Portfolio Analysis

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getPortfolio(er, cov.mat, weights)

- inputs:
  - er: expected returns vector of chosen stocks
  - cov.mat: covariance matrix of returns of chosen stocks
  - weights: designated portfolio weights of chosen stocks
- outputs:
  - er: portfolio expected return
  - sd: portfolio standard deviation
  - weights: designated portfolio weights of chosen stocks

efficient.portfolio(er, cov.mat, target.return)

- inputs:
  - er: expected returns vector of chosen stocks
  - cov.mat: covariance matrix of returns of chosen stocks
  - target.return: target expected return (the function finds the minimum risk portfolio with this target return)
- outputs:
  - er: portfolio expected return
  - sd: portfolio standard deviation
  - weights: portfolio weights of chosen stocks that minimizes the risk/sd at the level of target return

globalMin.portfolio(er, cov.mat)

- inputs:
  - er: expected returns vector of chosen stocks
  - cov.mat: covariance matrix of returns of chosen stocks
- outputs:
  - er: GMV portfolio expected return
  - sd: GMV portfolio standard deviation
  - weights: portfolio weights of chosen stocks that minimizes the risk/sd for any level of return

tangency.portfolio(er, cov.mat, risk.free)

- inputs:
  - er: expected returns vector of chosen stocks
  - cov.mat: covariance matrix of returns of chosen stocks
  - risk.free: the return of the risk-free asset
- outputs:
  - er: tangency/market portfolio expected return
  - sd: tangency/market portfolio standard deviation
  - weights: tangency/market portfolio weights

efficient.frontier(er, cov.mat, nport, alpha.min=-0.5, alpha.max=1.5)

- inputs:
  - er: expected returns vector of chosen stocks
  - cov.mat: covariance matrix of returns of chosen stocks
  - nport: number of efficient portfolios to compute
- outputs:
  - er: nport x 1 vector of expected returns of efficient portfolios
  - sd: nport x 1 vector of std deviations of efficient portfolios
  - weights: nport x N matrix of weights of efficient portfolios

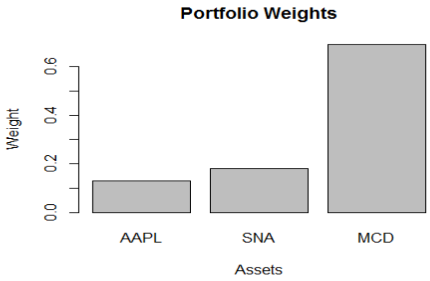
plot.portfolio(object)

- plot a portfolio weights

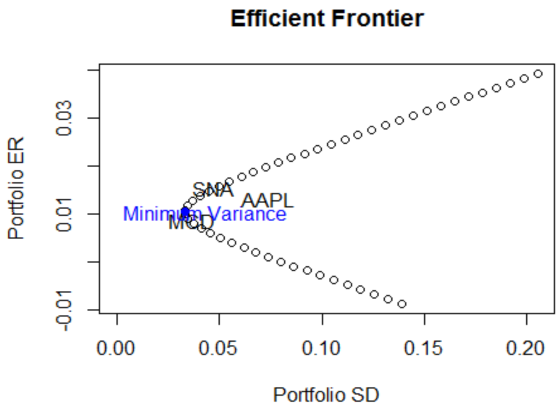
plot.Markowitz(object)

- plot efficient frontier curve

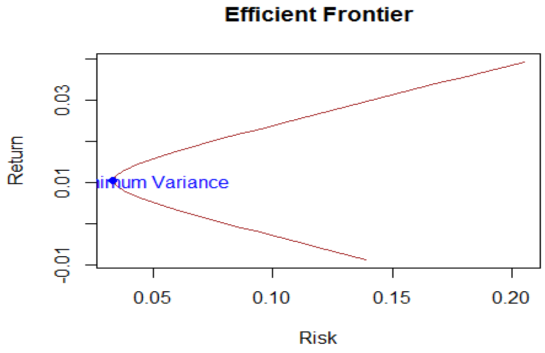
```
# Loading required libraries
library(quantmod)

# include source code
source("E:/Course Work at Harvard/Introduction to Financial Statisitcs/Eric Zivot.R")

# Pulling Stock Returns
getSymbols("AAPL", from="2013-01-01")

## [1] "AAPL"

getSymbols("SNA", from="2013-01-01")

## [1] "SNA"

getSymbols("MCD", from="2013-01-01")

## [1] "MCD"

aaplret<-monthlyReturn(Ad(AAPL))
snaret<-monthlyReturn(Ad(SNA))
mcdret<-monthlyReturn(Ad(MCD))

# expected return vector
er<-c(mean(aaplret), mean(snaret), mean(mcdret))

# covariance matrix
cov.mat<-cov(cbind(aaplret, snaret, mcdret))
names(er)<-c("AAPL","SNA", "MCD")
colnames(cov.mat)<-c("AAPL","SNA","MCD")
rownames(cov.mat)<-c("AAPL","SNA","MCD")

############################################
## Global Minimum Variance Portfolio
###########################################
gmin.port<-globalMin.portfolio(er,cov.mat)
print(gmin.port)

## Call:
## globalMin.portfolio(er = er, cov.mat = cov.mat)
##
## Portfolio expected return:     0.01048557
## Portfolio standard deviation:  0.03314065
## Portfolio weights:
##   AAPL    SNA    MCD
## 0.1284 0.1806 0.6911

plot(gmin.port)
```



```
###############################################
## Efficient Frontier Curve
###############################################
ef<-efficient.frontier(er, cov.mat, nport=50, alpha.min=-5, alpha.max=5)

# Let's plot the efficient frontier using Zivot function
## Interesting in R, plot.Markowitz overload plot, if the object is a portfolio, R will plot using plot.Ma
rkowitz function
plot(ef, plot.assets=T)

# More interestingly, add a point for the Global Minimum Variance Portfolio
points(gmin.port$sd, gmin.port$er, col="blue", pch=21, bg="blue")
text(gmin.port$sd+0.01, gmin.port$er, "Minimum Variance", col="blue")
```

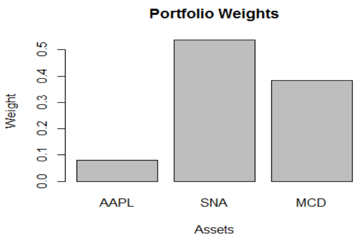


```
# You can also customize EF
plot(ef$sd, ef$er,
     type="l",
     col="brown",
     xlab="Risk",
     ylab="Return",
     main="Efficient Frontier")
points(gmin.port$sd, gmin.port$er, col="blue", pch=21, bg="blue")
text(gmin.port$sd+0.015, gmin.port$er, "Minimum Variance", col="blue")
```

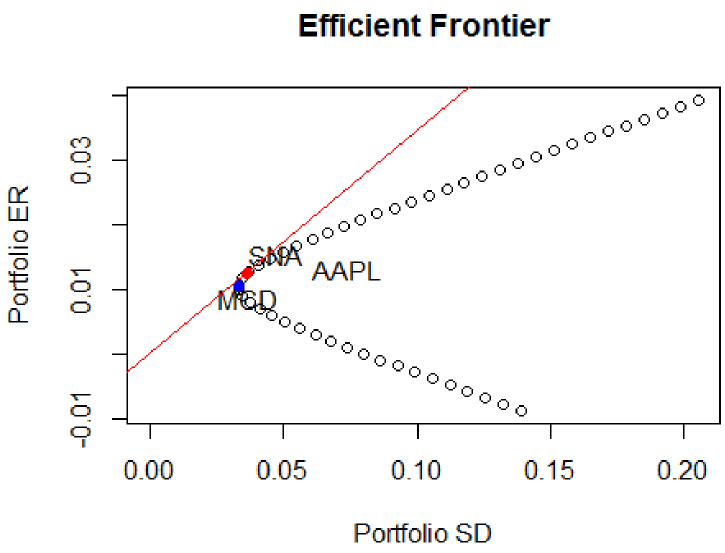


```
###############################################
## Tangency Portfolio and Capital Market Line
###############################################

# Compute tangency portfolio
rk.free<-0
tan.port<-tangency.portfolio(er, cov.mat, rk.free)
print(tan.port)
```

```
## Call:
## tangency.portfolio(er = er, cov.mat = cov.mat, risk.free = rk.free)
##
## Portfolio expected return:     0.01260822
## Portfolio standard deviation:  0.03634057
## Portfolio weights:
##   AAPL    SNA    MCD
## 0.0799 0.5372 0.3829

plot(tan.port)
```



```
# compute slope of tangent line (aka capital market line)
sr.tan<-(tan.port$er-rk.free)/tan.port$sd

# Let's plot our calculation so we can visualize it
## first plot the canvas then add on assets
plot(ef, plot.assets=T)

# Adds points to the plot representing GMV and tangent portfolios
points(gmin.port$sd, gmin.port$er, col="blue", pch=21, bg="blue")
points(tan.port$sd, tan.port$er, col="red", pch=21, bg="red")

# Adds a line to the plot representing the CML
abline(a=rk.free, b=sr.tan,col="red")
```


Efficient Frontier
Portfolio ER
Portfolio SD
SNA
AAPL
MCD