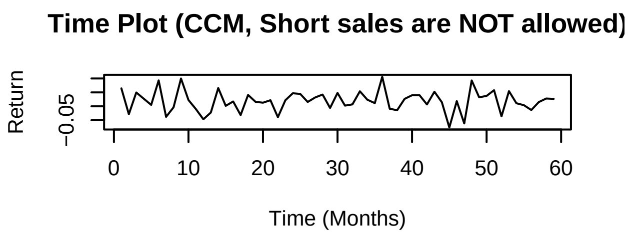
```
par(mfrow=c(3,2))
plot(as.matrix(r_group[-1]) %*% x, type='l', main='Time Plot', xlab='Time (Months)', ylab='Return')
plot(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6, type='l', main='Time Plot (Short sales are al
plot(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6, type='l', main='Time Plot (Short sales are
plot(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6, type='l', main='Time Plot (CCM, Short sales are al
plot(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6, type='l', main='Time Plot (CC
```











2. 1. Multi-group Model.

$(1+r_g)^{59} = (1+r_1)(1+r_2)...(1+r_{59})$, so that
$r_g = [(1+r_1)(1+r_2)...(1+r_{59})]^{\frac{1}{59}} - 1$.

```
prod(as.matrix(r_group[-1]) %*% x + 1)^(1/59) - 1
```

```
## [1] 0.01530617
```

Thus, $r_g = 0.01530617$.

2. General model when short sales are allowed.

```
prod(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6 + 1)^(1/60) - 1
```

```
## [1] 0.03812507
```

Thus, $r_g = 0.03812507$.

3. General model when short sales are NOT allowed.

```
prod(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6 + 1)^(1/60) - 1
```

```
## [1] 0.01899447
```

Thus, $r_g = 0.01899447$.

4. Constant Correlation Model when short sales are allowed.

```
prod(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6 + 1)^(1/60) - 1
```

```
## [1] -0.01271573
```

Thus, $r_g = -0.01271753$.

5. Constant Correlation Model when short sales are NOT allowed.

```
prod(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6 + 1)^(1/60) - 1
```

```
## [1] 0.01794777
```

Thus, $r_g = 0.01794777$.

3. Sharpe ratio

$$= \frac{\bar{R_p} - R_F}{\sigma_p}$$

, suppose $r_f = 0.001$.

1. Multi-group model.

```
rf_3 <- 0.001

(mean(as.matrix(r_group[-1]) %*% x) - rf_3) / sd(as.matrix(r_group[-1]) %*% x)
```

```
## [1] 0.5070449
```

Thus, $S_1 = 0.5070449$.

2. General model when short sales are allowed.

```
(mean(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6) - rf_3) / sd(as.matrix(rrr_hw6[,table1_hw6[,
```

```
## [1] 0.6178993
```

Thus, $S_2 = 0.6178993$.

3. General model when short sales are NOT allowed.

```
(mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - rf_3) / sd(as.matrix(rrr_hw6[,table2_hw
```

```
## [1] 0.5430201
```

Thus, $S_3 = 0.5430201$.

4. Constant Correlation Model when short sales are allowed.

```
(mean(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6) - rf_3) / sd(as.matrix(r_hw6[,-1]) %*% x_with_sho
```

```
## [1] -0.1305454
```

Thus, $S_4 = -0.1305454$.

5. Constant Correlation Model when short sales are NOT allowed.

```
(mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - rf_3) / sd(as.matrix(rrr_hw
```

```
## [1] 0.4744805
```

Thus, $S_5 = 0.4744805$.

to find Differential Excess Return, we have to find market index, so-called the point M.

```
mean(r_hw7$X.GSPC) ; sd(r_hw7$X.GSPC)
```

```
## [1] 0.008791199
## [1] 0.03446065
```

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC)
```

```
## [1] 0.2260897
```

Thus, the regression line is
$$\bar{R} = 0.2260897\sigma + 0.001$$
.

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(r_hw7$X.GSPC) + 0.001
```

```
## [1] 0.008791199
```

Thus, the point M is $(0.03446065, 0.008791199)$.

1. Multi-group model

```
mean(as.matrix(r_group[-1]) %*% x) ; sd(as.matrix(r_group[-1]) %*% x)
```

```
## [1] 0.0157153
```

```
## [1] 0.02902169
```

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(r_group[-1]) %*% x) + 0.001
```

```
## [1] 0.007561506
```

```
mean(as.matrix(r_group[-1]) %*% x) - ((mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(r_g
```

```
## [1] 0.008153795
```

Thus, \$ D_1 = 0.008153795\$.

2. General model when short sales are allowed.

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6
```

```
## [1] 0.01554601
```

```
mean(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6) - ((mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.G
```

```
## [1] 0.02520799
```

Thus, $D_2 = 0.02520799$.

3. General model when short sales are NOT allowed.

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_
```

```
## [1] 0.008871575
```

```
mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - ((mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$
```

```
## [1] 0.0110343
```

Thus, $D_3 = 0.0110343$.

4. Constant Correlation Model when short sales are allowed.

```
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6) + 0
```

```
## [1] 0.01939804
```

```
mean(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6) - ((mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC)
```

```
## [1] -0.02902117
```

Thus, $D_4 = -0.02902117$.

5. Constant Correlation Model when short sales are NOT allowed.

```r
(mean(r_hw7$X.GSPC) - rf_3) / sd(r_hw7$X.GSPC) * sd(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_n
```

```
## [1] 0.00955168
```

```r
mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - ((mean(r_hw7$X.GSPC) - rf_3)
```

```
## [1] 0.009395201
```

Thus, $D_5 = 0.009395201$.

Treynor Measure

$$= \frac{\bar{R_B} - R_F}{\beta_B}$$

.

1. Multigroup Model

```r
lm_treynor_1 <- lm(r_hw7$X.GSPC~as.vector(as.matrix(r_group[-1]) %*% x))

beta_treynor_1 <- lm_treynor_1$coefficients[2]

(mean(as.matrix(r_group[-1]) %*% x) - rf_3) / beta_treynor_1
```

```
## as.vector(as.matrix(r_group[-1]) %*% x)
##                                0.01450103
```

Thus, $T_1 = 0.01450103$.

2. General Model when short sales are allowed.

```r
lm_treynor_2 <- lm(r_hw7$X.GSPC~as.vector(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6))

beta_treynor_2 <- lm_treynor_2$coefficients[2]

(mean(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6) - rf_3) / beta_treynor_2
```

```
## as.vector(as.matrix(rrr_hw6[, table1_hw6[, 1]]) %*% x_short_hw6)
##                                                        0.3388127
```

Thus, $T_2 = 0.3388127$.

3. General Model when short sales are NOT allowed.

```r
lm_treynor_3 <- lm(r_hw7$X.GSPC~as.vector(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6))

beta_treynor_3 <- lm_treynor_3$coefficients[2]

(mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - rf_3) / beta_treynor_3
```

```
## as.vector(as.matrix(rrr_hw6[, table2_hw6[, 1]]) %*% x_no_short_hw6)
##                                                          0.02408695
```

Thus, $T_3 = 0.02408695$.

4. Constant Correlation Model when short sales are allowed.

```r
lm_treynor_4 <- lm(r_hw7$X.GSPC~as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6)

beta_treynor_4 <- lm_treynor_4$coefficients[2]

(mean(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6) - rf_3) / beta_treynor_4
```

```
## as.matrix(r_hw6[, -1]) %*% x_with_short_ccm_hw6
##                                        -0.04284463
```

Thus, $T_4 = -0.04284463$.

5. Constant Correlation Model when short sales are NOT allowed.

```r
lm_treynor_5 <- lm(r_hw7$X.GSPC~as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6)

beta_treynor_5 <- lm_treynor_5$coefficients[2]

(mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - rf_3) / beta_treynor_5
```

```
## as.matrix(rrr_hw6[, table_ccm_4_hw6[1:13, 1]]) %*% x_no_short_ccm_hw6
##                                                               0.02435349
```

Thus, $T_5 = 0.02435349$.

to find Jensen differential performance index, we have to check market.
Because $\beta_M = 1$, M is on $(1, 0.008791199)$.
Thus,

$$\bar{R} = 0.007791199\beta + 0.001$$

.

1. Multigroup Model.

```r
mean(as.matrix(r_group[-1]) %*% x) - (0.007791199 * beta_treynor_1 + 0.001)
```

```
## as.vector(as.matrix(r_group[-1]) %*% x)
##                               0.006808975
```

Thus, $J_1 = 0.006808975$.

2. General Model when short sales are allowed.

```r
mean(as.matrix(rrr_hw6[,table1_hw6[,1]]) %*% x_short_hw6) - (0.007791199 * beta_treynor_2 + 0.001)
```

```
## as.vector(as.matrix(rrr_hw6[, table1_hw6[, 1]]) %*% x_short_hw6)
##                                                         0.03883983
```

Thus, $J_2 = 0.03883983$.

3. General Model when short sales are NOT allowed.

```r
mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - (0.007791199 * beta_treynor_3 + 0.001)
```

```
## as.vector(as.matrix(rrr_hw6[, table2_hw6[, 1]]) %*% x_no_short_hw6)
##                                                            0.01279055
```

Thus, $J_3 = 0.01279055$.

4. Constant Correlation Model when short sales are allowed.

```r
mean(as.matrix(r_hw6[,-1]) %*% x_with_short_ccm_hw6) - (0.007791199 * beta_treynor_4 + 0.001)
```

```
## as.matrix(r_hw6[, -1]) %*% x_with_short_ccm_hw6
##                                        -0.01255492
```

Thus, $J_4 = -0.01255492$.

5. Constant Correlation Model when short sales are NOT allowed.

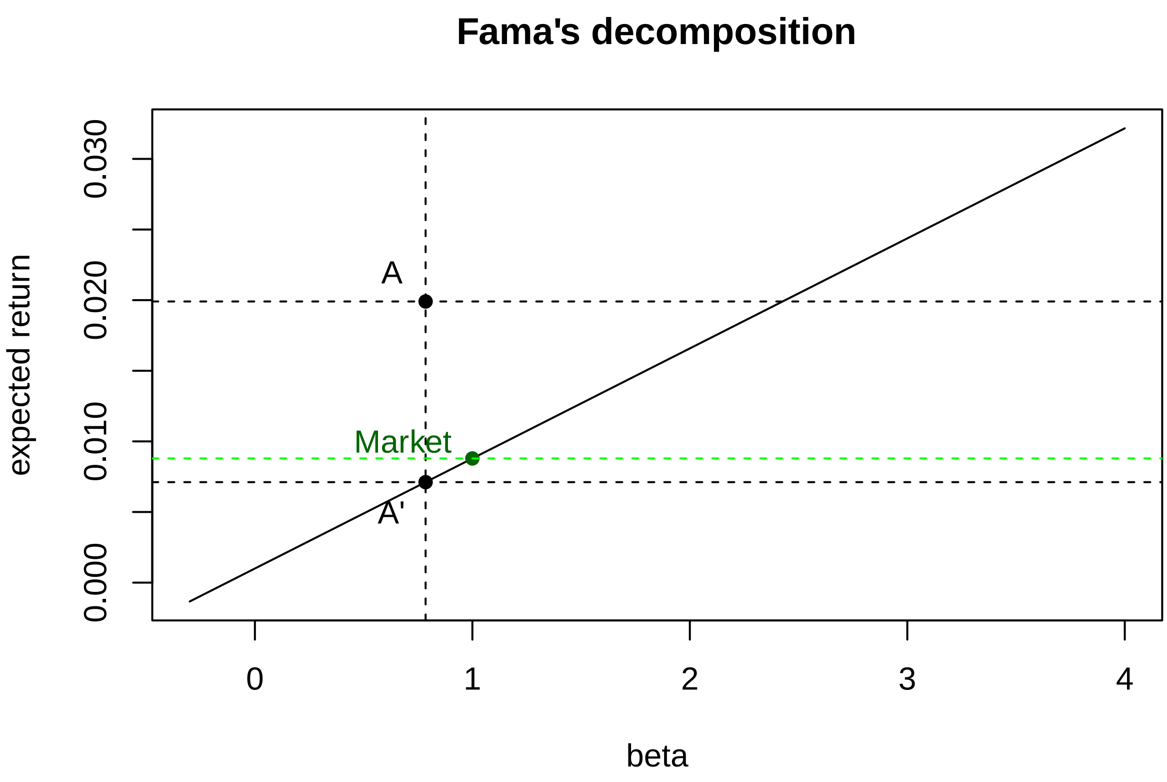
```r
mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - (0.007791199 * beta_treynor_
```

```
## as.matrix(rrr_hw6[, table_ccm_4_hw6[1:13, 1]]) %*% x_no_short_ccm_hw6
##                                                               0.01220529
```

Thus, $J_5 = 0.01220529$.

4. 3. General Model when short sales are NOT allowed.

```r
x <- seq(-0.3, 4, by=0.001)
y <- 0.001 + 0.007791199 * x

plot(x, y, type='l', xlab='beta', ylab='expected return', main='Fama\'s decomposition')
points(1, mean(r_hw7$X.GSPC), pch=16, col='darkgreen')
points(beta_treynor_3, mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6), pch=16)
points(beta_treynor_3, 0.007791199 * beta_treynor_3 + 0.001, pch=16)
abline(v=beta_treynor_3, lty='dashed')
abline(h=0.007791199 * beta_treynor_3 + 0.001, lty='dashed')
abline(h=mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6), lty='dashed')
abline(h=0.001 + 0.007791199 * 1, lty='dashed', col='green')
text(0.63, 0.022, 'A')
text(0.68, 0.01, 'Market', col='darkgreen')
text(0.63, 0.005, 'A\'')
```




```r
selectivity_3 <- mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - (0.007791199 * beta_tre
net_selectivity_3 <- mean(as.matrix(rrr_hw6[,table2_hw6[,1]]) %*% x_no_short_hw6) - (0.001 + 0.00779119
diversification_3 <- (0.001 + 0.007791199 * 1) - (0.007791199 * beta_treynor_3 + 0.001)

selectivity_3 ; net_selectivity_3 ; diversification_3
```

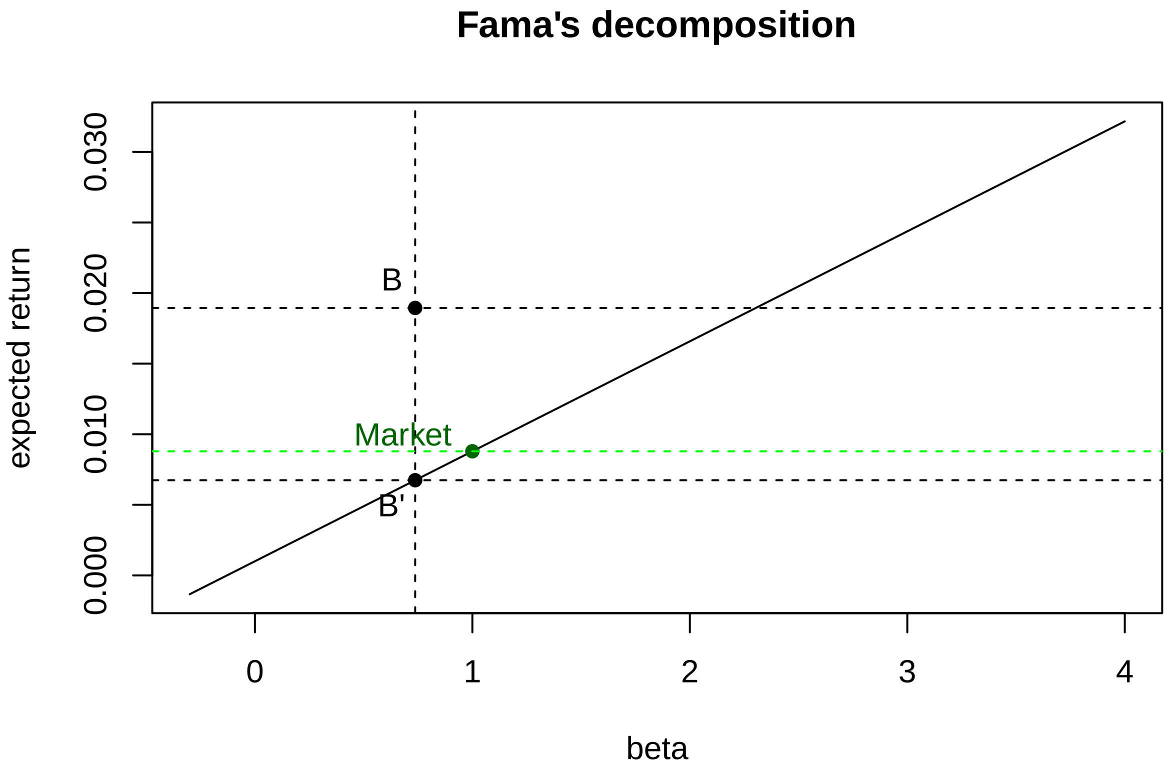
```
## as.vector(as.matrix(rrr_hw6[, table2_hw6[, 1]]) %*% x_no_short_hw6)
##                                                         0.01279055

## [1] 0.01111468
```

```
## as.vector(as.matrix(rrr_hw6[, table2_hw6[, 1]]) %*% x_no_short_hw6)
##                                                             0.001675877
```

Thus, $0.01279055 = 0.01111468 + 0.001675877$.

5. Constant Correlation Model when short sales are NOT allowed.

```
plot(x, y, type='l', xlab='beta', ylab='expected return', main='Fama\'s decomposition')
points(1, mean(r_hw7$X.GSPC), pch=16, col='darkgreen')
points(beta_treynor_5, mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6), pch=16
points(beta_treynor_5, 0.007791199 * beta_treynor_5 + 0.001, pch=16)
abline(v=beta_treynor_5, lty='dashed')
abline(h=0.007791199 * beta_treynor_5 + 0.001, lty='dashed')
abline(h=mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6), lty='dashed')
abline(h=0.001 + 0.007791199 * 1, lty='dashed', col='green')
text(0.63, 0.021, 'B')
text(0.68, 0.01, 'Market', col='darkgreen')
text(0.63, 0.005, 'B\'')
```




```
selectivity_5 <- mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - (0.0077911
net_selectivity_5 <- mean(as.matrix(rrr_hw6[,table_ccm_4_hw6[1:13,1]]) %*% x_no_short_ccm_hw6) - (0.001
diversification_5 <- (0.001 + 0.007791199 * 1) - (0.007791199 * beta_treynor_5 + 0.001)

selectivity_5 ; net_selectivity_5 ; diversification_5
```

```
## as.matrix(rrr_hw6[, table_ccm_4_hw6[1:13, 1]]) %*% x_no_short_ccm_hw6
##                                                                0.01220529

## [1] 0.01015568

## as.matrix(rrr_hw6[, table_ccm_4_hw6[1:13, 1]]) %*% x_no_short_ccm_hw6
##                                                               0.002049611
```

Thus, $0.01220529 = 0.01015568 + 0.002049611$.