Portfolio Return

Statistical Methods in Finance

Stock Price Data

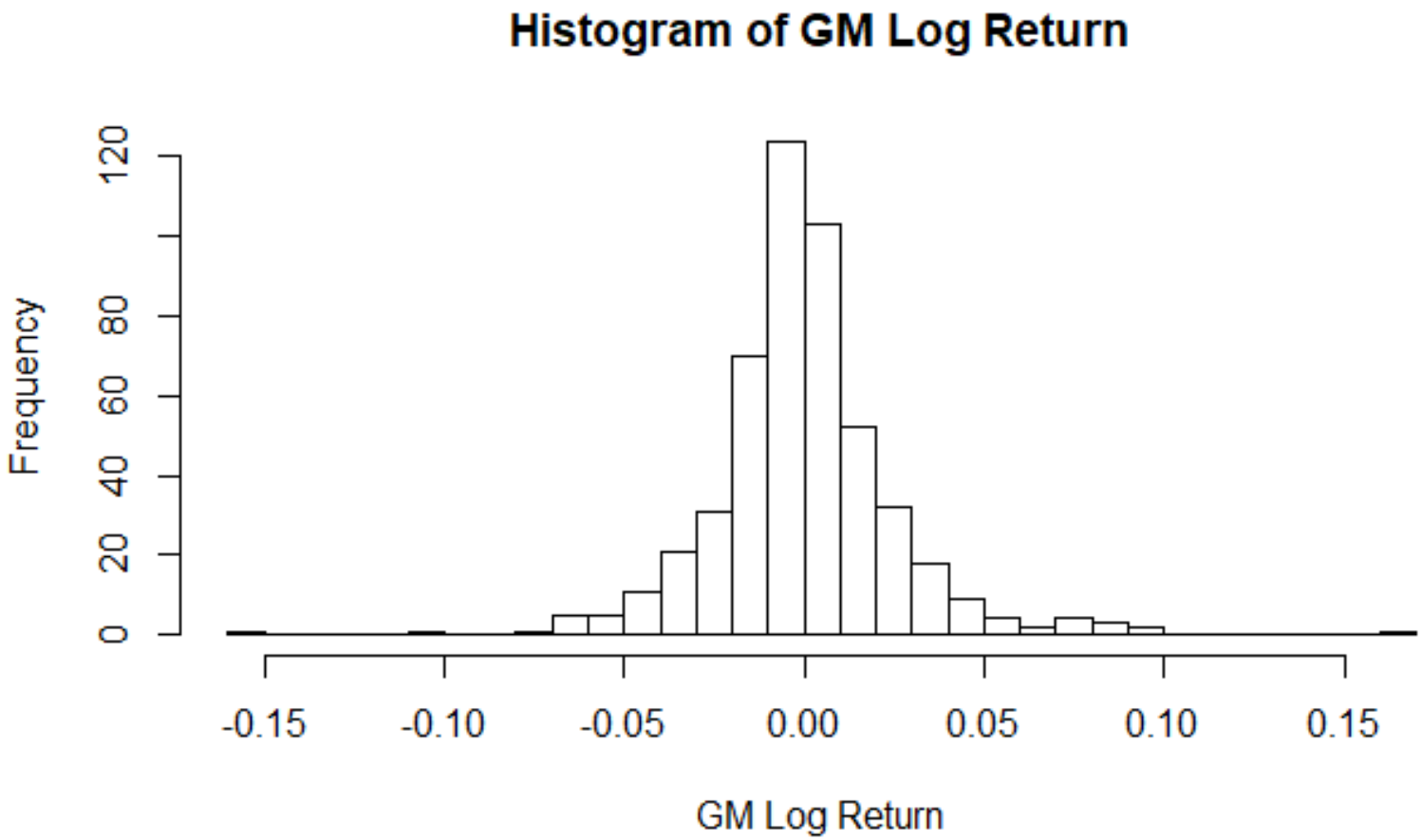
- "Stock_Bond.csv" contains the adjusted closing prices of 10 stocks from Jan 2, 1987 to Sep 1, 2006. We use the latest 500 days' data.

```
dat = read.csv("Stock_Bond.csv", header = T)
price = cbind(dat$GM_AC, dat$F_AC, dat$UTX_AC,
          dat$CAT_AC, dat$MRK_AC, dat$PFE_AC, dat$IBM_AC,
          dat$MSFT_AC, dat$C_AC, dat$XOM_AC)[4463:4963,]
```

- GM: General Motors
- F: Ford Motor
- UTX: United Technologies
- CAT: Caterpillar
- MRK: Merck & Co.
- PFE: Pfizer
- IBM: IBM
- MSFT: Microsoft
- C: Citigroup
- XOM: ExxonMobil

Log Returns

```
n = dim(price)[1]
r = log(price[2:n,]/price[1:(n-1),])   #log-returns
hist(r[,1],breaks=30,main="Histogram of GM Log Return",
     xlab="GM Log Return")   #plot GM log-return
```



Log Returns

```
mean_r = colMeans(r)   #mean of each log-return
sd_r = sqrt(diag(cov(r)))   #sd of each log-return
cor(returns)   #correlation of log-returns
       [,1]  [,2] [,3]  [,4]  [,5] [,6]  [,7] [,8] [,9] [,10]
 [1,] 1.00 0.576 0.21 0.192 0.030 0.13 0.184 0.17 0.16 0.101
 [2,] 0.58 1.000 0.24 0.219 0.099 0.21 0.263 0.19 0.21 0.113
 [3,] 0.21 0.244 1.00 0.490 0.108 0.17 0.292 0.31 0.38 0.365
 [4,] 0.19 0.219 0.49 1.000 0.094 0.22 0.276 0.25 0.35 0.362
 [5,] 0.03 0.099 0.11 0.094 1.000 0.31 0.049 0.12 0.18 0.097
 [6,] 0.13 0.205 0.17 0.215 0.306 1.00 0.196 0.19 0.31 0.179
 [7,] 0.18 0.263 0.29 0.276 0.049 0.20 1.000 0.35 0.29 0.225
 [8,] 0.17 0.185 0.31 0.250 0.116 0.19 0.354 1.00 0.21 0.195
 [9,] 0.16 0.215 0.38 0.350 0.180 0.31 0.290 0.21 1.00 0.278
[10,] 0.10 0.113 0.36 0.362 0.097 0.18 0.225 0.19 0.28 1.000
```

Observations

- All stock price returns are positively correlated, but some of them are more significant.
- Example: Return of stock 1 (GM) is most correlated with stock 2 (Ford), and least correlated with stock 5 (Merck).
- This is reasonable because GM and Ford are in the same industry, while Merck is in a virtually unrelated field.

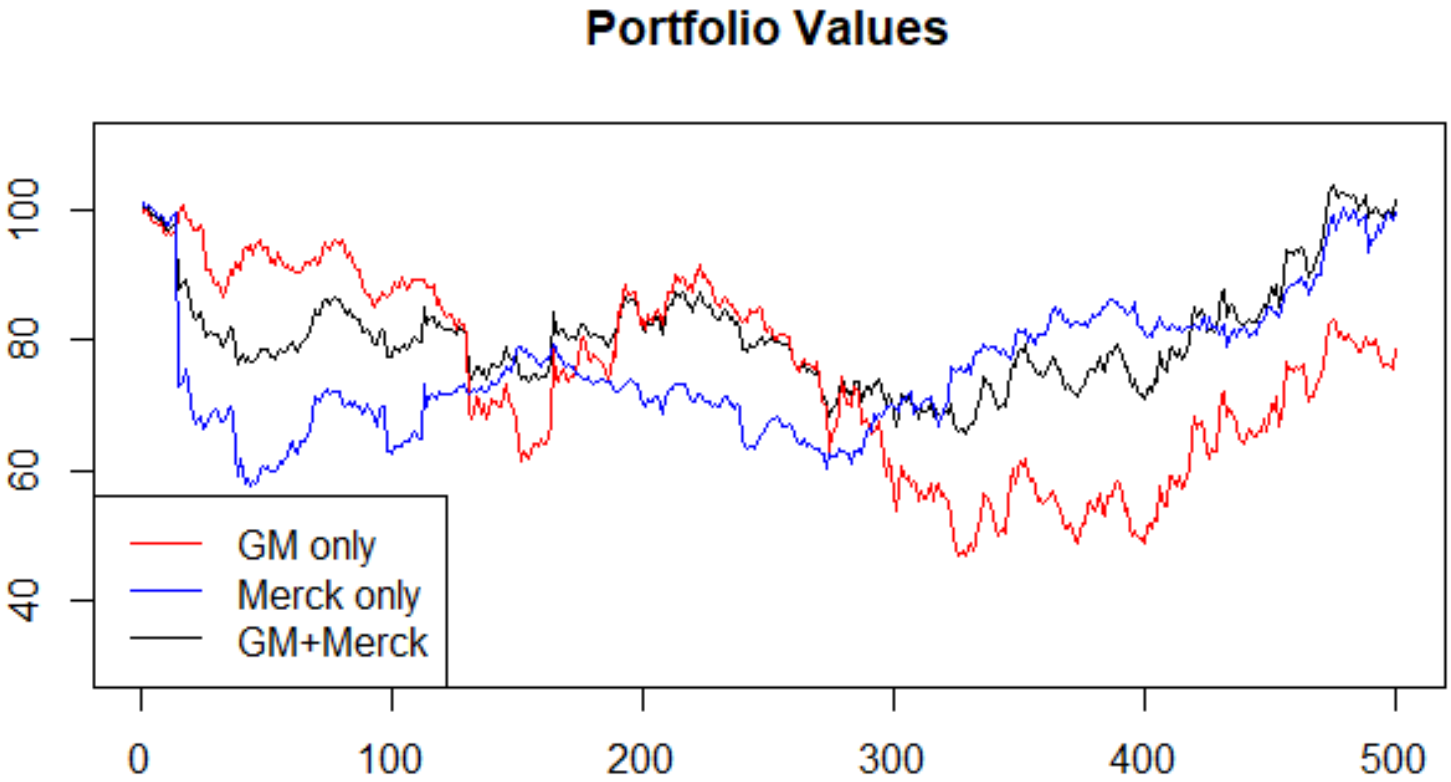
GM vs Merck vs GM+Merck

Suppose we have \$100m to invest, what is the portfolio return in each of these three cases:

- Invest only in GM;
- Invest only in Merck;
- Split evenly among GM and Merck, and re-weight the portfolio at the end of each trading day so that both stocks remain constituting half of the portfolio value.

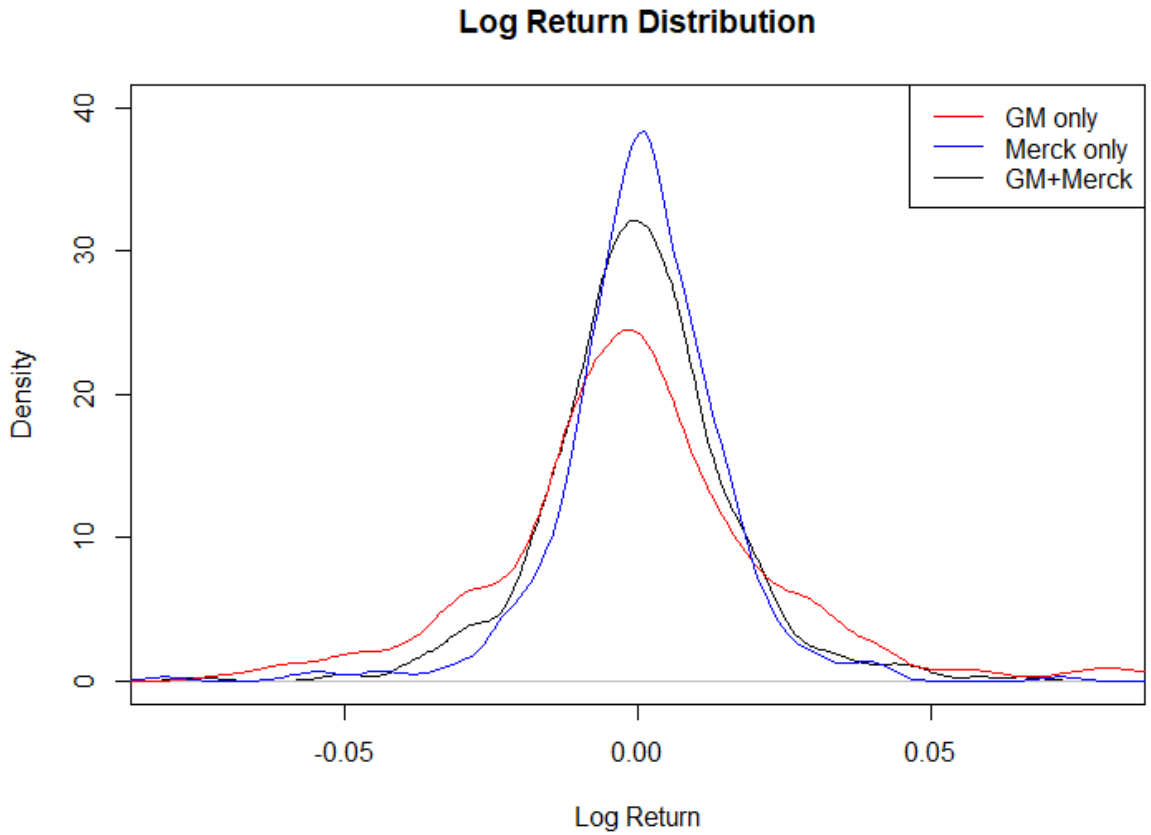
```
w = exp(r[,c(1,5)])/rowSums(exp(r[,c(1,5)]))   #weight
pr = rowSums(r[,c(1,5)]*w)   #weighted portfolio return
plot(100*exp(cumsum(pr)),type="l",col="black",
   xlab="",ylab="",ylim=c(30,110))   #GM+Merck portfolio value
lines(c(1:500),100*exp(cumsum(r[,1])),type="l",
   col="red",xlab="",ylab="")   #GM portfolio value
lines(c(1:500),100*exp(cumsum(r[,5])),type="l",
   col="blue",xlab="",ylab="")   #Merck portfolio value
title("Portfolio Values")
legend("bottomleft",legend=c("GM only","Merck only","GM+Merck"),
   col=c("red","blue","black"),lty=1:1)
```

GM vs Merck vs GM+Merck



The portfolio which puts half-half weights on GM and Merck is more stable because of the diversification effect.

GM vs Merck vs GM+Merck



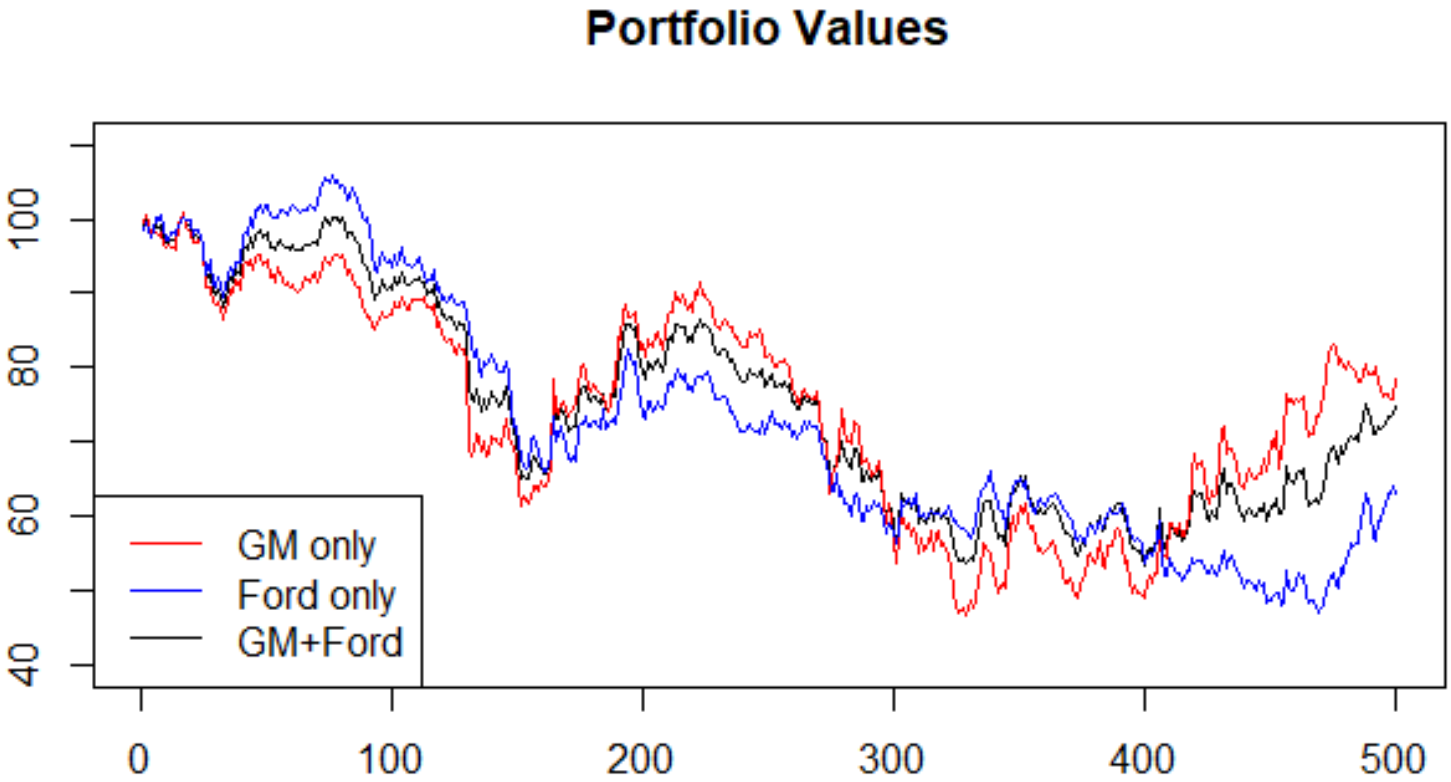
The portfolio which puts half-half weights on GM and Merck is more stable because of the diversification effect.

GM vs Ford vs GM+Ford

How about a combination of GM and Ford? Recall GM and Ford are most correlated.

```
w = exp(r[,c(1,2)])/rowSums(exp(r[,c(1,2)]))   #weight
pr = rowSums(r[,c(1,2)]*w)   #weighted portfolio return
plot(100*exp(cumsum(pr)),type="l",col="black",
   xlab="",ylab="",ylim=c(40,110))   #GM+Ford portfolio value
lines(c(1:500),100*exp(cumsum(r[,1])),type="l",
   col="red",xlab="",ylab="")   #GM portfolio value
lines(c(1:500),100*exp(cumsum(r[,2])),type="l",
   col="blue",xlab="",ylab="")   #Ford portfolio value
title("Portfolio Values")
legend("bottomleft",legend=c("GM only","Ford only","GM+Ford"),
   col=c("red","blue","black"),lty=1:1)
```

GM vs Ford vs GM+Ford



The diversification effect is less significant in this case as GM and Ford are more correlated with each other.

GM vs Ford vs GM+Ford