Project 7

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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_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_hw
           + rrr_hw7[,15] + rrr_hw7[,16] + rrr_hw7[,17] + rrr_hw7[,18] + rrr_hw7[,19] + rrr_hw7[,20] + r

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.

```
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 d
##   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
```

```
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')
points(var_with_short_hw6^0.5, mean_with_short_hw6, col='red')
points(var_no_short_hw6^0.5, mean_no_short_hw6, col='red')
points(var_no_short_ccm_hw6^0.5, mean_no_short_ccm_hw6, col='orange')
points(var_with_short_ccm_hw6^0.5, mean_with_short_ccm_hw6, col='orange')
text(0.03, 0.045, "(CCM) NOT \n Allowed", col='orange')
text(0.065, -0.03, "(CCM) Allowed", col='orange')
text(0.04, -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')
text(0.028, -0.01, "Multi- \n group", col='purple')
```