Computational Finance – HW 5

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Close all figures, clear the workspace, and clear the command window

```
close all; clc; clear;
```

Question 1

a. Download, Import and Merge Data

First, I import the monthly factor returns which is the same as the one we used in class.

```
file_name1 = 'F-F_Research_Data_Factors.CSV';
data1=importData(file_name1,1124);
```

Then I downloaded and import the 6 portfolio data.

```
file_name2 = '6_Portfolios_2x3.CSV'
```

```
file_name2 = '6_Portfolios_2x3.CSV'
```

```
data2=importData(file_name2,1136);
```

Merging Data

```
combinedData = innerjoin(data1, data2,'Keys','date');
```

b. Compute excess returns

```
excessReturns=combinedData{2:end,5:end}-combinedData.RF(1:end-1);
meanExcess=mean(excessReturns);
fprintf('\t\tSmall/ME1\t      Large/ME2\n')
```

```
                Small/ME1              Large/ME2
```

```
fprintf('LoBM%21.6f%21.6f\n',[meanExcess(1),meanExcess(4)])
```

```
LoBM             0.007041             0.006460
```

```
fprintf('BM2 %21.6f%21.6f\n',[meanExcess(2),meanExcess(5)])
```

```
BM2              0.009696             0.006843
```

```
fprintf('HiBM%21.6f%21.6f\n',[meanExcess(3),meanExcess(6)])
```

```
HiBM             0.011609             0.009068
```

c. Pattern Dicover

I noticed that the company with smaller size have higher excess returns, Furthermore, the higher the book-to-market ratio, the higher the excess returns.

d. Compute betas and plot SML

First compute betas for each of the six portfolios.

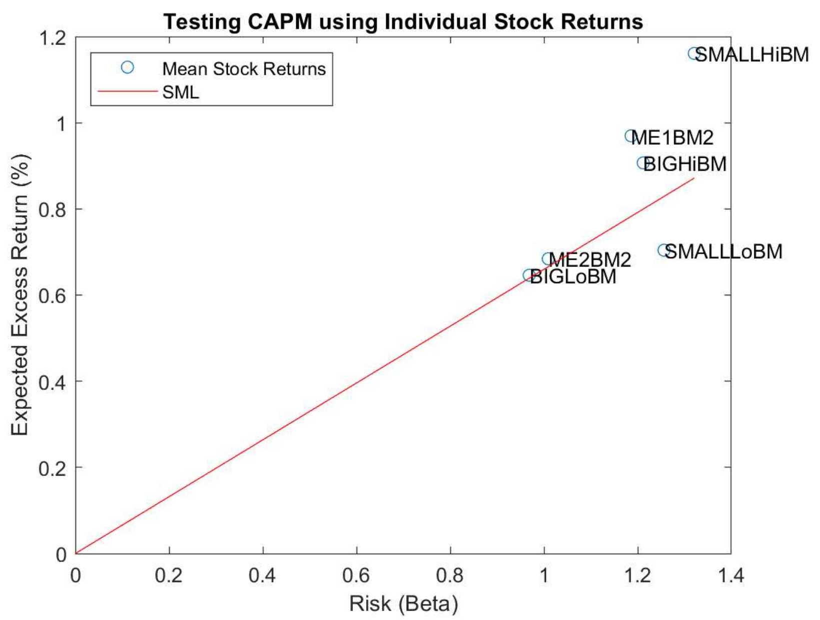
```
mktExcessReturn = combinedData.Mkt_RF(2:end);
covarianceMatrix = cov( [excessReturns, mktExcessReturn] );
beta = covarianceMatrix(end,1:end-1)/covarianceMatrix(end,end);
```

Plot the SML

```
portNam=data2.Properties.VariableNames
```

```
portNam = 1×6 cell array
    {'SMALLLoBM'}    {'ME1BM2'}    {'SMALLHiBM'}    {'BIGLoBM'}    {'ME2BM2'}    {'BIGHiBM'}
```

```
figure;
plot(beta,meanExcess*100,'o');
xlabel('Risk (Beta)');
ylabel('Expected Excess Return (%)');
title('Testing CAPM using Individual Stock Returns');
text(beta,meanExcess*100,portNam)
meanRm = mean(mktExcessReturn);
hold on;
plot([0,beta],[0,beta*meanRm*100],'r');
legend('Mean Stock Returns','SML','location','northwest');
```



e. Alpha and beta plot analysis

Small and high BM, Big and High BM and small and median BM portfolios have significant positive alphas.

Small and low BM portfolio have significnat negative alpha.

CAPM is not good enough to expain their returns since most of the points are deviate a lot from the SML.

f. Construct SMB and HML portfolios

```
smlPort=(sum(combinedData{1:end,5:7},2)-sum(combinedData{1:end,8:10},2))/6;
hmlPort=(sum(combinedData{1:end,[7,10]},2)-sum(combinedData{1:end,[5,8]},2))/4;
diffSML=combinedData.SMB-smlPort;
diffHML=combinedData.HML-hmlPort;
fprintf('Maximum differences of SML is %6.5f',max(diffSML))
```

```
Maximum differences of SML is 0.18350
```

```
fprintf('Maximum differences of HML is %6.5f',max(diffHML))
```

```
Maximum differences of HML is 0.17728
```

g. Portfolios performance relative to Market

Retrive the data for target 20 years.

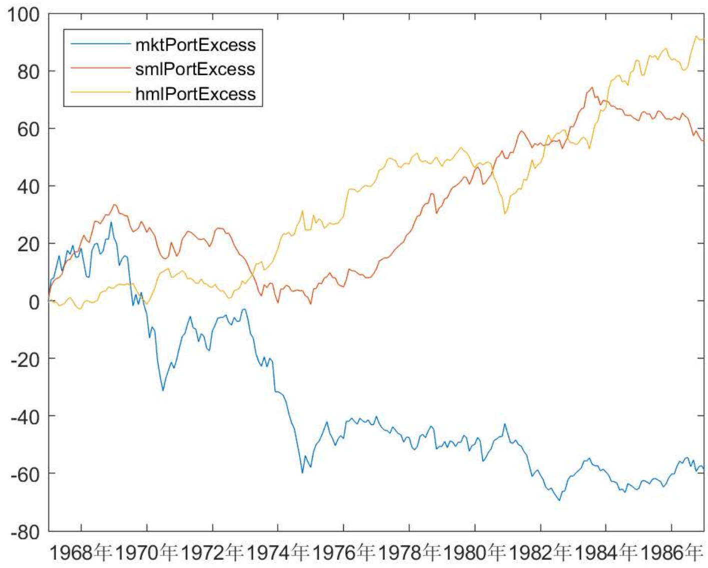
```
cumData=combinedData(find(combinedData.date ==datetime( '19661231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '19861231','InputFormat','yyyyMMdd')),:);
```

Compute returns for 3 zero cost portfolio

```
mktPortExcess=cumData.Mkt_RF-cumData.RF;
smlPortExcess=smlPort(find(combinedData.date ==datetime( '19661231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '19861231','InputFormat','yyyyMMdd')),:);
hmlPortExcess=hmlPort(find(combinedData.date ==datetime( '19661231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '19861231','InputFormat','yyyyMMdd')),:);
portReturns=table(mktPortExcess,smlPortExcess,hmlPortExcess);
cumreturns = portReturns;
cumreturns{:,:} = cumprod( (1+portReturns{:,:}) ) - 1;
```

Plot the cummulative returns of 20 years.

```
figure;
plot(cumData.date,100*cumreturns{:,:});
leg=legend(cumreturns.Properties.VariableNames,'location','northwest');
```

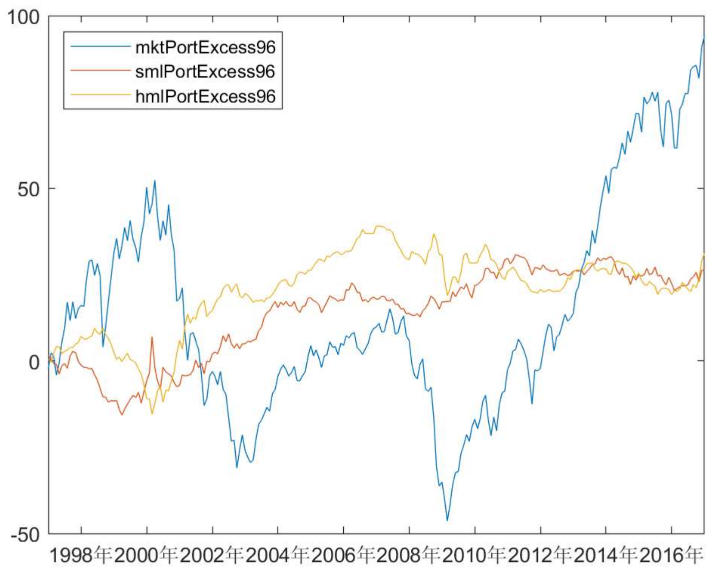


I have made 120% cummulative return over these 20 years if you invested in the SMB portfolio rather than in the market portfolio.

I have made 140% cummulative return over these 20 years if you invested in the HML portfolio rather than in the market portfolio.

h. Cummulative returns start on 1996

```
cumData96=combinedData(find(combinedData.date ==datetime( '19961231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '20161231','InputFormat','yyyyMMdd')),:);
mktPortExcess96=cumData96.Mkt_RF-cumData96.RF;
smlPortExcess96=smlPort(find(combinedData.date ==datetime( '19961231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '20161231','InputFormat','yyyyMMdd')),:);
hmlPortExcess96=hmlPort(find(combinedData.date ==datetime( '19961231','InputFormat','yyyyMMdd')):...
    find(combinedData.date ==datetime( '20161231','InputFormat','yyyyMMdd')),:);
portReturns96=table(mktPortExcess96,smlPortExcess96,hmlPortExcess96);
cumreturns96 = portReturns96;
cumreturns96{:,:} = cumprod( (1+portReturns96{:,:}) ) - 1;

figure;
plot(cumData96.date,100*cumreturns96{:,:});
leg=legend(cumreturns96.Properties.VariableNames,'location','northwest');
```



The return for SML and HML portfolios returns are both less than the market cummulative return during 1998 to 2018. After looking in these two graph, the cumulative returns for different strategies are not consistant in different market conditions. I am not so confident about what I've learned in my investment class.

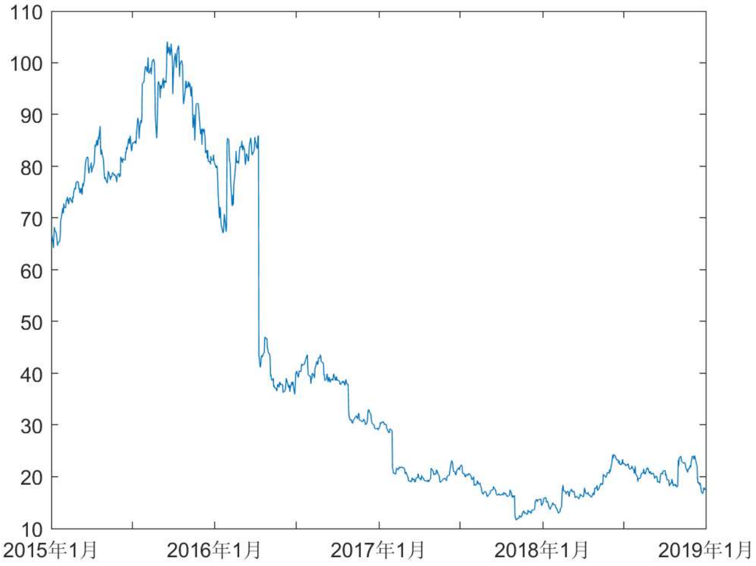
Question 2

a. Import data and plot

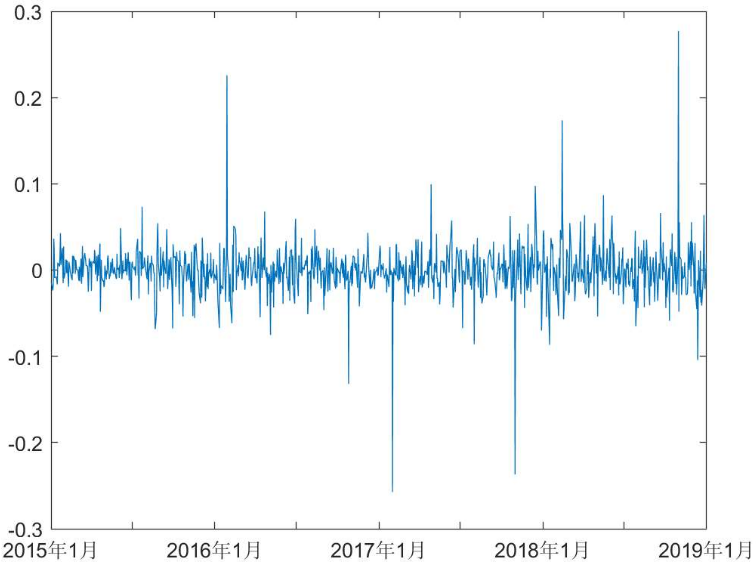
```
dataQ2 = readtable('UAA.csv');
dataQ2.date = datetime(dataQ2.date,'ConvertFrom','yyyyMMdd');
dataQ2= table2timetable(dataQ2);
summary(dataQ2)
```

```
RowTimes:

    date: 1006×1 datetime
        Values:
            Min         2015-01-02 00:00:00
            Median      2016-12-29 12:00:00
            Max         2018-12-31 00:00:00

Variables:

    PERMNO: 1006×1 double

        Values:

            Min        90979
```

```
figure;
plot(dataQ2.date,dataQ2.PRC)
```




```
plot(dataQ2.date,dataQ2.RET)
```



b. Computing the moving standard deviation

```
movinStdRet=movstd(dataQ2.RET,[252 0]);
```

c. Restrict my sample

```
date=dataQ2.date;
PRCQ2=dataQ2.PRC;
RETQ2=dataQ2.RET;
dataRestrict=timetable(date,PRCQ2,RETQ2,movinStdRet);
dataRestrict=dataRestrict(find(dataRestrict.date ==datetime( '20160104','InputFormat','yyyyMMdd')):...
    find(dataRestrict.date ==datetime( '20181130','InputFormat','yyyyMMdd')),:);
```

d. Calculating expiration date

```
expirDate=ones(735,1);
for i=1:735
    if dataRestrict.dateQ2(i)<nweekdate(3,5,year(dataRestrict.dateQ2(i)),month(dataRestrict.dateQ2(i)),[],'datetime')
        expirDate(i,1)=nweekdate(3,5,year(dataRestrict.dateQ2(i)),month(dataRestrict.dateQ2(i)));
    elseif month(dataRestrict.dateQ2(i))==12
        expirDate(i,1)=nweekdate(3,5,year(dataRestrict.dateQ2(i))+1,1);
    else
        expirDate(i,1)=nweekdate(3,5,year(dataRestrict.dateQ2(i)),month(dataRestrict.dateQ2(i))+1);
    end
end

timetoExpire=daysdif(dataRestrict.dateQ2,expirDate);
dataRestrict=addvars(dataRestrict,expirDate,timetoExpire);
```

e. Import Ken French’s daily factor data to get the risk-free rate

```
opts=detectImportOptions("F-F_Research_Data_Factors_daily.CSV");
rfData = readtable("F-F_Research_Data_Factors_daily.CSV",opts);
rfData.Properties.VariableNames{1} = 'kfdate';
year = floor( rfData.kfdate/10000 );
month = floor((rfData.kfdate - year*10000)/100);
Day = rfData.kfdate-year*10000-month*100;
rfData.date = datetime(year,month,Day+1)-1;
rfData.date.Format = 'defaultdate';
rfData.kfdate = [];
rfData=table2timetable(rfData);

FrenchMerge = innerjoin(rfData, dataRestrict,'Keys','date');
```

f. Compute prices for options

```
k=FrenchMerge.PRCQ2;
s0=FrenchMerge.PRCQ2;
r=FrenchMerge.RF;
vol=FrenchMerge.movinStdRet;
T=FrenchMerge.timetoExpire;
N = 10^6;

drift = (r-vol.^2/2).*T;
diffusion = vol.*sqrt(T);
price=zeros(length(drift),1);

for i=1:length(drift)
    sT = s0(i)*exp( drift(i) + diffusion(i)*randn(N,1) );
    call_payoff = max(sT-k(i),0);
    discounted_payoff = mean(call_payoff) * exp(-r(i)*T(i));

    price(i) = discounted_payoff;
end
```

g. Report my results

```
meanOptionPrc=mean(price);
maxOptionPrc=max(price);
fprintf('The average price of call option is %6.2f',meanOptionPrc);
```

```
The average price of call option is   1.87
```

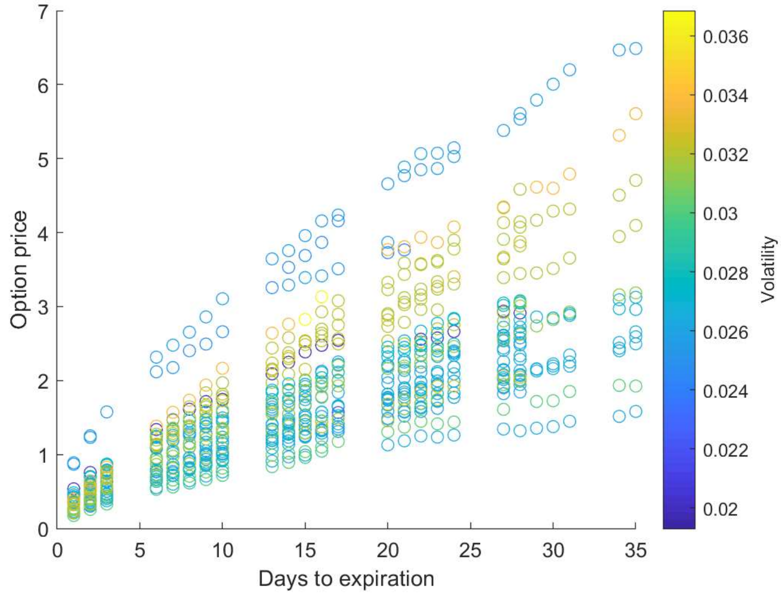
```
fprintf('The max price of call option is %6.2f',maxOptionPrc);
```

```
The max price of call option is   6.49
```

Plotting

```
figure;
```

```
scatter(T,price,[],vol);
xlabel('Days to expiration');
ylabel('Option price');
c=colorbar;
c.Label.String='Volatility';
```



h. Discovery from the graph

From the graph in part g, options with higher days to expiration have higher prices. Moreover, options with higher volativity of the underlying assets tend to have a higher prices.