APS1022 Project

Part a

Load data

```
data = readtable('monthly_prices_dec_to_june.csv');
dates = data{:,1};
prices = data{:,2:end};
returns = diff(log(prices));  % log returns
```

Estimate parameters

```
mu = mean(returns);                % monthly mean return
Q = cov(returns);                  % monthly covariance matrix
mu_annual = mu * 12;
Q_annual = Q * 12;
```

Obtain risk free rate

```
% Retrieve the actual U.S. risk-free rate for June 2011,
% using the 3-month Treasury Bill rate from FRED, which is
% a standard proxy in portfolio analysis.
c = fred;
data = fetch(c, 'TB3MS', '06/01/2011', '06/30/2011');  % 3-month T-bill
rf = data.Data(end,2) / 100;  % convert % to decimal
```

Compute market mean return using shares and prices data from yfinance

```
% We assume 20 stocks is the market. Since yfinance doesn't provide
historical market caps
% directly, we estimate it by using formula market cap = shares outstanding
* close price,
% where shares and close price are downloaded from yfinance.

% We will use latest shares outstanding with June 2011 prices (given that
float doesn't
% change much month-to-month) because yfinance only gives current shares
outstanding.

T = readtable('price_and_shares_2011.csv');

prices = T.Price_2011_06_30;
shares = T.Shares_Outstanding;
tickers = T.Ticker;
```

```
% Compute Market Capitalizations and Weights
market_caps = prices .* shares;
weights_mktcap = market_caps / sum(market_caps);

r_mkt_series = returns * weights_mktcap;  % full time series of market
return
mean_mkt = mean(r_mkt_series) * 12;       % annualized mean
var_mkt = var(r_mkt_series) * 12;         % annualized variance

lambda_idzorek = (mean_mkt - rf) / var_mkt;
fprintf('lambda = %.4f\n', lambda_idzorek);
```

```
lambda = 0.9588
```

Construct MVO

```
% Assume:
% - mu_annual: 1×n vector of annualized expected returns
% - Q_annual:  n×n annualized covariance matrix
% - lambda_idzorek: scalar
% - n = number of assets
n = length(mu_annual);

% Define MVO objective function
mvo_obj = @(x) lambda_idzorek * (x' * Q_annual * x) - mu_annual * x;

% Constraints
Aeq = ones(1, n);
beq = 1;
lb = [];
ub = [];
x0 = ones(n,1)/n;

% fmincon solver
opts = optimoptions('fmincon','Display','none','Algorithm','sqp');
[x_mvo, fval] = fmincon(mvo_obj, x0, [], [], Aeq, beq, lb, ub, [], opts);

% Display weights
disp('MVO Portfolio Weights:')
```

```
MVO Portfolio Weights:
```

```
disp(array2table(x_mvo', 'VariableNames', tickers'))
```

F	CAT	DIS	MCD	KO	PEP	WMT	C	WFC	JPM
1.2787	-2.3102	6.2093	-2.6341	0.26781	7.7859	0.064815	0.1239	-5.5249	-0.272

```
% Convert weights into table
```

```
x_mvo_table = array2table(x_mvo, 'VariableNames', {'MVO Portfolio
Weights'}, 'RowNames', tickers);
disp(x_mvo_table)
```

```
            MVO Portfolio Weights
            _____________________

    F               1.2787
    CAT            -2.3102
    DIS             6.2093
    MCD            -2.6341
    KO             0.26781
    PEP             7.7859
    WMT           0.064815
    C               0.1239
    WFC            -5.5249
    JPM           -0.27272
    AAPL            2.5689
    IBM             10.703
    PFE           -0.21225
    JNJ            -7.0389
    XOM             1.0108
    COP            -7.9527
    ED            -0.83034
    T              0.27239
    VZ               1.663
    NEM            -4.1725
```

Construct robust MVO with CI = 90%

```
T_obs = size(returns, 1);            % Number of time periods (e.g., 43
months)
alpha = 0.90;                        % 90% confidence level
epsilon = sqrt(chi2inv(alpha, n));  % sqrt of chi-squared critical value

Theta = diag(diag(Q_annual)) / T_obs;

% Set Up Optimization Problem
robust_obj_90 = @(x) lambda_idzorek * (x' * Q_annual * x) ...
                 - mu_annual * x ...
                 + epsilon * norm(sqrtm(Theta) * x, 2);

% Define Constraints
Aeq = ones(1, n);     % sum(x) = 1
beq = 1;
lb = [];     % x >= 0
ub = [];              % no upper bound
x0 = ones(n, 1) / n;  % initial guess: equal weights

% Solve Using fmincon
opts = optimoptions('fmincon', 'Display', 'off', 'Algorithm', 'sqp');

[x_robust_90, fval] = fmincon(robust_obj_90, x0, [], [], Aeq, beq, lb, ub,
[], opts);
```

```
% Display weights
disp('Robust MVO Weights (ellipsoidal, 90%):')
```

Robust MVO Weights (ellipsoidal, 90%):

```
disp(array2table(x_robust_90', 'VariableNames', tickers'))
```

F	CAT	DIS	MCD	KO	PEP	WMT	C	WFC	J
0.21046	-0.48048	0.47218	-0.281	0.1399	0.83847	0.11128	0.83594	-0.64041	-0.

```
% Convert weights into table
x_robust90_table = array2table(x_robust_90, 'VariableNames', {'Robust MVO
Weights (ellipsoidal, 90%)'}, 'RowNames', tickers);
disp(x_robust90_table)
```

	Robust MVO Weights (ellipsoidal, 90%)
F	0.21046
CAT	-0.48048
DIS	0.47218
MCD	-0.281
KO	0.1399
PEP	0.83847
WMT	0.11128
C	0.83594
WFC	-0.64041
JPM	-0.14037
AAPL	0.14656
IBM	2.3092
PFE	-0.076363
JNJ	-1.0619
XOM	0.068733
COP	-0.76324
ED	-0.19051
T	0.10558
VZ	0.32539
NEM	-0.92939

Construct robust MVO with CI = 95%

```
T_obs = size(returns, 1);            % Number of time periods (e.g., 43
months)
alpha = 0.95;                        % 95% confidence level
epsilon = sqrt(chi2inv(alpha, n));  % sqrt of chi-squared critical value

Theta = diag(diag(Q_annual)) / T_obs;

% Set Up Optimization Problem
robust_obj_95 = @(x) lambda_idzorek * (x' * Q_annual * x) ...
                 - mu_annual * x ...
                 + epsilon * norm(sqrtm(Theta) * x, 2);

% Define Constraints
```

```
Aeq = ones(1, n);      % sum(x) = 1
beq = 1;
lb = [];     % x >= 0
ub = [];               % no upper bound
x0 = ones(n, 1) / n;  % initial guess: equal weights

% Solve Using fmincon
opts = optimoptions('fmincon', 'Display', 'off', 'Algorithm', 'sqp');

[x_robust_95, fval] = fmincon(robust_obj_95, x0, [], [], Aeq, beq, lb, ub,
[], opts);

% Display weights
disp('Robust MVO Weights (ellipsoidal, 95%):')
```

```
Robust MVO Weights (ellipsoidal, 95%):
```

```
disp(array2table(x_robust_95', 'VariableNames', tickers'))
```

F	CAT	DIS	MCD	KO	PEP	WMT	C	WFC
0.1869	-0.41518	0.37303	-0.24307	0.12842	0.71352	0.097129	0.76853	-0.50911

```

% Convert weights into table
x_robust95_table = array2table(x_robust_95, 'VariableNames', {'Robust MVO
Weights (ellipsoidal, 95%)'}, 'RowNames', tickers);
disp(x_robust95_table)
```

	Robust MVO Weights (ellipsoidal, 95%)
F	0.1869
CAT	-0.41518
DIS	0.37303
MCD	-0.24307
KO	0.12842
PEP	0.71352
WMT	0.097129
C	0.76853
WFC	-0.50911
JPM	-0.11898
AAPL	0.12869
IBM	1.9892
PFE	-0.061326
JNJ	-0.87527
XOM	0.044912
COP	-0.62815
ED	-0.16204
T	0.078995
VZ	0.29756
NEM	-0.79376

Construct Risk Parity Portfolio

```
% define objective function
```

```
% Q_annual: covariance matrix (n×n)
n = size(Q_annual, 1);

% Objective function: sum of squared deviations from θ
risk_parity_obj = @(z) sum((z(1:n) .* (Q_annual * z(1:n)) - z(end)).^2);

% set constraints
Aeq = [ones(1, n), 0];     % sum(x) = 1
beq = 1;
lb = [zeros(n, 1); -Inf];  % x ≥ 0, θ unrestricted
ub = [];                   % no upper bound
x0 = [ones(n, 1)/n; 0.01]; % initial guess for [x; θ]

% solve Using fmincon
opts = optimoptions('fmincon', 'Display', 'off', 'Algorithm', 'sqp');

[z_opt, fval] = fmincon(risk_parity_obj, x0, [], [], Aeq, beq, lb, ub, [],
opts);
x_risk_parity = z_opt(1:n);    % extract weights

% display portfolio weights
disp('Risk Parity Portfolio Weights:')
```

```
Risk Parity Portfolio Weights:
```

```
disp(array2table(x_risk_parity', 'VariableNames', tickers'))
```

F	CAT	DIS	MCD	KO	PEP	WMT	C	WFC
0.036936	0.013179	0.020277	0.030853	0.036434	0.10024	0.016082	0.061993	0.05834

```
% Convert weights into table
x_rp_table = array2table(x_risk_parity, 'VariableNames', {'Risk Parity
Portfolio Weights'}, 'RowNames', tickers);
disp(x_rp_table)
```

	Risk Parity Portfolio Weights
F	0.036936
CAT	0.013179
DIS	0.020277
MCD	0.030853
KO	0.036434
PEP	0.10024
WMT	0.016082
C	0.061993
WFC	0.058343
JPM	0.034072
AAPL	0.054386
IBM	0.070394
PFE	0.05557
JNJ	0.059023

```
    XOM            0.050083
    COP            0.058521
    ED             0.056296
    T              0.025291
    VZ             0.088359
    NEM            0.073662
```

Construct a portfolio where weights are based on market capitalizations

```
% the weights are already computed above in the section of
% computing market mean return.
% Convert weights into table
x_mkt_table = array2table(weights_mktcap, 'VariableNames', {'Market Cap
Portfolio Weights'}, 'RowNames', tickers);
disp(x_mkt_table)
```

```
            Market Cap Portfolio Weights
            ____________________________

    F              0.023085
    CAT             0.02146
    DIS            0.030081
    MCD            0.025841
    KO             0.062069
    PEP            0.041388
    WMT            0.060743
    C              0.033334
    WFC            0.039137
    JPM            0.048765
    AAPL           0.076743
    IBM            0.065331
    PFE            0.047626
    JNJ            0.068599
    XOM             0.15032
    COP            0.031014
    ED            0.0082216
    T              0.073217
    VZ             0.067279
    NEM            0.025746
```

Compute metrics for each portfolios using July data

```
% load file
P = readtable('monthly_prices_july.csv');
P.Date = datetime(P.Date);  % convert string to datetime

% extract prices
price_0630 = P{P.Date == datetime(2011,7,1), 2:end};  % June 30 prices
price_0731 = P{P.Date == datetime(2011,8,1), 2:end};  % July 29/30 prices

% compute july log returns
r_july = log(price_0731 ./ price_0630)';  % returns as column vector (n×1)

% obtain rf again
% Retrieve the actual U.S. risk-free rate for July 2011,
```

```
% using the 3-month Treasury Bill rate from FRED, which is
% a standard proxy in portfolio analysis.
c = fred;
rf_data = fetch(c, 'TB3MS', '07/01/2011', '07/31/2011');  % 3-month T-bill
rf_july = rf_data.Data(end, 2) / 100;  % convert % to decimal

% define a function to evaluate portfolios
function [ret, var_, std_, sharpe] = eval_portfolio(w, r, rf, Q)
    ret = w' * r;
    var_ = w' * Q * w;
    std_ = sqrt(var_);
    if std_ > 0
        sharpe = (ret - rf) / std_;
    else
        sharpe = NaN;
    end
end

% evaluate portfolios
[ret_mvo, var_mvo, std_mvo, sr_mvo] = eval_portfolio(x_mvo, r_july,
rf_july, Q_annual);
[ret_rob90, var_rob90, std_rob90, sr_rob90] = eval_portfolio(x_robust_90,
r_july, rf_july, Q_annual);
[ret_rob95, var_rob95, std_rob95, sr_rob95] = eval_portfolio(x_robust_95,
r_july, rf_july, Q_annual);
[ret_rp,  var_rp,  std_rp,  sr_rp ] = eval_portfolio(x_risk_parity, r_july,
rf_july, Q_annual);
[ret_mkt, var_mkt, std_mkt, sr_mkt] = eval_portfolio(weights_mktcap,
r_july, rf_july, Q_annual);

% display results
strategy_names = {'MVO', 'Robust MVO 90%', 'Robust MVO 95%', 'Risk Parity',
'Market Cap'};
results = table(strategy_names', ...
    [ret_mvo; ret_rob90; ret_rob95; ret_rp; ret_mkt], ...
    [var_mvo; var_rob90; var_rob95; var_rp; var_mkt], ...
    [std_mvo; std_rob90; std_rob95; std_rp; std_mkt], ...
    [sr_mvo; sr_rob90; sr_rob95; sr_rp; sr_mkt], ...
    'VariableNames', {'Strategy', 'Return', 'Var', 'StdDev',
'SharpeRatio'});

disp('Portfolio Evaluation for July 2011:')
```

```
Portfolio Evaluation for July 2011:
```

```
disp(results)
```

Strategy	Return	Var	StdDev	SharpeRatio
{'MVO' }	1.3445	2.3241	1.5245	0.88167
{'Robust MVO 90%'}	0.21134	0.12179	0.34899	0.60443

```
    {'Robust MVO 95%'}       0.18236    0.095128    0.30843       0.58996
    {'Risk Parity'   }    -0.0042342      0.0266    0.16309     -0.028414
    {'Market Cap'    }     -0.020456    0.045596    0.21353      -0.09767
```

```
%
```

Part b

Load data (Jan 2011 to Nov 2011)

```
prices = readtable('monthly_prices_jan_to_nov.csv');  % must include dates
from Jan 2011 to Dec 2011
T = readtable('price_and_shares_2011.csv');
prices.Date = datetime(prices.Date);            % ensure datetime format
```

Rolling window loop

```
test_months = 7:11;  % July to November
results = [];
c = fred;   % Create FRED connection once
prev_rf = 0.0004;  % Default in case of missing data

for m = test_months
    % Define estimation window: previous 6 months
    start_idx = m - 6;
    end_idx = m - 1;

    % Get estimation window log returns
    price_window = prices{start_idx:end_idx, 2:end};  % exclude date column
    log_returns = diff(log(price_window));            % (5 x 20)

    mu = mean(log_returns);      % monthly mean return
    Q = cov(log_returns);        % monthly covariance
    mu_annual = mu * 12;
    Q_annual = Q * 12;

    % Market cap weights for this month
    % Use price at end of estimation window (i.e., end of month m - 1)
    price_latest = prices{end_idx, 2:end};           % 1×20 row vector
    shares = T.Shares_Outstanding;                   % 20×1 vector
    market_caps = price_latest .* shares';           % 1×20 .* 1×20
(element-wise)
    weights_mktcap = market_caps / sum(market_caps); % normalize to sum to 1

    % Market return and variance
    r_mkt_series = log_returns * weights_mktcap';
    mean_mkt = mean(r_mkt_series) * 12;
    var_mkt = var(r_mkt_series) * 12;
```

```
    % Get risk-free rate for month m-1
    estimation_date = datestr(prices.Date(end_idx), 'mm/dd/yyyy');  % e.g.,
'06/30/2011'
    start_rf = datestr(prices.Date(end_idx - 1), 'mm/dd/yyyy');
    end_rf = datestr(prices.Date(end_idx), 'mm/dd/yyyy');
    rf_data = fetch(c, 'TB3MS', start_rf, end_rf);

    if isempty(rf_data.Data)
        warning('Missing FRED data for %s. Using previous rate.',
estimation_date);
        if m > 7
            rf = prev_rf;
        else
            rf = 0.0004;  % fallback if July has no data
        end
    else
        rf = rf_data.Data(end, 2) / 100;  % convert % to decimal
        prev_rf = rf;
    end

    % compute lambda
    lambda_idzorek = (mean_mkt - rf) / var_mkt;

    % === Solve all 4 portfolios using previous code blocks ===

    % 1. MVO --> x_mvo
    % Assume:
    % - mu_annual: 1×n vector of annualized expected returns
    % - Q_annual:  n×n annualized covariance matrix
    % - lambda_idzorek: scalar
    % - n = number of assets

    n = length(mu_annual);
    e = ones(n, 1);
    mu_vec = mu_annual';

    % Define MVO objective function
    mvo_obj = @(x) lambda_idzorek * (x' * Q_annual * x) - mu_annual * x;

    % Constraints
    Aeq = ones(1, n);
    beq = 1;
    lb = zeros(n,1);
    ub = [];
    x0 = ones(n,1)/n;

    % fmincon solver
    opts = optimoptions('fmincon','Display','off','Algorithm','sqp');
    [x_mvo, fval] = fmincon(mvo_obj, x0, [], [], Aeq, beq, lb, ub, [],
opts);
```

```
    % 2. Robust MVO with CI=90% --> x_robust_90
    T_obs = size(log_returns, 1);            % Number of time periods
(e.g., 43 months)
    alpha = 0.90;                         % 90% confidence level
    epsilon_rob90 = sqrt(chi2inv(alpha, n));  % sqrt of chi-squared
critical value

    Theta = diag(diag(Q_annual)) / T_obs;

    % Set Up Optimization Problem
    robust_obj_90 = @(x) lambda_idzorek * (x' * Q_annual * x) ...
                    - mu_annual * x ...
                    + epsilon_rob90 * norm(sqrtm(Theta) * x, 2);

    % Define Constraints
    Aeq = ones(1, n);     % sum(x) = 1
    beq = 1;
    lb = zeros(n, 1);     % x >= 0
    ub = [];              % no upper bound
    x0 = ones(n, 1) / n;  % initial guess: equal weights

    % Solve Using fmincon
    opts = optimoptions('fmincon', 'Display', 'off', 'Algorithm', 'sqp');

    [x_robust_90, fval] = fmincon(robust_obj_90, x0, [], [], Aeq, beq, lb,
ub, [], opts);

    % 3. Robust MVO with CI=95% --> x_robust_95
    alpha = 0.95;                         % 95% confidence level
    epsilon_rob95 = sqrt(chi2inv(alpha, n));  % sqrt of chi-squared
critical value

    Theta = diag(diag(Q_annual)) / T_obs;

    % Set Up Optimization Problem
    robust_obj_95 = @(x) lambda_idzorek * (x' * Q_annual * x) ...
                    - mu_annual * x ...
                    + epsilon_rob95 * norm(sqrtm(Theta) * x, 2);
    % Solve Using fmincon
    [x_robust_95, fval] = fmincon(robust_obj_95, x0, [], [], Aeq, beq, lb,
ub, [], opts);

    % 4. Risk Parity --> x_risk_parity
    % define objective function

    % Q_annual: covariance matrix (n×n)
    n = size(Q_annual, 1);

    % Objective function: sum of squared deviations from θ
```

```
    risk_parity_obj = @(z) sum((z(1:n) .* (Q_annual * z(1:n)) - z(end)).^2);

    % set constraints
    Aeq_rp = [ones(1, n), 0];     % sum(x) = 1
    beq_rp = 1;
    lb_rp = [zeros(n, 1); -Inf];  % x ≥ 0, θ unrestricted
    ub_rp = [];                   % no upper bound
    x0_rp = [ones(n, 1)/n; 0.01]; % initial guess for [x; θ]

    % solve Using fmincon
    [z_opt, fval] = fmincon(risk_parity_obj, x0_rp, [], [], Aeq_rp, beq_rp,
lb_rp, ub_rp, [], opts);
    x_risk_parity = z_opt(1:n);    % extract weights

    % 5. Market Cap --> weights_mktcap
    % the weights are already computed above
    weights_mktcap = weights_mktcap';

    % ==== Evaluate on next month ====
    price_start = prices{m, 2:end};
    price_end = prices{m+1, 2:end};
    r_test = log(price_end ./ price_start)';

    % Store performance
    [r1, v1, s1, sh1] = eval_portfolio(x_mvo, r_test, rf, Q_annual);
    [r2, v2, s2, sh2] = eval_portfolio(x_robust_90, r_test, rf, Q_annual);
    [r3, v3, s3, sh3] = eval_portfolio(x_robust_95, r_test, rf, Q_annual);
    [r4, v4, s4, sh4] = eval_portfolio(x_risk_parity, r_test, rf, Q_annual);
    [r5, v5, s5, sh5] = eval_portfolio(weights_mktcap, r_test, rf,
Q_annual);

    results = [results;
        r1, v1, s1, sh1;
        r2, v2, s2, sh2;
        r3, v3, s3, sh3;
        r4, v4, s4, sh4;
        r5, v5, s5, sh5];

end
```

Display results

```
methods = repmat(["MVO"; "Robust MVO 90% CI"; "Robust MVO 95% CI"; "Risk
Parity"; "Market Cap"], 5, 1);
months = repelem(["July", "August", "September", "October", "November"]',
5);

T_result = array2table(results, ...
    'VariableNames', {'Return', 'Variance', 'StdDev', 'Sharpe'});
T_result.Method = methods;
```

```
T_result.Month = months;

T_result = movevars(T_result, {'Month', 'Method'}, 'Before', 'Return');
format shortG
disp(T_result)
```

Month	Method	Return	Variance	StdDev	Sharpe
"July"	"MVO"	0.026428	0.0004283	0.020695	1.2577
"July"	"Robust MVO 90% CI"	0.030605	0.00020532	0.014329	2.1079
"July"	"Robust MVO 95% CI"	0.030588	0.00020231	0.014223	2.1224
"July"	"Risk Parity"	-0.00030617	0.0010824	0.032899	-0.021465
"July"	"Market Cap"	-0.011711	0.0056892	0.075427	-0.16056
"August"	"MVO"	-0.022324	0.0015681	0.0396	-0.57385
"August"	"Robust MVO 90% CI"	-0.018736	0.0012116	0.034808	-0.54975
"August"	"Robust MVO 95% CI"	-0.018601	0.0012015	0.034662	-0.54816
"August"	"Risk Parity"	-0.043215	0.0013885	0.037263	-1.1705
"August"	"Market Cap"	-0.054255	0.004846	0.069613	-0.78512
"September"	"MVO"	0.064476	0.060139	0.24523	0.2621
"September"	"Robust MVO 90% CI"	0.055696	0.00084714	0.029106	1.9067
"September"	"Robust MVO 95% CI"	0.055696	0.00084714	0.029106	1.9067
"September"	"Risk Parity"	0.053925	0.00018172	0.01348	3.9855
"September"	"Market Cap"	0.072202	0.0048688	0.069777	1.0319
"October"	"MVO"	-0.10668	0.078635	0.28042	-0.3808
"October"	"Robust MVO 90% CI"	-0.10668	0.078635	0.28042	-0.3808
"October"	"Robust MVO 95% CI"	-0.10668	0.078635	0.28042	-0.3808
"October"	"Risk Parity"	0.0085666	0.00097998	0.031305	0.27046
"October"	"Market Cap"	0.0056897	0.0041564	0.06447	0.086703
"November"	"MVO"	-0.13785	0.04649	0.21561	-0.64028
"November"	"Robust MVO 90% CI"	0.021506	0.0055173	0.074279	0.28683
"November"	"Robust MVO 95% CI"	0.021901	0.0053437	0.0731	0.29686
"November"	"Risk Parity"	0.033902	0.0043648	0.066066	0.51013
"November"	"Market Cap"	0.0051989	0.024016	0.15497	0.032257

Part c

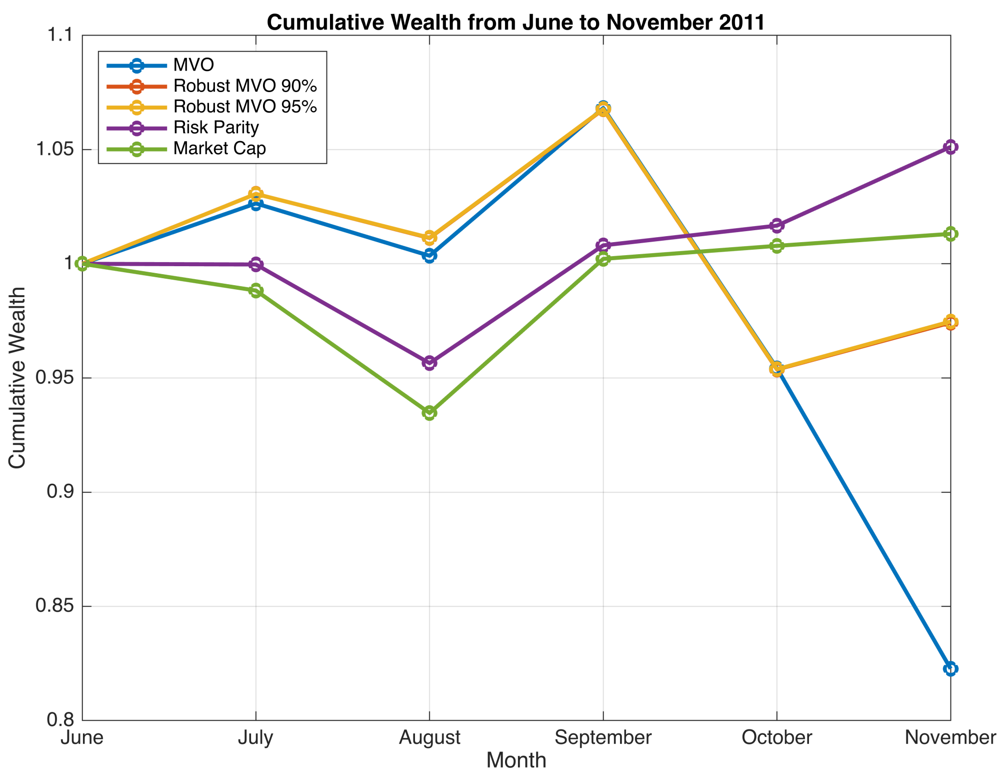
Extract returns and Sharpe ratios

```
% Extract monthly returns (reshape to 5 portfolios x 5 months)
returns = reshape(results(:,1), [5, 5]);     % 5 portfolios × 5 months
(July–Nov)
stds    = reshape(results(:,3), [5, 5]);     % corresponding StdDevs

% Compute cumulative wealth over June–Nov
% Start from June 30 prices → apply July return first
W0 = ones(5, 1);                         % Initial wealth = 1 for all portfolios
wealth = zeros(5, 6);
wealth(:,1) = W0;

for t = 1:5
    wealth(:,t+1) = wealth(:,t) .* (1 + returns(:,t));  % recursively
multiply
end

% Compute Sharpe ratios
```

```
sharpe = returns ./ stds;
```

Plot cumulative wealth

```
% Plot cumulative wealth from June to November
months = ["June", "July", "August", "September", "October", "November"];
methods = ["MVO", "Robust MVO 90%", "Robust MVO 95%", "Risk Parity",
"Market Cap"];

plot(wealth', '-o', 'LineWidth', 2)
legend(methods, 'Location', 'northwest')
xlabel('Month')
ylabel('Cumulative Wealth')
xticks(1:6)
xticklabels(months)
title('Cumulative Wealth from June to November 2011')
grid on
```



Plot Sharpe ratios

```
plot(sharpe', '-o', 'LineWidth', 2)
legend(methods, 'Location', 'northwest')
xlabel('Month')
ylabel('Sharpe Ratio (no rf)')
xticks(1:5)
xticklabels(["July", "August", "September", "October", "November"])
```

```
title('Monthly Sharpe Ratios (No Risk-Free Rate)')
grid on
```