Project 6

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tinytex::install_tinytex()

a.

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

r_hw6 <- (hw[-1, 3:ncol(hw)]-hw[-nrow(hw),3:ncol(hw)])/hw[-nrow(hw),3:ncol(hw)]

covmat_hw6 <- cov(r_hw6)
beta_hw6 <- covmat_hw6[1,-1] / covmat_hw6[1,1]

rrr_hw6 <- r_hw6[,-c(1,which(beta_hw6<0)+1)]

beta_new_hw6 <- rep(0,ncol(rrr_hw6))
alpha_hw6 <- rep(0,ncol(rrr_hw6))
mse_hw6 <- rep(0,ncol(rrr_hw6))
Ribar_hw6 <- rep(0,ncol(rrr_hw6))
Ratio_hw6 <- rep(0,ncol(rrr_hw6))
stock_hw6 <- rep(0,ncol(rrr_hw6))

rf_hw6 <- 0.001

for(i in 1:ncol(rrr_hw6)) {
  q_hw6 <- lm(data=rrr_hw6, formula=rrr_hw6[,i]~r_hw6[,1])
  beta_new_hw6[i] <- q_hw6$coefficients[2]
  alpha_hw6[i] <- q_hw6$coefficients[1]
  mse_hw6[i] <- summary(q_hw6)$sigma^2
  Ribar_hw6[i] <- q_hw6$coefficients[1] + q_hw6$coefficients[2] * mean(r_hw6[,1])
  Ratio_hw6[i] <- (Ribar_hw6[i] - rf_hw6) / beta_new_hw6[i]
  stock_hw6[i] <- i
}

xx_hw6 <- (cbind(stock_hw6, alpha_hw6, beta_new_hw6, Ribar_hw6, mse_hw6, Ratio_hw6))

A_hw6 <- xx_hw6[order(-xx_hw6[,6]),]
```

b.

1. If short sales are allowed:

```
col1_hw6 <- rep(0,nrow(A_hw6))
col2_hw6 <- rep(0,nrow(A_hw6))
col3_hw6 <- rep(0,nrow(A_hw6))
```

```r
col4_hw6 <- rep(0,nrow(A_hw6))
col5_hw6 <- rep(0,nrow(A_hw6))

col1_hw6 <- (A_hw6[,4]-rf_hw6)*A_hw6[,3]/A_hw6[,5]
col3_hw6 <- A_hw6[,3]^2 / A_hw6[,5]
for(i in 1:nrow(A_hw6)) {
  col2_hw6[i] <- sum(col1_hw6[1:i])
  col4_hw6[i] <- sum(col3_hw6[1:i])
}

head(cbind(A_hw6, col1_hw6, col2_hw6, col3_hw6, col4_hw6))
```

```
##      stock_hw6   alpha_hw6 beta_new_hw6   Ribar_hw6     mse_hw6 Ratio_hw6
## [1,]        10 0.012302336    0.4415913 0.016184453 0.001534396 0.03438576
## [2,]         7 0.014207885    0.6063894 0.019538775 0.014905473 0.03057239
## [3,]         5 0.021888991    1.4667521 0.034783501 0.012180070 0.02303286
## [4,]        21 0.014978015    1.0119216 0.023874019 0.001159385 0.02260454
## [5,]        11 0.005838142    0.3725544 0.009113341 0.002604566 0.02177760
## [6,]        19 0.011967695    0.9192540 0.020049039 0.000981385 0.02072228
##        col1_hw6  col2_hw6   col3_hw6  col4_hw6
## [1,]  4.3700073  4.370007 127.08771  127.0877
## [2,]  0.7542006  5.124208  24.66934  151.7570
## [3,]  4.0682871  9.192495 176.62967  328.3867
## [4,] 19.9646503 29.157145 883.21434 1211.6011
## [5,]  1.1605237 30.317669  53.28979 1264.8908
## [6,] 17.8430528 48.160722 861.05639 2125.9472
```

```r
for(i in 1:nrow(A_hw6)) {
  col5_hw6[i] <- var(r_hw6[,1])*col2_hw6[i]/(1+var(r_hw6[,1])*col4_hw6[i])
}

z_short_hw6 <- (A_hw6[,3]/A_hw6[,5])*(A_hw6[,6]-col5_hw6[nrow(A_hw6)])
x_short_hw6 <- z_short_hw6/sum(z_short_hw6)

Weights_with_short_hw6 <- cbind(A_hw6, col1_hw6, col2_hw6, col3_hw6, col4_hw6, col5_hw6, z_short_hw6, x_

Weights_with_short_hw6[,13]
```

```
##  [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
```

2. If short sales are NOT allowed:

```r
table1_hw6 <- cbind(A_hw6, col1_hw6, col2_hw6, col3_hw6, col4_hw6, col5_hw6)
table2_hw6 <- table1_hw6[1:which(col5_hw6==max(col5_hw6)),]

z_no_short_hw6 <- (table2_hw6[,3]/table2_hw6[,5]) * (table2_hw6[,6] - max(col5_hw6))

x_no_short_hw6 <- z_no_short_hw6 / sum(z_no_short_hw6)

Weights_no_short_hw6 <- cbind(table2_hw6, z_no_short_hw6, x_no_short_hw6)
```

```r
Weights_no_short_hw6[,13]
```

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

```r
r_2_hw6 <- r_hw6[,A_hw6[,1]]

means_hw6 <- colMeans(r_2_hw6)
covmat_hw6 <- cov(r_2_hw6)
corrmat_hw6 <- cor(r_2_hw6)
variances_hw6 <- diag(covmat_hw6)
stdev_hw6 <- diag(covmat_hw6)^.5

ones_hw6 <- rep(1,30)

A_plot_hw6 <- sum(covmat_hw6^(-1) * means_hw6)
A2_plot_hw6 <- t(ones_hw6) %*% solve(covmat_hw6) %*% means_hw6
B_plot_hw6 <- sum(covmat_hw6^(-1) * means_hw6 * means_hw6)
B2_plot_hw6 <- t(means_hw6) %*% solve(covmat_hw6) %*% means_hw6
C_plot_hw6 <- sum(covmat_hw6^(-1))
C2_plot_hw6 <- t(ones_hw6) %*% solve(covmat_hw6) %*% ones_hw6
D_plot_hw6 <- B_plot_hw6 * C_plot_hw6 - A_plot_hw6 * A_plot_hw6
D2_plot_hw6 <- B2_plot_hw6 * C2_plot_hw6 - A2_plot_hw6 * A2_plot_hw6

x_plot_hw6 <- seq(-0.1,0.1, 0.001)
sigma_squared_hw6 <- (C2_plot_hw6 * x_plot_hw6 * x_plot_hw6 - 2 * A2_plot_hw6 * x_plot_hw6 + B2_plot_hw6
```

```
## 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 o
##   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.
```

```r
#minvar_hw6 <- 1/C2_plot_hw6
#minE_hw6 <- A2_plot_hw6 / C2_plot_hw6
#sdeff_hw6 <- seq((minvar_hw6)^.5,1, by=0.0001)
#plot(sdeff_hw6, x_plot_hw6)

### 1. Short sales are allowed
mean_with_short_hw6 <- t(as.matrix(A_hw6[,4])) %*% as.matrix(Weights_with_short_hw6[,13])
var_with_short_hw6 <- t(as.matrix(Weights_with_short_hw6[,13])) %*% covmat_hw6 %*% as.matrix(Weights_wi

### 2. Short sales are NOT allowed
covmat_no_short_hw6 <- cov(r_2_hw6[,1:11])

mean_no_short_hw6 <- t(as.matrix(A_hw6[1:11,4])) %*% as.matrix(Weights_no_short_hw6[,13])
var_no_short_hw6 <- t(as.matrix(Weights_no_short_hw6[,13])) %*% covmat_no_short_hw6 %*% as.matrix(Weigh

plot(sigma_squared_hw6, x_plot_hw6, type='l')
points(variances_hw6, means_hw6)
```
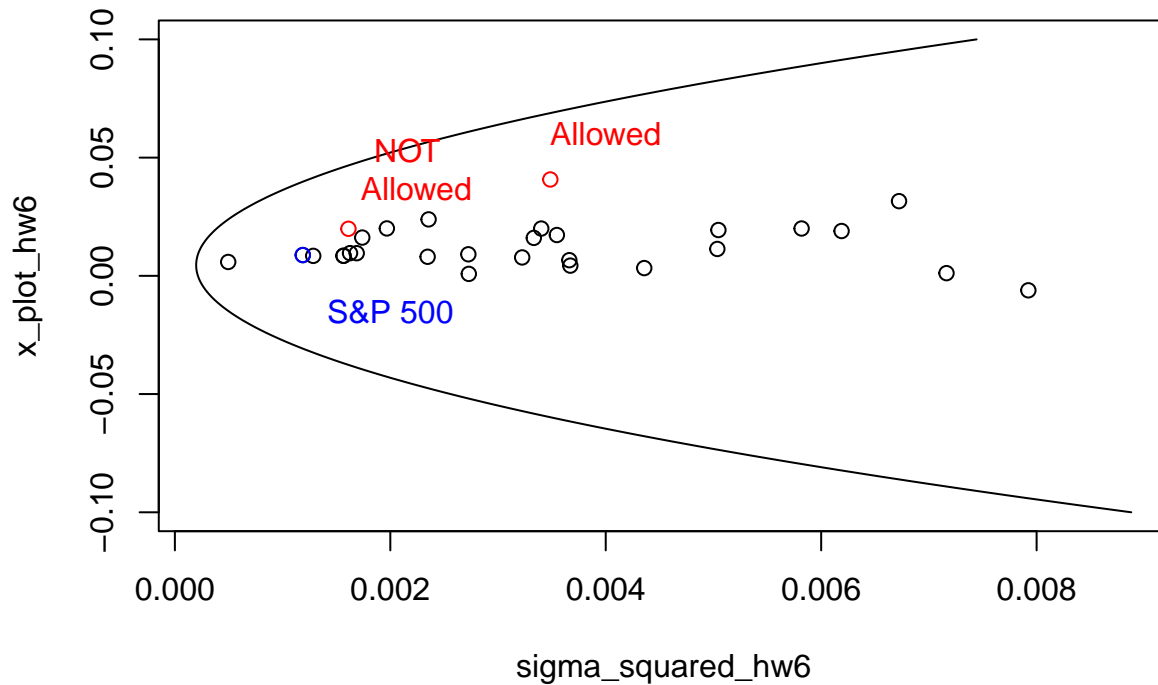
```r
points(var(r_hw6$X.GSPC), mean(r_hw6$X.GSPC), col='blue')
points(var_with_short_hw6, mean_with_short_hw6, col='red')
points(var_no_short_hw6, mean_no_short_hw6, col='red')
text(0.002, -0.015, "S&P 500", col='blue')
text(0.004, 0.06, "Allowed", col='red')
text(0.0022, 0.045, "NOT \n Allowed", col='red')
```


c.

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

r <- (a[-1,3:ncol(a)]-a[-nrow(a),3:ncol(a)])/a[-nrow(a),3:ncol(a)]

covmat <- var(r)
beta <- covmat[1,-1] / covmat[1,1]

rrr <- r[,-c(1,which(beta<0)+1)]

Rfr <- seq(-0.05,.01,0.0005)

rbar_opt <- rep(0,length(Rfr))
risk_opt <- rep(0,length(Rfr))

length(Rfr)
```

```
## [1] 121
```

```r
for(l in 1:length(Rfr)){
rf <- Rfr[l]

beta <- rep(0,ncol(rrr))
alpha <- rep(0,ncol(rrr))
```

```r
mse <- rep(0,ncol(rrr))
Ribar <- rep(0,ncol(rrr))
Ratio <- rep(0,ncol(rrr))
stocknum <- rep(0,ncol(rrr))

for(i in 1:ncol(rrr)){
    q <- lm(data=rrr, formula=rrr[,i] ~ r[,1])
    beta[i] <- q$coefficients[2]
    alpha[i] <- q$coefficients[1]
     mse[i] <- summary(q)$sigma^2
    Ribar[i] <- q$coefficients[1]+q$coefficients[2]*mean(r[,1])
    Ratio[i] <- (Ribar[i]-rf)/beta[i]
    stocknum[i] <- i
}

xx <- (data.frame(stocknum,alpha, beta, Ribar, mse, Ratio))

A <- xx[order(-xx[,6]),]

col1 <- rep(0,nrow(A))
col2 <- rep(0,nrow(A))
col3 <- rep(0,nrow(A))
col4 <- rep(0,nrow(A))
col5 <- rep(0,nrow(A))

col1 <- (A[,4]-rf)*A[,3]/A[,5]
col3 <- A[,3]^2/A[,5]
for(i in(1:nrow(A))) {
col2[i] <- sum(col1[1:i])
col4[i] <- sum(col3[1:i])
}

cbind(A, col1, col2, col3, col4)

for(i in (1:nrow(A))) {
col5[i] <- var(r[,1])*col2[i]/(1+var(r[,1])*col4[i])
}


#The final table when short sales allowed:
B <- cbind(A, col1, col2, col3, col4, col5)
rownames(B) <- NULL

#SHORT SALES NOT ALLOWED:
table2 <- B[1:which(col5==max(col5)), ]

z_no_short <- (table2[,3]/table2[,5])*(table2[,6]-max(col5))
x_no_short <- z_no_short/sum(z_no_short)

r1 <- data.frame(rrr[,table2[,1]])

beta1 <- rep(0,ncol(r1))
sigma_e1 <- rep(0,ncol(r1))
```

```r
alpha1 <- rep(0,ncol(r1))

for(i in 1:ncol(r1)){
    q1<- lm(r1[,i] ~ r[,1])
beta1[i] <- q1$coefficients[2]
sigma_e1[i] <- summary(q1)$sigma^2
alpha1[i] <- q1$coefficients[1]
}

means1 <- colMeans(r1)

xx <- rep(0,ncol(r1)*(ncol(r1)))
varcovar <- matrix(xx,nrow=ncol(r1),ncol=ncol(r1))


for (i in 1:ncol(r1)){
    for (j in 1:ncol(r1)){
        varcovar[i,j]=beta1[i]*beta1[j]*var(r[,1])
        if(i==j){varcovar[i,j]=beta1[i]^2*var(r[,1])+ sigma_e1[i]}
        }
        }


rbar_opt[l] <- t(x_no_short) %*% means1
risk_opt[l] <- ( t(x_no_short) %*% varcovar %*% x_no_short )^.5

}

plot(risk_opt, rbar_opt, type="l", main="Efficient frontier when short sales not allowed", ylab="Portfol
```
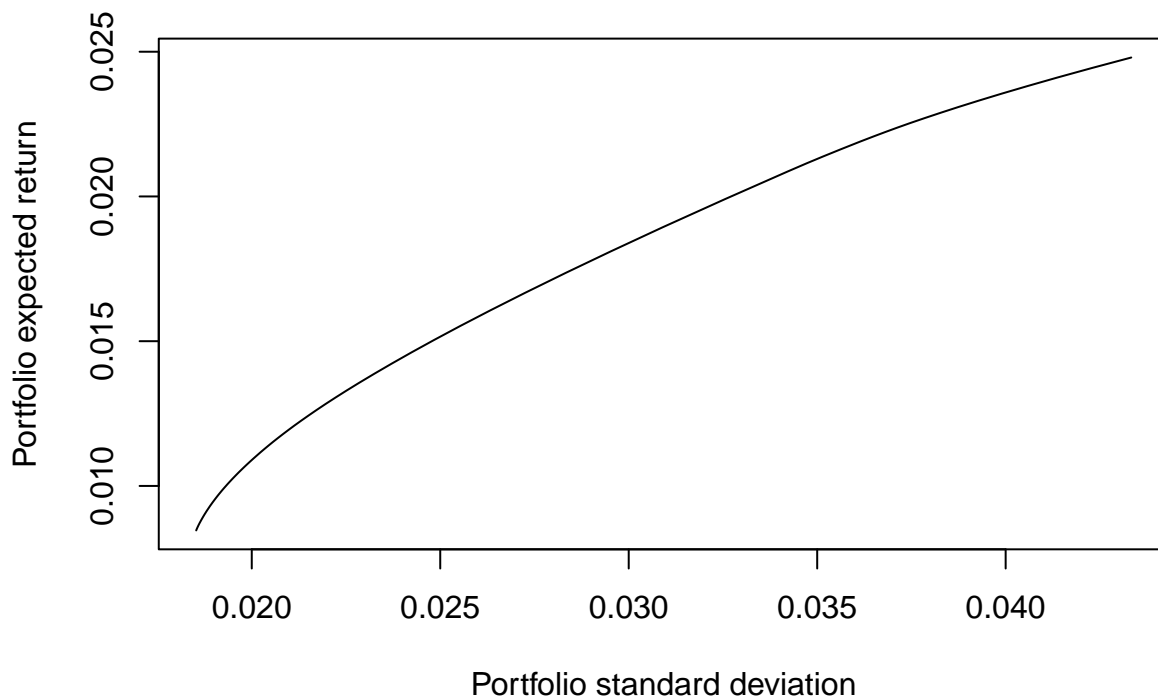
Efficient frontier when short sales not allowed

d.

```r
average_corr_hw6 <- (sum(cor(r_hw6[-1])) - 30) / (length(r_hw6[-1]) * (length(r_hw6[-1]) - 1))

Ribar_Rf <- Ribar_hw6 - rf_hw6

sigma_i_hw6 <- rep(0, ncol(rrr_hw6))
corr_rate_hw6 <- rep(0, ncol(rrr_hw6))
stacked_i_hw6 <- rep(0, ncol(rrr_hw6))
c_i_hw6 <- rep(0, ncol(rrr_hw6))
ratio_sigma <- rep(0, ncol(rrr_hw6))

for(i in 1:ncol(rrr_hw6)) {
  sigma_i_hw6[i] <- sd(rrr_hw6[,i])
  corr_rate_hw6[i] <- average_corr_hw6 / (1 - average_corr_hw6 + i * average_corr_hw6)
  ratio_sigma[i] <- Ribar_Rf[i] / sigma_i_hw6[i]
  stacked_i_hw6[i] <- sum(ratio_sigma[1:i])
  c_i_hw6[i] <- (1 / (1 - average_corr_hw6) * sigma_i_hw6[i]) * stacked_i_hw6[i]
}

table_ccm_hw6 <- cbind(stock_hw6, Ribar_hw6, Ribar_Rf, sigma_i_hw6, ratio_sigma, corr_rate_hw6, stacked
table_ccm_hw6
```

```
##         stock_hw6    Ribar_hw6       Ribar_Rf sigma_i_hw6  ratio_sigma
##  [1,]           1  0.020022021   0.0190220208  0.07627697  0.249380902
##  [2,]           2  0.003281867   0.0022818668  0.06601056  0.034568206
##  [3,]           3  0.017265705   0.0162657046  0.05955063  0.273140759
##  [4,]           4  0.019378066   0.0183780662  0.07103405  0.258721916
##  [5,]           5  0.034783501   0.0337835006  0.12051925  0.280316225
##  [6,]           6  0.031586905   0.0305869055  0.08199295  0.373043100
##  [7,]           7  0.019538775   0.0185387754  0.12282162  0.150940657
##  [8,]           8  0.020261764   0.0192617640  0.10815806  0.178089037
##  [9,]           9  0.016047510   0.0150475097  0.05772541  0.260673937
## [10,]          10  0.016184453   0.0151844527  0.04170748  0.364070220
## [11,]          11  0.009113341   0.0081133412  0.05219661  0.155438087
## [12,]          12  0.008442489   0.0074424894  0.03583657  0.207678646
## [13,]          13  0.009595586   0.0085955863  0.04032283  0.213169198
## [14,]          14  0.000818295  -0.0001817050  0.05223655 -0.003478503
## [15,]          15  0.007782731   0.0067827312  0.05678194  0.119452271
## [16,]          16  0.006620060   0.0056200600  0.06051397  0.092872106
## [17,]          17  0.008472248   0.0074722477  0.03956493  0.188860397
## [18,]          18  0.008482492   0.0074824917  0.03957051  0.189092637
## [19,]          19  0.020049039   0.0190490390  0.04436176  0.429402221
## [20,]          20  0.019996544   0.0189965436  0.05832013  0.325728774
## [21,]          21  0.023874019   0.0228740187  0.04853262  0.471312234
## [22,]          22  0.005869061   0.0048690610  0.02224887  0.218845285
## [23,]          23  0.011371238   0.0103712384  0.07096465  0.146146545
## [24,]          24  0.004324766   0.0033247663  0.06059021  0.054872996
## [25,]          25  0.018953119   0.0179531193  0.07867325  0.228198526
## [26,]          26 -0.006129357  -0.0071293573  0.08901397 -0.080092566
## [27,]          27  0.009573748   0.0085737479  0.04108588  0.208678671
## [28,]          28  0.008060794   0.0070607935  0.04843964  0.145764790
## [29,]          29  0.001136975   0.0001369746  0.08463859  0.001618347
## [30,]          30 -0.003765884  -0.0047658844  0.10476175 -0.045492600
```

```
##         corr_rate_hw6 stacked_i_hw6     c_i_hw6
##  [1,]      0.29606302     0.2493809 0.02702233
##  [2,]      0.22843258     0.2839491 0.02662687
##  [3,]      0.18595451     0.5570899 0.04712787
##  [4,]      0.15679734     0.8158118 0.08232330
##  [5,]      0.13554435     1.0961280 0.18766527
##  [6,]      0.11936508     1.4691711 0.17112566
##  [7,]      0.10663642     1.6201118 0.28267409
##  [8,]      0.09636084     1.7982008 0.27628880
##  [9,]      0.08789154     2.0588747 0.16883527
## [10,]      0.08079072     2.4229450 0.14355680
## [11,]      0.07475149     2.5783830 0.19118594
## [12,]      0.06955235     2.7860617 0.14183497
## [13,]      0.06502940     2.9992309 0.17180159
## [14,]      0.06105879     2.9957524 0.22230368
## [15,]      0.05754515     3.1152047 0.25128294
## [16,]      0.05441389     3.2080768 0.27578246
## [17,]      0.05160582     3.3969372 0.19092557
## [18,]      0.04907335     3.5860298 0.20158199
## [19,]      0.04677781     4.0154320 0.25305055
## [20,]      0.04468743     4.3411608 0.35965869
## [21,]      0.04277588     4.8124730 0.33179382
## [22,]      0.04102117     5.0313183 0.15902157
## [23,]      0.03940474     5.1774649 0.52194584
## [24,]      0.03791087     5.2323379 0.45036480
## [25,]      0.03652613     5.4605364 0.61027925
## [26,]      0.03523899     5.3804438 0.68036583
## [27,]      0.03403947     5.5891225 0.32621392
## [28,]      0.03291893     5.7348873 0.39463172
## [29,]      0.03186981     5.7365056 0.68973465
## [30,]      0.03088549     5.6910130 0.84695150
```

e.

```
### 1. Short sales are allowed

z_with_short_ccm_hw6 <- rep(0, ncol(rrr_hw6))

for (i in 1:ncol(rrr_hw6)) {
  z_with_short_ccm_hw6[i] <- 1 / ((1 - average_corr_hw6) * sigma_i_hw6[i]) * (ratio_sigma[i] - c_i_hw6[i
}

x_with_short_ccm_hw6 <- z_with_short_ccm_hw6 / sum(z_with_short_ccm_hw6)

mean_with_short_ccm_hw6 <- t(as.matrix(Ribar_hw6)) %*% as.matrix(x_with_short_ccm_hw6)
var_with_short_ccm_hw6 <- t(as.matrix(x_with_short_ccm_hw6)) %*% covmat_hw6 %*% as.matrix(x_with_short_

### 2. Short sales are NOT allowed

table_ccm_2_hw6 <- table_ccm_hw6[order(-table_ccm_hw6[,5]),]

table_ccm_3_hw6 <- cbind(table_ccm_2_hw6, table_ccm_2_hw6[,5] - table_ccm_2_hw6[,8])

table_ccm_4_hw6 <- table_ccm_3_hw6[order(-table_ccm_3_hw6[,9]),]
```

`table_ccm_4_hw6`

```
##       stock_hw6      Ribar_hw6       Ribar_Rf sigma_i_hw6 ratio_sigma
##  [1,]         3  0.017265705  0.0162657046  0.05955063  0.273140759
##  [2,]         1  0.020022021  0.0190220208  0.07627697  0.249380902
##  [3,]        10  0.016184453  0.0151844527  0.04170748  0.364070220
##  [4,]         6  0.031586905  0.0305869055  0.08199295  0.373043100
##  [5,]         4  0.019378066  0.0183780662  0.07103405  0.258721916
##  [6,]        19  0.020049039  0.0190490390  0.04436176  0.429402221
##  [7,]        21  0.023874019  0.0228740187  0.04853262  0.471312234
##  [8,]         5  0.034783501  0.0337835006  0.12051925  0.280316225
##  [9,]         9  0.016047510  0.0150475097  0.05772541  0.260673937
## [10,]        12  0.008442489  0.0074424894  0.03583657  0.207678646
## [11,]        22  0.005869061  0.0048690610  0.02224887  0.218845285
## [12,]        13  0.009595586  0.0085955863  0.04032283  0.213169198
## [13,]         2  0.003281867  0.0022818668  0.06601056  0.034568206
## [14,]        17  0.008472248  0.0074722477  0.03956493  0.188860397
## [15,]        18  0.008482492  0.0074824917  0.03957051  0.189092637
## [16,]        20  0.019996544  0.0189965436  0.05832013  0.325728774
## [17,]        11  0.009113341  0.0081133412  0.05219661  0.155438087
## [18,]         8  0.020261764  0.0192617640  0.10815806  0.178089037
## [19,]        27  0.009573748  0.0085737479  0.04108588  0.208678671
## [20,]         7  0.019538775  0.0185387754  0.12282162  0.150940657
## [21,]        15  0.007782731  0.0067827312  0.05678194  0.119452271
## [22,]        16  0.006620060  0.0056200600  0.06051397  0.092872106
## [23,]        14  0.000818295 -0.0001817050  0.05223655 -0.003478503
## [24,]        28  0.008060794  0.0070607935  0.04843964  0.145764790
## [25,]        23  0.011371238  0.0103712384  0.07096465  0.146146545
## [26,]        25  0.018953119  0.0179531193  0.07867325  0.228198526
## [27,]        24  0.004324766  0.0033247663  0.06059021  0.054872996
## [28,]        29  0.001136975  0.0001369746  0.08463859  0.001618347
## [29,]        26 -0.006129357 -0.0071293573  0.08901397 -0.080092566
## [30,]        30 -0.003765884 -0.0047658844  0.10476175 -0.045492600
##       corr_rate_hw6 stacked_i_hw6   c_i_hw6
##  [1,]    0.18595451     0.5570899 0.04712787  0.226012885
##  [2,]    0.29606302     0.2493809 0.02702233  0.222358568
##  [3,]    0.08079072     2.4229450 0.14355680  0.220513425
##  [4,]    0.11936508     1.4691711 0.17112566  0.201917444
##  [5,]    0.15679734     0.8158118 0.08232330  0.176398613
##  [6,]    0.04677781     4.0154320 0.25305055  0.176351673
##  [7,]    0.04277588     4.8124730 0.33179382  0.139518418
##  [8,]    0.13554435     1.0961280 0.18766527  0.092650955
##  [9,]    0.08789154     2.0588747 0.16883527  0.091838671
## [10,]    0.06955235     2.7860617 0.14183497  0.065843673
## [11,]    0.04102117     5.0313183 0.15902157  0.059823717
## [12,]    0.06502940     2.9992309 0.17180159  0.041367611
## [13,]    0.22843258     0.2839491 0.02662687  0.007941333
## [14,]    0.05160582     3.3969372 0.19092557 -0.002065174
## [15,]    0.04907335     3.5860298 0.20158199 -0.012489356
## [16,]    0.04468743     4.3411608 0.35965869 -0.033929913
## [17,]    0.07475149     2.5783830 0.19118594 -0.035747855
## [18,]    0.09636084     1.7982008 0.27628880 -0.098199763
## [19,]    0.03403947     5.5891225 0.32621392 -0.117535251
## [20,]    0.10663642     1.6201118 0.28267409 -0.131733433
```

```
## [21,]    0.05754515    3.1152047 0.25128294 -0.131830667
## [22,]    0.05441389    3.2080768 0.27578246 -0.182910350
## [23,]    0.06105879    2.9957524 0.22230368 -0.225782186
## [24,]    0.03291893    5.7348873 0.39463172 -0.248866925
## [25,]    0.03940474    5.1774649 0.52194584 -0.375799298
## [26,]    0.03652613    5.4605364 0.61027925 -0.382080728
## [27,]    0.03791087    5.2323379 0.45036480 -0.395491809
## [28,]    0.03186981    5.7365056 0.68973465 -0.688116307
## [29,]    0.03523899    5.3804438 0.68036583 -0.760458392
## [30,]    0.03088549    5.6910130 0.84695150 -0.892444098
```

```r
table_ccm_4_hw6[,1][14:30]
```

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

```r
z_no_short_ccm_hw6 <- rep(0, 13)

for (i in 1:13) {
  z_no_short_ccm_hw6[i] <- (1 / (1-average_corr_hw6) * table_ccm_4_hw6[,4][i]) * (table_ccm_4_hw6[,7][i]
}

z_no_short_ccm_hw6
```

```
##  [1] 0.04314102 0.02409426 0.13505121 0.15119334 0.07401609 0.23710343
##  [7] 0.30891844 0.15553558 0.15499016 0.13461433 0.15399548 0.16196047
## [13] 0.02412998
```

```r
x_no_short_ccm_hw6 <- z_no_short_ccm_hw6 / sum(z_no_short_ccm_hw6)

covmat_no_short_hw6 <- cov(r_2_hw6[,-table_ccm_4_hw6[,1][14:30]])

mean_no_short_ccm_hw6 <- t(as.matrix(table_ccm_2_hw6[1:13,2])) %*% as.matrix(x_no_short_ccm_hw6)
var_no_short_ccm_hw6 <- t(as.matrix(x_no_short_ccm_hw6)) %*% covmat_no_short_hw6 %*% as.matrix(x_no_sho

plot(sigma_squared_hw6, x_plot_hw6, type='l',  ylab="Portfolio expected return", xlab="Portfolio standa
points(variances_hw6, means_hw6)
points(var(r_hw6$X.GSPC), mean(r_hw6$X.GSPC), col='blue')
points(var_with_short_hw6, mean_with_short_hw6, col='red')
points(var_no_short_hw6, mean_no_short_hw6, col='red')
points(var_no_short_ccm_hw6, mean_no_short_ccm_hw6, col='orange')
points(var_with_short_ccm_hw6, mean_with_short_ccm_hw6, col='orange')
text(0.001, 0.045, "(CCM) NOT \n Allowed", col='orange')
text(0.004, -0.03, "(CCM) Allowed", col='orange')
text(0.0014, -0.012, "S&P 500", col='blue')
text(0.004, 0.06, "Allowed", col='red')
text(0.0022, 0.045, "NOT \n Allowed", col='red')
```