Project 4

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tinytex::install_tinytex()

Project 4.

```
hw4 <- read.csv("/Users/user/Desktop/Yonsei/Junior/3-2/Statistical Models in Finance/stockData2.csv",sep

r_hw4 <- (hw4[-1, 3:ncol(hw4)]-hw4[-nrow(hw4),3:ncol(hw4)])/hw4[-nrow(hw4),3:ncol(hw4)]

lm1_hw4 <- lm(r_hw4$X.GSPC~r_hw4$AAPL, data=r_hw4)

summary(lm1_hw4)
```

1.

```
##
## Call:
## lm(formula = r_hw4$X.GSPC ~ r_hw4$AAPL, data = r_hw4)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.069380 -0.015170  0.002915  0.011725  0.062321
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.002434   0.003656   0.666    0.508
## r_hw4$AAPL  0.218545   0.049826   4.386 5.03e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02726 on 57 degrees of freedom
## Multiple R-squared:  0.2523, Adjusted R-squared:  0.2392
## F-statistic: 19.24 on 1 and 57 DF,  p-value: 5.033e-05
```

```
var(lm1_hw4$residuals)
```

```
## [1] 0.0007303755
```

```
lm1_hw4$coefficients[1]
```

```
## (Intercept)
## 0.002433742
```

length(colnames(r_hw4))

```r
alpha_hw4 <- vector()
beta_hw4 <- vector()
varepsilon_hw4 <- vector()

i <- 1

GSPC <- as.vector(r_hw4$X.GSPC)

for (i in 2:30) {

    stock_hw4 <- as.vector(as.matrix(r_hw4)[,i])
    lm1_hw4 <- lm(GSPC~stock_hw4)
    alpha_hw4[i-1] <- lm1_hw4$coefficients[1]
    beta_hw4[i-1] <- lm1_hw4$coefficients[2]
    varepsilon_hw4[i-1] <- var(lm1_hw4$residuals)

}

alpha_hw4
```

```
##  [1]  2.433742e-03  7.079970e-03  2.844231e-03  3.671962e-03  3.928477e-03
##  [6]  1.105572e-04  5.412324e-03  3.231804e-03  1.803766e-03  5.489478e-03
## [11]  3.445247e-03  2.784945e-03  6.678528e-03  4.956295e-03  5.347862e-03
## [16]  2.066278e-04  1.632925e-05 -1.624243e-03  1.584299e-03 -1.181404e-03
## [21]  2.931258e-03  3.891358e-03  5.750581e-03  9.945962e-04  8.680688e-03
## [26]  2.230642e-03  1.989167e-03  6.322300e-03  5.525904e-03
```

```r
beta_hw4
```

```
##  [1] 0.21854529 0.29948070 0.30328487 0.18016853 0.06894533 0.22010914
##  [7] 0.05138147 0.20912890 0.31592612 0.10811806 0.39011250 0.40793233
## [13] 0.37699174 0.28654722 0.22129542 0.56312853 0.56882943 0.46545424
## [19] 0.34953739 0.42893197 0.63930050 0.27252922 0.19664300 0.25753760
## [25] 0.15613888 0.42504797 0.42272293 0.15484676 0.16124345
```

```r
varepsilon_hw4
```

```
##  [1] 0.0007303755 0.0006609972 0.0006602044 0.0008538119 0.0008948190
##  [6] 0.0006265819 0.0009404646 0.0008472449 0.0008092451 0.0009427909
## [11] 0.0007602445 0.0007064361 0.0006672216 0.0006957511 0.0007967724
## [16] 0.0005030611 0.0004968727 0.0005001168 0.0005799465 0.0005197844
## [21] 0.0007668186 0.0006461242 0.0008486267 0.0006788692 0.0008784223
## [26] 0.0006944820 0.0006261293 0.0008134866 0.0007296983
```

Note that Alibaba didn't have sufficient data, so that I collected only 29 stocks.

2.

```
covmat_hw4 <- cov(r_hw4[-1])

covmat_hw4
```

```
##                AAPL          IBM         GOOGL          META          NFLX
## AAPL   5.161402e-03 8.154776e-04 0.0012866042  1.424916e-03  2.563224e-03
## IBM    8.154776e-04 3.522155e-03 0.0009113984  2.085421e-04  1.636867e-03
## GOOGL  1.286604e-03 9.113984e-04 0.0034429695  2.024376e-03  3.900137e-03
## META   1.424916e-03 2.085421e-04 0.0020243764  3.791748e-03  2.978820e-03
## NFLX   2.563224e-03 1.636867e-03 0.0039001369  2.978820e-03  1.726651e-02
## AMZN   1.902617e-03 1.828950e-03 0.0033756943  2.249842e-03  6.554263e-03
## TSLA   1.122050e-03 4.157924e-04 0.0007026942  1.659269e-03  4.010647e-03
## NKE    5.166174e-04 6.599151e-04 0.0008425891  1.291272e-03  1.195775e-03
## MCD    3.055658e-04 9.711158e-05 0.0007271631  4.180872e-04 -9.065485e-04
## WMT    5.568008e-04 2.525074e-04 0.0001979783  1.042180e-04 -1.050295e-03
## KO     4.636274e-04 3.429239e-04 0.0008405450  2.109764e-04  4.052922e-04
## PEP    6.388790e-04 4.034710e-04 0.0008670723  1.926557e-04 -3.014354e-04
## XOM    1.061794e-04 9.096249e-04 0.0002842845  2.058189e-04  8.020140e-05
## CVX   -1.836160e-04 1.432372e-03 0.0002884520  1.522793e-04 -8.766992e-05
## SHEL  -1.773665e-05 1.102970e-03 0.0003274993  4.537269e-04  1.057686e-03
## BRK.A  5.411592e-04 1.058980e-03 0.0004096452 -9.917718e-05 -1.769499e-04
## BRK.B  5.955250e-04 1.087811e-03 0.0004090822 -6.462784e-05 -1.161862e-04
## V      1.494399e-03 5.255194e-04 0.0018280038  1.475847e-03  2.506864e-03
## JPM    4.542262e-04 1.550686e-03 0.0006922671  6.807921e-05  6.214435e-04
## MA     1.816320e-03 8.865423e-04 0.0015778624  1.218052e-03  2.980241e-03
## C.PJ   7.236398e-04 1.363505e-04 0.0005669395  3.964828e-04  5.079095e-04
## MS     7.004060e-04 1.407620e-03 0.0006506278  2.782306e-04  1.181140e-03
## HSBC  -3.867845e-04 8.620732e-04 0.0005775490  4.156278e-04  2.041948e-03
## BA     1.219026e-03 8.380009e-04 0.0014216121  1.165737e-03  3.327334e-03
## GE     1.266879e-03 4.458322e-04 0.0004676958  6.789714e-04  4.377790e-04
## JNJ    5.154461e-04 6.351447e-04 0.0005315028  7.262320e-05 -1.141233e-03
## PFE    2.332502e-04 9.282776e-04 0.0006974582  6.997456e-05 -6.764219e-04
## PKX    1.229960e-03 1.601849e-03 0.0004760450  1.440172e-03  1.299825e-03
## BIDU   1.970496e-03 7.169175e-04 0.0016521173  2.946421e-03  3.229958e-03
##                AMZN          TSLA           NKE           MCD           WMT
## AAPL   0.0019026173 1.122050e-03  5.166174e-04  3.055658e-04  5.568008e-04
## IBM    0.0018289502 4.157924e-04  6.599151e-04  9.711158e-05  2.525074e-04
## GOOGL  0.0033756943 7.026942e-04  8.425891e-04  7.271631e-04  1.979783e-04
## META   0.0022498417 1.659269e-03  1.291272e-03  4.180872e-04  1.042180e-04
## NFLX   0.0065542633 4.010647e-03  1.195775e-03 -9.065485e-04 -1.050295e-03
## AMZN   0.0072306900 1.557785e-03  1.382206e-03  8.401319e-04  3.276239e-04
## TSLA   0.0015577852 1.379896e-02  2.569594e-04  3.655092e-04  4.146595e-04
## NKE    0.0013822056 2.569594e-04  2.964446e-03  2.633847e-04  2.890924e-04
## MCD    0.0008401319 3.655092e-04  2.633847e-04  1.679698e-03  7.307442e-04
## WMT    0.0003276239 4.146595e-04  2.890924e-04  7.307442e-04  2.917464e-03
## KO     0.0008277755 9.833069e-04  2.500265e-04  9.297492e-04  8.259870e-04
## PEP    0.0009116359 5.669634e-04  4.484398e-04  7.122870e-04  6.440811e-04
## XOM    0.0005998186 5.546061e-05  3.469047e-04  6.200364e-04  2.226793e-04
## CVX    0.0004753342 1.703241e-04 -2.245262e-06  9.045952e-04 -1.107870e-04
## SHEL   0.0008604151 5.767812e-04  3.589788e-05  6.554628e-04  1.094697e-04
## BRK.A  0.0007943267 5.205452e-05  4.805429e-04  5.338279e-04  6.546147e-04
## BRK.B  0.0008115421 1.243223e-04  4.975719e-04  5.470123e-04  6.293613e-04
## V      0.0026514995 6.745652e-04  1.000524e-03  5.577183e-04  2.315395e-04
```

```
## JPM   0.0011990638 7.633182e-04  6.925872e-04  4.975185e-04 -4.101389e-06
## MA    0.0025345065 9.154285e-04  7.795380e-04  3.145465e-04 -1.059468e-04
## C.PJ  0.0007828357 4.861594e-04  9.052776e-05  1.640488e-04  8.709971e-05
## MS    0.0010076453 1.031604e-03  5.275087e-04  1.992203e-04 -1.915928e-06
## HSBC  0.0016235425 1.384753e-03  1.541834e-04  3.331698e-04 -5.400316e-05
## BA    0.0025565115 3.122172e-04  9.459638e-04  6.299939e-04  3.978525e-04
## GE    0.0004048987 6.462503e-04  2.669322e-04  4.074932e-04 -3.853461e-04
## JNJ   0.0006767991 3.924255e-04  3.050479e-04  8.862411e-04  7.709756e-04
## PFE   0.0015203212 2.729686e-04  5.098308e-04  5.996435e-04  3.522962e-04
## PKX   0.0013885741 7.089264e-04 -3.053373e-05  6.380441e-04  4.073173e-04
## BIDU  0.0027070303 8.594939e-04  1.103980e-03  6.597535e-04 -7.497932e-04
##                KO           PEP           XOM           CVX          SHEL
## AAPL  4.636274e-04  6.388790e-04 1.061794e-04 -1.836160e-04 -1.773665e-05
## IBM   3.429239e-04  4.034710e-04 9.096249e-04  1.432372e-03  1.102970e-03
## GOOGL 8.405450e-04  8.670723e-04 2.842845e-04  2.884520e-04  3.274993e-04
## META  2.109764e-04  1.926557e-04 2.058189e-04  1.522793e-04  4.537269e-04
## NFLX  4.052922e-04 -3.014354e-04 8.020140e-05 -8.766992e-05  1.057686e-03
## AMZN  8.277755e-04  9.116359e-04 5.998186e-04  4.753342e-04  8.604151e-04
## TSLA  9.833069e-04  5.669634e-04 5.546061e-05  1.703241e-04  5.767812e-04
## NKE   2.500265e-04  4.484398e-04 3.469047e-04 -2.245262e-06  3.589788e-05
## MCD   9.297492e-04  7.122870e-04 6.200364e-04  9.045952e-04  6.554628e-04
## WMT   8.259870e-04  6.440811e-04 2.226793e-04 -1.107870e-04  1.094697e-04
## KO    1.423571e-03  1.050509e-03 5.534537e-04  6.427843e-04  7.412262e-04
## PEP   1.050509e-03  1.625266e-03 6.041965e-04  7.230605e-04  5.075905e-04
## XOM   5.534537e-04  6.041965e-04 2.178912e-03  2.150856e-03  2.052789e-03
## CVX   6.427843e-04  7.230605e-04 2.150856e-03  3.424015e-03  2.611105e-03
## SHEL  7.412262e-04  5.075905e-04 2.052789e-03  2.611105e-03  3.678092e-03
## BRK.A 6.417387e-04  6.243327e-04 6.701885e-04  7.635481e-04  6.919924e-04
## BRK.B 6.455710e-04  6.248171e-04 6.675790e-04  7.580065e-04  6.905998e-04
## V     5.440545e-04  6.595379e-04 3.713907e-04  3.830234e-04  3.244132e-04
## JPM   2.775633e-04  3.678218e-04 8.777800e-04  1.383463e-03  6.996301e-04
## MA    3.545187e-04  5.455099e-04 5.387545e-04  6.859243e-04  5.850646e-04
## C.PJ  2.342371e-04  3.492504e-04 4.494090e-05  1.309495e-04  5.142941e-05
## MS    5.010228e-05  9.336812e-05 7.874916e-04  1.399439e-03  8.427665e-04
## HSBC  3.579933e-04  3.398898e-04 8.003459e-04  1.441499e-03  1.369684e-03
## BA    7.786148e-04  6.730496e-04 7.377771e-04  1.134168e-03  1.393781e-03
## GE    4.790724e-04  3.087148e-04 8.837439e-04  1.211094e-03  1.092346e-03
## JNJ   9.419922e-04  1.131900e-03 8.046473e-04  8.559758e-04  8.056109e-04
## PFE   4.969867e-04  7.325690e-04 7.386476e-04  9.088495e-04  6.677733e-04
## PKX   5.396295e-04  6.388812e-04 1.024243e-03  2.142115e-03  2.590820e-03
## BIDU  6.171448e-04  6.553895e-04 1.605039e-03  2.499057e-03  2.037649e-03
##               BRK.A         BRK.B            V           JPM            MA
## AAPL   5.411592e-04  5.955250e-04 0.0014943987  4.542262e-04  0.0018163197
## IBM    1.058980e-03  1.087811e-03 0.0005255194  1.550686e-03  0.0008865423
## GOOGL  4.096452e-04  4.090822e-04 0.0018280038  6.922671e-04  0.0015778624
## META  -9.917718e-05 -6.462784e-05 0.0014758471  6.807921e-05  0.0012180523
## NFLX  -1.769499e-04 -1.161862e-04 0.0025068639  6.214435e-04  0.0029802406
## AMZN   7.943267e-04  8.115421e-04 0.0026514995  1.199064e-03  0.0025345065
## TSLA   5.205452e-05  1.243223e-04 0.0006745652  7.633182e-04  0.0009154285
## NKE    4.805429e-04  4.975719e-04 0.0010005244  6.925872e-04  0.0007795380
## MCD    5.338279e-04  5.470123e-04 0.0005577183  4.975185e-04  0.0003145465
## WMT    6.546147e-04  6.293613e-04 0.0002315395 -4.101389e-06 -0.0001059468
## KO     6.417387e-04  6.455710e-04 0.0005440545  2.775633e-04  0.0003545187
## PEP    6.243327e-04  6.248171e-04 0.0006595379  3.678218e-04  0.0005455099
```

```
## XOM    6.701885e-04  6.675790e-04 0.0003713907  8.777800e-04  0.0005387545
## CVX    7.635481e-04  7.580065e-04 0.0003830234  1.383463e-03  0.0006859243
## SHEL   6.919924e-04  6.905998e-04 0.0003244132  6.996301e-04  0.0005850646
## BRK.A  1.494207e-03  1.478370e-03 0.0006244556  1.302157e-03  0.0005744461
## BRK.B  1.478370e-03  1.483532e-03 0.0006564324  1.267561e-03  0.0006025958
## V      6.244556e-04  6.564324e-04 0.0022007061  8.729463e-04  0.0019838292
## JPM    1.302157e-03  1.267561e-03 0.0008729463  3.248976e-03  0.0010395920
## MA     5.744461e-04  6.025958e-04 0.0019838292  1.039592e-03  0.0024845295
## C.PJ   1.765480e-04  1.845724e-04 0.0004715384  1.886344e-04  0.0004423973
## MS     1.448726e-03  1.382435e-03 0.0008500588  3.249996e-03  0.0011034799
## HSBC   5.277662e-04  5.162097e-04 0.0007268910  1.198023e-03  0.0008571328
## BA     1.176696e-03  1.206026e-03 0.0012919606  1.250543e-03  0.0015172625
## GE     3.345867e-04  2.970479e-04 0.0002909159  7.560151e-04  0.0003469740
## JNJ    7.291119e-04  7.519546e-04 0.0004663965  7.275413e-04  0.0002432757
## PFE    8.113435e-04  8.375196e-04 0.0008852594  1.237453e-03  0.0006969986
## PKX    1.221256e-03  1.132196e-03 0.0007612663  8.685071e-04  0.0012328237
## BIDU   7.371205e-04  7.243659e-04 0.0022213311  1.131771e-03  0.0022152715
##                C.PJ            MS          HSBC            BA            GE
## AAPL   7.236398e-04  7.004060e-04 -3.867845e-04 0.0012190263  0.0012668788
## IBM    1.363505e-04  1.407620e-03  8.620732e-04 0.0008380009  0.0004458322
## GOOGL  5.669395e-04  6.506278e-04  5.775490e-04 0.0014216121  0.0004676958
## META   3.964828e-04  2.782306e-04  4.156278e-04 0.0011657374  0.0006789714
## NFLX   5.079095e-04  1.181140e-03  2.041948e-03 0.0033273344  0.0004377790
## AMZN   7.828357e-04  1.007645e-03  1.623542e-03 0.0025565115  0.0004048987
## TSLA   4.861594e-04  1.031604e-03  1.384753e-03 0.0003122172  0.0006462503
## NKE    9.052776e-05  5.275087e-04  1.541834e-04 0.0009459638  0.0002669322
## MCD    1.640488e-04  1.992203e-04  3.331698e-04 0.0006299939  0.0004074932
## WMT    8.709971e-05 -1.915928e-06 -5.400316e-05 0.0003978525 -0.0003853461
## KO     2.342371e-04  5.010228e-05  3.579933e-04 0.0007786148  0.0004790724
## PEP    3.492504e-04  9.336812e-05  3.398898e-04 0.0006730496  0.0003087148
## XOM    4.494090e-05  7.874916e-04  8.003459e-04 0.0007377771  0.0008837439
## CVX    1.309495e-04  1.399439e-03  1.441499e-03 0.0011341677  0.0012110945
## SHEL   5.142941e-05  8.427665e-04  1.369684e-03 0.0013937813  0.0010923460
## BRK.A  1.765480e-04  1.448726e-03  5.277662e-04 0.0011766960  0.0003345867
## BRK.B  1.845724e-04  1.382435e-03  5.162097e-04 0.0012060259  0.0002970479
## V      4.715384e-04  8.500588e-04  7.268910e-04 0.0012919606  0.0002909159
## JPM    1.886344e-04  3.249996e-03  1.198023e-03 0.0012505432  0.0007560151
## MA     4.423973e-04  1.103480e-03  8.571328e-04 0.0015172625  0.0003469740
## C.PJ   5.140040e-04  3.256405e-04  2.979412e-04 0.0003567673  0.0004188118
## MS     3.256405e-04  4.453491e-03  1.880611e-03 0.0017847081  0.0008687923
## HSBC   2.979412e-04  1.880611e-03  3.317119e-03 0.0013099674  0.0005850154
## BA     3.567673e-04  1.784708e-03  1.309967e-03 0.0044933693  0.0004780132
## GE     4.188118e-04  8.687923e-04  5.850154e-04 0.0004780132  0.0040391680
## JNJ    2.974854e-04  3.850925e-04  1.375320e-04 0.0005181394  0.0002600534
## PFE    3.258579e-04  1.028323e-03  3.958526e-04 0.0010737447  0.0002251642
## PKX    3.808461e-04  1.330097e-03  1.768446e-03 0.0018717670  0.0012291192
## BIDU   4.081753e-04  1.990092e-03  2.153650e-03 0.0030065042  0.0013022453
##                 JNJ           PFE           PKX          BIDU
## AAPL   0.0005154461  2.332502e-04  1.229960e-03  0.0019704964
## IBM    0.0006351447  9.282776e-04  1.601849e-03  0.0007169175
## GOOGL  0.0005315028  6.974582e-04  4.760450e-04  0.0016521173
## META   0.0000726232  6.997456e-05  1.440172e-03  0.0029464214
## NFLX  -0.0011412327 -6.764219e-04  1.299825e-03  0.0032299583
## AMZN   0.0006767991  1.520321e-03  1.388574e-03  0.0027070303
```

```
## TSLA   0.0003924255  2.729686e-04  7.089264e-04  0.0008594939
## NKE    0.0003050479  5.098308e-04 -3.053373e-05  0.0011039798
## MCD    0.0008862411  5.996435e-04  6.380441e-04  0.0006597535
## WMT    0.0007709756  3.522962e-04  4.073173e-04 -0.0007497932
## KO     0.0009419922  4.969867e-04  5.396295e-04  0.0006171448
## PEP    0.0011318998  7.325690e-04  6.388812e-04  0.0006553895
## XOM    0.0008046473  7.386476e-04  1.024243e-03  0.0016050390
## CVX    0.0008559758  9.088495e-04  2.142115e-03  0.0024990572
## SHEL   0.0008056109  6.677733e-04  2.590820e-03  0.0020376493
## BRK.A  0.0007291119  8.113435e-04  1.221256e-03  0.0007371205
## BRK.B  0.0007519546  8.375196e-04  1.132196e-03  0.0007243659
## V      0.0004663965  8.852594e-04  7.612663e-04  0.0022213311
## JPM    0.0007275413  1.237453e-03  8.685071e-04  0.0011317707
## MA     0.0002432757  6.969986e-04  1.232824e-03  0.0022152715
## C.PJ   0.0002974854  3.258579e-04  3.808461e-04  0.0004081753
## MS     0.0003850925  1.028323e-03  1.330097e-03  0.0019900916
## HSBC   0.0001375320  3.958526e-04  1.768446e-03  0.0021536500
## BA     0.0005181394  1.073745e-03  1.871767e-03  0.0030065042
## GE     0.0002600534  2.251642e-04  1.229119e-03  0.0013022453
## JNJ    0.0015631773  9.741587e-04  7.078725e-04  0.0005635115
## PFE    0.0009741587  1.962931e-03  7.021218e-06  0.0004981744
## PKX    0.0007078725  7.021218e-06  6.815053e-03  0.0033531749
## BIDU   0.0005635115  4.981744e-04  3.353175e-03  0.0095077521
```

3.

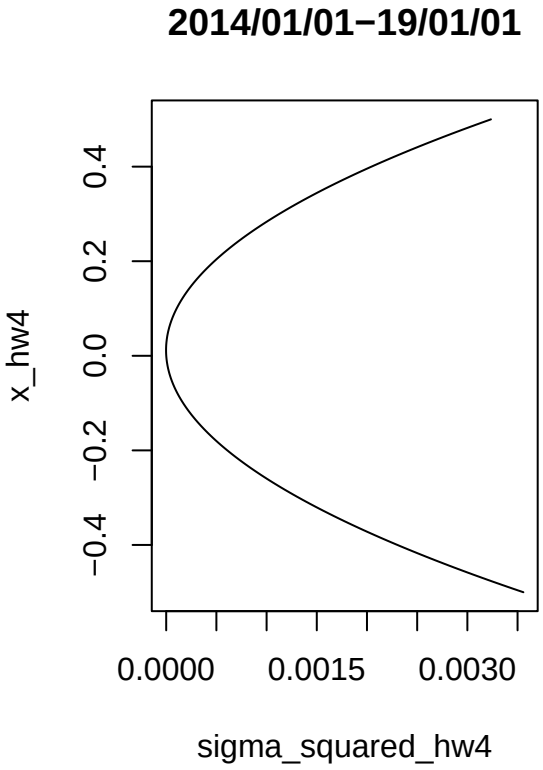
```
means_hw4 <- colMeans(r_hw4[-1])
corrmat_hw4 <- cor(r_hw4[-1])
variances_hw4 <- diag(covmat_hw4)
stdev_hw4 <- diag(covmat_hw4)^(0.5)

B2_hw4 <- t(means_hw4) %*% covmat_hw4^(-1) %*% means_hw4

A_hw4 <- sum(covmat_hw4^(-1) * means_hw4)
B_hw4 <- sum(covmat_hw4^(-1) * means_hw4 * means_hw4)
C_hw4 <- sum(covmat_hw4^(-1))
D_hw4 <- B_hw4 * C_hw4 - A_hw4 * A_hw4

x_hw4 <- seq(-0.5, 0.5, 0.001)
sigma_squared_hw4 <- (C_hw4 * x_hw4 * x_hw4 - 2 * A_hw4 * x_hw4 + B_hw4) / D_hw4

hw2 <- read.csv("/Users/user/Desktop/Yonsei/Junior/3-2/Statistical Models in Finance/stockData.csv",sep=

r_hw2 <- (hw2[-1, 3:ncol(hw2)]-hw2[-nrow(hw2),3:ncol(hw2)])/hw2[-nrow(hw2),3:ncol(hw2)]
means_hw2 <- colMeans(r_hw2[-1])
covmat_hw2 <- cov(r_hw2[-1])
corrmat_hw2 <- cor(r_hw2[-1])
variances_hw2 <- diag(covmat_hw2)
stdev_hw2 <- diag(covmat_hw2)^(0.5)

A_hw2 <- sum(covmat_hw2^(-1) * means_hw2)
B_hw2 <- sum(covmat_hw2^(-1) * means_hw2 * means_hw2)
C_hw2 <- sum(covmat_hw2^(-1))
D_hw2 <- B_hw2 * C_hw2 - A_hw2 * A_hw2

B2_hw2 <- t(means_hw2) %*% covmat_hw2^(-1) %*% means_hw2

sigma_squared_hw2 <- (C_hw2 * x_hw4 * x_hw4 - 2 * A_hw2 * x_hw4 + B_hw2) / D_hw2



sigma_squared_hw4_2 <- (C_hw4 * x_hw4 * x_hw4 - 2 * A_hw4 * x_hw4 + B2_hw4) / D_hw4
```

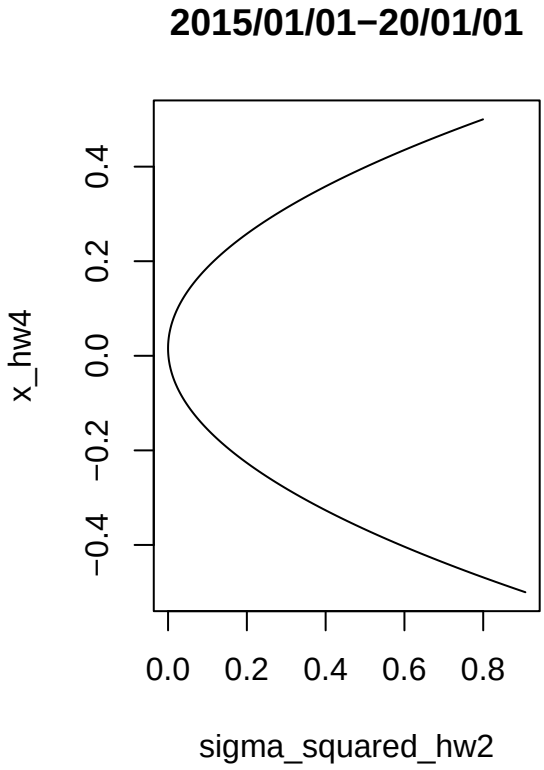
```
## Warning in C_hw4 * x_hw4 * x_hw4 - 2 * A_hw4 * x_hw4 + B2_hw4: Recycling array of length 1 in vector
##   Use c() or as.vector() instead.
```

```
sigma_squared_hw2_2 <-  (C_hw2 * x_hw4 * x_hw4 - 2 * A_hw2 * x_hw4 + B2_hw2) / D_hw2
```

```
## Warning in C_hw2 * x_hw4 * x_hw4 - 2 * A_hw2 * x_hw4 + B2_hw2: Recycling array of length 1 in vector
##   Use c() or as.vector() instead.
```

```
par(mfrow=c(1,2))
plot(sigma_squared_hw4, x_hw4, type='l', main='2014/01/01-19/01/01')
plot(sigma_squared_hw2, x_hw4, type='l', main='2015/01/01-20/01/01')
```


2014/01/01−19/01/01
x_hw4
0.4
0.2
0.0
−0.2
−0.4
0.0000
0.0015
0.0030
sigma_squared_hw4


2015/01/01−20/01/01
x_hw4
0.4
0.2
0.0
−0.2
−0.4
0.0
0.2
0.4
0.6
0.8
sigma_squared_hw2