**Appendix 1: Code for part 1**

%% part a: Formulate a linear program

% Objective coefficient (Take inverse to get maximum)

c1 = [20, (20 - 15) \* 100, 100]';

c2 = [40, (40 - 15) \* 100, 100]';

c3 = [12, 0, 100]';

c = -1 \* (c1 + c2 + c3) / 3;

% Inequality constraints

A = [];

b = [];

% Equality constraints

Aeq = [20, 1000, 90];

beq = [20000];

% Variable bounds

ub = [inf, 50, inf]';

lb = [0, -50, 0]';

% Call linprog from matlab

fprintf('Part A\n')

[x, fval] = linprog(c, A, b, Aeq, beq, lb, ub);

fprintf('Investing in:\n\t%.2f shares of stocks\n\t%.2f options\n\t%.2f bonds\n', x(1), x(2), x(3))

fprintf('Total estimated profit:\t$%d\n\n', round(-1 \* fval - 20000))

%% part b: Does the portfolio make profit in evert case?

% Calculate the profit in each case

profit\_1 = c1' \* x - 20000;

profit\_2 = c2' \* x - 20000;

profit\_3 = c3' \* x - 20000;

fprintf('Part B\n')

fprintf('Profit in case 1: %.2f\n', profit\_1);

fprintf('Profit in case 2: %.2f\n', profit\_2);

fprintf('Profit in case 3: %.2f\n\n', profit\_3);

%% part c: Have at least 2000 profit in all scenarios

% Inequility constraints (Take inverse to get "greater than")

A = -1 \* [c1'; c2'; c3'];

b = -1 \* 22000 \* ones(3, 1);

% Call linprog from matlab

fprintf('Part C\n')

[x, fval] = linprog(c, A, b, Aeq, beq, lb, ub);

fprintf('Investing in:\n\t%.2f shares of stocks\n\t%.2f options\n\t%.2f bonds\n', x(1), x(2), x(3))

profit\_1 = c1' \* x - 20000;

profit\_2 = c2' \* x - 20000;

profit\_3 = c3' \* x - 20000;

fprintf('Profit in case 1: %.2f\n', profit\_1);

fprintf('Profit in case 2: %.2f\n', profit\_2);

fprintf('Profit in case 3: %.2f\n\n', profit\_3);

%% part d: Max riskless profit under all three scenarios

% Introduce new riskless profit p, which is the objective function. Take

% inverse to maximize

c = -1 \* [0, 0, 0, 1]';

% Inequality constraints. Take inverse to get lower limit

A = -1 \* [c1', -1; c2', -1; c3', -1];

b = [0, 0, 0]';

% Equality constraints

Aeq = [Aeq, 0];

beq = [20000];

% Variable bounds

ub = [ub; inf];

lb = [lb; -inf];

fprintf('Part D\n')

[x, fval] = linprog(c, A, b, Aeq, beq, lb, ub);

fprintf('Investing in:\n\t%.2f shares of stocks\n\t%.2f options\n\t%.2f bonds\n', x(1), x(2), x(3))

fprintf('Maximum riskless profit:\t%.2f\n', round(x(4),2) - 20000)

**Appendix 2: Output for part 1**

Part A

Optimization terminated.

Investing in:

3500.00 shares of stocks

-50.00 options

0.00 bonds

Total estimated profit: $14000

Part B

Profit in case 1: 25000.00

Profit in case 2: -5000.00

Profit in case 3: 22000.00

Part C

Optimization terminated.

Investing in:

2800.00 shares of stocks

-36.00 options

0.00 bonds

Profit in case 1: 18000.00

Profit in case 2: 2000.00

Profit in case 3: 13600.00

Part D

Optimization terminated.

Investing in:

2272.73 shares of stocks

-25.45 options

0.00 bonds

Maximum riskless profit: 7272.73

**Appendix 3: Code for part 2**

%% Part a:

% Calculate expected returns of the portfolio

r\_1 = 0.161576319453774;

r\_2 = -0.016142707038591;

r\_3 = -0.083850395954210;

% Calculate stddev and cov of the portfolio

std\_1 = 9.436465492538190;

std\_2 = 0.470579874738465;

std\_3 = 3.563572312667640;

cov\_12 = 1.354063990681560;

cov\_13 = 6.147032932019340;

cov\_23 = -0.262925558879088;

%% Part b: Generate an efficient frontier between three assets

% Create portfolio

m = [std\_1, std\_2, std\_3]';

C = [std\_1^2, cov\_12, cov\_13;

    cov\_12, std\_2^2, cov\_23;

    cov\_13, cov\_23, std\_3^2];

p = Portfolio('assetmean', m, 'assetcovar', C, 'budget', 1, 'lb', 0);

plotFrontier(p);

% Estimate portfolio under specific profits

pwgt = estimateFrontierByReturn(p, [1 : 9]);

prsk = estimatePortRisk(p, pwgt);

% Produce table

fprintf('Portfolio and risk under different return goal:\n');

tbl = [pwgt', prsk]

%% Part c: Pick a portfolio and try it on January 2017

% Calculate realized return of each portfolio

r\_realized\_1 = 1.039291504403617;

r\_realized\_2 = 1.002798835772569;

r\_realized\_3 = 1.019317943695971;

r\_realized = [r\_realized\_1, r\_realized\_2, r\_realized\_3];

fprintf('The realized individual return of three assets:\n');

fprintf('\tSPT:\t%f\n', r\_realized(1));

fprintf('\tGOVT:\t%f\n', r\_realized(2));

fprintf('\tEEMV:\t%f\n', r\_realized(3));

% Pick a portfolio (#5)

port = pwgt(:, 5);

profit = r\_realized \* port;

fprintf('Choose the following Portfolio:\n');

fprintf('\tSPT:\t%f\n', port(1));

fprintf('\tGOVT:\t%f\n', port(2));

fprintf('\tEEMV:\t%f\n', port(3));

fprintf('The portfolio have profit %f\n', profit);

**Appendix 4: Output for part 2**

Portfolio and risk under different return goal:

tbl =

0.0191 0.8652 0.1157 0.6227

0.0836 0.6643 0.2521 1.3597

0.1481 0.4634 0.3885 2.1716

0.2126 0.2626 0.5248 2.9981

0.2771 0.0617 0.6612 3.8297

0.4149 0 0.5851 4.7601

0.5851 0 0.4149 5.9714

0.7554 0 0.2446 7.3379

0.9257 0 0.0743 8.7874

The realized individual return of three assets:

SPT: 1.039292

GOVT: 1.002799

EEMV: 1.019318

Choose the following Portfolio:

SPT: 0.277089

GOVT: 0.061715

EEMV: 0.661196

The portfolio have profit 1.023833