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HW3 - Portfolio Optimization

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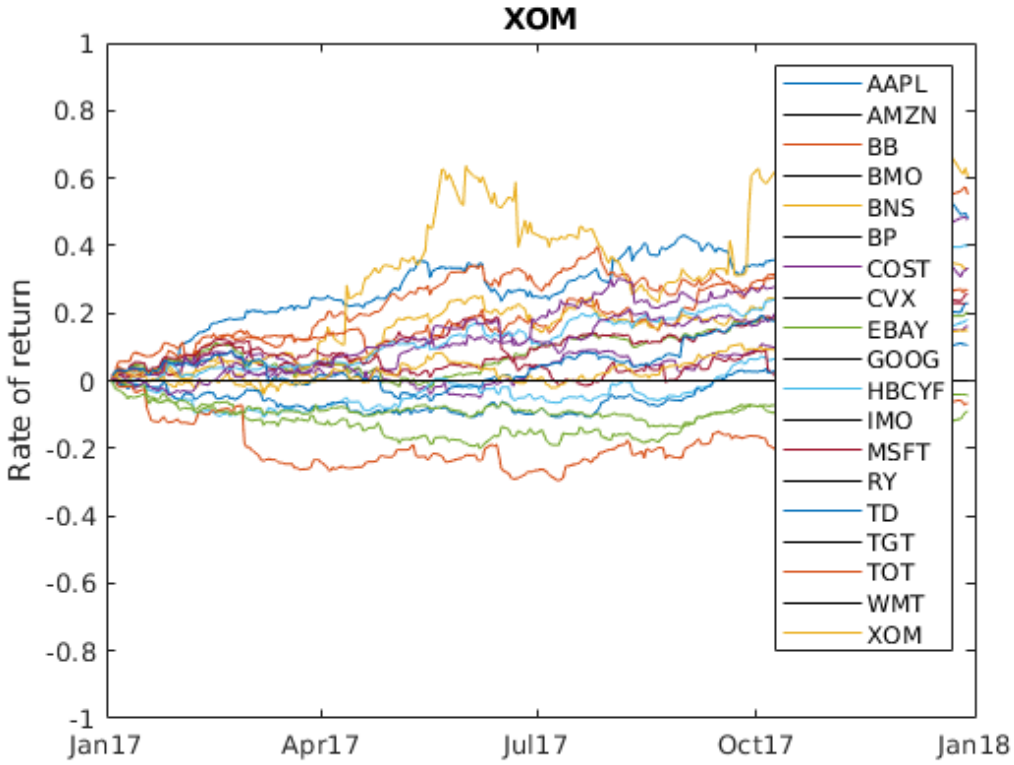
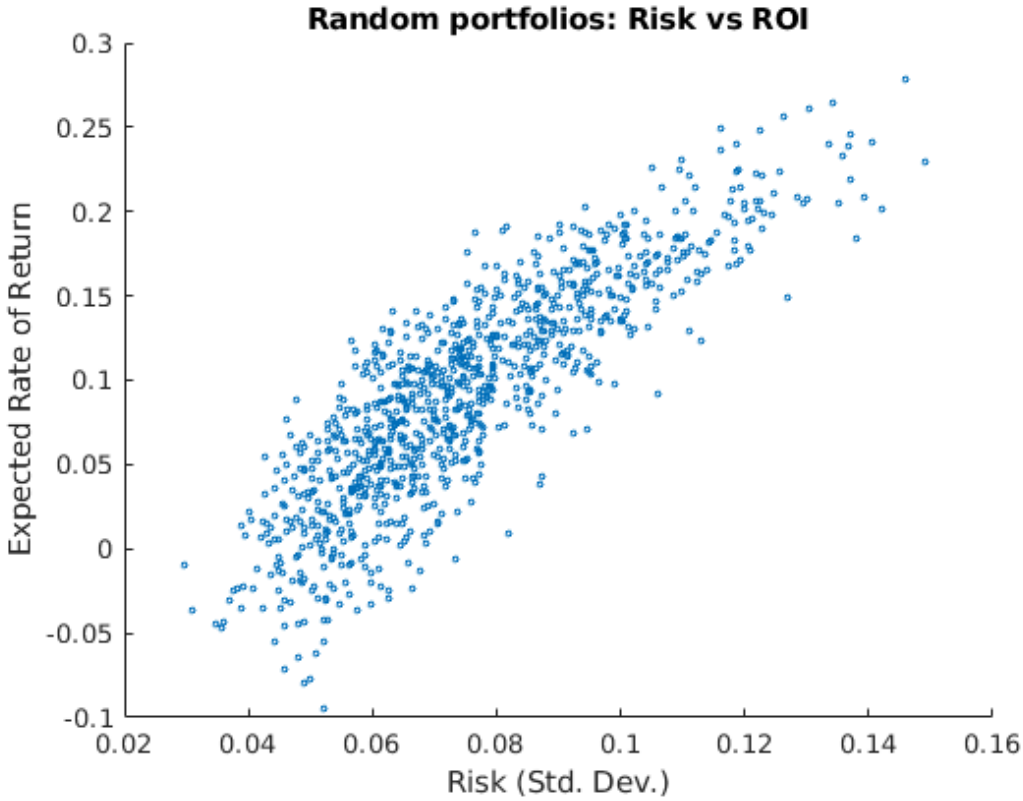
Supplementary files:

```
sup_code = [
"load_stocks"
"load_stock"
"portfolio_scatter"
"meancov"
"return_range"
"efficient_frontier"
"market_portfolio"
];
for i = 1:length(sup_code)
    publish(sup_code(i), 'format', 'pdf', 'evalCode', false);
end

clear all
close all

warning('off', 'MATLAB:table:ModifiedAndSavedVarnames');
% rng(1); % Random seed for testing\debugging
```

Q1

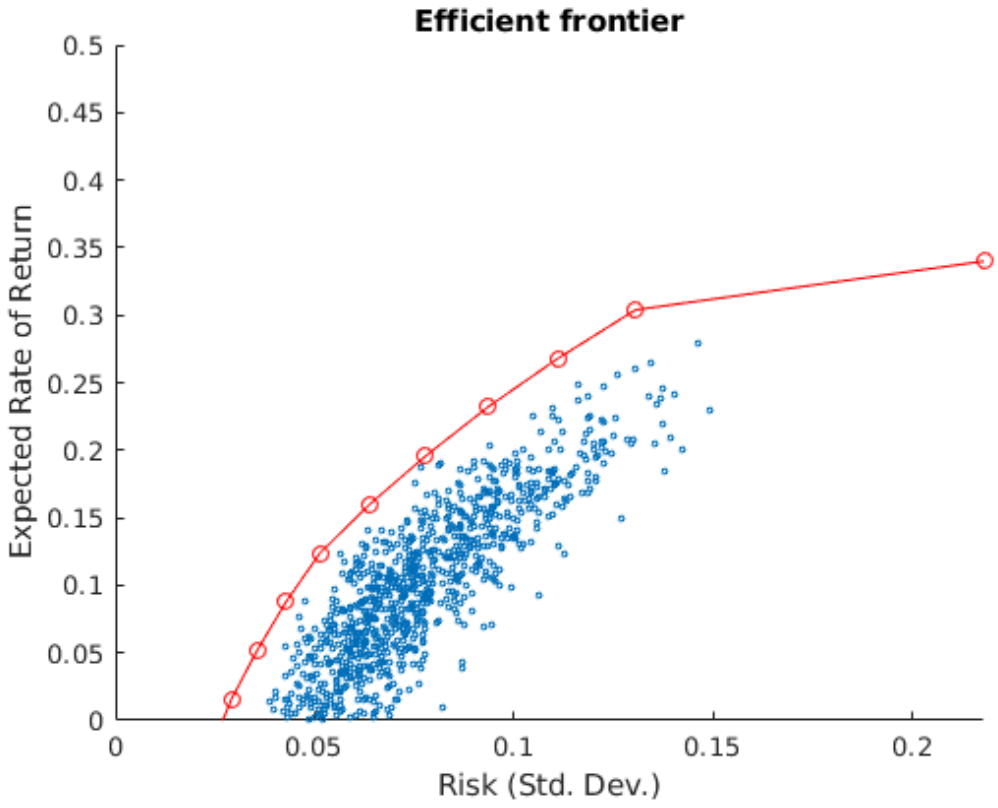
```
[X, dates, names] = load_stocks("data", "2017-01-03","2017-12-29");
disp_stocks(X, dates, names);
[r, Sig] = meancov(X);
h = portfolio_scatter(r, Sig, 1000);
```


XOM
Rate of return
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Jan17
Apr17
Jul17
Oct17
Jan18
AAPL
AMZN
BB
BMO
BNS
BP
COST
CVX
EBAY
GOOG
HBCYF
IMO
MSFT
RY
TD
TGT
TOT
WMT
XOM


Random portfolios: Risk vs ROI
Expected Rate of Return
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Risk (Std. Dev.)

Q2

```
num = 12;
[Y,rates,sigs]= efficient_frontier(r,Sig,num);
figure(h);
hold on;
title("Efficient frontier");
plot(sigs, rates, 'ro-');
ylim([0 0.5]);
xlim([0 max(sigs)]);
```

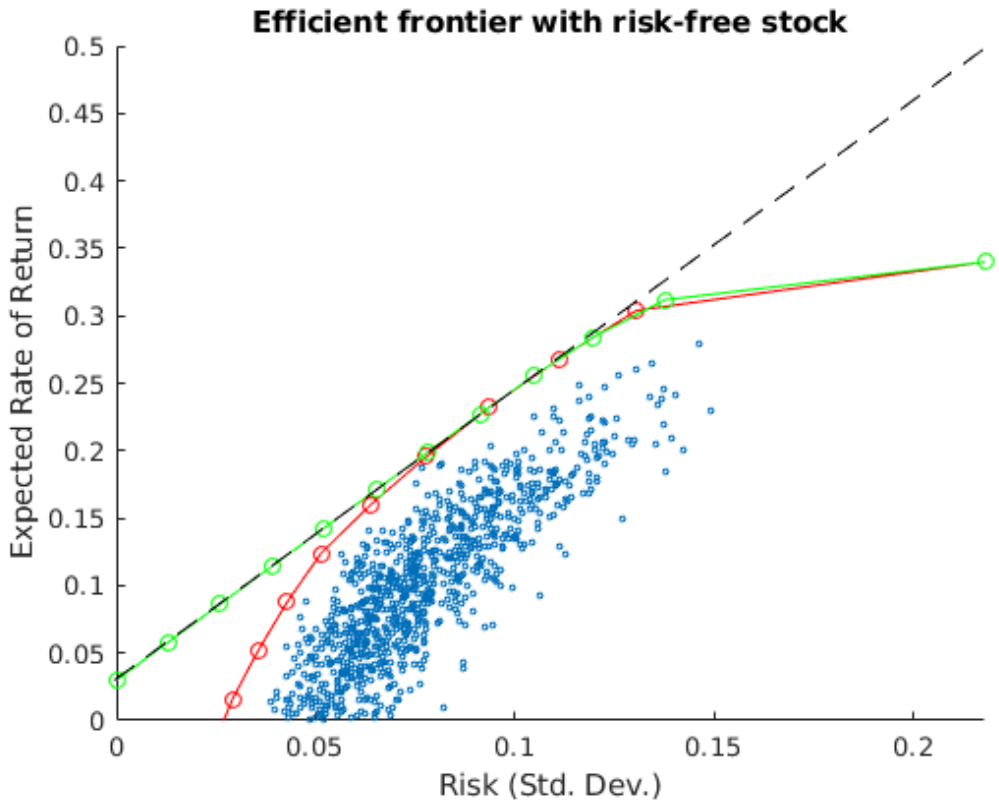


Q3

```
f = 0.03;
r_= [r, f]; % add risk free return
Sig_ = [Sig , zeros(19,1)] ;
Sig_ = [Sig_; zeros(1,20)]; % build risk free Sig
[Y_,rates_,sigs_]=efficient_frontier(r_,Sig_,num); %calculate
 coresponding efficient frontier
plot(sigs_,rates_,'go-');
title("Efficient frontier with risk-free stock")
market_x = market_portfolio(f,r',Sig);
annotation(h,'line',[0.128070175438597 0.910526315789474],...
    [0.15852380952381 0.928571428571429],'LineStyle','--');
```

Binary search:

```
Iter         x     |f(x)|
   1  1.20e-01  3.28e-02
   2  7.09e-02  3.14e-02
   3  9.54e-02  5.54e-04
   4  1.08e-01  1.99e-02
   5  1.01e-01  1.10e-02
   6  9.84e-02  5.67e-03
   7  9.69e-02  2.68e-03
   8  9.61e-02  1.09e-03
   9  9.57e-02  2.78e-04
  10  9.56e-02  1.36e-04
  11  9.57e-02  7.13e-05
  12  9.56e-02  3.23e-05
  13  9.56e-02  1.96e-05
  14  9.56e-02  6.35e-06
  15  9.56e-02  6.61e-06
  16  9.56e-02  1.29e-07
Done.
```



Q3 - Meaning of linear part

The linear half-line (Before the tangent point) represents the new extended region of the efficient frontier thanks to the addition of the risk free stock. This stock has no variance by definition thus including in the portfolio results in a linear gain in rate of return

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