```
% 1  The tangible benefits of rebalancing

% Question 1: What is the optimal (i.e. mean-variance efficient) allocation among the two secur
% parameters
mean_return = 0.1;
std_dev = 0.2;
correlation = 0;

% Optimal allocation (mean-variance efficient)
weights = [0.5, 0.5];

fprintf('Optimal Allocation: %.2f AAA, %.2f ZZZ\n', weights);
```

```
Optimal Allocation: 0.50 AAA, 0.50 ZZZ
```

```
% 1.2: (a) Simulate a vector of returns for the two risky assets, AAA and ZZZ. Use your softwar
% Simulation parameters
num_simulations = 10000;
num_years = 100;

% Preallocate arrays
buy_and_hold_returns = zeros(num_simulations, 1);
rebalanced_returns = zeros(num_simulations, 1);

% Simulation loop
for i = 1:num_simulations
    % Simulate returns for AAA and ZZZ
    aaa_returns = mean_return + std_dev * randn(num_years, 1);
    zzz_returns = mean_return + std_dev * randn(num_years, 1);

    % Buy and hold strategy
    buy_and_hold_returns(i) = sum(aaa_returns + zzz_returns);

    % Rebalanced strategy
    weights = [0.5, 0.5];
    rebalanced_returns(i) = sum(weights(1) * aaa_returns + weights(2) * zzz_returns);
end

% Calculate Sharpe ratios
sharpe_buy_and_hold = mean(buy_and_hold_returns) / std(buy_and_hold_returns);
sharpe_rebalanced = mean(rebalanced_returns) / std(rebalanced_returns);

% Display results
fprintf('Average Sharpe ratio (Buy and Hold): %.4f\n', sharpe_buy_and_hold);
```

```
Average Sharpe ratio (Buy and Hold): 7.0931
```

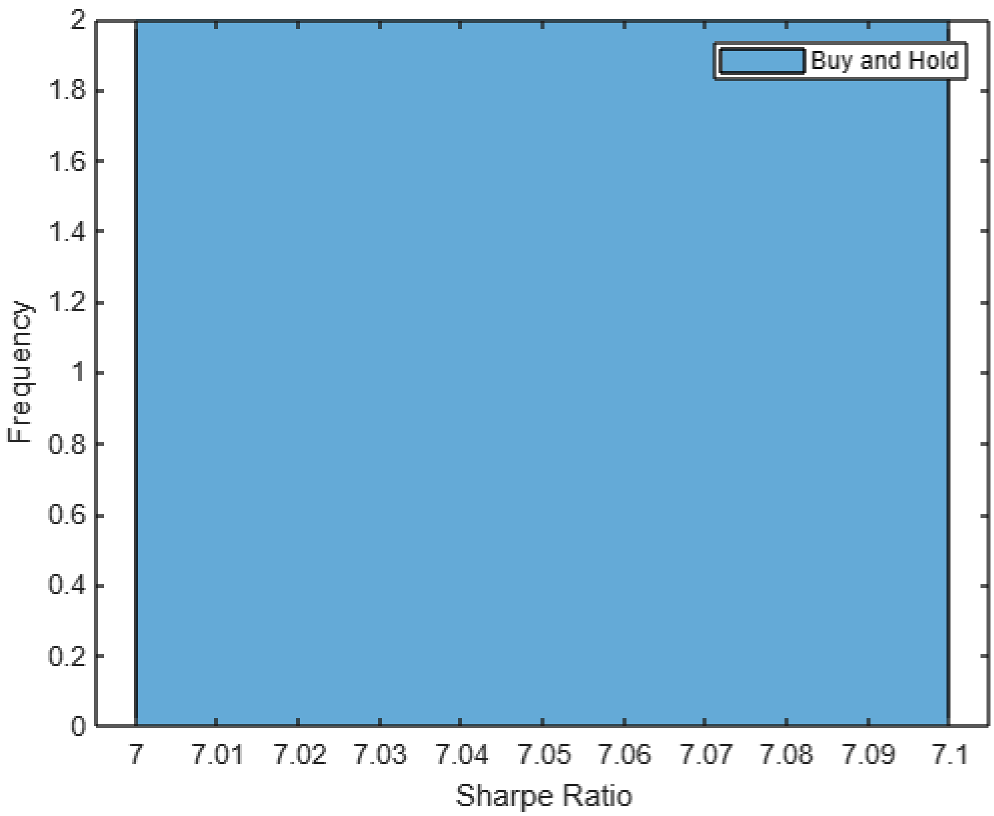
```
fprintf('Average Sharpe ratio (Rebalanced): %.4f\n', sharpe_rebalanced);
```

```
Average Sharpe ratio (Rebalanced): 7.0931
```

```
% Plot histogram of Sharpe ratios
figure;
histogram([sharpe_buy_and_hold; sharpe_rebalanced], 'binwidth', 0.1);
xlabel('Sharpe Ratio');
```

```
ylabel('Frequency');
legend('Buy and Hold', 'Rebalanced');
```

```
Warning: Ignoring extra legend entries.
```




```
% Question 2

% 2.i: (i) First assume that your human capital is riskless. Solve your portfolio choice proble

% parameters
riskless_return = 0.01;
expected_returns = [0.08, 0.037, 0.06];
volatilities = [0.19, 0.25, 0.15];
correlations = [1, 0.5, 0.8; 0.5, 1, 0.2; 0.8, 0.2, 1];
gamma = 4;

% Set up the optimization problem
fun = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3) * expected_returns(3
Aeq = [1, 1, 1];
beq = 1;
lb = zeros(3, 1);
ub = ones(3, 1);

% Solve the optimization problem
options = optimoptions('fmincon', 'Display', 'off');
weights_riskless_human = fmincon(fun, [1/3, 1/3, 1/3], [], [], Aeq, beq, lb, ub, [], options);

% Display results
```

```
fprintf('Optimal Weights (Riskless Human Capital): %.2f US, %.2f Japan, %.2f Mexico, %.2f Riskl
```

```
Optimal Weights (Riskless Human Capital): 1.00 US, 0.00 Japan, 0.00 Mexico,
```

```
% Display optimal weights
fprintf('Optimal Weights (Riskless Human Capital): %.2f US, %.2f Japan, %.2f Mexico, %.2f Riskl
```

```
Optimal Weights (Riskless Human Capital): 1.00 US, 0.00 Japan, 0.00 Mexico,
```

```
fprintf('Optimal Weights (Riskless Human Capital): %.2f US, %.2f Japan, %.2f Mexico, %.2f Riskl
```

```
Optimal Weights (Riskless Human Capital): 1.00 US, 0.00 Japan, 0.00 Mexico,
```

```
% Question 2.ii : (ii) Redo part (i) assuming that your human capital is only 20% of your total
% parameters
riskless_return = 0.01;
expected_returns = [0.08, 0.037, 0.06];
volatilities = [0.19, 0.25, 0.15];
correlations = [1, 0.5, 0.8; 0.5, 1, 0.2; 0.8, 0.2, 1];
gamma = 4;

% Set up the optimization problem for 20% risky human capital
fun_risky_human_20 = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3) * exp
Aeq_risky_human_20 = [1, 1, 1];
beq_risky_human_20 = 1;
lb_risky_human_20 = zeros(3, 1);
ub_risky_human_20 = ones(3, 1);

% Solve the optimization problem for 20% risky human capital
options = optimoptions('fmincon', 'Display', 'off');
weights_risky_human_20 = fmincon(fun_risky_human_20, [1/3, 1/3, 1/3], [], [], Aeq_risky_human_2

% Display results
fprintf('Optimal Weights (Risky Human Capital 20%%): %.2f US, %.2f Japan, %.2f Mexico, %.2f Ris
```

```
Optimal Weights (Risky Human Capital 20%): 1.00 US, 0.00 Japan, 0.00 Mexico,
```

```
% Question 2.iii :(iii) Now assume that human capital is risky. To keep things simple (at first
%% (a) If human capital is 20% of your wealth, can you achieve the same Sharpe ratio as in part
%% (b) If human capital is 50% of your wealth, can you achieve the same Sharpe ratio as in part

% parameters for the risky human capital
human_cap_return = 0.08;
human_cap_volatility = 0.19;

% (a) If human capital is 20% of your wealth
fun_risky_human_20_sharpe = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3
Aeq_risky_human_20_sharpe = [1, 1, 1, 0, 0];
beq_risky_human_20_sharpe = 1;
lb_risky_human_20_sharpe = zeros(5, 1);
ub_risky_human_20_sharpe = ones(5, 1);

% Solve the optimization problem for 20% risky human capital
options = optimoptions('fmincon', 'Display', 'off');
weights_risky_human_20_sharpe = fmincon(fun_risky_human_20_sharpe, [1/3, 1/3, 1/3, 0, 0], [], [
```

```
% (b) If human capital is 50% of your wealth
fun_risky_human_50_sharpe = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3
Aeq_risky_human_50_sharpe = [1, 1, 1, 0, 0];
beq_risky_human_50_sharpe = 1;
lb_risky_human_50_sharpe = zeros(5, 1);
ub_risky_human_50_sharpe = ones(5, 1);

% Solve the optimization problem for 50% risky human capital
weights_risky_human_50_sharpe = fmincon(fun_risky_human_50_sharpe, [1/3, 1/3, 1/3, 0, 0], [], [

% Display results
fprintf('Optimal Weights (Risky Human Capital 20%%) to Achieve Same Sharpe Ratio: %.2f US, %.2f
```

```
Optimal Weights (Risky Human Capital 20%) to Achieve Same Sharpe Ratio: 1.00 US, 0.00 Japan, 0.00 Mexico, 1.00 Riskl
```

```
fprintf('Optimal Weights (Risky Human Capital 50%%) to Achieve Same Sharpe Ratio: %.2f US, %.2f
```

```
Optimal Weights (Risky Human Capital 50%) to Achieve Same Sharpe Ratio: 1.00 US, 0.00 Japan, 0.00 Mexico, 1.00 Riskl
```

```
% Display results for 20% risky human capital
fprintf('Optimal Weights (Risky Human Capital 20%%) to Achieve Same Sharpe Ratio: ');
```

```
Optimal Weights (Risky Human Capital 20%) to Achieve Same Sharpe Ratio:
```

```
fprintf('%.2f US, %.2f Japan, %.2f Mexico, %.2f Riskless, %.2f Human Capital\n', weights_risky_
```

```
1.00 US, 0.00 Japan, 0.00 Mexico, 1.00 Riskless,
```

```
% Question 2.iv : (iv) Optional "Challenge" Question: you are not required to answer this quest

% parameters for the risky human capital
human_cap_return = 0.08;
human_cap_volatility = 0.19;

% (a) If human capital is 20% of your wealth
fun_risky_human_20_sharpe = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3
Aeq_risky_human_20_sharpe = [1, 1, 1, 0];
beq_risky_human_20_sharpe = 1;
lb_risky_human_20_sharpe = zeros(4, 1);
ub_risky_human_20_sharpe = ones(4, 1);

% Solve the optimization problem for 20% risky human capital
options = optimoptions('fmincon', 'Display', 'off');
weights_risky_human_20_sharpe = fmincon(fun_risky_human_20_sharpe, [1/3, 1/3, 1/3, 0], [], [],

% (b) If human capital is 50%
fun_risky_human_50_sharpe = @(x) -x(1) * expected_returns(1) - x(2) * expected_returns(2) - x(3
Aeq_risky_human_50_sharpe = [1, 1, 1, 0];
beq_risky_human_50_sharpe = 1;
lb_risky_human_50_sharpe = zeros(4, 1);
ub_risky_human_50_sharpe = ones(4, 1);

% Solve the optimization problem for 50% risky human capital
weights_risky_human_50_sharpe = fmincon(fun_risky_human_50_sharpe, [1/3, 1/3, 1/3, 0], [], [],

% Display results
```

```
fprintf('Optimal Weights (Risky Human Capital 20%%) to Achieve Same Sharpe Ratio: %.2f US, %.2f
```

```
Optimal Weights (Risky Human Capital 20%) to Achieve Same Sharpe Ratio: 1.00 US, 0.00 Japan, 0.00 Mexico, 1.00 Human
```

```
fprintf('Optimal Weights (Risky Human Capital 50%%) to Achieve Same Sharpe Ratio: %.2f US, %.2f
```

```
Optimal Weights (Risky Human Capital 50%) to Achieve Same Sharpe Ratio: 1.00 US, 0.00 Japan, 0.00 Mexico, 1.00 Human
```