ALMA MATER STUDIORUM, UNIVERSITÀ DI BOLOGNA

Statistical Sciences Department
Second Cycle Degree in Quantitative Finance

Economics of Financial Markets
Take Home Exam

January 20th - 27th, 2025

QUESTION 1: ASSET ALLOCATION PROBLEM - STOCKS

using MATLAB and EXCEL

GROUP 1
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Resources

Github Repository (Scritps, Databases, Excel Model “Portfolio Management”)

https://github.com/tommasozeri/Economics-Of-Financial-Markets-exam-2025-code

Disclaimer

- Some scripts are duplicated (for example, one script specifically for NYSE stocks and another for Nasdaq stocks, or one script for daily frequency data and another for monthly frequency data), while others are single and only change the input data. The scripts in this document represent only a portion of the total code actually written for the exam, which can be found in the Github repository
- The data with NaN values were handled by taking the arithmetic mean of the known values.

Abstract

This report presents all the results of the MATLAB scripts developed for Question 1, illustrating the code, the results from the Command Window, and the relevant figures for each question. The analysis was primarily conducted using MATLAB, complemented by an Excel model specifically developed to analyze individual securities in detail and facilitate comparisons. The focus of the analysis is on the construction of various types of portfolios.
The first portfolio (**Min Risk**) aims to minimize risk while maintaining returns above a certain threshold.
The second (**Min Risk Max Ret**) seeks to minimize risk and simultaneously maximize returns.
The third (**HRP**) is constructed using the Hierarchical Risk Parity model (from which HRP), while the fourth (**Max Sharpe Ratio**) focuses on maximizing the Sharpe ratio.
The fifth portfolio is built following the **Black-Litterman** approach, and the last one (**GMVP**, Global Minimum Variance Portfolio) is designed to minimize variance.
All analyses were conducted based on two main databases: one derived from NASDAQ and the other from NYSE.

Key statistics

Throughout the report, the following key statistical metrics are extensively utilized.

$$\textbf{Portfolio Mean} = \sum_{i=1}^{n}(w_i \times R_i)$$

- w_i: The weight of asset i in the portfolio, which represents the proportion of capital invested in that asset.
- R_i: The expected return of asset i.
- The summation $\sum_{i=1}^{n}$ aggregates the contributions of all n assets in the portfolio.
- This formula provides the weighted average return of the portfolio, taking into account the relative allocation to each asset.

$$\textbf{Portfolio Variance} = \mathbb{E}\left[\sum_{i=1}^{n}\left(w_i \times (\tilde{R}_i - \mu_i)\right)\right]^2$$

- w_i: The weight of asset i in the portfolio, as defined above.
- $\tilde{R}_i$: The realized (or stochastic) return of asset i, which can deviate from its expected return.
- μ_i: The expected return of asset i.
- $\mathbb{E}$: The expectation operator, denoting the mean or expected value of the quantity enclosed.
- This formula measures the portfolio variance, capturing the total risk arising from the volatility of returns across all assets in the portfolio.

$$\textbf{Portfolio Skewness} = \frac{\sum_{i=1}^{n}\left(w_i^3 \times \mathrm{Skew}(R_i)\right)}{\left(\sum_{i=1}^{n} w_i^2\right)^{3/2}}$$

- w_i^3: The cube of the weight of asset i, which increases the relative influence of more heavily weighted assets in the portfolio.
- $\mathrm{Skew}(R_i)$: The skewness coefficient of the return of asset i. This measures the asymmetry of the return distribution.
  - Positive skewness indicates a distribution with a longer tail on the right, meaning more extreme positive returns.
  - Negative skewness implies a longer tail on the left, suggesting more extreme negative returns.
- The denominator $\left(\sum_{i=1}^{n} w_i^2\right)^{3/2}$: Normalizes the overall portfolio skewness to provide a consistent measure.
- This formula computes the asymmetry of the portfolio's return distribution, which is important for understanding deviations from normality.

$$\textbf{Portfolio Kurtosis} = \frac{\sum_{i=1}^{n}\left(w_i^4 \times \mathrm{Kurt}(R_i)\right)}{\left(\sum_{i=1}^{n} w_i^2\right)^{2}}$$

- w_i^4: The fourth power of the weight of asset i, assigning greater importance to dominant assets in the portfolio.
- $\mathrm{Kurt}(R_i)$: The kurtosis coefficient of the return of asset i. This measures the "tailedness" or extremity of the return distribution compared to a normal distribution.
  - Higher kurtosis indicates heavier tails, meaning a higher likelihood of extreme returns (both positive and negative).
  - Lower kurtosis suggests lighter tails, where extreme returns are less likely.
- The denominator $\left(\sum_{i=1}^{n} w_i^2\right)^{2}$: Normalizes the kurtosis for the portfolio.
- This formula provides a measure of the portfolio's return distribution shape, with particular emphasis on the presence of outliers and extreme values.

QUESTION 1 & 2 : NASDAQ DAILY STATISTICS

Presented below is the code used to answer this question.

```matlab
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheet = 'nasdaq daily';

% Carica il file Excel
opts = detectImportOptions(filename, 'Sheet', sheet);
opts.VariableNamingRule = 'preserve';
data = readtable(filename, opts);

% Visualizza i dati
disp(data);

% Estrai le date e i ticker
dates = data{:, 1};
tickers = data.Properties.VariableNames(2:end);

% Converti i dati delle celle in valori numerici se necessario
for i = 2:width(data)
    if iscell(data{:, i})
        data{:, i} = str2double(data{:, i});
    end
end

% Calcola i rendimenti giornalieri
returns = diff(log(data{:, 2:end}));

% Inizializza le variabili per i risultati
mean_values = mean(returns);
variance_values = var(returns);
std_dev_values = std(returns);
skewness_values = skewness(returns);
kurtosis_values = kurtosis(returns);

% Crea una tabella con i risultati
results = table(tickers', mean_values', variance_values', std_dev_values', skewness_values',
kurtosis_values', ...
    'VariableNames', {'Ticker', 'Mean', 'Variance', 'StandardDeviation', 'Skewness', 'Kurtosis'});

% Visualizza i risultati
disp(results);

%% GRAFICI ---------------------------------------------------------------------------------------------
----------------------------------------------------------

% Crea i grafici per ogni categoria
figure;
bar(mean_values);
title('Mean');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(variance_values);
title('Variance');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(std_dev_values);
title('Standard Deviation');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(skewness_values);
title('Skewness');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(kurtosis_values);
title('Kurtosis');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

% Aggiusta la dimensione della figura
set(gcf, 'Position', [100, 100, 1200, 800]);

% Visualizza i grafici
sgtitle();
```

QUESTION 1 & 2 : NASDAQ DAILY STATISTICS

The command window results display a table with all the statistics for each asset.

The mean represents the average return of the asset, the standard deviation is a measure of the volatility of the asset's returns, and skewness indicates the asymmetry of the return distribution relative to the mean. If skewness is positive, extreme gains are more likely; if it is negative, extreme losses are more probable.

Kurtosis measures the concentration and the tails of the return distribution. High kurtosis indicates heavier tails, meaning extreme events are more frequent compared to a normal distribution, whereas low kurtosis implies that extreme events are less likely.

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosi:
{'APPLE'}	0.00085524	0.00038364	0.019587	-0.10088	8.6475
{'NVIDIA'}	0.0023773	0.0011014	0.033187	0.13931	6.6441
{'MICROSOFT'}	0.00073122	0.00035633	0.018877	-0.28065	10.905
{'AMAZON.COM'}	0.00064661	0.00049486	0.022246	-0.13373	7.3208
{'META PLATFORMS A'}	0.00079559	0.00078972	0.028102	-1.2427	26.877
{'TESLA'}	0.0019282	0.0017212	0.041487	-0.10126	6.4287
{'ALPHABET 'A''}	0.00075765	0.00040448	0.020112	-0.2248	6.9755
{'BROADCOM'}	0.0015436	0.00066609	0.025809	0.0082536	14.851
{'COSTCO WHOLESALE'}	0.00087975	0.00022311	0.014937	-0.3669	12.659
{'NETFLIX'}	0.00071604	0.00083944	0.028973	-2.6794	46.868
{'T-MOBILE US'}	0.00075389	0.00028726	0.016949	0.03392	12.245
{'CISCO SYSTEMS'}	0.00016874	0.00028795	0.016969	-0.84804	17.456
{'ADVANCED MICRO DEVICES'}	0.00067379	0.0010534	0.032456	-0.039628	5.273
{'LINDE (NYS)'}	0.00052376	0.00025706	0.016033	-0.12552	10.461
{'INTUITIVE SURGICAL'}	0.00077328	0.00048274	0.021971	-0.1691	11.276
{'PEPSICO'}	4.4856e-05	0.00018826	0.013721	-0.62711	24.694
{'ADOBE (NAS)'}	0.00013622	0.00058805	0.02425	-0.79832	12.293
{'QUALCOMM'}	0.00042408	0.00065689	0.02563	-0.087225	7.248
{'COMCAST A'}	-0.00016303	0.00031542	0.01776	-0.2743	9.338
{'PALO ALTO NETWORKS'}	0.0011308	0.00069419	0.026348	-1.5226	28.007
{'INTUIT'}	0.00062648	0.00053935	0.023224	-0.055245	8.7771
{'GILEAD SCIENCES'}	0.00024799	0.00026195	0.016185	0.4816	10.891
{'STARBUCKS'}	1.756e-05	0.00043513	0.02086	0.35055	23.505
{'MARVELL TECHNOLOGY'}	0.0011202	0.0011252	0.033544	0.56036	9.2354
{'INTEL'}	-0.00086147	0.00074978	0.027382	-1.4826	20.24
{'APPLOVIN A'}	0.0011979	0.0015389	0.039228	1.5719	16.608
{'CADENCE DESIGN SYS.'}	0.0010801	0.00052288	0.022867	0.02004	6.5455
{'CME GROUP'}	8.5169e-05	0.00030959	0.017595	-1.6223	27.776
{'CINTAS'}	0.00076551	0.00037609	0.019393	-0.95871	19.162
{'MARRIOTT INTL.'A''}	0.00047649	0.00059577	0.024408	0.13419	11.372
{'MONDELEZ INTERNATIONAL CL.A'}	2.7742e-05	0.00018759	0.013696	-0.23224	15.894
{'REGENERON PHARMS.'}	0.00046187	0.00035982	0.018969	0.44611	11.801
{'SYNOPSYS'}	0.00091897	0.00051209	0.022629	-0.18303	6.9212
{'O REILLY AUTOMOTIVE'}	0.00077279	0.00029644	0.017217	-1.2723	20.211
{'CSX'}	0.00020082	0.00032934	0.018148	-0.39594	16.854
{'AIRBNB A'}	-5.8296e-05	0.00074515	0.027298	-0.079748	6.7005
{'COINBASE GLOBAL A'}	0.00037124	0.0026506	0.051484	2.1798	34.969
{'COPART'}	0.00064986	0.00035818	0.018926	-0.11246	12.504
{'PACCAR'}	0.00055176	0.00029357	0.017134	0.24865	10.247
{'ROPER TECHNOLOGIES'}	0.00023415	0.0002529	0.015903	-0.7113	13.543
{'ROSS STORES'}	0.00017524	0.00055675	0.023596	-1.1309	24.811
{'WORKDAY CLASS A'}	0.00025037	0.00062891	0.025078	0.15557	8.8605
{'BAKER HUGHES A'}	0.0004245	0.00075873	0.027545	-0.33417	13.55
{'CHARTER COMMS.CL.A'}	-0.0003148	0.00047874	0.02188	-0.86716	15.151
{'MONSTER BEVERAGE'}	0.00032211	0.00027577	0.016606	-0.18994	8.9112
{'NXP SEMICONDUCTORS'}	0.00035766	0.00073145	0.027045	-0.37822	9.3495
{'COGNIZANT TECH.SLTN.'A''}	0.00016612	0.00038502	0.019622	-0.81826	18.478
{'EXELON'}	9.4172e-05	0.00032034	0.017898	-0.24276	22.281
{'GE HEALTHCARE TECHNOLOGIES'}	6.334e-05	0.00019162	0.013843	-5.6988	119.88
{'KRAFT HEINZ'}	-5.6711e-05	0.00028742	0.016953	-0.16967	23.188
{'UNITED AIRLINES HOLDINGS'}	0.00015662	0.0014744	0.038398	-0.62384	15.508
{'WILLIS TOWERS WATSON'}	0.00032409	0.00028862	0.016989	-0.072699	13.49
{'EBAY'}	0.00048731	0.00042311	0.02057	-0.35428	6.6186
{'IDEXX LABORATORIES'}	0.00030266	0.00046054	0.02146	-0.15146	6.1892
{'MICROCHIP TECH.'}	-3.1177e-06	0.00075563	0.027489	-0.38741	9.4577
{'WARNER BROS DISCOVERY SERIES A'}	-0.00091104	0.0011638	0.034115	-0.89529	11.384
{'T ROWE PRICE GROUP'}	-0.00012306	0.00046422	0.021546	0.065576	10.975
{'BIOGEN'}	-0.00052823	0.00073979	0.027199	3.3446	77.974
{'CARLYLE GROUP'}	0.00035797	0.00068342	0.026142	-0.67464	11.998
{'DOMINO'S PIZZA'}	0.00025328	0.00040642	0.02016	0.95391	22.115
{'EXPEDIA GROUP'}	0.00037344	0.00096788	0.031111	-0.43818	13.854
{'INTERACTIVE BROKERS GROUP A'}	0.0010264	0.00044002	0.020977	0.042817	7.1218
{'CYBER ARK SOFTWARE'}	0.00070939	0.00082554	0.028732	-0.23279	7.2035
{'STEEL DYNAMICS'}	0.00097269	0.00074778	0.027346	-0.19023	10.247
{'SBA COMMS.'}	-0.00018323	0.000378	0.019442	0.1105	6.3512
{'ASPEN TECHNOLOGY'}	0.00045259	0.00063151	0.02513	-0.46142	27.237
{'BENTLEY SYSTEMS B'}	-1.0951e-05	0.00059975	0.02449	-1.9872	30.211
{'AKAMAI TECHS.'}	-3.8646e-05	0.00034748	0.018641	-1.1195	14.039
{'MODERNA'}	0.00060676	0.0021045	0.045875	0.25792	6.6298
{'MATTEL'}	0.00021717	0.00055551	0.023569	-0.038905	8.553
{'MORNINGSTAR'}	0.00054249	0.00035521	0.018847	-0.26144	8.7906
{'QUANTUM COMPUTING'}	0.0011902	0.0072401	0.085089	1.1299	14.884
{'REGENCY CENTERS'}	8.107e-05	0.00053627	0.023158	0.60353	38.828
{'ROYALTY PHARMA A'}	-0.00016498	0.00030405	0.017437	1.3317	18.746
{'ROCKET LAB USA A'}	0.00093214	0.0016012	0.040016	1.0751	12.755
{'TRIPADVISOR 'A''}	-0.0005762	0.0012795	0.03577	-0.52371	13.566
{'ABVC BIOPHARMA'}	-0.0033523	0.0054	0.073485	0.91194	32.121
{'ACCELERATE DIAGNOSTICS'}	-0.0038543	0.0045153	0.067196	-0.85673	20.53
{'ASTROTECH'}	-0.0017587	0.0033468	0.057852	8.7306	195.54
{'ORAMED PHARMACEUTICALS'}	-0.00058976	0.0039804	0.06309	-9.0002	215.41
{'VIMEO'}	-0.00041665	0.0033626	0.057988	17.857	518.04

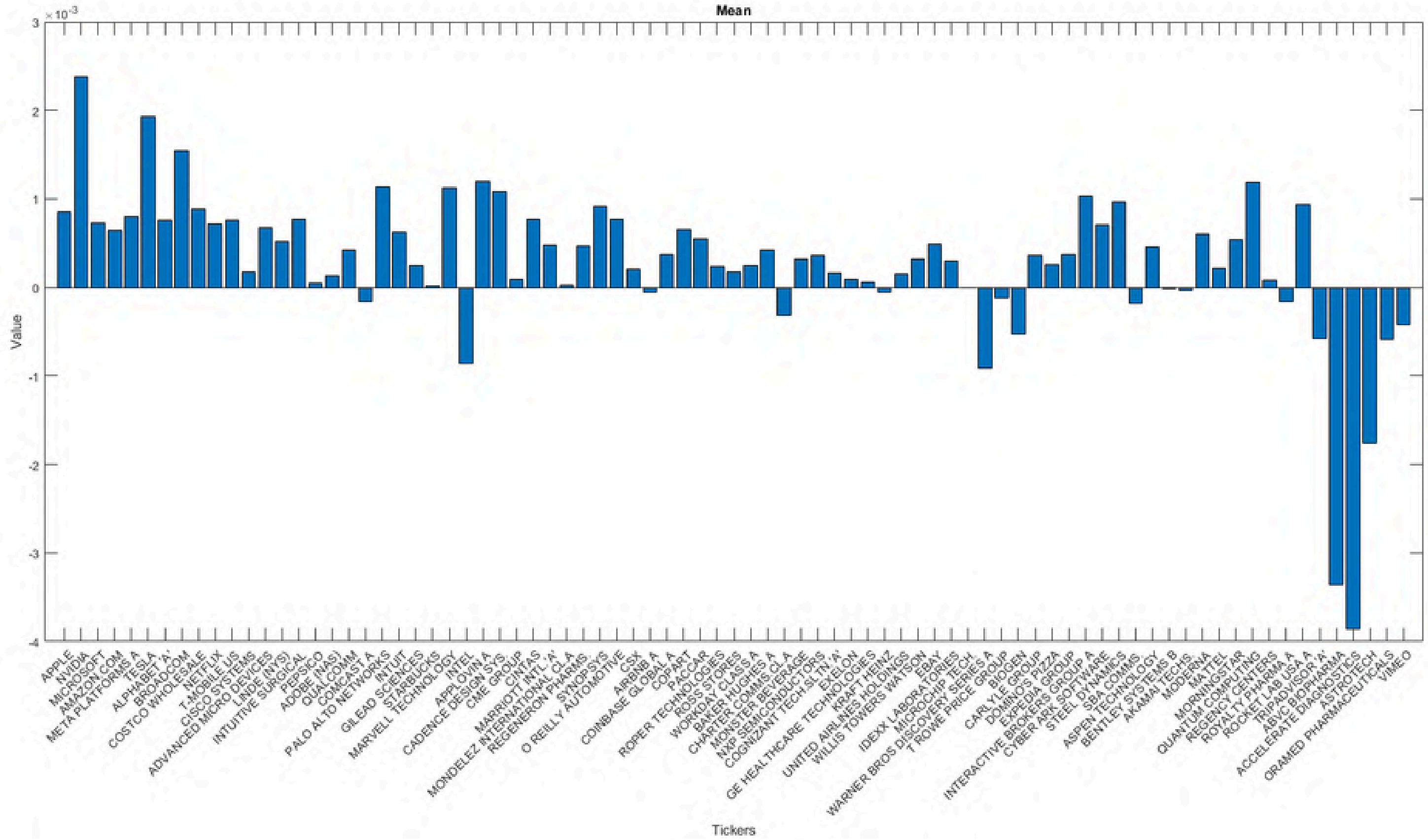
The following chart displays the securities with the maximum and minimum of each statistic.

```
Statistiche migliori e peggiori:
Media: Max = NVIDIA (0.0024), Min = ACCELERATE DIAGNOSTICS (-0.0039)
Varianza: Max = QUANTUM COMPUTING (0.0072), Min = MONDELEZ INTERNATIONAL CL.A (0.0002)
Deviazione Standard: Max = QUANTUM COMPUTING (0.0851), Min = MONDELEZ INTERNATIONAL CL.A (0.0137)
Skewness: Max = VIMEO (17.8567), Min = ORAMED PHARMACEUTICALS (-9.0002)
Curtosi: Max = VIMEO (518.0356), Min = ADVANCED MICRO DEVICES (5.2730)
```

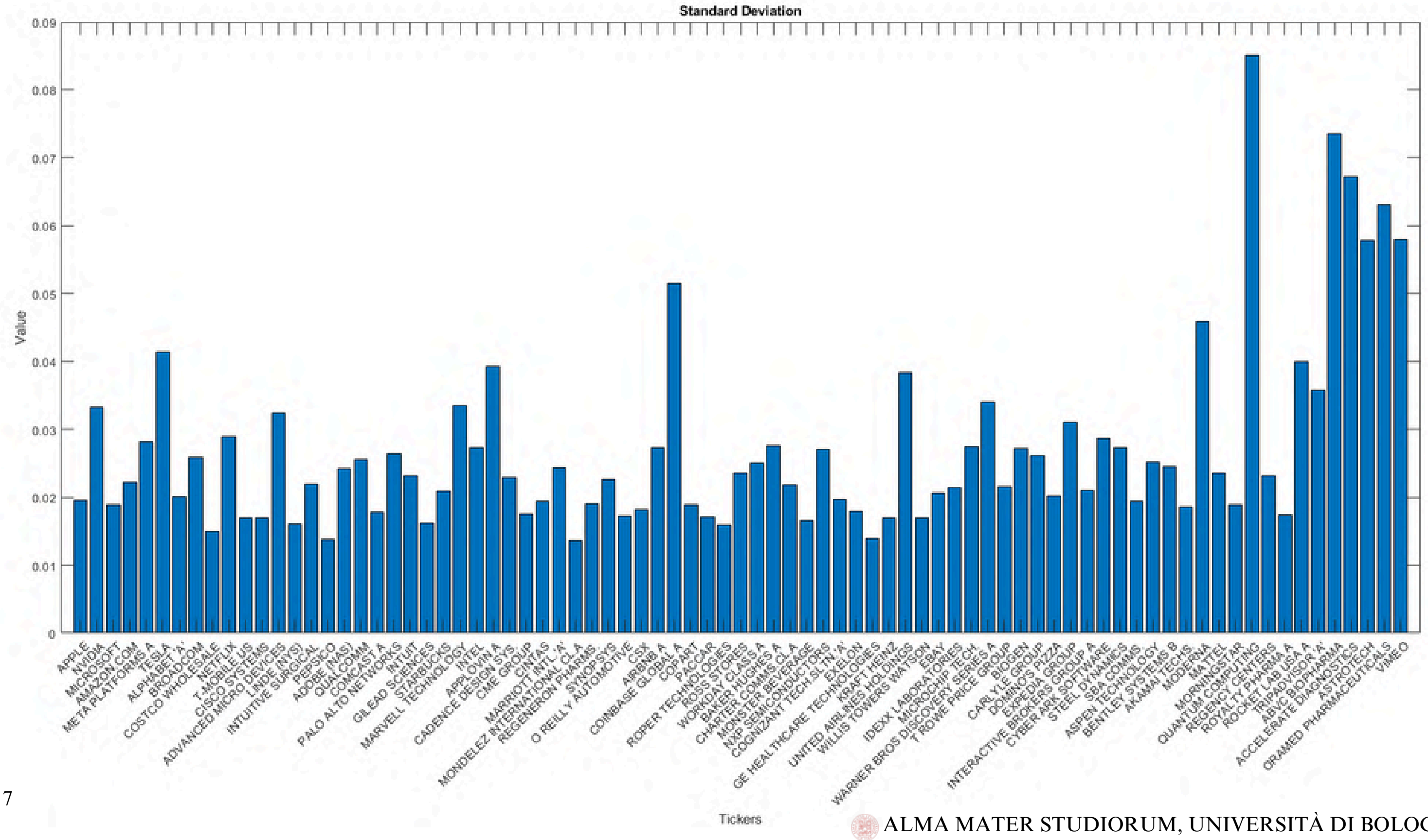
QUESTION 1 & 2 : NASDAQ DAILY STATISTICS

Presented below are the histograms related to the statistics. It can be noted that the stock with the best performance was NVIDIA (0.0024), while ACCELERATE DIAGNOSTIC (-0.0039) had the worst performance. Regarding standard deviation, the stock with the lowest risk was MONDELEZ INTERNATIONAL (0.0137), while the one with the highest risk was QUANTUM COMPUTING (0.0851). The stock with the highest skewness was VIMEO (17.85), while the one with the lowest skewness was ORAMED (-9.0002). Regarding kurtosis, VIMEO has the highest kurtosis, while ADVANCED MICRO DEVICES has the lowest.

MEAN

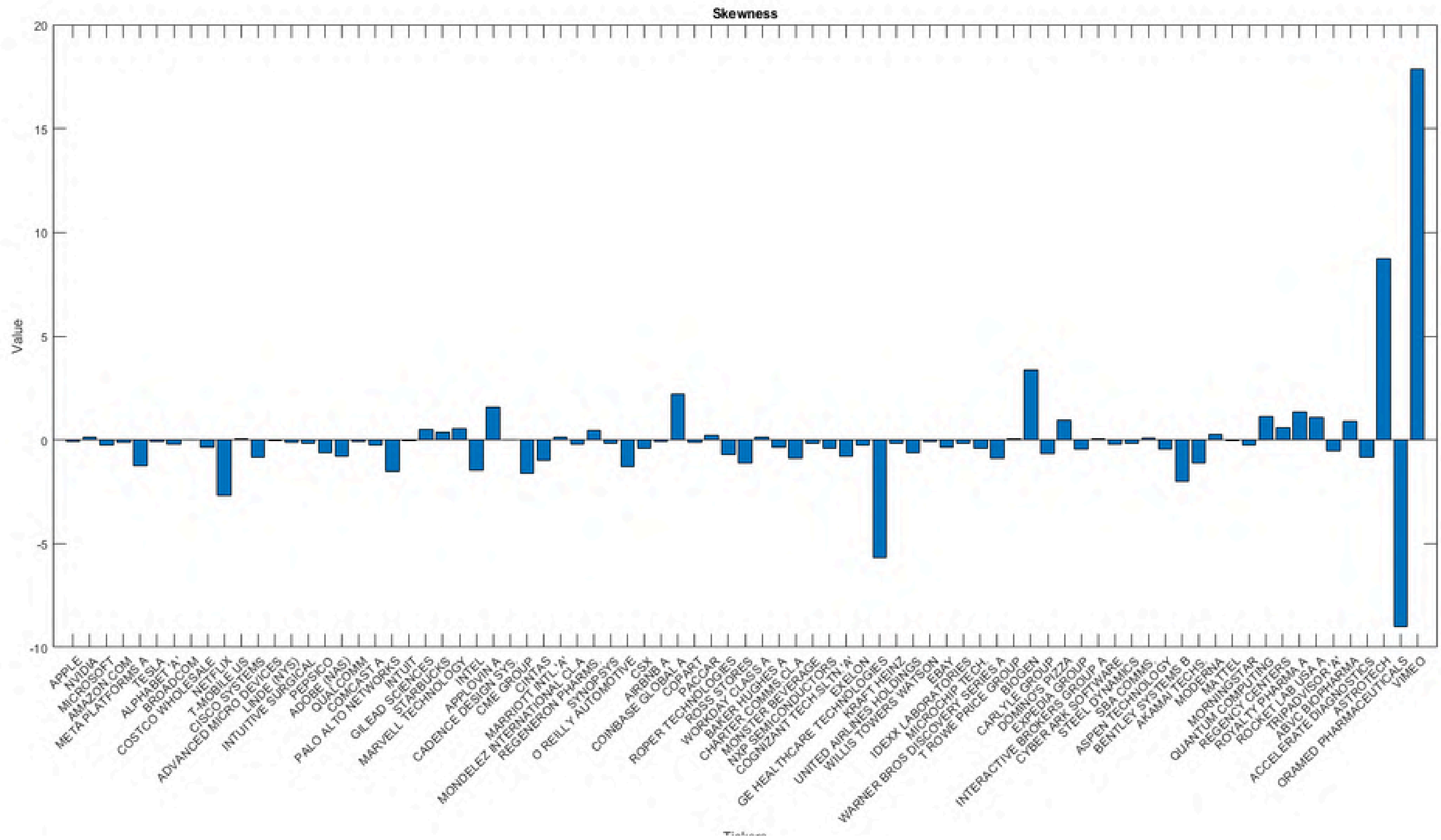


STANDARD DEVIATION

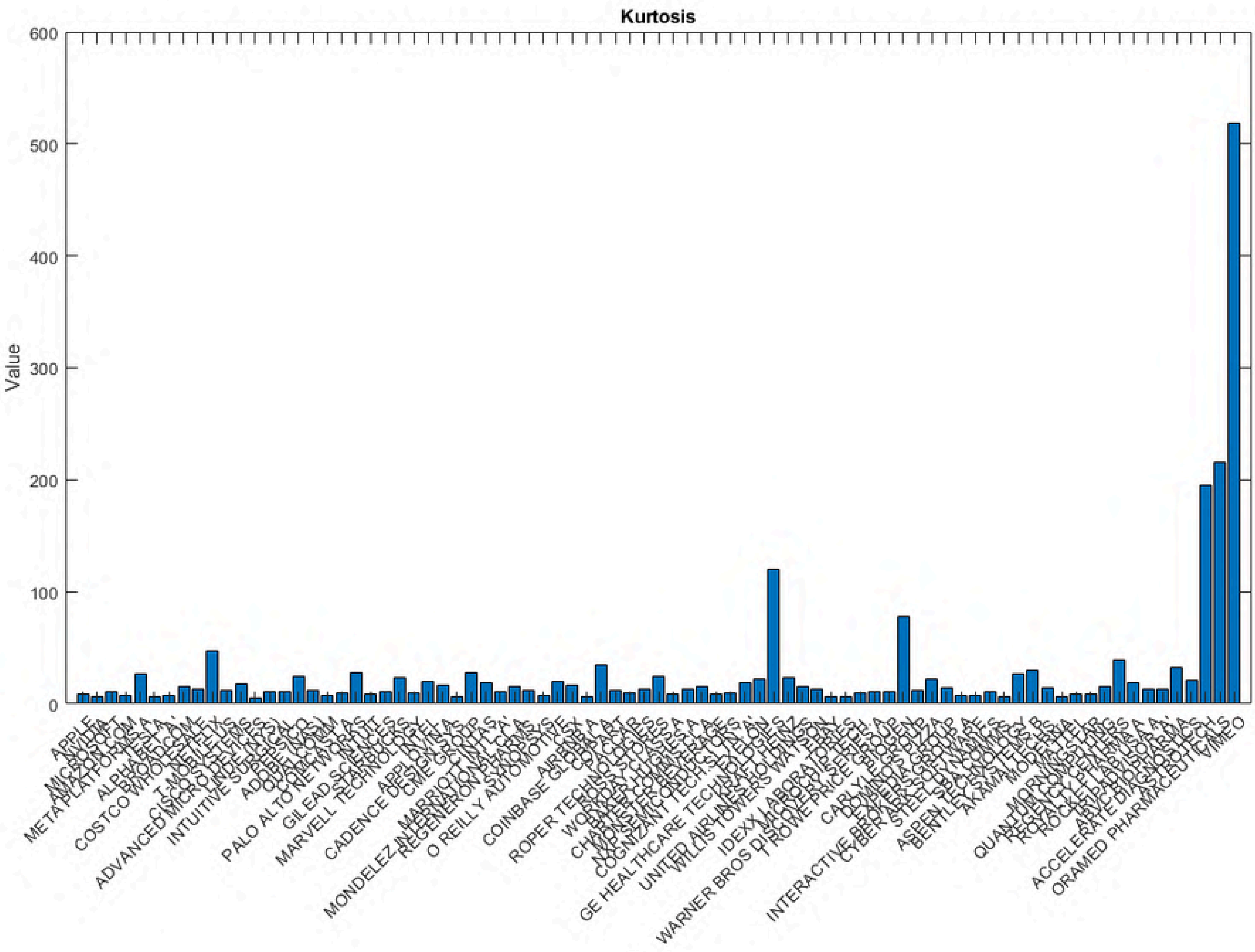


QUESTION 1 & 2 : NASDAQ DAILY STATISTICS

SKEWNESS



KURTOSIS



QUESTION 1 & 2 : NASDAQ MONTHLY STATISTICS

Presented below is the code used to answer this question.

```matlab
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheet = 'nasdaq monthly';

% Carica il file Excel
opts = detectImportOptions(filename, 'Sheet', sheet);
opts.VariableNamingRule = 'preserve';
data = readtable(filename, opts);

% Visualizza i dati
disp(data);

% Estrai le date e i ticker
dates = data{:, 1};
tickers = data.Properties.VariableNames(2:end);

% Calcola i rendimenti mensili
returns = diff(log(data{:, 2:end}));

% Inizializza le variabili per i risultati
mean_values = zeros(1, length(tickers));
variance_values = zeros(1, length(tickers));
std_dev_values = zeros(1, length(tickers));
skewness_values = zeros(1, length(tickers));
kurtosis_values = zeros(1, length(tickers));

% Calcola le statistiche per ogni ticker
for i = 1:length(tickers)
    mean_values(i) = mean(returns(:, i));
    variance_values(i) = var(returns(:, i));
    std_dev_values(i) = std(returns(:, i));
    skewness_values(i) = skewness(returns(:, i));
    kurtosis_values(i) = kurtosis(returns(:, i));
end

% Crea una tabella con i risultati
results = table(tickers', mean_values', variance_values', std_dev_values', skewness_values',
kurtosis_values', ...
    'VariableNames', {'Ticker', 'Mean', 'Variance', 'StandardDeviation', 'Skewness', 'Kurtosis'});

% Visualizza i risultati
disp(results);

%% GRAFICI ------------------------------------------------------------------------------------------
-----------------------------------------------------------

% Crea i grafici per ogni categoria
figure;
bar(mean_values);
title('Mean');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(variance_values);
title('Variance');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(std_dev_values);
title('Standard Deviation');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(skewness_values);
title('Skewness');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(kurtosis_values);
title('Kurtosis');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

% Aggiusta la dimensione della figura
set(gcf, 'Position', [100, 100, 1200, 800]);

% Visualizza i grafici
sgtitle();
urn go(f, seed, [])
}
```

QUESTION 1 & 2 : NASDAQ MONTHLY STATISTICS

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'APPLE'}	0.018601	0.0064141	0.080088	0.1637	2.4117
{'NVIDIA'}	0.051707	0.019273	0.13883	-0.11807	2.9692
{'MICROSOFT'}	0.015904	0.0050901	0.071345	-0.30528	2.8282
{'AMAZON.COM'}	0.014064	0.0094121	0.097016	-0.94189	5.0106
{'META PLATFORMS A'}	0.017304	0.012007	0.10958	-0.69083	4.7553
{'TESLA'}	0.041939	0.042429	0.20598	0.41786	2.6552
{'ALPHABET 'A''}	0.016479	0.0057311	0.075704	-0.38571	2.9237
{'BROADCOM'}	0.033574	0.0087085	0.093319	0.15001	3.3634
{'COSTCO WHOLESALE'}	0.019135	0.0037292	0.061067	-0.84172	3.9353
{'NETFLIX'}	0.015574	0.020336	0.1426	-2.0792	11.654
{'T-MOBILE US'}	0.016397	0.0034846	0.05903	-0.011757	2.6269
{'CISCO SYSTEMS'}	0.0036702	0.0045881	0.067736	-0.91868	4.1741
{'ADVANCED MICRO DEVICES'}	0.014655	0.020118	0.14184	-0.18957	3.5285
{'LINDE (NYS)'}	0.011392	0.0043663	0.066078	-0.22246	4.1407
{'INTUITIVE SURGICAL'}	0.016819	0.0089231	0.094462	-0.20135	5.5758
{'PEPSICO'}	0.00097561	0.0021768	0.046656	0.017542	3.1858
{'ADOBE (NAS)'}	0.0029628	0.013373	0.11564	-0.45493	3.3841
{'QUALCOMM'}	0.0092237	0.0087367	0.09347	-0.2575	2.685
{'COMCAST A'}	-0.0035458	0.0044144	0.066441	-0.58196	3.2416
{'PALO ALTO NETWORKS'}	0.024596	0.013591	0.11658	-1.1483	5.2681
{'INTUIT'}	0.013626	0.0074453	0.086286	-0.84283	4.0431
{'GILEAD SCIENCES'}	0.0053938	0.0040452	0.063602	0.45975	5.734
{'STARBUCKS'}	0.00038194	0.0048978	0.069984	0.085676	3.3747
{'MARVELL TECHNOLOGY'}	0.024364	0.015218	0.12336	0.40313	3.1328
{'INTEL'}	-0.018737	0.016649	0.12903	-1.4049	6.9584
{'APPLOVIN A'}	0.025423	0.050182	0.22401	-0.0092803	4.263
{'CADENCE DESIGN SYS.'}	0.023493	0.0073343	0.08564	-0.46706	2.5998
{'CME GROUP'}	0.0018524	0.0040219	0.063419	-0.71974	3.9439
{'CINTAS'}	0.01665	0.006236	0.078968	-0.75754	6.8777
{'MARRIOTT INTL.'A''}	0.010364	0.0087871	0.09374	-0.95233	4.9786
{'MONDELEZ INTERNATIONAL CL.A'}	0.00060338	0.0032258	0.056796	0.16006	2.5819
{'REGENERON PHARMS.'}	0.010046	0.0070298	0.083844	-0.44559	2.9939
{'SYNOPSYS'}	0.019988	0.008952	0.094615	-0.44397	2.4258
{'O REILLY AUTOMOTIVE'}	0.016808	0.0041889	0.064721	-0.4406	3.8193
{'CSX'}	0.0043679	0.0053491	0.073137	-0.52966	4.3287
{'AIRBNB A'}	-0.001223	0.01196	0.10936	-0.064958	5.0306
{'COINBASE GLOBAL A'}	0.0081707	0.053088	0.23041	0.26683	5.3494
{'COPART'}	0.014134	0.0058984	0.076801	-0.75792	4.2671
{'PACCAR'}	0.012001	0.0044573	0.066763	0.21016	2.8728
{'ROPER TECHNOLOGIES'}	0.0050927	0.0042156	0.064928	0.1076	3.0142
{'ROSS STORES'}	0.0038116	0.005889	0.07674	-0.20983	2.2403
{'WORKDAY CLASS A'}	0.0054455	0.011021	0.10498	-0.3106	2.5459
{'BAKER HUGHES A'}	0.0092328	0.019118	0.13827	-0.38371	4.536
{'CHARTER COMMS.CL.A'}	-0.0068469	0.0087541	0.093563	-0.23053	3.3122
{'MONSTER BEVERAGE'}	0.0070059	0.0039198	0.062608	0.015059	2.1274
{'NXP SEMICONDUCTORS'}	0.0077791	0.0082524	0.090843	-0.27095	2.3846
{'COGNIZANT TECH.SLTN.'A''}	0.0036132	0.0047743	0.069096	-0.53179	4.431
{'EXELON'}	0.0020482	0.0036597	0.060496	-0.34641	3.6058
{'GE HEALTHCARE TECHNOLOGIES'}	0.0013917	0.0034073	0.058372	-1.2608	9.413
{'KRAFT HEINZ'}	-0.0012335	0.0051892	0.072036	-0.033801	2.7097
{'UNITED AIRLINES HOLDINGS'}	0.0034065	0.027594	0.16611	-0.32255	4.3941
{'WILLIS TOWERS WATSON'}	0.007049	0.003665	0.06054	-0.39696	3.7556
{'EBAY'}	0.010599	0.0078578	0.088644	0.063112	2.7724
{'IDEXX LABORATORIES'}	0.0065829	0.010094	0.10047	-1.4644	10.482
{'MICROCHIP TECH.'}	-6.7809e-05	0.0085563	0.0925	-0.38137	3.6135
{'WARNER BROS DISCOVERY SERIES A'}	-0.019815	0.020332	0.14259	0.0068317	4.0191
{'T ROWE PRICE GROUP'}	-0.0026765	0.007419	0.086133	-0.61006	3.0642
{'BIOGEN'}	-0.011489	0.0099031	0.099514	1.2499	6.6276
{'CARLYLE GROUP'}	0.0077858	0.011125	0.10547	-0.59338	4.2683
{'DOMINO'S PIZZA'}	0.0055089	0.0071455	0.084531	0.0060507	2.8031
{'EXPEDIA GROUP'}	0.0081222	0.01486	0.1219	-0.46781	3.2438
{'INTERACTIVE BROKERS GROUP A'}	0.022325	0.0067001	0.081854	-0.18505	3.3601
{'CYBER ARK SOFTWARE'}	0.015429	0.016211	0.12732	-0.70715	5.1676
{'STEEL DYNAMICS'}	0.021156	0.01146	0.10705	0.067039	2.5373
{'SBA COMMS.'}	-0.0039853	0.0065118	0.080696	-0.52022	3.4453
{'ASPEN TECHNOLOGY'}	0.0098438	0.010714	0.10351	-0.91584	4.6385
{'BENTLEY SYSTEMS B'}	-0.0002194	0.014181	0.11908	-0.46052	5.8527
{'AKAMAI TECHS.'}	-0.00084054	0.0066642	0.081634	-0.49597	2.5505
{'MODERNA'}	0.013197	0.065357	0.25565	0.67152	3.3553
{'MATTEL'}	0.0047235	0.0088356	0.093998	-0.69149	4.9216
{'MORNINGSTAR'}	0.011799	0.0069115	0.083136	-0.41684	2.8973
{'QUANTUM COMPUTING'}	0.025886	0.1521	0.39	1.597	7.2267
{'REGENCY CENTERS'}	0.0017633	0.006603	0.081259	-0.19835	4.3252
{'ROYALTY PHARMA A'}	-0.0036155	0.006709	0.081909	0.70342	3.5238
{'ROCKET LAB USA A'}	0.019859	0.034327	0.18528	0.66508	3.9782
{'TRIPADVISOR 'A''}	-0.012532	0.020696	0.14386	0.076614	3.7808
{'ABVC BIOPHARMA'}	-0.072913	0.084327	0.29039	-0.78581	5.6551
{'ACCELERATE DIAGNOSTICS'}	-0.083832	0.085815	0.29294	-0.38439	5.4436
{'ASTROTECH'}	-0.038252	0.043033	0.20744	0.42587	8.535
{'ORAMED PHARMACEUTICALS'}	-0.012827	0.10503	0.32408	-1.4372	10.471
{'VIMEO'}	-0.0084742	0.061157	0.2473	3.5913	23.779

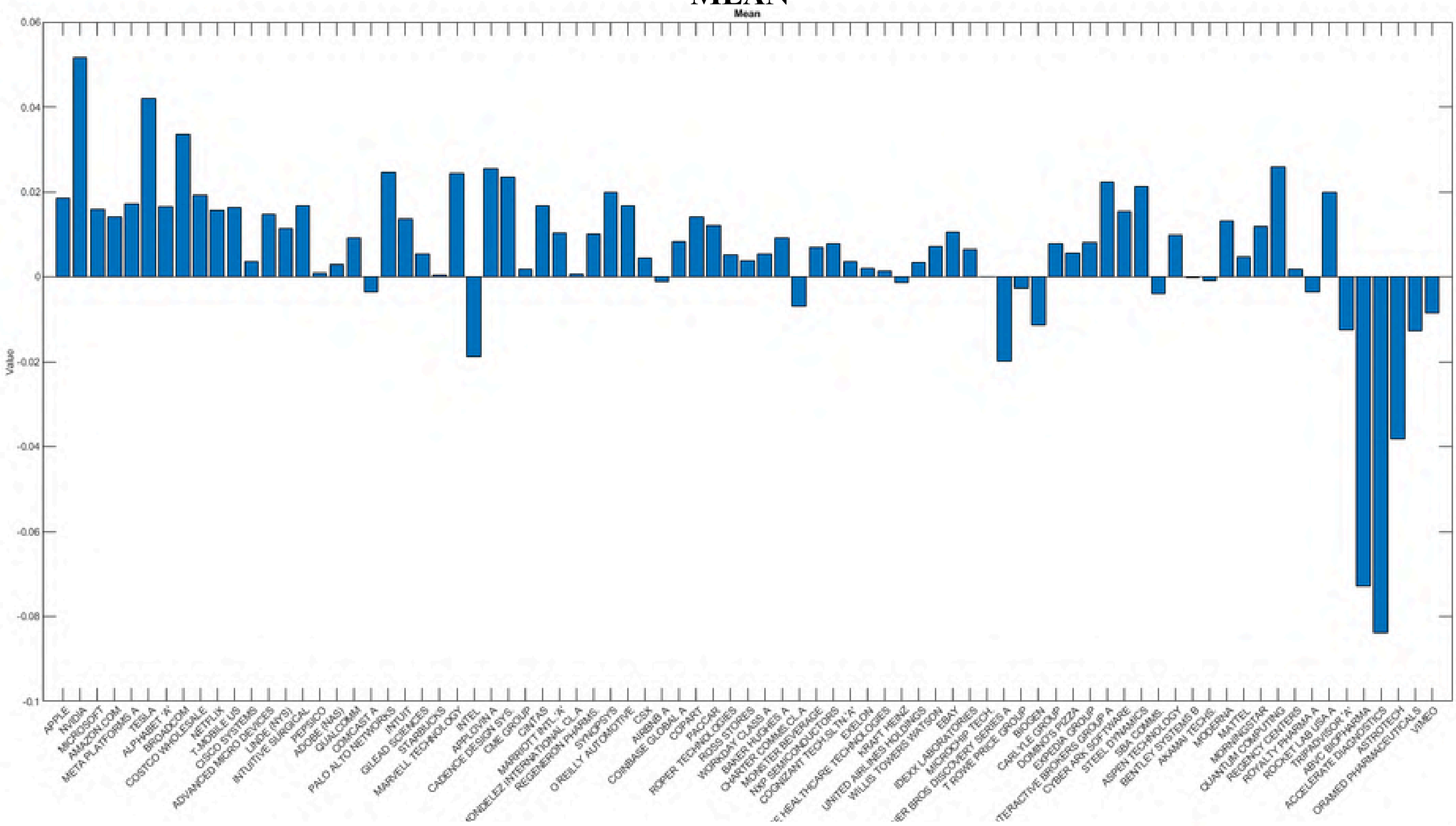
The following chart displays the securities with the maximum and minimum of each statistic.

```
Statistiche migliori e peggiori:
Media: Max = NVIDIA (0.0517), Min = ACCELERATE DIAGNOSTICS (-0.0838)
Varianza: Max = QUANTUM COMPUTING (0.1521), Min = PEPSICO (0.0022)
Deviazione Standard: Max = QUANTUM COMPUTING (0.3900), Min = PEPSICO (0.0467)
Skewness: Max = VIMEO (3.5913), Min = NETFLIX (-2.0792)
Curtosi: Max = VIMEO (23.7794), Min = MONSTER BEVERAGE (2.1274)
```

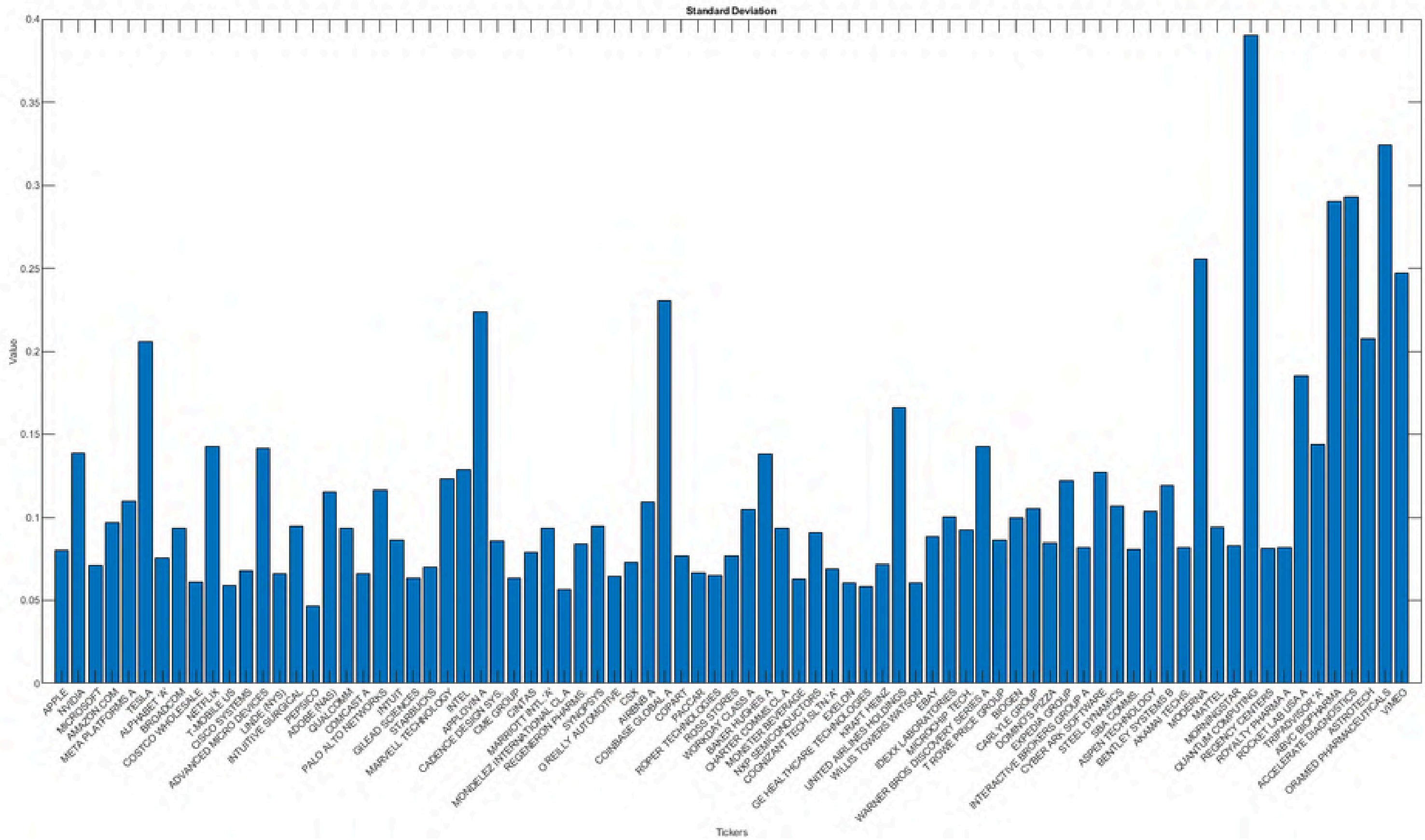
QUESTION 1 & 2 : NASDAQ MONTHLY STATISTICS

Below are the histograms related to the statistics. It can be noted that the stock with the best performance was NVIDIA (0.0024), while ACCELERATE DIAGNOSTIC (-0.0039) had the worst performance. Regarding standard deviation, the stock with the lowest risk was MONDELEZ INTERNATIONAL (0.0137), while the one with the highest risk was QUANTUM COMPUTING (0.0851). The stock with the highest skewness was VIMEO (17.85), while the one with the lowest skewness was ORAMED (-9.0002). Regarding kurtosis, VIMEO has the highest kurtosis, while ADVANCED MICRO DEVICES has the lowest.

MEAN

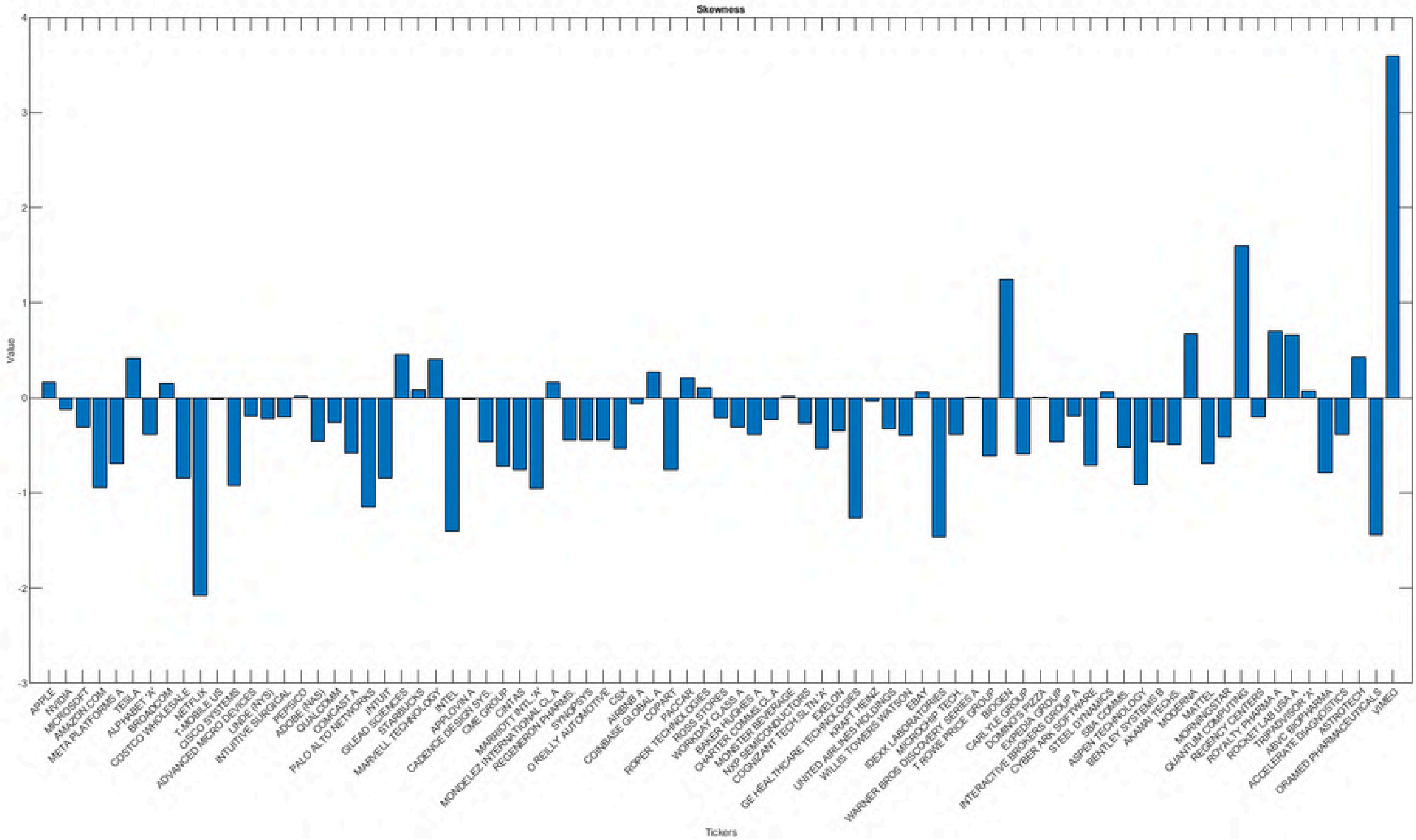


STANDARD DEVIATION

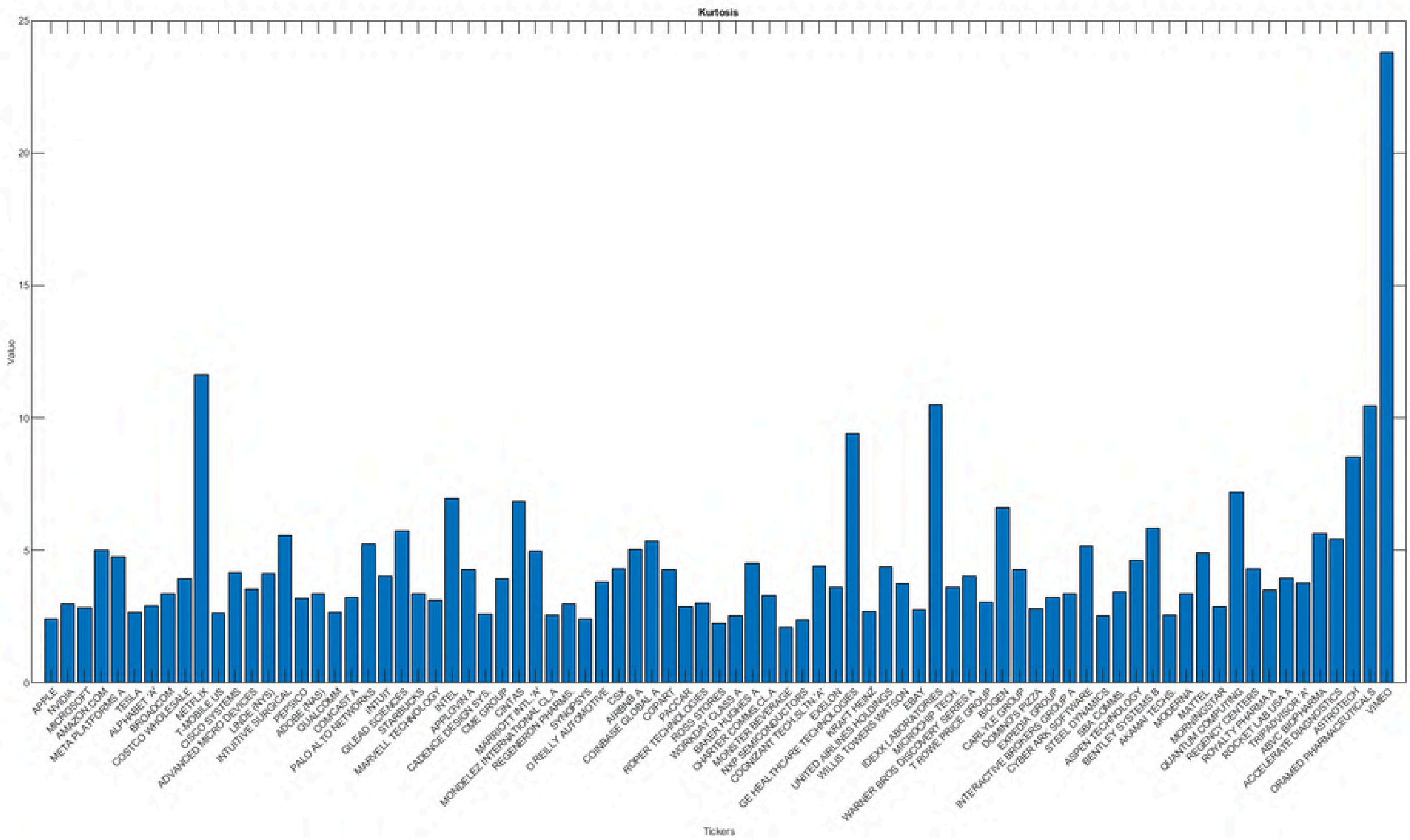


QUESTION 1 & 2 : NASDAQ MONTHLY STATISTICS

SKEWNESS



KURTOSIS



QUESTION 1 & 2 : NYSE DAILY STATISTICS

Presented below is the code used to answer this question.

```
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheet = 'nyse daily';

% Carica il file Excel
opts = detectImportOptions(filename, 'Sheet', sheet);
opts.VariableNamingRule = 'preserve';
data = readtable(filename, opts);

% Visualizza i dati
disp(data);

% Estrai le date e i ticker
dates = data{:, 1};
tickers = data.Properties.VariableNames(2:end);

% Converti i dati delle celle in valori numerici se necessario
for i = 2:width(data)
    if iscell(data{:, i})
        data{:, i} = str2double(data{:, i});
    end
end

% Calcola i rendimenti giornalieri
returns = diff(log(data{:, 2:end}));

% Inizializza le variabili per i risultati
mean_values = mean(returns);
variance_values = var(returns);
std_dev_values = std(returns);
skewness_values = skewness(returns);
kurtosis_values = kurtosis(returns);

% Crea una tabella con i risultati
results = table(tickers', mean_values', variance_values', std_dev_values', skewness_values',
kurtosis_values', ...
    'VariableNames', {'Ticker', 'Mean', 'Variance', 'StandardDeviation', 'Skewness', 'Kurtosis'});

% Visualizza i risultati
disp(results);

%% GRAFICI ----------------------------------------------------------------------------------------
-------------------------------------------------------------

% Crea i grafici per ogni categoria
figure;
bar(mean_values);
title('Mean');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(variance_values);
title('Variance');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(std_dev_values);
title('Standard Deviation');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(skewness_values);
title('Skewness');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(kurtosis_values);
title('Kurtosis');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

% Aggiusta la dimensione della figura
set(gcf, 'Position', [100, 100, 1200, 800]);


}
```

QUESTION 1 & 2 : NYSE DAILY STATISTICS

The results from the Command Window for Nyse are the following:

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'3M'}	-0.00010707	0.00032978	0.01816	0.85463	21.399
{'AAR'}	0.00029835	0.001127	0.033571	-1.1369	32.921
{'ABBOTT LABORATORIES'}	0.00021026	0.0002612	0.016162	-0.068621	10.016
{'AMERICAN EXPRESS'}	0.0006397	0.00055662	0.023593	0.61625	17.313
{'BANK OF AMERICA'}	0.00020016	0.00048667	0.022061	0.05854	13.572
{'BANK OF NEW YORK MELLON'}	0.00030675	0.00037875	0.019462	-0.409	13.725
{'BARNES GROUP'}	-0.00021732	0.00083799	0.028948	-2.647	41.14
{'BOEING'}	-0.00049912	0.0010032	0.031673	-0.4305	16.038
{'BRISTOL MYERS SQUIBB'}	-0.00011924	0.00021404	0.01463	0.19227	10.64
{'CABOT'}	0.00050551	0.00063803	0.025259	-0.88161	18.661
{'CALERES'}	-4.4343e-05	0.0021153	0.045992	-0.27852	19.056
{'CARPENTER TECH.'}	0.0010495	0.0011874	0.034458	-0.33894	9.5406
{'CATERPILLAR'}	0.00067149	0.00040539	0.020134	-0.34707	8.2942
{'CHEVRON'}	0.00020994	0.0004939	0.022224	-1.0943	27.86
{'COCA COLA'}	7.2872e-05	0.00016743	0.012939	-0.87621	12.525
{'COLGATE-PALM.'}	0.0001593	0.000163	0.012767	0.11874	16.554
{'COMERICA'}	-9.7952e-05	0.0010347	0.032167	-1.2149	17.539
{'CONOCOPHILLIPS'}	0.00033974	0.00075084	0.027401	-0.67503	19.538
{'CONSOLIDATED EDISON'}	5.7589e-06	0.00023627	0.015371	-0.16538	23.662
{'CVS HEALTH'}	-0.00031171	0.00036443	0.01909	-1.1268	16.037
{'DEERE'}	0.00065662	0.00042143	0.020529	-0.48892	10.638
{'DOVER'}	0.00035354	0.00033599	0.01833	-0.87442	17.68
{'DUKE ENERGY'}	0.00012071	0.00023341	0.015278	-0.16914	16.07
{'DXC TECHNOLOGY'}	-0.00046544	0.0013037	0.036107	-0.75054	26.144
{'DYCOM INDS.'}	0.0010449	0.0012908	0.035928	-1.1583	22.34
{'ELI LILLY'}	0.0013465	0.00039556	0.019889	1.0701	12.321
{'EXXON MOBIL'}	0.00033133	0.00045502	0.021331	-0.15246	7.8367
{'FOOT LOCKER'}	-0.00049367	0.001386	0.037229	-2.0877	24.449
{'FORD MOTOR'}	3.244e-05	0.00076181	0.027601	-0.2064	9.8268
{'GENERAL DYNAMICS'}	0.00028204	0.00024049	0.015508	-0.47606	10.827
{'HALLIBURTON'}	8.6853e-05	0.0012388	0.035197	-2.1386	34.651
{'H&R BLOCK'}	0.00062725	0.0005823	0.024131	-0.039997	14.477
{'HP'}	0.00033724	0.0005698	0.023871	-0.37503	12.738
{'HUMANA'}	-0.0002319	0.00051422	0.022676	-1.2966	19.339
{'IDACORP'}	5.5599e-06	0.00026183	0.016181	-0.33093	16.757
{'JACOBS SOLUTIONS'}	0.00043442	0.00032282	0.017967	-0.49226	9.4072
{'JEFFERIES FINANCIAL GROUP'}	0.00095047	0.00053613	0.023154	-0.33221	8.8714
{'JOHNSON & JOHNSON'}	-1.6014e-05	0.00014872	0.012195	0.24821	11.264
{'JP MORGAN CHASE & CO.'}	0.00043443	0.00040347	0.020087	0.0086097	16.031
{'KIMBERLY-CLARK'}	-9.1417e-05	0.00017793	0.013339	-0.13615	11.981
{'KROGER'}	0.0005629	0.00030698	0.017521	0.21483	8.6863
{'LA-Z-BOY'}	0.00024676	0.00068061	0.026089	-0.25848	13.596
{'LINCOLN NATIONAL'}	-0.00051648	0.00134	0.036606	-1.3374	25.735
{'MARSH & MCLENNAN'}	0.00048049	0.0002098	0.014484	-0.51619	17.65
{'MASTEC'}	0.00065251	0.00089049	0.029841	-0.90506	12.557
{'MCDONALDS'}	0.00023677	0.00021075	0.014517	-0.32414	37.16
{'MEDTRONIC'}	-0.00029567	0.00027329	0.016532	-0.39828	11.316
{'MERCK & COMPANY'}	0.00011545	0.00021226	0.014569	-0.44973	11.334
{'MOTOROLA SOLUTIONS'}	0.00076711	0.00029976	0.017314	-0.3713	11.725
{'MSA SAFETY'}	0.00013466	0.00038883	0.019719	0.13437	16.537
{'MURPHY OIL'}	0.00015513	0.0016416	0.040517	-1.9188	32.734
{'MYERS INDUSTRIES'}	-0.0003348	0.00087542	0.029588	-3.8106	84.825
{'NATIONAL FUEL GAS'}	0.00025378	0.00029045	0.017042	-0.36628	13.174
{'NEW YORK TIMES 'A''}	0.00037232	0.00041522	0.020377	-0.36663	10.657
{'NEWMONT'}	-5.9736e-05	0.00051727	0.022744	-0.1686	9.4318
{'NORTHROP GRUMMAN'}	0.00015561	0.00028712	0.016945	0.041922	12.185
{'PARKER-HANNIFIN'}	0.0008592	0.00051132	0.022612	-0.44551	15.024
{'PFIZER'}	-0.00025838	0.00029057	0.017046	0.21169	6.8571
{'PROCTER & GAMBLE'}	0.00018858	0.00016919	0.013007	-0.1061	15.142
{'QUAKER HOUGHTON'}	-0.0002126	0.00066974	0.025879	0.61227	10.166
{'QUANEX BUILDING PRODUCTS'}	0.00018429	0.00079747	0.028239	-0.76837	19.503
{'STANLEY BLACK & DECKER'}	-0.0005585	0.00065479	0.025589	-0.54193	16.992
{'STATE STREET'}	0.00010682	0.00056789	0.02383	-0.37852	14.74
{'TARGET'}	9.7315e-05	0.00051428	0.022678	-2.3143	38.663
{'TENNANT'}	-5.9358e-06	0.00045245	0.021271	-0.086649	10.359
{'THERMO FISHER SCIENTIFIC'}	0.0003836	0.00029907	0.017294	-0.061246	6.4351
{'TIMKEN'}	0.00018063	0.00062017	0.024903	-0.43658	13.721
{'UNION PACIFIC'}	0.00018053	0.0002916	0.017076	-0.43227	15.572
{'WALMART'}	0.00067	0.00019534	0.013976	-0.27095	17.842
{'WALT DISNEY'}	-0.00021914	0.00044011	0.020979	-0.0098119	11.576
{'WELLS FARGO & CO'}	0.00022001	0.00058709	0.02423	-0.19854	9.9667
{'WEST PHARM.SVS.'}	0.00059487	0.00048412	0.022003	-0.43822	11.729
{'WHIRLPOOL'}	-0.00018217	0.00068397	0.026153	0.03579	18.298
{'WOLVERINE WWD.'}	-0.0002834	0.0013248	0.036398	-1.1034	24.893
{'WORTHINGTON ENTERPRISES'}	0.00035785	0.00082338	0.028695	-0.40801	9.8977
{'TELEPHONE & DATA SYS.'}	0.00023333	0.0013689	0.036998	3.5812	77.318
{'BERKSHIRE HATHAWAY 'A''}	0.00051133	0.00017192	0.013112	-0.18175	11.956

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'FEDEX'}	0.00041934	0.00054261	0.023294	-1.1003	20.57
{'WELLTOWER'}	0.00031427	0.00061947	0.024889	-0.94698	29.065
{'AON CLASS A'}	0.00039748	0.00028054	0.016749	-0.5979	21.051
{'TEAM'}	-0.0017614	0.0041675	0.064556	0.14133	15.456
{'HOME DEPOT'}	0.00042394	0.00032672	0.018075	-1.5734	25.71
{'NORFOLK SOUTHERN'}	0.00012956	0.0003716	0.019277	-0.049675	15.133
{'JOHN WILEY AND SONS A'}	-9.1992e-05	0.00049972	0.022354	-0.54955	12.688
{'VERIZON COMMUNICATIONS'}	-0.00034084	0.00018082	0.013447	0.004878	9.3157
{'AT&T'}	-0.00022748	0.00027608	0.016616	-0.28226	10.425
{'INSTEEL INDUSTRIES'}	9.273e-05	0.00085079	0.029168	-0.71846	12.15
{'ORACLE'}	0.00079917	0.00040719	0.020179	0.51586	18.67
{'HARLEY-DAVIDSON'}	-0.00017297	0.00095454	0.030896	0.31242	11.681
{'CITIGROUP'}	-7.9931e-05	0.0005932	0.024356	-0.45215	16.16
{'CHARLES SCHWAB'}	0.00032205	0.00057413	0.023961	-0.11688	9.9628
{'ALLIANCEBERNSTEIN HLDG. UNT.'}	8.0904e-05	0.00059895	0.024473	-0.52086	28.674
{'MORGAN STANLEY'}	0.00065943	0.00048308	0.021979	0.1631	16.162
{'LOCKHEED MARTIN'}	9.4345e-05	0.00026337	0.016229	-0.70344	18.397
{'CREDICORP'}	-0.00011969	0.00052462	0.022904	-0.73955	14.575
{'BOSTON BEER 'A''}	-0.00027783	0.0008129	0.028511	-0.1721	22.976
{'FTI CONSULTING'}	0.00039514	0.00040594	0.020148	-0.59993	24.062
{'RALPH LAUREN CL.A'}	0.00053575	0.0006869	0.026209	-0.017965	8.6451
{'BLACKROCK'}	0.00047794	0.00038115	0.019523	-0.078376	12.055
{'LAZARD'}	6.9124e-05	0.00057637	0.024008	-0.13487	9.5546
{'MASTERCARD'}	0.00037055	0.00036494	0.019103	0.10079	12.747
{'PHILIP MORRIS INTL.'}	0.00022396	0.00025025	0.015819	-0.98927	15.707
{'WHITESTONE REIT'}	4.0529e-06	0.00070767	0.026602	-1.0961	18.382
{'APOLLO GLOBAL MANAGEMENT'}	0.0008709	0.00069831	0.026426	0.074175	13.302
{'GLOBUS MEDICAL CL.A'}	0.00037722	0.00049032	0.022143	-0.048814	15.691
{'ACCENTURE CLASS A'}	0.00039956	0.00033015	0.01817	0.10941	8.5673
{'ALCOA'}	0.00046986	0.0015319	0.039139	-0.20418	7.1246
{'BLACKSTONE'}	0.00080416	0.00065975	0.025686	-0.33481	8.6562
{'ESTEE LAUDER COS.'A''}	-0.00081087	0.00061282	0.024755	-1.559	17.797
{'GARMIN'}	0.00059276	0.0003334	0.018259	1.1568	21.265
{'GOLDMAN SACHS GP.'}	0.00064256	0.00041901	0.02047	-0.030462	13.338
{'GUESS'}	-0.00039673	0.0021444	0.046307	3.1442	85.58
{'HERBALIFE'}	-0.0015085	0.0011798	0.034348	-1.6884	22.572
{'KORN FERRY'}	0.00033449	0.00055432	0.023544	-0.23506	11.403
{'LEVI STRAUSS A'}	-4.3534e-05	0.00077479	0.027835	-0.39605	9.7335
{'MACY'S'}	-8.9825e-05	0.0016634	0.040785	0.23823	7.9324
{'MAGNOLIA OIL GAS A'}	0.00052746	0.0011516	0.033936	0.032312	7.9545
{'MCCORMICK & CO'}	-9.7405e-05	0.00034379	0.018542	-0.6943	11.962
{'METLIFE'}	0.0003256	0.00047595	0.021816	-0.76967	16.547
{'MOODY'S'}	0.00046124	0.00038432	0.019604	-0.20492	15.74
{'NIKE 'B''}	-0.00026715	0.00046986	0.021676	-0.8585	18.714
{'NORDIC AMER.TANKERS'}	-0.00036445	0.0015417	0.039265	0.5185	9.8635
{'PJT PARTNERS CL.A'}	0.0009577	0.00052651	0.022946	-1.1976	26.079
{'SONOCO PRODUCTS'}	-0.00018104	0.00031697	0.017804	-0.32798	14.054
{'SUNOCO'}	0.00037845	0.00053726	0.023179	-2.2289	43.109
{'UBER TECHNOLOGIES'}	0.0005077	0.0011021	0.033198	0.60839	14.082
{'UNITED PARCEL SER.'B''}	4.7501e-05	0.00034854	0.018669	0.1212	12.682
{'VICTORIA S SECRET'}	6.7126e-05	0.0010885	0.032993	-0.14688	18.222
{'VISA 'A''}	0.0003544	0.00029681	0.017228	-0.041794	13.711
{'WK KELLOGG'}	-3.8195e-05	0.00023967	0.015481	-0.76098	32.911
{'MARRIOTT VACATIONS WWD.'}	-0.00032337	0.0011047	0.033237	-2.7524	50.21
{'MAIN STREET CAPITAL'}	0.0002148	0.00045923	0.02143	-1.4096	32.805
{'HYATT HOTELS CL.A'}	0.00043119	0.00068409	0.026155	-0.16253	11.991
{'BIOHAVEN'}	0.00014723	0.0025855	0.050848	-16.349	476.46

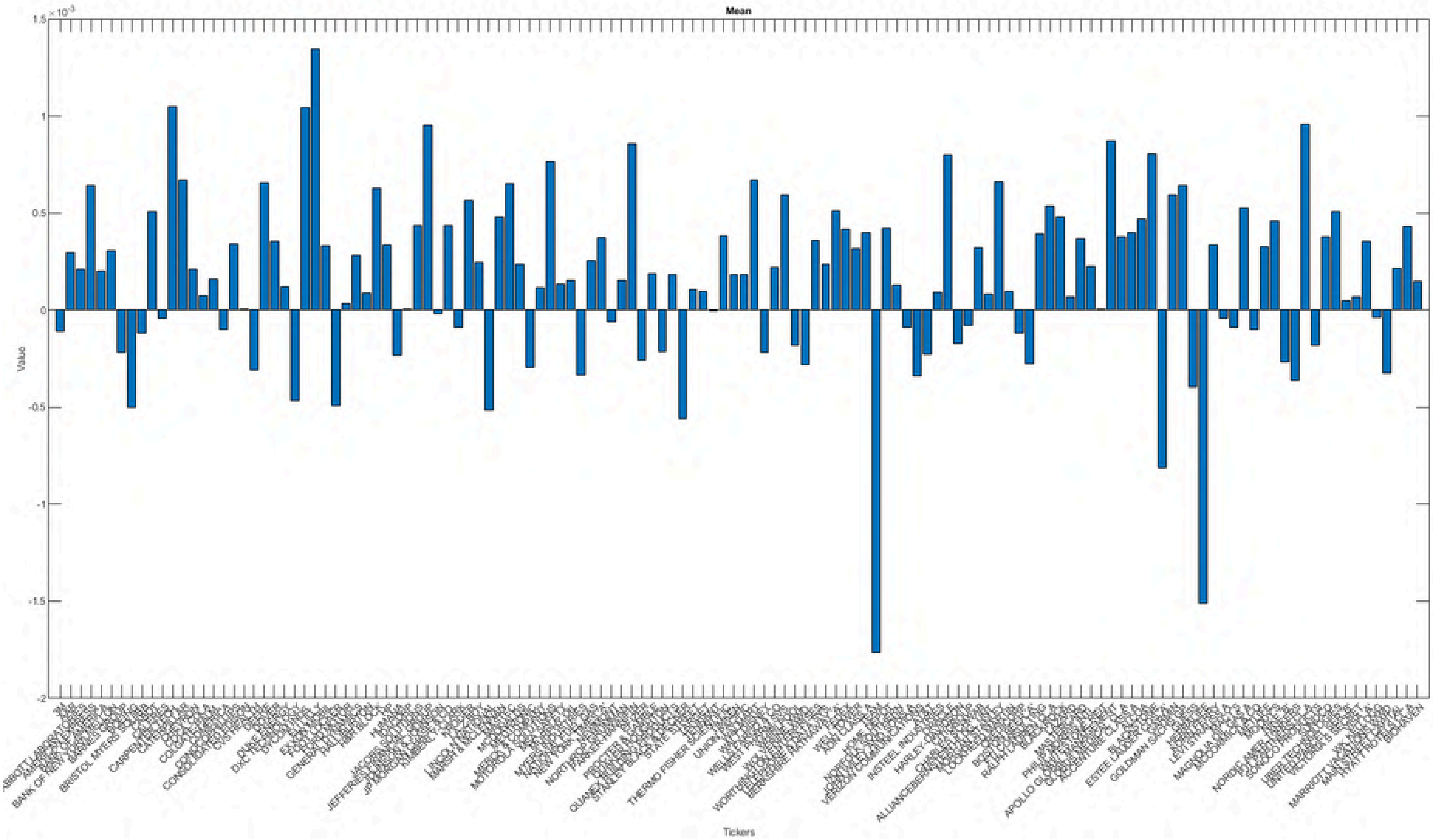
The following chart displays the securities with the maximum and minimum of each statistic.

```
Statistiche migliori e peggiori:
Media: Max = ELI LILLY (0.0293), Min = TEAM (-0.0383)
Varianza: Max = TEAM (0.0814), Min = JOHNSON & JOHNSON (0.0018)
Deviazione Standard: Max = TEAM (0.2853), Min = JOHNSON & JOHNSON (0.0426)
Skewness: Max = TELEPHONE & DATA SYS. (1.3543), Min = BIOHAVEN (-2.0522)
Curtosi: Max = BIOHAVEN (15.6974), Min = JOHNSON & JOHNSON (2.1410)
```

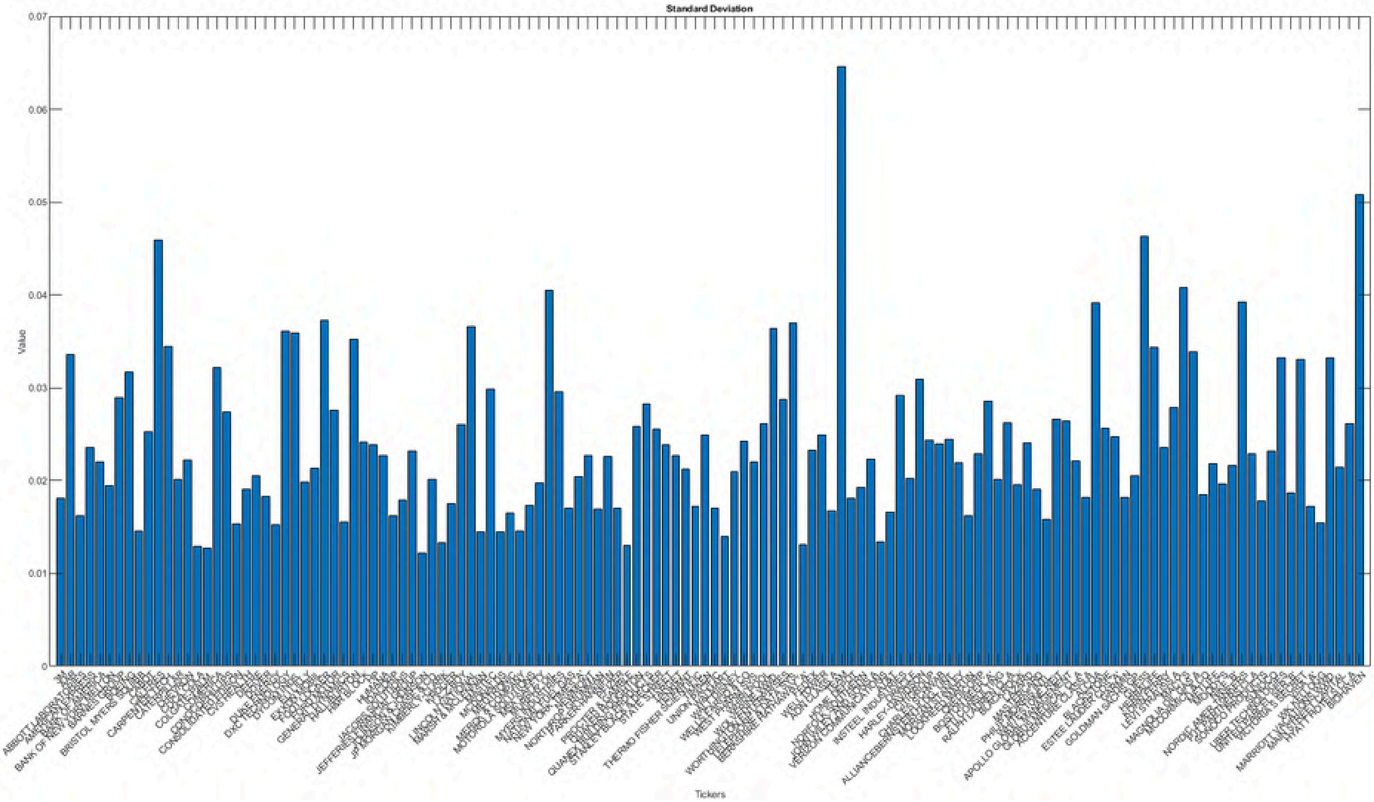
QUESTION 1 & 2 : NYSE DAILY STATISTICS

It can be noted that the stock with the best performance was ELI LILLY (0.0013), while TEAM (-0.0018) had the worst performance. Regarding standard deviation, the stock with the lowest risk was JOHNSON & JOHNSON (0.0122), while the one with the highest risk was TEAM (0.0646). The stock with the highest skewness was TELEPHONE & DATA SYS. (3.5812), while the one with the lowest skewness was BIOHAVEN (-16.3495). Regarding kurtosis, BIOHAVEN has the highest kurtosis, while THERMO FISHER SCIENTIFIC has the lowest.

MEAN

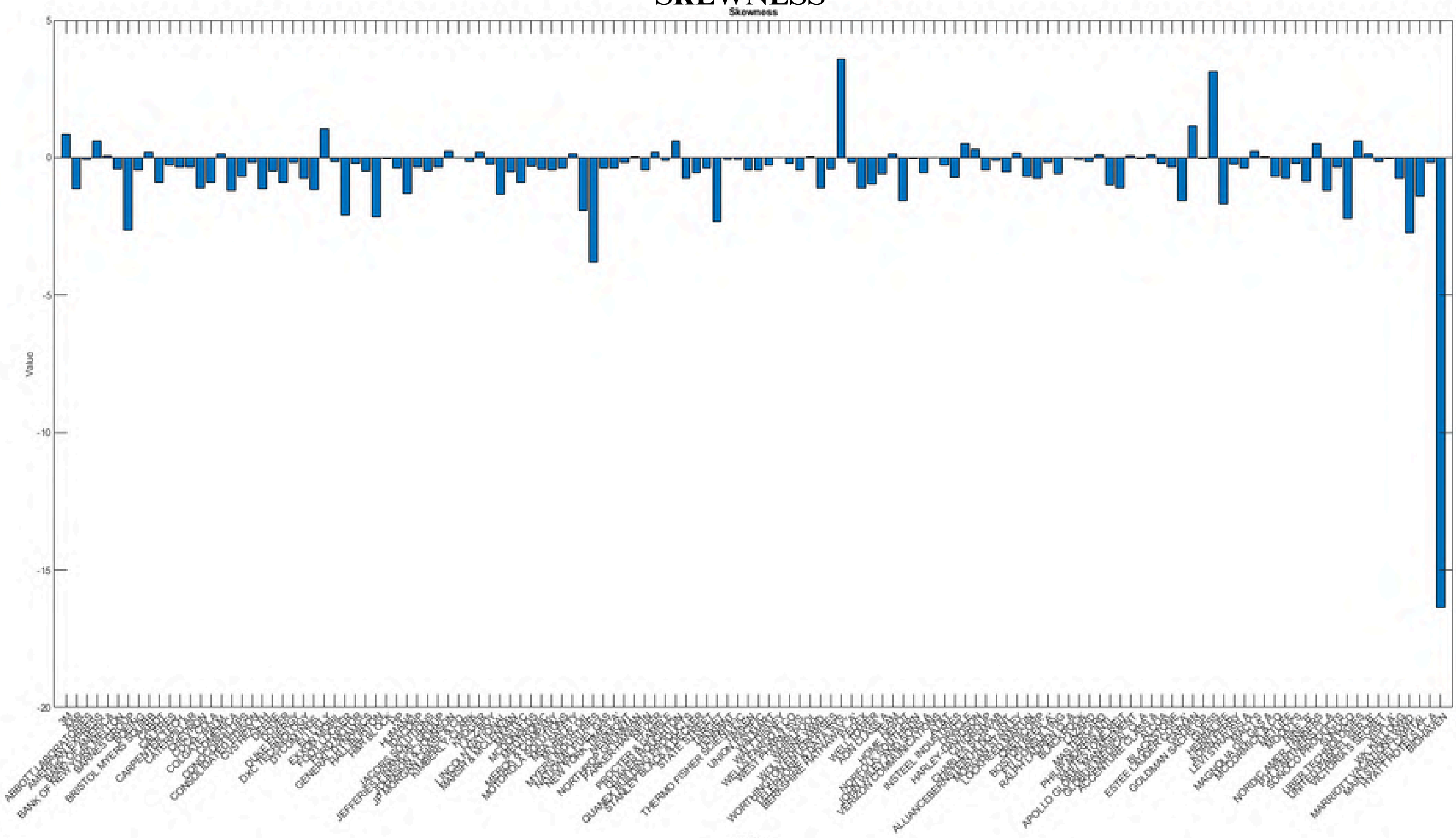


STANDARD DEVIATIONS



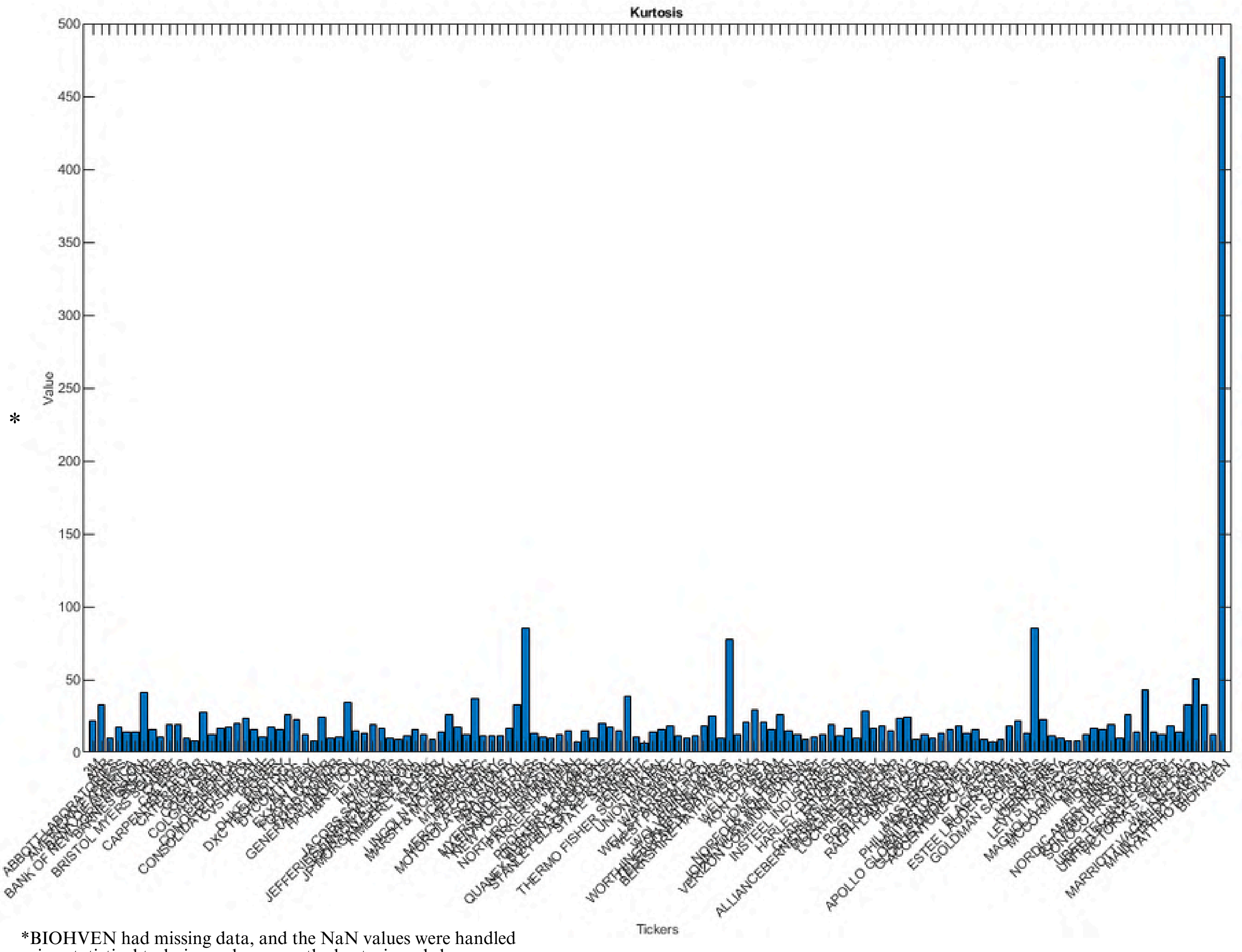
QUESTION 1 & 2 : NYSE DAILY STATISTICS

SKEWNESS



KURTOSIS

*



*BIOHVEN had missing data, and the NaN values were handled using statistical techniques; however, the kurtosis and skewness values should not be considered as accurate as the others.

QUESTION 1 & 2 : NYSE MONTHLY STATISTICS

Presented below is the code used to answer this question.

```matlab
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheet = 'nyse monthly';

% Carica il file Excel
opts = detectImportOptions(filename, 'Sheet', sheet);
opts.VariableNamingRule = 'preserve';
data = readtable(filename, opts);

% Visualizza i dati
disp(data);

% Estrai le date e i ticker
dates = data{:, 1};
tickers = data.Properties.VariableNames(2:end);

% Converti i dati delle celle in valori numerici se necessario
for i = 2:width(data)
    if iscell(data{:, i})
        data{:, i} = str2double(data{:, i});
    end
end

% Calcola i rendimenti mensili
returns = diff(log(data{:, 2:end}));

% Inizializza le variabili per i risultati
mean_values = mean(returns);
variance_values = var(returns);
std_dev_values = std(returns);
skewness_values = skewness(returns);
kurtosis_values = kurtosis(returns);

% Crea una tabella con i risultati
results = table(tickers', mean_values', variance_values', std_dev_values', skewness_values',
kurtosis_values', ...
    'VariableNames', {'Ticker', 'Mean', 'Variance', 'StandardDeviation', 'Skewness', 'Kurtosis'});

% Visualizza i risultati
disp(results);


%% GRAFICI ----------------------------------------------------------------------------------------------
----------------------------------------------------------

% Crea i grafici per ogni categoria
figure;
bar(mean_values);
title('Mean');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(variance_values);
title('Variance');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(std_dev_values);
title('Standard Deviation');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(skewness_values);
title('Skewness');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(kurtosis_values);
title('Kurtosis');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

% Aggiusta la dimensione della figura
set(gcf, 'Position', [100, 100, 1200, 800]);

set(gca, 'FontSize', 6); % Dimezza la grandezza del font

figure;
bar(kurtosis_values);
title('Kurtosis');
set(gca, 'XTick', 1:length(tickers), 'XTickLabel', tickers);
xtickangle(45);
ylabel('Value');
xlabel('Tickers');
set(gca, 'FontSize', 6); % Dimezza la grandezza del font

% Aggiusta la dimensione della figura
set(gcf, 'Position', [100, 100, 1200, 800]);


}
```

QUESTION 1 & 2 : NYSE MONTHLY STATISTICS

The results from the Command Window for Nyse are the following:

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'3M'}	-0.0023288	0.006311	0.079442	0.098554	3.3914
{'AAR'}	0.0064892	0.017008	0.13041	-0.69755	5.1025
{'ABBOTT LABORATORIES'}	0.0045731	0.0036819	0.060678	-0.30214	2.2271
{'AMERICAN EXPRESS'}	0.013913	0.0074079	0.086069	-0.42567	3.1013
{'BANK OF AMERICA'}	0.0043535	0.0090631	0.0952	-1.1954	6.3292
{'BANK OF NEW YORK MELLON'}	0.0066718	0.0057709	0.075966	-1.1437	4.6769
{'BARNES GROUP'}	-0.0047267	0.011975	0.10943	-0.16376	3.465
{'BOEING'}	-0.010856	0.019815	0.14076	-0.069941	4.9463
{'BRISTOL MYERS SQUIBB'}	-0.0025935	0.0040344	0.063517	0.25368	2.9413
{'CABOT'}	0.010995	0.0075817	0.087073	-0.45349	3.7005
{'CALERES'}	-0.00096446	0.025469	0.15959	-1.5296	6.9313
{'CARPENTER TECH.'}	0.022828	0.019534	0.13976	-0.35048	3.5357
{'CATERPILLAR'}	0.014605	0.0079993	0.089439	-0.050205	3.4605
{'CHEVRON'}	0.0045663	0.0075348	0.086803	-0.29468	3.982
{'COCA COLA'}	0.001585	0.0026584	0.051559	-0.24496	2.8656
{'COLGATE-PALM.'}	0.0034648	0.0026375	0.051357	-0.19435	2.4486
{'COMERICA'}	-0.0021304	0.016567	0.12871	-0.73034	3.8172
{'CONOCOPHILLIPS'}	0.0073893	0.01579	0.12566	-1.0253	6.7966
{'CONSOLIDATED EDISON'}	0.00012526	0.0040666	0.06377	-0.57405	4.3024
{'CVS HEALTH'}	-0.0067797	0.0071696	0.084674	-0.36865	3.2014
{'DEERE'}	0.014281	0.006101	0.078109	0.19156	2.1866
{'DOVER'}	0.0076895	0.0047638	0.06902	-0.22528	2.6936
{'DUKE ENERGY'}	0.0026254	0.003523	0.059355	-0.59686	4.2652
{'DXC TECHNOLOGY'}	-0.010123	0.017938	0.13393	-1.8377	10.494
{'DYCOM INDS.'}	0.022727	0.023856	0.15445	-1.623	10.326
{'ELI LILLY'}	0.029287	0.0066067	0.081282	0.22158	2.2329
{'EXXON MOBIL'}	0.0072065	0.0092053	0.095944	-0.65601	4.0768
{'FOOT LOCKER'}	-0.010737	0.021645	0.14712	-0.4113	3.4715
{'FORD MOTOR'}	0.00070557	0.019013	0.13789	0.027294	2.8466
{'GENERAL DYNAMICS'}	0.0061344	0.0036665	0.060552	-0.471	3.9667
{'HALLIBURTON'}	0.0018891	0.031612	0.1778	-1.9452	12.599
{'H&R BLOCK'}	0.013643	0.012583	0.11218	-0.049986	5.769
{'HP'}	0.0073349	0.007281	0.085329	-0.28128	2.9619
{'HUMANA'}	-0.0050437	0.0081639	0.090355	-0.88425	4.2625
{'IDACORP'}	0.00012093	0.0029835	0.054621	-0.086167	2.7328
{'JACOBS SOLUTIONS'}	0.0094487	0.0040468	0.063614	0.29097	2.5731
{'JEFFERIES FINANCIAL GROUP'}	0.020673	0.0086805	0.093169	-0.84747	3.8866
{'JOHNSON & JOHNSON'}	-0.0003483	0.0018111	0.042557	0.14969	2.141
{'JP MORGAN CHASE & CO.'}	0.0094488	0.0064523	0.080326	-0.80888	7.1534
{'KIMBERLY-CLARK'}	-0.0019883	0.0032459	0.056973	0.017177	2.9422
{'KROGER'}	0.012243	0.0049558	0.070398	0.619	4.3315
{'LA-Z-BOY'}	0.0053671	0.0070158	0.083761	-0.37662	3.2172
{'LINCOLN NATIONAL'}	-0.011233	0.016807	0.12964	-1.1419	5.677
{'MARSH & MCLENNAN'}	0.010451	0.0025833	0.050826	-0.35105	3.1099
{'MASTEC'}	0.014192	0.021284	0.14589	-0.38133	3.8754
{'MCDONALDS'}	0.0051497	0.0033309	0.057714	-0.0044298	3.2928
{'MEDTRONIC'}	-0.0064308	0.003768	0.061384	-0.33223	3.8848
{'MERCK & COMPANY'}	0.0025109	0.0032049	0.056611	0.10727	3.2987
{'MOTOROLA SOLUTIONS'}	0.016685	0.0049499	0.070355	-0.74633	3.4443
{'MSA SAFETY'}	0.0029288	0.0044273	0.066538	0.03939	3.5427
{'MURPHY OIL'}	0.0033741	0.041799	0.20445	-1.0175	6.801
{'MYERS INDUSTRIES'}	-0.007282	0.010536	0.10264	-0.0031107	3.1534
{'NATIONAL FUEL GAS'}	0.0055197	0.0034446	0.058691	0.0060507	2.4581
{'NEW YORK TIMES 'A''}	0.0080979	0.0090606	0.095187	-0.0087495	4.6578
{'NEWMONT'}	-0.0012993	0.0099875	0.099937	-0.032589	2.826
{'NORTHROP GRUMMAN'}	0.0033846	0.0037461	0.061206	0.38178	3.4238
{'PARKER-HANNIFIN'}	0.018688	0.0069077	0.083112	-0.28303	4.0883
{'PFIZER'}	-0.0056197	0.0056857	0.075404	0.45214	2.6093
{'PROCTER & GAMBLE'}	0.0041016	0.0025693	0.050688	-0.16721	3.0302
{'QUAKER HOUGHTON'}	-0.004624	0.01271	0.11274	0.72471	4.285
{'QUANEX BUILDING PRODUCTS'}	0.0040083	0.012013	0.10961	-0.29905	3.4751
{'STANLEY BLACK & DECKER'}	-0.012147	0.0066857	0.081766	-0.25177	2.7577
{'STATE STREET'}	0.0023234	0.0085212	0.09231	-0.88071	5.6901
{'TARGET'}	0.0021166	0.0095238	0.09759	-0.87745	5.6052
{'TENNANT'}	-0.0001291	0.0061124	0.078182	0.017717	2.8319
{'THERMO FISHER SCIENTIFIC'}	0.0083434	0.0041354	0.064307	-0.24884	2.1972
{'TIMKEN'}	0.0039286	0.0092825	0.096346	-0.10692	3.501
{'UNION PACIFIC'}	0.0039264	0.0044511	0.066716	-0.78373	4.6108
{'WALMART'}	0.014573	0.0032292	0.056826	-0.78131	5.4756
{'WALT DISNEY'}	-0.0047663	0.0080338	0.089631	-0.29243	3.186
{'WELLS FARGO & CO'}	0.0047852	0.011355	0.10656	-0.48182	3.3868
{'WEST PHARM.SVS.'}	0.012938	0.010066	0.10033	-0.88299	4.1981
{'WHIRLPOOL'}	-0.0039622	0.0091305	0.095554	0.24378	3.1084
{'WOLVERINE WWD.'}	-0.0061639	0.020366	0.14271	-0.27499	3.4838
{'WORTHINGTON ENTERPRISES'}	0.0077833	0.014193	0.11913	0.18469	3.5076
{'TELEPHONE & DATA SYS.'}	0.0050749	0.022637	0.15046	1.3543	11.045
{'BERKSHIRE HATHAWAY 'A''}	0.011121	0.0027266	0.052217	0.015274	3.6481

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'FEDEX'}	0.0091206	0.0099095	0.099546	-0.59054	4.1749
{'WELLTOWER'}	0.0068354	0.01001	0.10005	-0.72565	4.4956
{'AON CLASS A'}	0.0086451	0.0046105	0.0679	-0.89378	4.7574
{'TEAM'}	-0.03831	0.08137	0.28525	0.14018	3.0862
{'HOME DEPOT'}	0.0092206	0.0045411	0.067388	0.2077	2.6028
{'NORFOLK SOUTHERN'}	0.0028179	0.0062911	0.079317	-0.50262	3.994
{'JOHN WILEY AND SONS A'}	-0.0020008	0.0095692	0.097823	-0.08691	3.1195
{'VERIZON COMMUNICATIONS'}	-0.0074132	0.0028856	0.053718	-0.074743	3.1503
{'AT&T'}	-0.0049477	0.0050777	0.071258	0.36583	4.0816
{'INSTEEL INDUSTRIES'}	0.0020169	0.012159	0.11027	0.084145	2.6543
{'ORACLE'}	0.017382	0.0069911	0.083613	-0.3549	2.7772
{'HARLEY-DAVIDSON'}	-0.0037622	0.011593	0.10767	0.11421	3.5005
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
{'MORGAN STANLEY'}	0.014343	0.0082716	0.090948	-0.88774	3.8375
{'LOCKHEED MARTIN'}	0.002052	0.0043418	0.065892	0.26799	4.3165
{'CREDICORP'}	-0.0026032	0.011781	0.10854	0.42183	4.5358
{'BOSTON BEER 'A''}	-0.0060429	0.012605	0.11227	-0.50604	4.3126
{'FTI CONSULTING'}	0.0085944	0.0056184	0.074956	0.14314	2.8078
{'RALPH LAUREN CL.A'}	0.011652	0.0085016	0.092204	-0.17922	2.9649
{'BLACKROCK'}	0.010395	0.0085056	0.092226	0.0013063	4.9684
{'LAZARD'}	0.0015034	0.0095757	0.097855	-0.50943	3.4666
{'MASTERCARD'}	0.0080594	0.0038031	0.06167	-0.44991	3.4946
{'PHILIP MORRIS INTL.'}	0.0048712	0.0038006	0.061649	-0.17057	2.8118
{'WHITESTONE REIT'}	8.815e-05	0.015535	0.12464	-1.8785	11.787
{'APOLLO GLOBAL MANAGEMENT'}	0.018942	0.010643	0.10316	-0.09486	3.5227
{'GLOBUS MEDICAL CL.A'}	0.0082046	0.0090561	0.095163	-0.58171	3.6386
{'ACCENTURE CLASS A'}	0.0086905	0.0054321	0.073703	-0.61596	3.2031
{'ALCOA'}	0.010219	0.035467	0.18833	-0.0020395	3.2494
{'BLACKSTONE'}	0.017491	0.011088	0.1053	-0.66442	2.9571
{'ESTEE LAUDER COS.'A''}	-0.017636	0.011611	0.10776	-0.51917	4.2777
{'GARMIN'}	0.012893	0.0058128	0.076242	0.41649	3.7449
{'GOLDMAN SACHS GP.'}	0.013976	0.0065615	0.081003	-0.059317	4.3333
{'GUESS'}	-0.008629	0.022474	0.14991	-0.73877	7.0127
{'HERBALIFE'}	-0.03281	0.024256	0.15574	0.52322	2.772
{'KORN FERRY'}	0.0072752	0.0084421	0.091881	-0.42647	3.2212
{'LEVI STRAUSS A'}	-0.00094686	0.010572	0.10282	-0.46348	2.5895
{'MACY'S'}	-0.0019537	0.027517	0.16588	0.11115	4.6901
{'MAGNOLIA OIL GAS A'}	0.011472	0.023881	0.15453	-0.81886	6.8655
{'MCCORMICK & CO'}	-0.0021186	0.0048993	0.069995	-0.46249	3.3193
{'METLIFE'}	0.0070818	0.0070011	0.083673	-1.7136	10.077
{'MOODY'S'}	0.010032	0.0055069	0.074208	-0.75454	3.9576
{'NIKE 'B''}	-0.0058106	0.0084488	0.091917	-0.53178	3.6973
{'NORDIC AMER.TANKERS'}	-0.0079268	0.020891	0.14454	0.43656	3.0784
{'PJT PARTNERS CL.A'}	0.02083	0.0069519	0.083378	-0.46925	3.1491
{'SONOCO PRODUCTS'}	-0.0039375	0.0030314	0.055058	-0.52846	4.5528
{'SUNOCO'}	0.0082313	0.0074117	0.086091	-0.67312	7.3628
{'UBER TECHNOLOGIES'}	0.011042	0.017434	0.13204	-0.060208	3.4595
{'UNITED PARCEL SER.'B''}	0.0010332	0.0074539	0.086336	0.80818	5.5132
{'VICTORIA S SECRET'}	0.0015508	0.036133	0.19009	0.78177	6.4268
{'VISA 'A''}	0.0077081	0.0029714	0.054511	-0.53388	3.2783
{'WK KELLOGG'}	-0.00053071	0.0088131	0.093878	-0.73228	12.164
{'MARRIOTT VACATIONS WWD.'}	-0.0070332	0.012865	0.11342	0.24534	3.5898
{'MAIN STREET CAPITAL'}	0.004672	0.0071176	0.084366	-1.0589	6.0375
{'HYATT HOTELS CL.A'}	0.0093783	0.0082877	0.091037	-0.67538	4.1892
{'BIOHAVEN'}	0.0029816	0.037779	0.19437	-2.0522	15.697

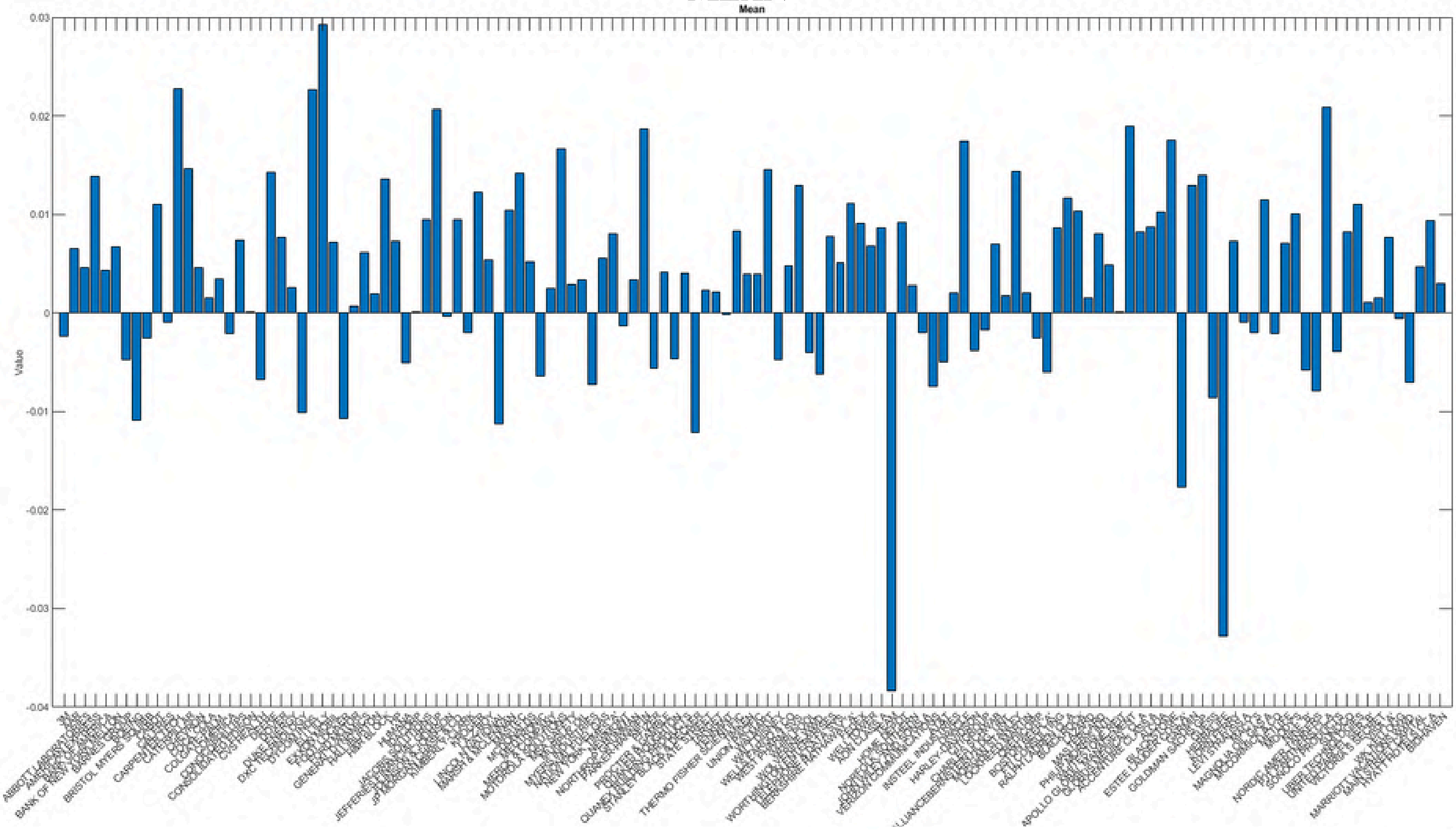
The following chart displays the securities with the maximum and minimum of each statistic.

```
Statistiche migliori e peggiori:
Media: Max = ELI LILLY (0.0293), Min = TEAM (-0.0383)
Varianza: Max = TEAM (0.0814), Min = JOHNSON & JOHNSON (0.0018)
Deviazione Standard: Max = TEAM (0.2853), Min = JOHNSON & JOHNSON (0.0426)
Skewness: Max = TELEPHONE & DATA SYS. (1.3543), Min = BIOHAVEN (-2.0522)
Curtosi: Max = BIOHAVEN (15.6974), Min = JOHNSON & JOHNSON (2.1410)
```

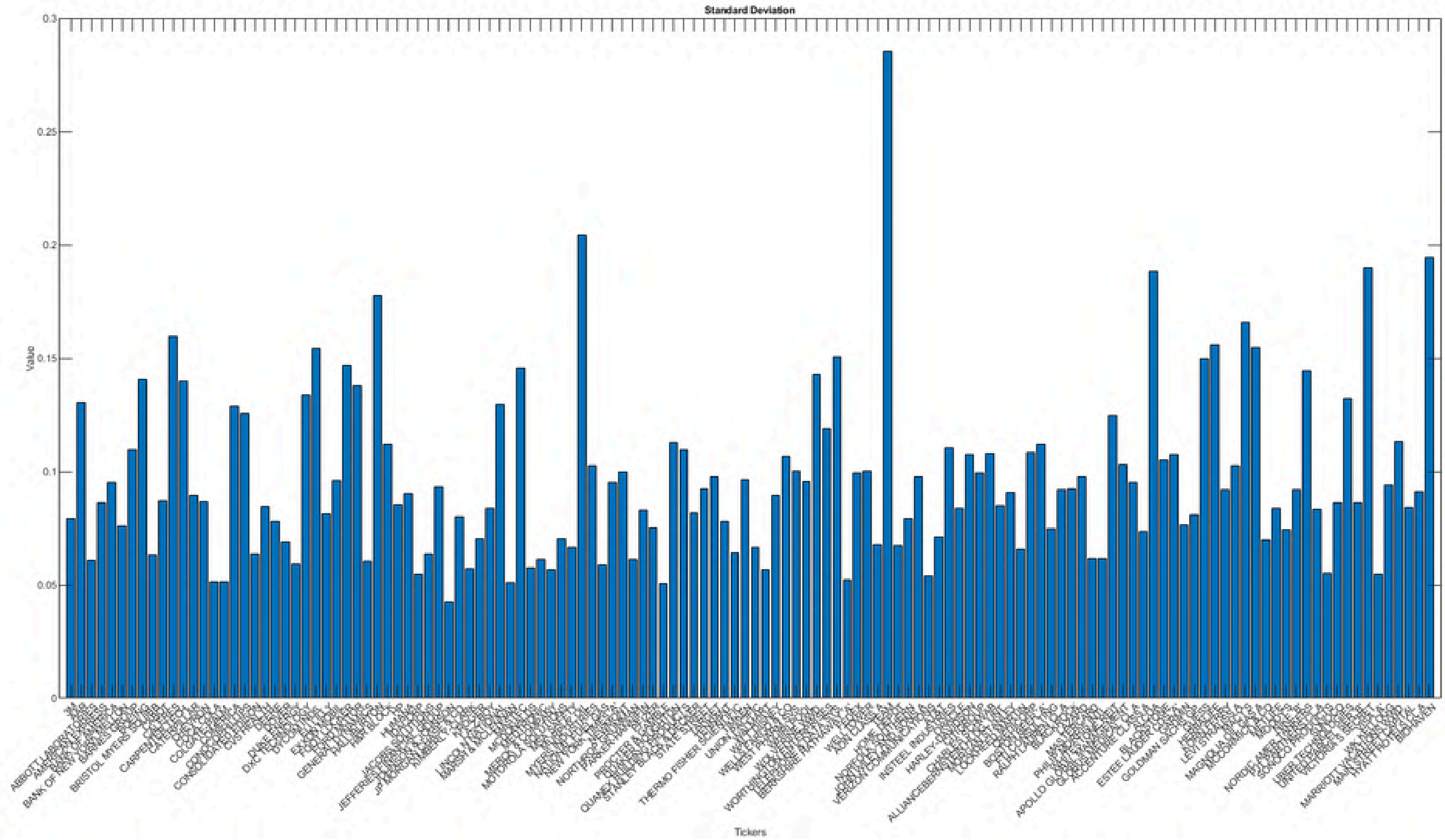
QUESTION 1 & 2 : NYSE MONTHLY STATISTICS

It can be noted that the stock with the best performance was ELI LILLY (0.0293), while TEAM (-0.0383) had the worst performance. Regarding standard deviation, the stock with the lowest risk was JOHNSON & JOHNSON (0.0426), while the one with the highest risk was TEAM (0.2853). The stock with the highest skewness was TELEPHONE & DATA SYS. (1.3543), while the one with the lowest skewness was BIOHAVEN (-2.0522). Regarding kurtosis, BIOHAVEN has the highest kurtosis, while JOHNSON & JOHNSON has the lowest.

MEAN

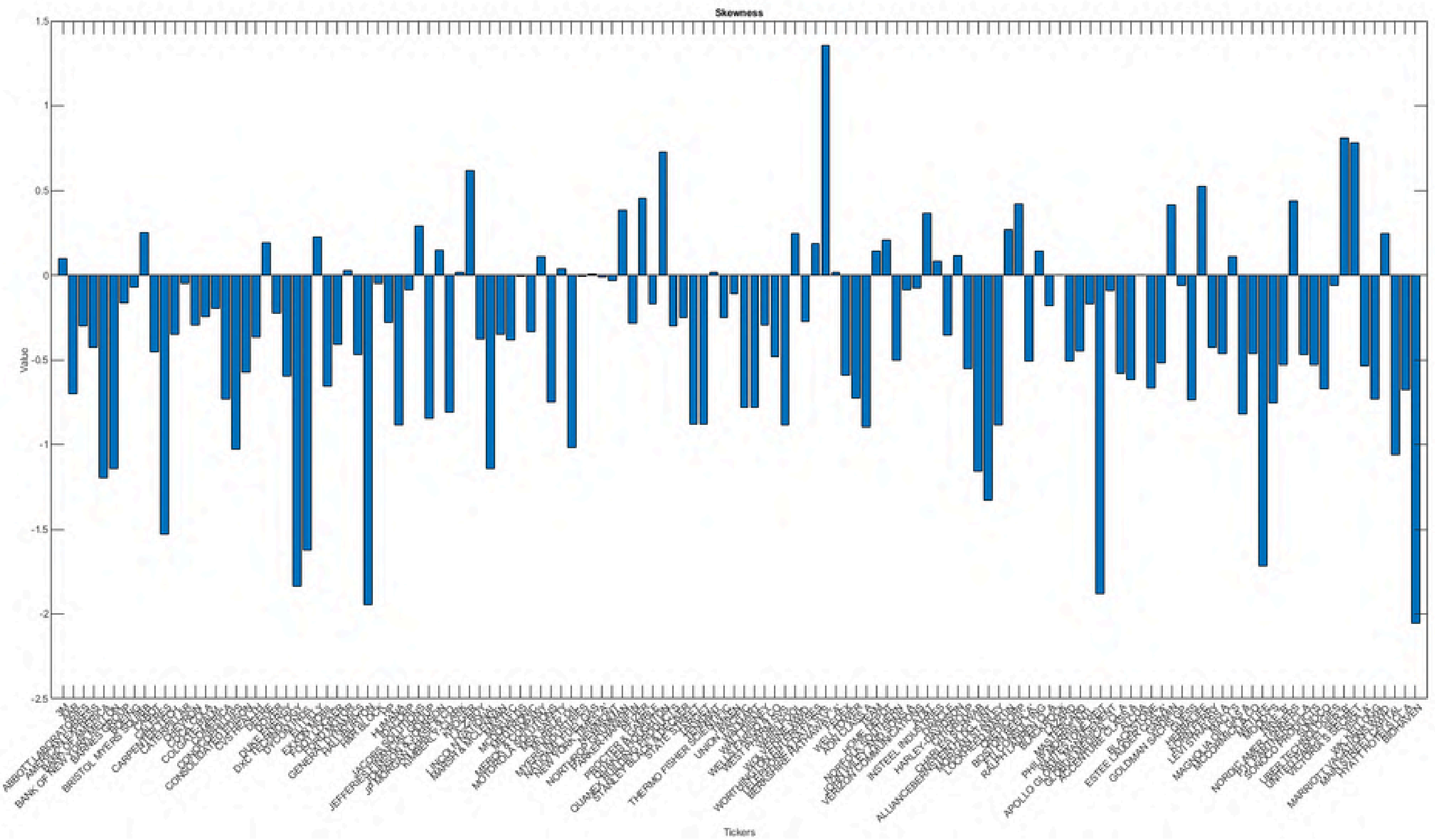


STANDARD DEVIATION

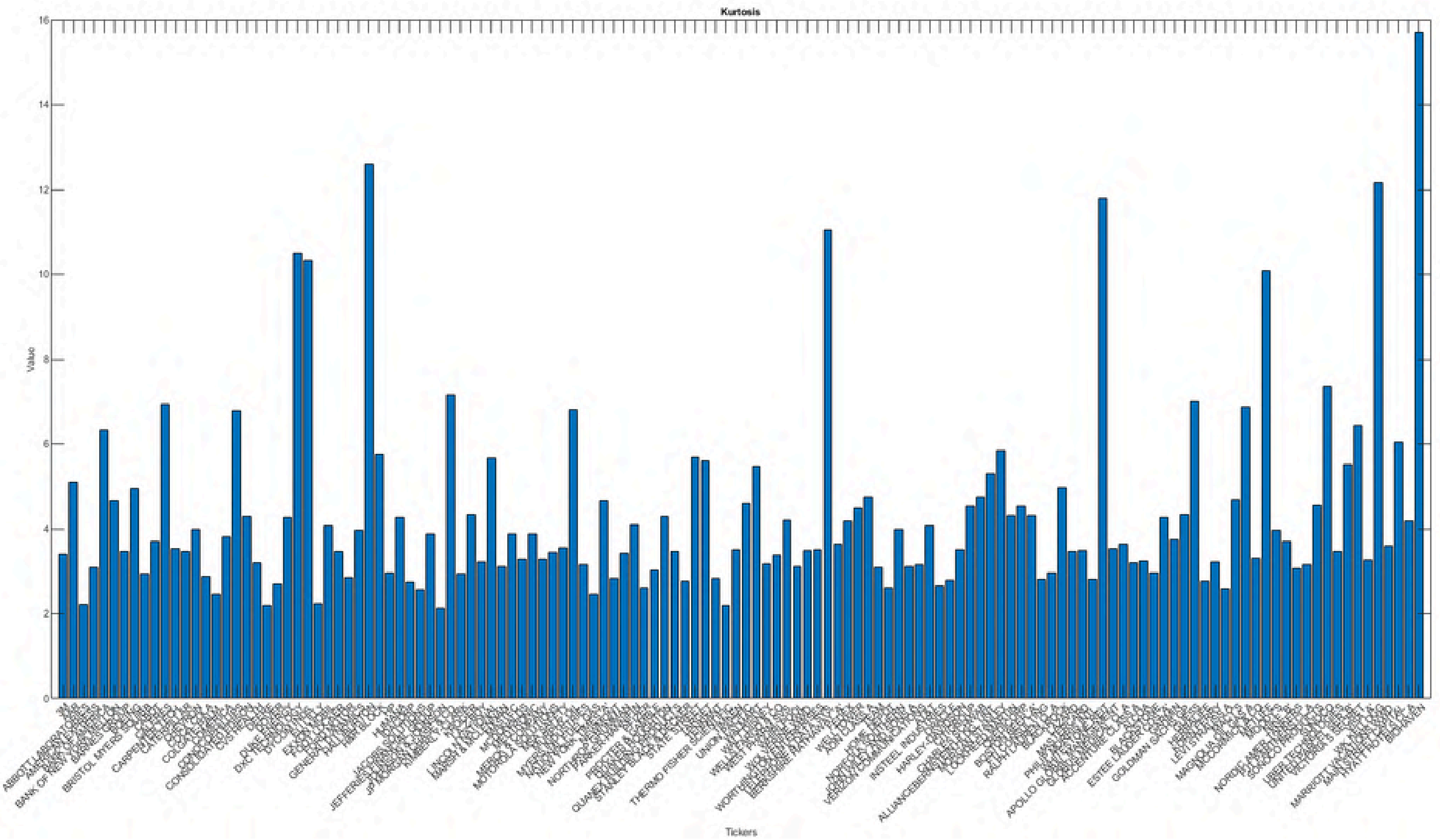


QUESTION 1 & 2 : NYSE MONTHLY STATISTICS

SKEWNESS



KURTOSIS



QUESTION 3: NASDAQ DAILY VARIANCE-COVARIANCE AND CORRELATION MATRIX

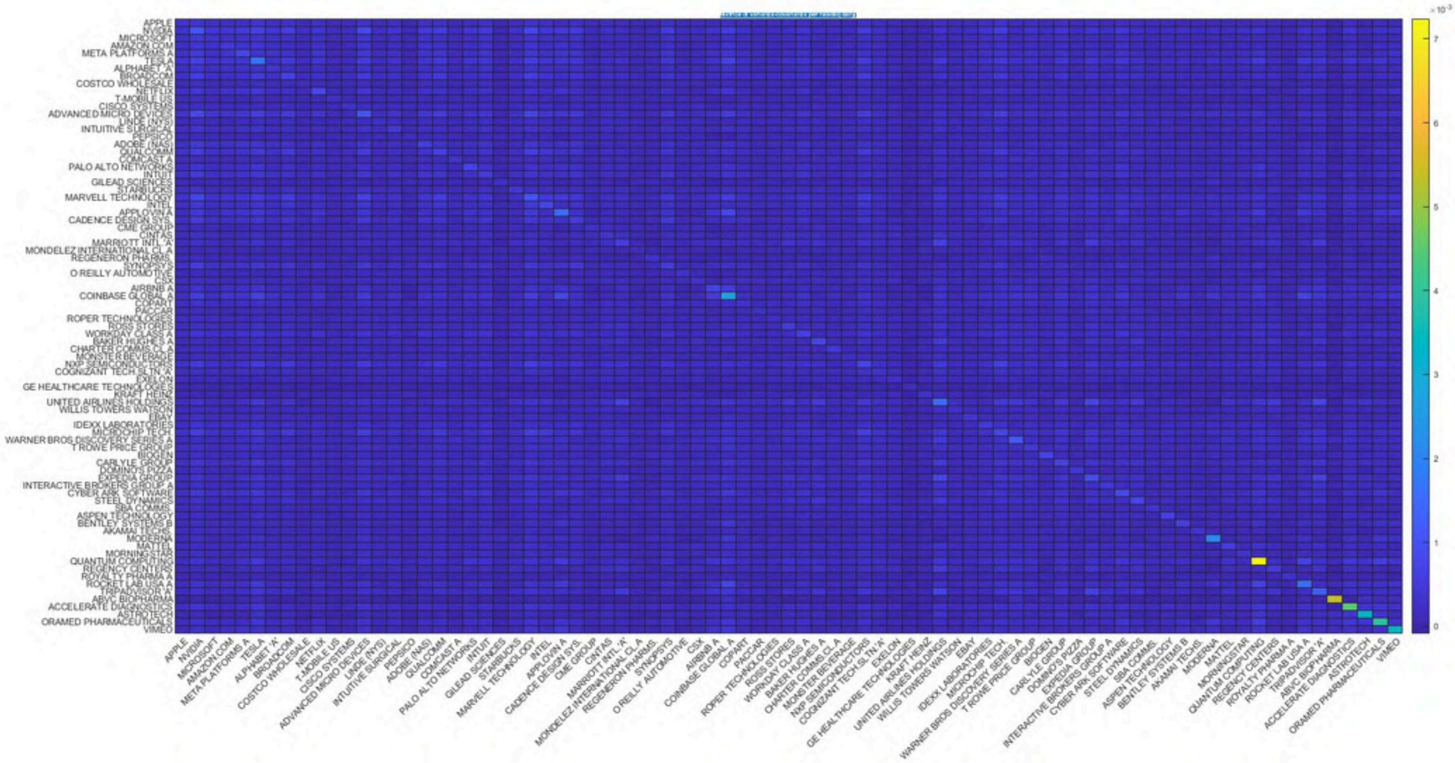
A correlation matrix is a table that shows the correlation coefficients between multiple variables in a dataset. It is a square, symmetric matrix where each element represents the degree of relationship (correlation) between two variables.

A variance-covariance matrix (or simply covariance matrix) is a square matrix that summarizes the variances and covariances between multiple variables in a dataset. It provides information about the spread (variance) of individual variables and how they vary together (covariance).

```
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';

% Fogli di lavoro
sheets = {'nasdaq monthly', 'nyse monthly', 'nasdaq daily', 'nyse daily'};

for s = 1:length(sheets)
    sheet = sheets{s};

    % Carica il file Excel
    opts = detectImportOptions(filename, 'Sheet', sheet);
    opts.VariableNamingRule = 'preserve';
    data = readtable(filename, opts);

    % Estrai i ticker
    tickers = data.Properties.VariableNames(2:end);

    % Calcola i rendimenti logaritmici
    returns = diff(log(data{:, 2:end}));

    % Calcola la matrice di varianza-covarianza
    cov_matrix = cov(returns);

    % Calcola la matrice di correlazione
    corr_matrix = corrcoef(returns);

    % Visualizza le matrici
    disp(['Matrice di varianza-covarianza per ', sheet]);
    disp(cov_matrix);

    disp(['Matrice di correlazione per ', sheet]);
    disp(corr_matrix);

    % Crea le heatmap
    figure;
    heatmap(tickers, tickers, cov_matrix, 'Colormap', parula, 'ColorbarVisible', 'on');
    title(['Matrice di varianza-covarianza per ', sheet]);
    ax = gca;
    ax.FontSize = ax.FontSize * 0.5; % regola la dimensione del font

    figure;
    heatmap(tickers, tickers, corr_matrix, 'Colormap', parula, 'ColorbarVisible', 'on');
    title(['Matrice di correlazione per ', sheet]);
    ax = gca;
    ax.FontSize = ax.FontSize * 0.5; % regola la dimensione del font
end
```

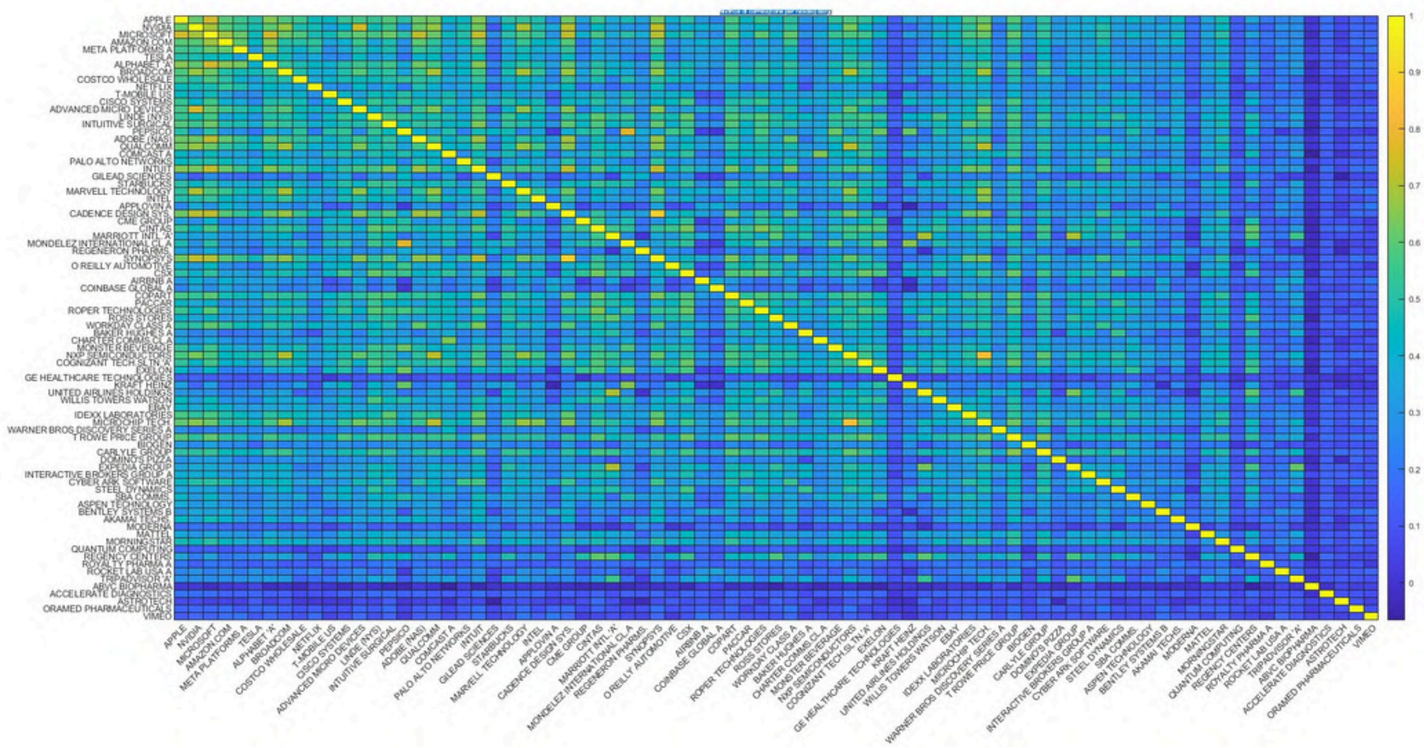
QUESTION 3: NASDAQ DAILY VARIANCE-COVARIANCE MATRIX

It can be noted from the heatmap of the variance-covariance matrix that the values are generally low, which indicates a low covariance between the stocks.



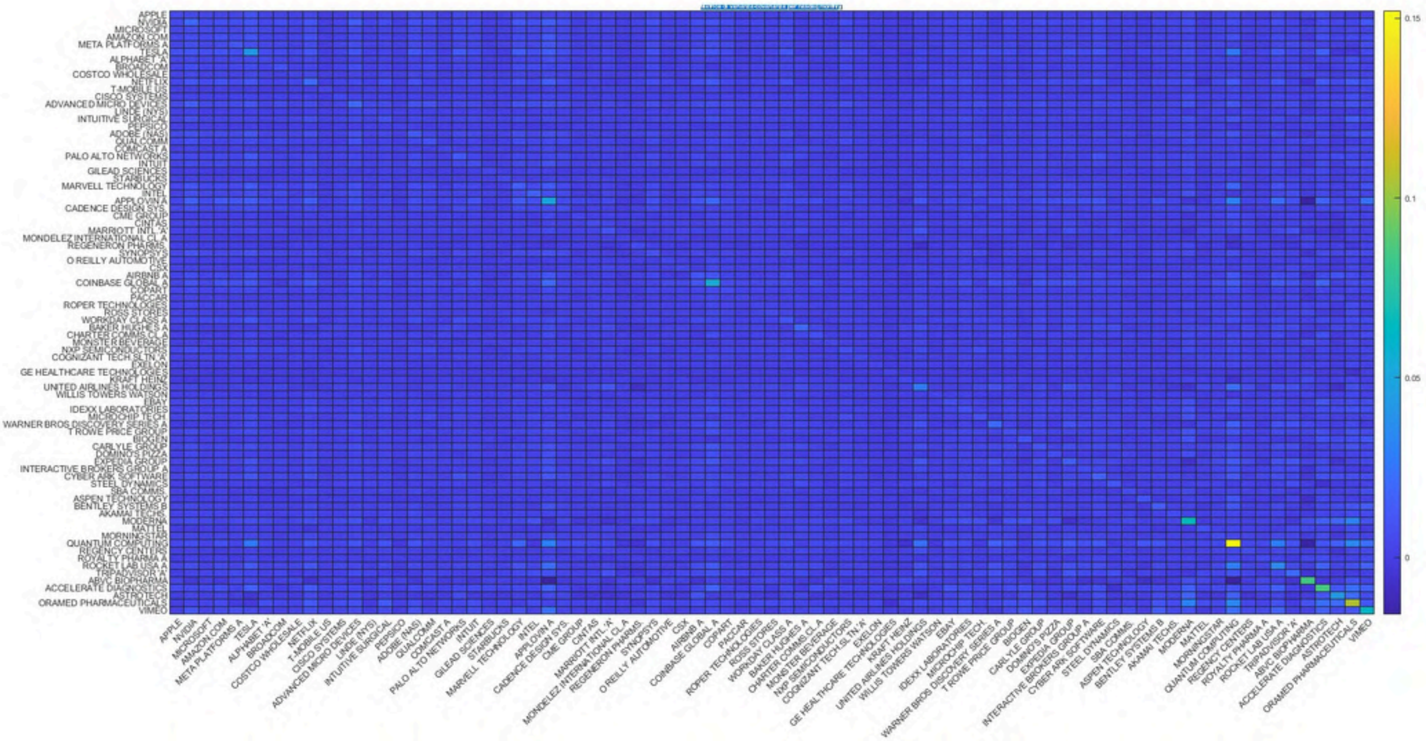
QUESTION 3: NASDAQ DAILY CORRELATION MATRIX

Regarding the correlation matrix, it can be noted that in the top-left corner, the correlation coefficients are generally higher, while moving towards the southeast, the coefficients gradually decrease. This is mainly due to the arrangement of the stocks in their respective rows and columns.



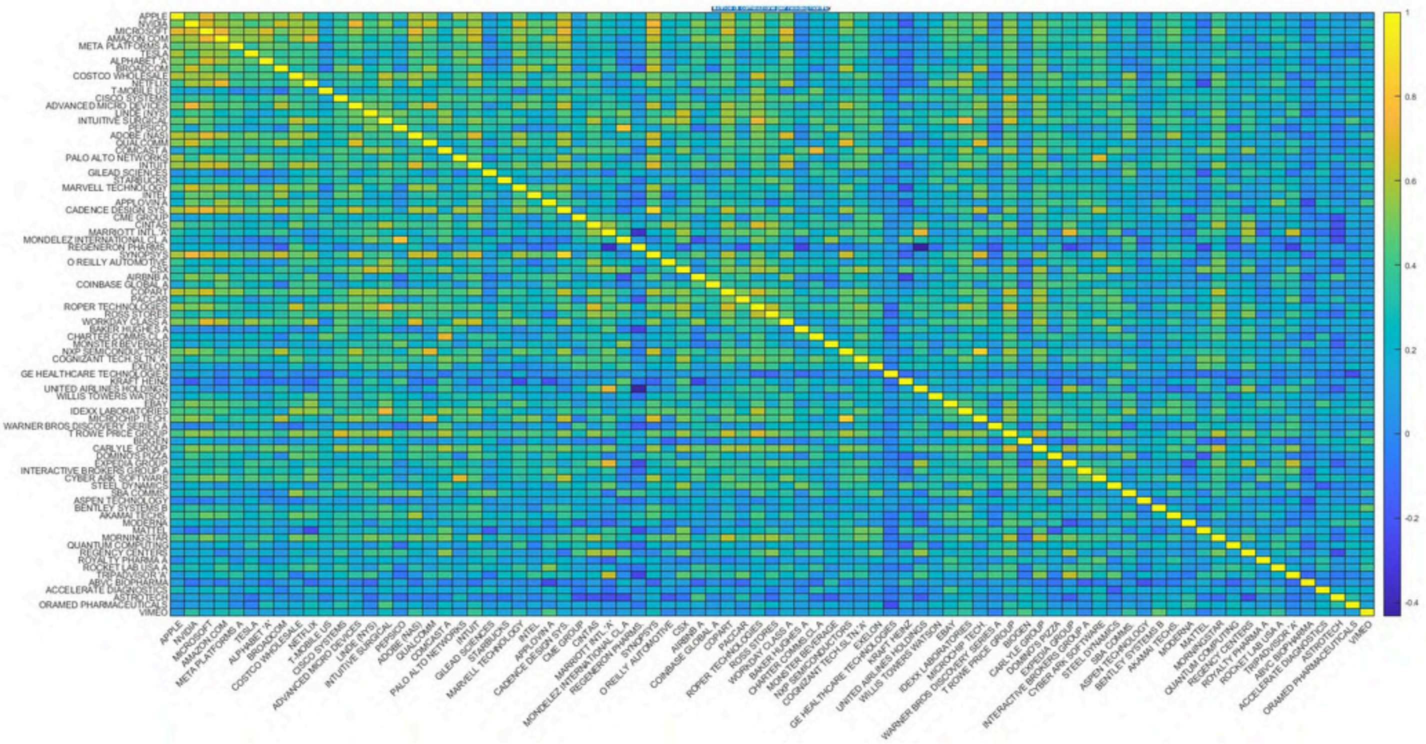
QUESTION 3: NASDAQ MONTHLY VARIANCE-COVARIANCE MATRIX

It can be noted that the variance-covariance matrix with monthly values shows higher values compared to the one with daily frequency. On a monthly basis, fluctuations in returns tend to be more stable and more visible compared to daily data, which can be subject to smaller and noisier movements. Additionally, by aggregating the data over a longer period (monthly), the relationships between the stocks may appear stronger or more apparent, as the daily variations accumulate, amplifying the effect observed in the correlation and variance-covariance matrices.



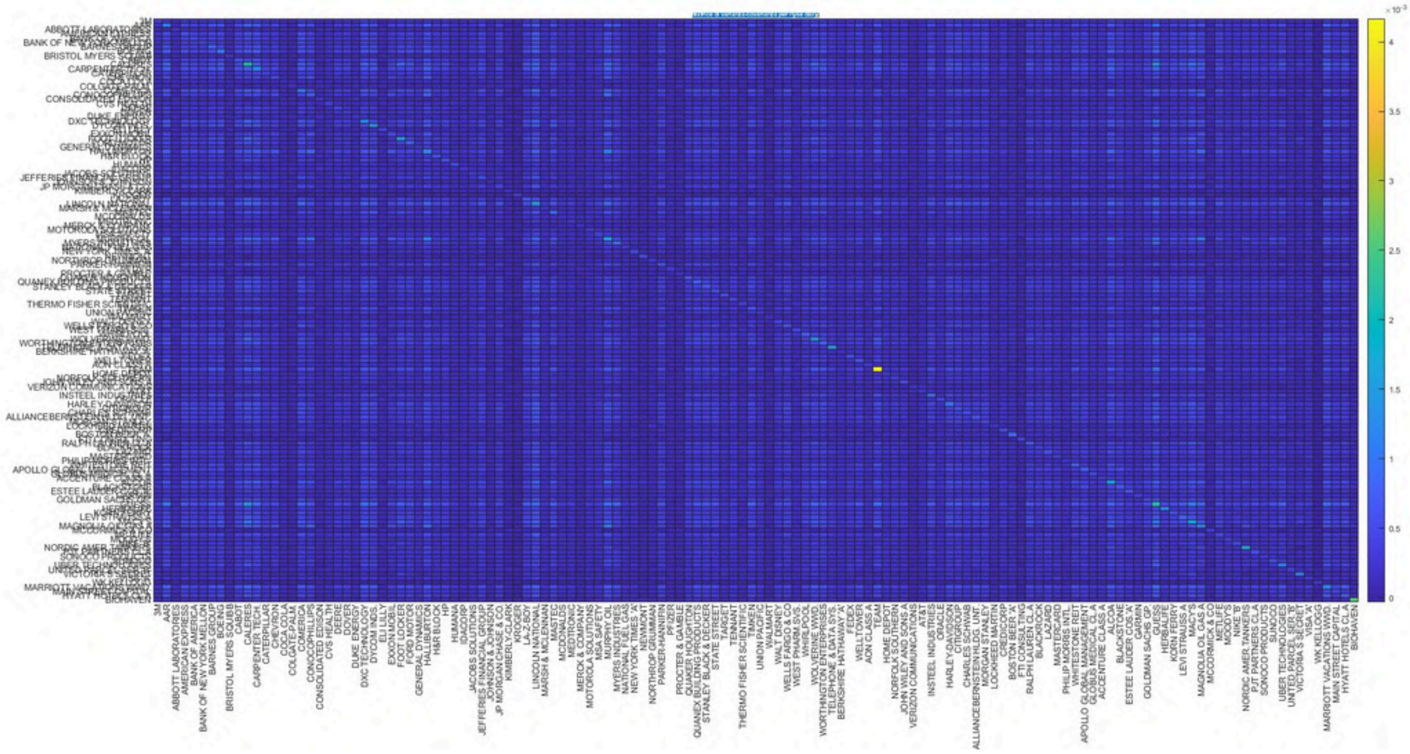
QUESTION 3: NASDAQ MONTHLY CORRELATION MATRIX

The same can be applied to the correlation matrix with monthly frequency.



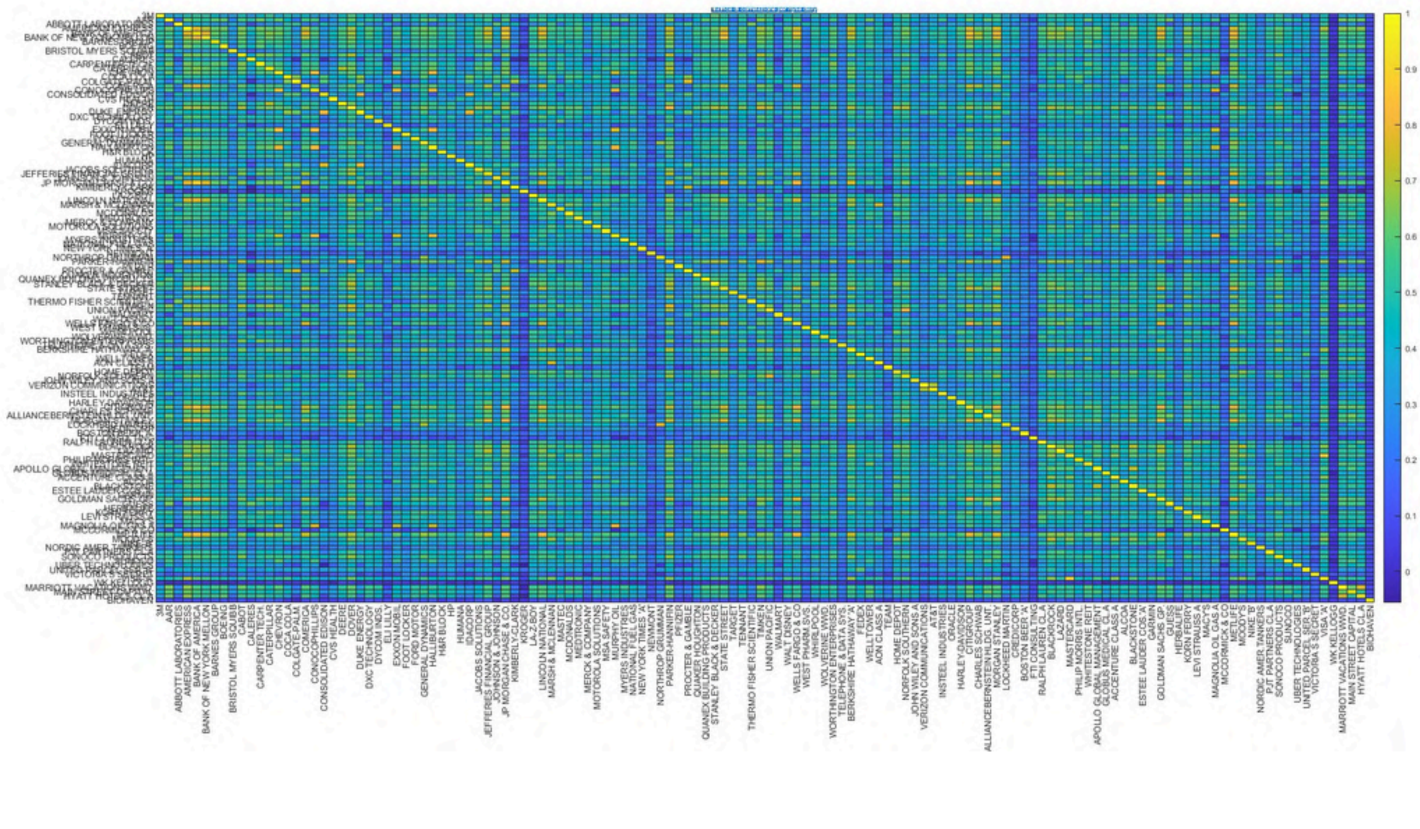
QUESTION 3: NYSE DAILY VARIANCE-COVARIANCE MATRIX

As before, it can be noted from the heatmap of the variance-covariance matrix that the values are generally low, which indicates a low covariance between the stocks.



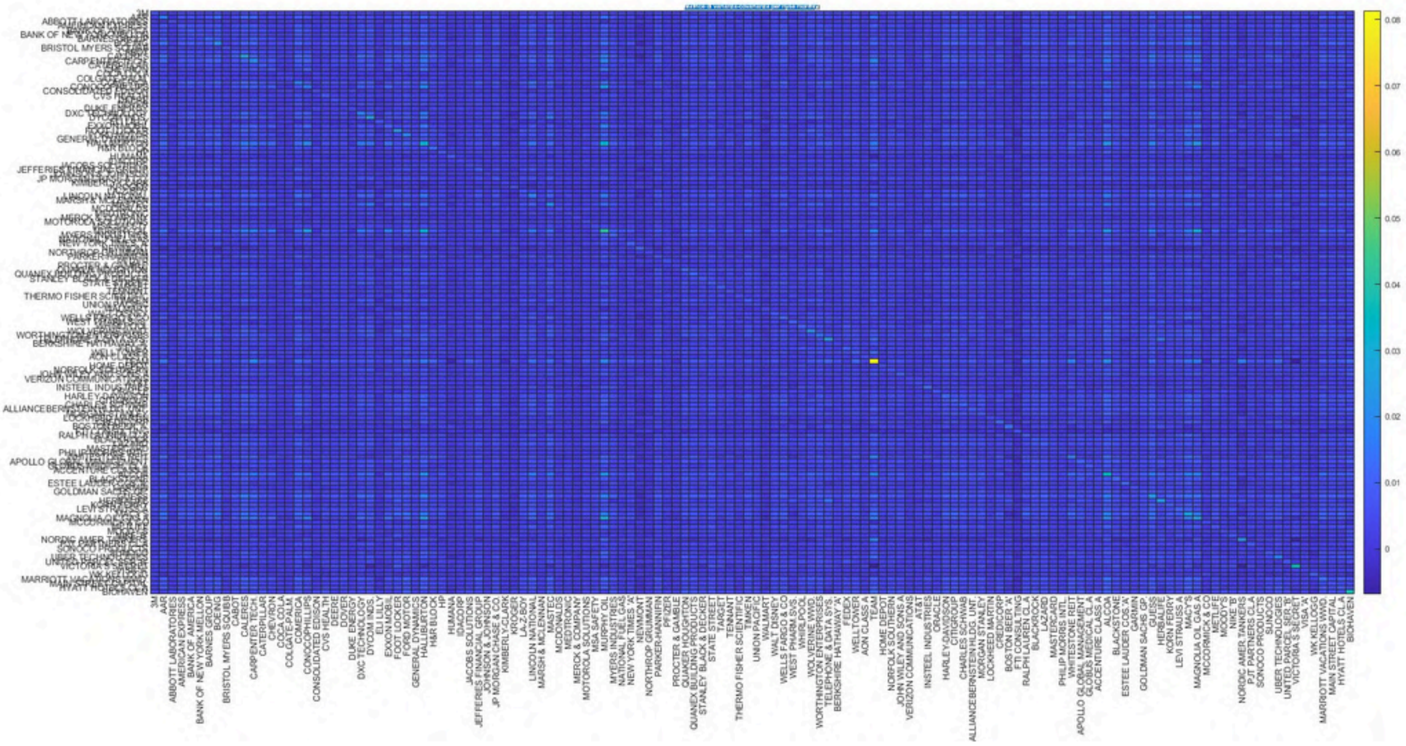
QUESTION 3: NYSE DAILY CORRELATION MATRIX

Unlike before, there is no specific pattern in the correlation matrix, and the values are generally higher compared to the Nasdaq matrix.



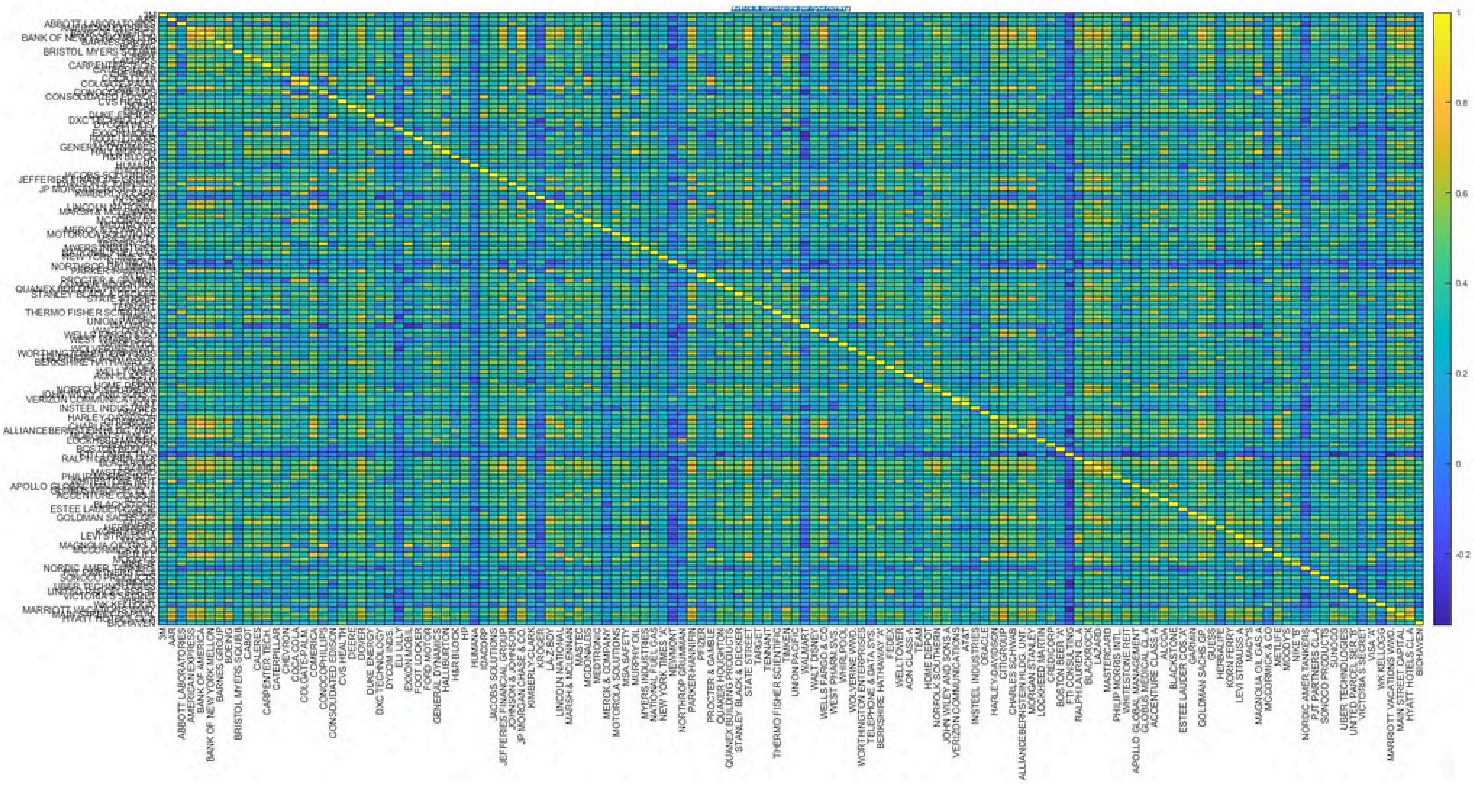
QUESTION 3: NYSE MONTHLY VARIANCE-COVARIANCE MATRIX

The data aggregated to monthly frequency also indicate generally higher values compared to the daily frequency.



QUESTION 3: NYSE MONTHLY CORRELATION MATRIX

The same applies to the monthly frequency correlation matrix.



QUESTION 4 AND 5 NYSE SECURITIES SELECTION

Presented below is the code to answer this questions.

```matlab
% Carica i dati dal file Excel con la regola di denominazione delle variabili impostata su 'preserve'
opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'nyse
daily');
opts.VariableNamingRule = 'preserve';
nyse_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet',
'SP500indexD');
opts.VariableNamingRule = 'preserve';
benchmark_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

% Converti le date in formato datetime
nyse_data.DATE = datetime(nyse_data.DATE, 'InputFormat', 'dd/MM/yyyy');
benchmark_data.DATE = datetime(benchmark_data.DATE, 'InputFormat', 'dd/MM/yyyy');

% Allinea i dati delle date
start_date = datetime('10/01/2020', 'InputFormat', 'dd/MM/yyyy');
end_date = datetime('17/01/2025', 'InputFormat', 'dd/MM/yyyy');

nyse_data = nyse_data(nyse_data.DATE >= start_date & nyse_data.DATE <= end_date, :);
benchmark_data = benchmark_data(benchmark_data.DATE >= start_date & benchmark_data.DATE <= end_date, :);

% Trova le date comuni
common_dates = intersect(nyse_data.DATE, benchmark_data.DATE);

% Filtra i dati per le date comuni
nyse_data = nyse_data(ismember(nyse_data.DATE, common_dates), :);
benchmark_data = benchmark_data(ismember(benchmark_data.DATE, common_dates), :);

% Calcola i rendimenti giornalieri normali
nyse_returns = diff(nyse_data{:, 2:end}) ./ nyse_data{1:end-1, 2:end};
benchmark_returns = diff(benchmark_data{:, 2}) ./ benchmark_data{1:end-1, 2};

% Assicurati che le dimensioni delle matrici siano compatibili
if size(nyse_returns, 1) ~= size(benchmark_returns, 1)
    error('Le dimensioni delle matrici dei rendimenti non corrispondono.');
end

% Calcola i beta dei titoli
num_stocks = size(nyse_returns, 2);
beta = zeros(num_stocks, 1);
mean_returns = zeros(num_stocks, 1);
std_returns = zeros(num_stocks, 1);
sharpe_ratio = zeros(num_stocks, 1);
information_ratio = zeros(num_stocks, 1);
average_drawdown = zeros(num_stocks, 1);
pain_index = zeros(num_stocks, 1);
sterling_ratio = zeros(num_stocks, 1);
burke_ratio = zeros(num_stocks, 1);
jensen_alpha = zeros(num_stocks, 1);
treynor_index = zeros(num_stocks, 1);
treynor_black_ratio = zeros(num_stocks, 1);
stock_names = nyse_data.Properties.VariableNames(2:end);

% Tasso privo di rischio giornaliero
risk_free_rate_daily = 0.02 / 252;

for i = 1:num_stocks
    X = [ones(size(benchmark_returns)), benchmark_returns];
    y = nyse_returns(:, i);
    b = X \ y;
    beta(i) = b(2);
    mean_returns(i) = mean(nyse_returns(:, i));
    std_returns(i) = std(nyse_returns(:, i));
    sharpe_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / std_returns(i);
    information_ratio(i) = (mean_returns(i) - mean(benchmark_returns)) / std_returns(i);

    % Calcola l'Average Drawdown
    cumulative_returns = cumprod(1 + nyse_returns(:, i)) - 1;
    drawdowns = cumulative_returns - cummax(cumulative_returns);
    average_drawdown(i) = mean(drawdowns(drawdowns < 0));

    % Calcola il Pain Index
    pain_index(i) = mean(abs(drawdowns(drawdowns < 0)));

    % Calcola lo Sterling Ratio
    sterling_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / abs(average_drawdown(i));

    % Calcola il Burke Ratio
    burke_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / sqrt(mean(drawdowns(drawdowns < 0).^2));

    % Calcola il Jensen Alpha
    jensen_alpha(i) = mean_returns(i) - (risk_free_rate_daily + beta(i) * (mean(benchmark_returns) -
risk_free_rate_daily));

    % Calcola il Treynor Index
    treynor_index(i) = (mean_returns(i) - risk_free_rate_daily) / beta(i);

    % Calcola il Treynor-Black Ratio
    treynor_black_ratio(i) = jensen_alpha(i) / beta(i);
end

% Visualizza i risultati in una tabella
results_table = table(stock_names', beta, mean_returns, std_returns, sharpe_ratio, information_ratio, ...
    average_drawdown, pain_index, sterling_ratio, burke_ratio, jensen_alpha, treynor_index,
treynor_black_ratio, ...
    'VariableNames', {'Stock', 'Beta', 'Mean_Return', 'Std_Dev', 'Sharpe_Ratio', 'Information_Ratio', ...
    'Average_Drawdown', 'Pain_Index', 'Sterling_Ratio', 'Burke_Ratio', 'Jensen_Alpha', 'Treynor_Index',
'Treynor_Black_Ratio'});
disp('Beta, media dei rendimenti, deviazione standard, Sharpe Ratio, Information Ratio, Average Drawdown,
Pain Index, Sterling Ratio, Burke Ratio, Jensen Alpha, Treynor Index e Treynor-Black Ratio dei titoli:');
disp(results_table);
```

```matlab
% Calcola le medie delle metriche
mean_mean_returns = mean(mean_returns);
mean_std_returns = mean(std_returns);
mean_sharpe_ratio = mean(sharpe_ratio);
mean_information_ratio = mean(information_ratio);
mean_average_drawdown = mean(average_drawdown);
mean_pain_index = mean(pain_index);
mean_sterling_ratio = mean(sterling_ratio);
mean_burke_ratio = mean(burke_ratio);
mean_jensen_alpha = mean(jensen_alpha);
mean_treynor_index = mean(treynor_index);


% Calcola la matrice di correlazione tra i rendimenti dei titoli e il benchmark
correlation_matrix = corr(nyse_returns, benchmark_returns);

% Definisci i pesi per ciascuna categoria, inclusa la correlazione
weights = struct('mean_returns', 0.05, ...
                 'std_returns', 0.15, ...
                 'sharpe_ratio', 0.05, ...
                 'information_ratio', 0.2, ...
                 'pain_index', 0.05, ...
                 'sterling_ratio', 0.05, ...
                 'burke_ratio', 0.05, ...
                 'jensen_alpha', 0.05, ...
                 'treynor_index', 0.05, ...
                 'correlation', 0.3);

% Assegna un punteggio a ciascun titolo in base ai criteri ponderati
scores = zeros(num_stocks, 1);
for i = 1:num_stocks
    score = 0;
    if mean_returns(i) > mean_mean_returns
        score = score + 5 * weights.mean_returns; % Assegna 5 punti ponderati se il rendimento medio è
superiore alla media
    else
        score = score + 1 * weights.mean_returns; % Assegna 1 punto ponderato se il rendimento medio è
inferiore o uguale alla media
    end

    if std_returns(i) < mean_std_returns
        score = score + 5 * weights.std_returns; % Assegna 5 punti ponderati se la deviazione standard è
inferiore alla media
    else
        score = score + 1 * weights.std_returns; % Assegna 1 punto ponderato se la deviazione standard è
superiore o uguale alla media
    end

    if sharpe_ratio(i) > mean_sharpe_ratio
        score = score + 5 * weights.sharpe_ratio; % Assegna 5 punti ponderati se lo Sharpe Ratio è
superiore alla media
    else
        score = score + 1 * weights.sharpe_ratio; % Assegna 1 punto ponderato se lo Sharpe Ratio è
inferiore o uguale alla media
    end

    if information_ratio(i) > mean_information_ratio
        score = score + 5 * weights.information_ratio; % Assegna 5 punti ponderati se l'Information Ratio
è superiore alla media
    else
        score = score + 1 * weights.information_ratio; % Assegna 1 punto ponderato se l'Information Ratio
è inferiore o uguale alla media
    end

    if pain_index(i) < mean_pain_index
        score = score + 5 * weights.pain_index; % Assegna 5 punti ponderati se il Pain Index è inferiore
alla media
    else
        score = score + 1 * weights.pain_index; % Assegna 1 punto ponderato se il Pain Index è superiore
o uguale alla media
    end

    if sterling_ratio(i) > mean_sterling_ratio
        score = score + 5 * weights.sterling_ratio; % Assegna 5 punti ponderati se lo Sterling Ratio è
superiore alla media
    else
        score = score + 1 * weights.sterling_ratio; % Assegna 1 punto ponderato se lo Sterling Ratio è
inferiore o uguale alla media
    end

    if burke_ratio(i) > mean_burke_ratio
        score = score + 5 * weights.burke_ratio; % Assegna 5 punti ponderati se il Burke Ratio è
superiore alla media
    else
        score = score + 1 * weights.burke_ratio; % Assegna 1 punto ponderato se il Burke Ratio è
inferiore o uguale alla media
    end

    if jensen_alpha(i) > mean_jensen_alpha
        score = score + 5 * weights.jensen_alpha; % Assegna 5 punti ponderati se il Jensen Alpha è
superiore alla media
    else
        score = score + 1 * weights.jensen_alpha; % Assegna 1 punto ponderato se il Jensen Alpha è
inferiore o uguale alla media
    end

    if treynor_index(i) > mean_treynor_index
        score = score + 5 * weights.treynor_index; % Assegna 5 punti ponderati se il Treynor Index è
superiore alla media
    else
        score = score + 1 * weights.treynor_index; % Assegna 1 punto ponderato se il Treynor Index è
inferiore o uguale alla media
    end

    % Penalizza la correlazione alta
    if correlation_matrix(i) > 0.5 % Soglia arbitraria, puoi modificarla in base alle tue esigenze
        score = score + 1 * weights.correlation; % Assegna 1 punto ponderato se la correlazione è
superiore a 0.5
    else
        score = score + 5 * weights.correlation; % Assegna 5 punti ponderati se la correlazione è
inferiore o uguale a 0.5
    end

    scores(i) = score;
end

% Aggiungi i punteggi alla tabella dei risultati
results_table.Score = scores;

% Ordina i titoli in base ai punteggi e seleziona i migliori 10
sorted_stocks = sortrows(results_table, 'Score', 'descend');
top_10_stocks = sorted_stocks(1:min(10, height(sorted_stocks)), :);

disp('I migliori 10 titoli selezionati sono:');
disp(top_10_stocks);

% Calcola i rendimenti annualizzati e le deviazioni standard annualizzate
annualized_mean_returns = mean_returns * 252;
annualized_std_returns = std_returns * sqrt(252);
annualized_sharpe_ratio = sharpe_ratio * sqrt(252);
annualized_information_ratio = information_ratio * sqrt(252);
annualized_jensen_alpha = jensen_alpha * 252;
annualized_treynor_index = treynor_index * 252;
annualized_treynor_black_ratio = treynor_black_ratio * 252;

% Visualizza i risultati annualizzati in una tabella
annualized_results_table = table(stock_names', beta, annualized_mean_returns, annualized_std_returns,
annualized_sharpe_ratio, annualized_information_ratio, ...
    pain_index, sterling_ratio, burke_ratio, annualized_jensen_alpha, annualized_treynor_index,
annualized_treynor_black_ratio, scores, ...
    'VariableNames', {'Stock', 'Beta', 'Annualized_Mean_Return', 'Annualized_Std_Dev',
'Annualized_Sharpe_Ratio', 'Annualized_Information_Ratio', ...
    'Pain_Index', 'Sterling_Ratio', 'Burke_Ratio', 'Annualized_Jensen_Alpha', 'Annualized_Treynor_Index',
'Annualized_Treynor_Black_Ratio', 'Score'});

disp('Beta, rendimenti annualizzati, deviazione standard annualizzata, Sharpe Ratio annualizzato,
Information Ratio annualizzato, Pain Index, Sterling Ratio, Burke Ratio, Jensen Alpha annualizzato,
Treynor Index annualizzato e Treynor-Black Ratio annualizzato dei titoli:');
disp(annualized_results_table);

% Ordina i titoli in base ai punteggi e seleziona i migliori 10
sorted_annualized_stocks = sortrows(annualized_results_table, 'Score', 'descend');
top_10_annualized_stocks = sorted_annualized_stocks(1:min(10, height(sorted_annualized_stocks)), :);

disp('I migliori 10 titoli selezionati sono:');
disp(top_10_annualized_stocks);
```

QUESTION 4 AND 5 NYSE SECURITIES SELECTION

We've created an algorithm to help us analyze a group of stocks and pick out the best performers based on a mix of financial and risk-related metrics. We assess each stock using various factors like average return, risk (in terms of standard deviation), Sharpe ratio, drawdowns, and others that give us insight into its risk and performance. We also look at how closely each stock tracks the benchmark (such as the Nasdaq), giving lower scores to those that follow it too closely.
To start, the algorithm calculates key numbers for each stock, like its beta, which shows how much the stock moves compared to the benchmark. It also calculates the average return, standard deviation (volatility), Sharpe ratio (how well the stock performs compared to the risk it takes on), and the information ratio (which tells us how well the stock performs compared to the benchmark, adjusted for risk). We also track things like drawdowns (the drops in value) and the pain index (how severe those drops are). Other metrics like the Sterling ratio, Burke ratio, and Jensen alpha give us even more insight into how the stock does relative to its risk.
Then, we look at the correlation between the stock returns and the benchmark, which shows us if the stock is moving similarly to the benchmark or if it's offering something different. If a stock's returns are too similar to the benchmark, we penalize it, as we want to find stocks that stand out.
Next, we assign a weight to each of these metrics based on how important we think they are. For instance, things like return and risk (volatility) carry more weight because they're more directly related to performance. We also give a significant weight to correlation, as we want stocks that don't just mirror the benchmark.
Using these weights, the algorithm gives each stock a score. If a stock has better-than-average returns, it gets a higher score; if its risk is lower than average, it gets a higher score as well. Stocks that are too closely correlated with the benchmark get penalized, so they earn lower scores.
At the end, we create a table showing the scores along with the key metrics for each stock. Then, we sort the stocks by their scores, and we pick the top 10. These top 10 stocks are the ones that stand out based on all of the factors we've measured, and they're displayed with all their important performance numbers so that we can easily see which ones are performing best.
In short, we built this algorithm to give us a clear picture of which stocks are really performing well, not just in terms of returns, but also when you factor in the risk involved. By considering a variety of metrics and weighing them based on their importance, we can pick out the stocks that stand out from the crowd, helping us make better investment decisions.
These are the results:

I migliori 10 titoli selezionati sono:

Stock	Beta	Annualized_Mean_Return	Annualized_Std_Dev	Annualized_Sharpe_Ratio	Annualized_Information_Ratio	Pain_Index	Sterling_Ratio
{'ELI LILLY' }	0.65208	0.3898	0.31994	1.1558	0.79973	0.20715	0.0070841
{'KROGER' }	0.25779	0.18062	0.27902	0.57566	0.16732	0.28358	0.0022476
{'WALMART' }	0.46558	0.19348	0.22182	0.78211	0.26846	0.052061	0.007478
{'FTI CONSULTING' }	0.37871	0.15056	0.31891	0.4094	0.052129	0.15274	0.003392
{'CALERES' }	1.3445	0.25488	0.73357	0.32019	0.16487	0.30909	0.0030154
{'TELEPHONE & DATA SYS.'}	0.83556	0.2405	0.64654	0.34105	0.16482	0.32633	0.0026813
{'NEW YORK TIMES 'A'' }	0.75668	0.14603	0.32278	0.39044	0.037465	0.35609	0.0014045
{'MURPHY OIL' }	1.3998	0.24131	0.62641	0.3533	0.17141	0.37805	0.002323
{'MAGNOLIA OIL GAS A' }	1.1909	0.27819	0.54066	0.47755	0.26681	0.4128	0.002482
{'BIOHAVEN' }	0.45429	0.29834	0.62666	0.44417	0.26236	0.4364	0.002531

Burke_Ratio	Annualized_Jensen_Alpha	Annualized_Treynor_Index	Annualized_Treynor_Black_Ratio	Score
0.0042595	0.29551	0.56711	0.45318	5
0.0018092	0.13125	0.62306	0.50913	5
0.0058162	0.12039	0.3723	0.25836	5
0.0028159	0.087411	0.34474	0.23081	5
0.0024882	0.081688	0.17469	0.060756	4.4
0.002326	0.1253	0.26389	0.14996	4.4
0.0011599	0.039816	0.16656	0.052619	4.4
0.0020388	0.061824	0.1581	0.044166	4.2
0.0021842	0.1225	0.2168	0.10286	4.2
0.0022202	0.22658	0.61271	0.49877	4.2

In particular, the metrics used were:

Sterling Ratio: $SR = \frac{\mu_p - \mu_f}{D_{\max}}$

where: μ_p = portfolio return, μ_f = risk-free rate, $D_{\max}$ = maximum drawdown.

Burke Ratio: $BR = \frac{\mu_p - \mu_f}{\sqrt{\sum_{i=1}^{d} D_i^2}}$

where: μ_p = portfolio return, μ_f = risk-free rate, D_i = drawdown for period i.

Jensen's Alpha: $\alpha = \mu_p - \mu_f - \beta_p (\mu_m - \mu_f)$

where: μ_p = portfolio return, μ_f = risk-free rate, β_p = portfolio beta, μ_m = market return.

Sharpe Ratio: $SR = \frac{\mu_p - \mu_f}{\sigma_p}$

where: μ_p = portfolio return, μ_f = risk-free rate, σ_p = portfolio standard deviation.

Treynor Index: $T = \frac{\mu_p - \mu_f}{\beta_p}$

where: μ_p = portfolio return, μ_f = risk-free rate, β_p = portfolio beta (systematic risk).

Information Ratio: $IR = \frac{\mu_p - \mu_b}{TE}$

where: μ_p = portfolio return, μ_b = benchmark return, TE = tracking error.

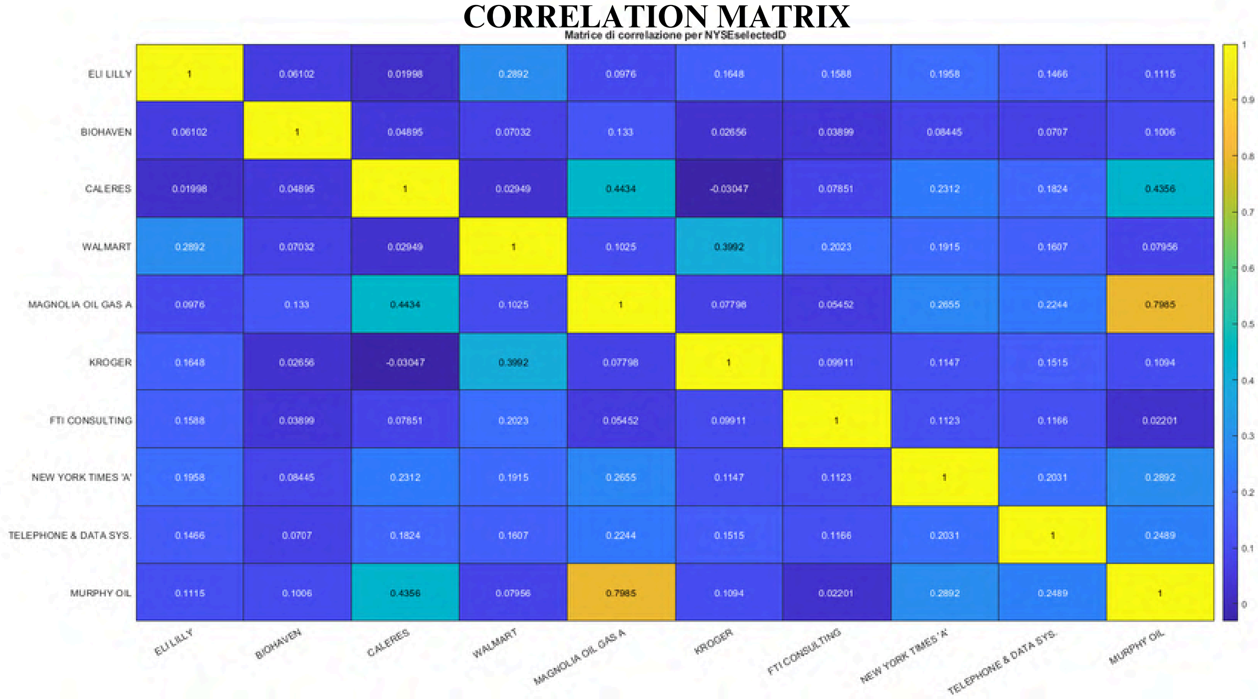
Pain Ratio: $PR = \frac{\mu_p - \mu_f}{\sum_{i=1}^{n} D_i}$

where: μ_p = portfolio return, μ_f = risk-free rate, D_i = drawdown for period i.

QUESTION 4 AND 5 NYSE SECURITIES SELECTION

The correlation and variance-covariance matrices for Nyse are the following:

CORRELATION MATRIX



VARIANCE-COVARIANCE MATRIX

QUESTION 4 AND 5 NASDAQ SECURITIES SELECTION

Presented below is the code to answer this questions.

```matlab
% Carica i dati dal file Excel con la regola di denominazione delle variabili impostata su 'preserve'
opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'nasdaq
daily');
opts.VariableNamingRule = 'preserve';
nasdaq_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet',
'NASindexD');
opts.VariableNamingRule = 'preserve';
benchmark_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

% Converti le date in formato datetime
nasdaq_data.DATE = datetime(nasdaq_data.DATE, 'InputFormat', 'dd/MM/yyyy');
benchmark_data.DATE = datetime(benchmark_data.DATE, 'InputFormat', 'dd/MM/yyyy');

% Allinea i dati delle date
start_date = datetime('10/01/2020', 'InputFormat', 'dd/MM/yyyy');
end_date = datetime('17/01/2025', 'InputFormat', 'dd/MM/yyyy');

nasdaq_data = nasdaq_data(nasdaq_data.DATE >= start_date & nasdaq_data.DATE <= end_date, :);
benchmark_data = benchmark_data(benchmark_data.DATE >= start_date & benchmark_data.DATE <= end_date, :);

% Trova le date comuni
common_dates = intersect(nasdaq_data.DATE, benchmark_data.DATE);

% Filtra i dati per le date comuni
nasdaq_data = nasdaq_data(ismember(nasdaq_data.DATE, common_dates), :);
benchmark_data = benchmark_data(ismember(benchmark_data.DATE, common_dates), :);

% Calcola i rendimenti giornalieri normali
nasdaq_returns = diff(nasdaq_data{:, 2:end}) ./ nasdaq_data{1:end-1, 2:end};
benchmark_returns = diff(benchmark_data{:, 2}) ./ benchmark_data{1:end-1, 2};

% Assicurati che le dimensioni delle matrici siano compatibili
if size(nasdaq_returns, 1) ~= size(benchmark_returns, 1)
    error('Le dimensioni delle matrici dei rendimenti non corrispondono.');
end

% Calcola i beta dei titoli
num_stocks = size(nasdaq_returns, 2);
beta = zeros(num_stocks, 1);
mean_returns = zeros(num_stocks, 1);
std_returns = zeros(num_stocks, 1);
sharpe_ratio = zeros(num_stocks, 1);
information_ratio = zeros(num_stocks, 1);
average_drawdown = zeros(num_stocks, 1);
pain_index = zeros(num_stocks, 1);
sterling_ratio = zeros(num_stocks, 1);
burke_ratio = zeros(num_stocks, 1);
jensen_alpha = zeros(num_stocks, 1);
treynor_index = zeros(num_stocks, 1);
treynor_black_ratio = zeros(num_stocks, 1);
stock_names = nasdaq_data.Properties.VariableNames(2:end);
```

```matlab
% Tasso privo di rischio giornaliero
risk_free_rate_daily = 0.02 / 252;

for i = 1:num_stocks
    X = [ones(size(benchmark_returns)), benchmark_returns];
    y = nasdaq_returns(:, i);
    b = X \ y;
    beta(i) = b(2);
    mean_returns(i) = mean(nasdaq_returns(:, i));
    std_returns(i) = std(nasdaq_returns(:, i));
    sharpe_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / std_returns(i);
    information_ratio(i) = (mean_returns(i) - mean(benchmark_returns)) / std_returns(i);

    % Calcola l'Average Drawdown
    cumulative_returns = cumprod(1 + nasdaq_returns(:, i)) - 1;
    drawdowns = cumulative_returns - cummax(cumulative_returns);
    average_drawdown(i) = mean(drawdowns(drawdowns < 0));

    % Calcola il Pain Index
    pain_index(i) = mean(abs(drawdowns(drawdowns < 0)));

    % Calcola lo Sterling Ratio
    sterling_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / abs(average_drawdown(i));

    % Calcola il Burke Ratio
    burke_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / sqrt(mean(drawdowns(drawdowns < 0).^2));

    % Calcola il Jensen Alpha
    jensen_alpha(i) = mean_returns(i) - (risk_free_rate_daily + beta(i) * (mean(benchmark_returns) -
risk_free_rate_daily));

    % Calcola il Treynor Index
    treynor_index(i) = (mean_returns(i) - risk_free_rate_daily) / beta(i);

    % Calcola il Treynor-Black Ratio
    treynor_black_ratio(i) = jensen_alpha(i) / beta(i);
end

% Visualizza i risultati in una tabella
results_table = table(stock_names', beta, mean_returns, std_returns, sharpe_ratio, information_ratio, ...
    average_drawdown, pain_index, sterling_ratio, burke_ratio, jensen_alpha, treynor_index,
treynor_black_ratio, ...
    'VariableNames', {'Stock', 'Beta', 'Mean_Return', 'Std_Dev', 'Sharpe_Ratio', 'Information_Ratio', ...
    'Average_Drawdown', 'Pain_Index', 'Sterling_Ratio', 'Burke_Ratio', 'Jensen_Alpha', 'Treynor_Index',
'Treynor_Black_Ratio'});
disp('Beta, media dei rendimenti, deviazione standard, Sharpe Ratio, Information Ratio, Average Drawdown,
Pain Index, Sterling Ratio, Burke Ratio, Jensen Alpha, Treynor Index e Treynor-Black Ratio dei titoli:');
disp(results_table);

% Calcola le medie delle metriche
mean_mean_returns = mean(mean_returns);
mean_std_returns = mean(std_returns);
mean_sharpe_ratio = mean(sharpe_ratio);
mean_information_ratio = mean(information_ratio);
mean_average_drawdown = mean(average_drawdown);
mean_pain_index = mean(pain_index);
mean_sterling_ratio = mean(sterling_ratio);
mean_burke_ratio = mean(burke_ratio);
mean_jensen_alpha = mean(jensen_alpha);
mean_treynor_index = mean(treynor_index);


% Calcola la matrice di correlazione tra i rendimenti dei titoli e il benchmark
correlation_matrix = corr(nasdaq_returns, benchmark_returns);

% Definisci i pesi per ciascuna categoria, inclusa la correlazione
weights = struct('mean_returns', 0.05, ...
                 'std_returns', 0.1, ...
                 'sharpe_ratio', 0.025, ...
                 'information_ratio', 0.3, ...
                 'pain_index', 0.05, ...
                 'sterling_ratio', 0.025, ...
                 'burke_ratio', 0.05, ...
                 'jensen_alpha', 0.05, ...
                 'treynor_index', 0.05, ...
                 'correlation', 0.3);

% Assegna un punteggio a ciascun titolo in base ai criteri ponderati
scores = zeros(num_stocks, 1);
for i = 1:num_stocks
    score = 0;
    if mean_returns(i) > mean_mean_returns
        score = score + 5 * weights.mean_returns; % Assegna 5 punti ponderati se il rendimento medio è
superiore alla media
    else
        score = score + 1 * weights.mean_returns; % Assegna 1 punto ponderato se il rendimento medio è
inferiore o uguale alla media
    end

    if std_returns(i) < mean_std_returns
        score = score + 5 * weights.std_returns; % Assegna 5 punti ponderati se la deviazione standard è
inferiore alla media
    else
        score = score + 1 * weights.std_returns; % Assegna 1 punto ponderato se la deviazione standard è
superiore o uguale alla media
    end

    if sharpe_ratio(i) > mean_sharpe_ratio
        score = score + 5 * weights.sharpe_ratio; % Assegna 5 punti ponderati se lo Sharpe Ratio è
superiore alla media
    else
        score = score + 1 * weights.sharpe_ratio; % Assegna 1 punto ponderato se lo Sharpe Ratio è
inferiore o uguale alla media
    end

    if information_ratio(i) > mean_information_ratio
        score = score + 5 * weights.information_ratio; % Assegna 5 punti ponderati se l'Information Ratio
è superiore alla media
    else
        score = score + 1 * weights.information_ratio; % Assegna 1 punto ponderato se l'Information Ratio
è inferiore o uguale alla media
    end

    if pain_index(i) < mean_pain_index
        score = score + 5 * weights.pain_index; % Assegna 5 punti ponderati se il Pain Index è inferiore
alla media
    else
        score = score + 1 * weights.pain_index; % Assegna 1 punto ponderato se il Pain Index è superiore
o uguale alla media
    end

    if sterling_ratio(i) > mean_sterling_ratio
        score = score + 5 * weights.sterling_ratio; % Assegna 5 punti ponderati se lo Sterling Ratio è
superiore alla media
    else
        score = score + 1 * weights.sterling_ratio; % Assegna 1 punto ponderato se lo Sterling Ratio è
inferiore o uguale alla media
    end

    if burke_ratio(i) > mean_burke_ratio
        score = score + 5 * weights.burke_ratio; % Assegna 5 punti ponderati se il Burke Ratio è
superiore alla media
    else
        score = score + 1 * weights.burke_ratio; % Assegna 1 punto ponderato se il Burke Ratio è
inferiore o uguale alla media
    end

    if jensen_alpha(i) > mean_jensen_alpha
        score = score + 5 * weights.jensen_alpha; % Assegna 5 punti ponderati se il Jensen Alpha è
superiore alla media
    else
        score = score + 1 * weights.jensen_alpha; % Assegna 1 punto ponderato se il Jensen Alpha è
inferiore o uguale alla media
    end

    if treynor_index(i) > mean_treynor_index
        score = score + 5 * weights.treynor_index; % Assegna 5 punti ponderati se il Treynor Index è
superiore alla media
    else
        score = score + 1 * weights.treynor_index; % Assegna 1 punto ponderato se il Treynor Index è
inferiore o uguale alla media
    end

    % Penalizza la correlazione alta
    if correlation_matrix(i) > 0.5 % Soglia arbitraria, puoi modificarla in base alle tue esigenze
        score = score + 1 * weights.correlation; % Assegna 1 punto ponderato se la correlazione è
superiore a 0.5
    else
        score = score + 5 * weights.correlation; % Assegna 5 punti ponderati se la correlazione è
inferiore o uguale a 0.5
    end

    scores(i) = score;
end

% Aggiungi i punteggi alla tabella dei risultati
results_table.Score = scores;

% Ordina i titoli in base ai punteggi e seleziona i migliori 10
sorted_stocks = sortrows(results_table, 'Score', 'descend');
top_10_stocks = sorted_stocks(1:min(10, height(sorted_stocks)), :);

disp('I migliori 10 titoli selezionati sono:');
disp(top_10_stocks);

% Calcola i rendimenti annualizzati e le deviazioni standard annualizzate
annualized_mean_returns = mean_returns * 252;
annualized_std_returns = std_returns * sqrt(252);
annualized_sharpe_ratio = sharpe_ratio * sqrt(252);
annualized_information_ratio = information_ratio * sqrt(252);
annualized_jensen_alpha = jensen_alpha * 252;
annualized_treynor_index = treynor_index * 252;
annualized_treynor_black_ratio = treynor_black_ratio * 252;

% Visualizza i risultati annualizzati in una tabella
annualized_results_table = table(stock_names', beta, annualized_mean_returns, annualized_std_returns,
annualized_sharpe_ratio, annualized_information_ratio, ...
    pain_index, sterling_ratio, burke_ratio, annualized_jensen_alpha, annualized_treynor_index,
annualized_treynor_black_ratio, scores, ...
    'VariableNames', {'Stock', 'Beta', 'Annualized_Mean_Return', 'Annualized_Std_Dev',
'Annualized_Sharpe_Ratio', 'Annualized_Information_Ratio', ...
    'Pain_Index', 'Sterling_Ratio', 'Burke_Ratio', 'Annualized_Jensen_Alpha', 'Annualized_Treynor_Index',
'Annualized_Treynor_Black_Ratio', 'Score'});

disp('Beta, rendimenti annualizzati, deviazione standard annualizzata, Sharpe Ratio annualizzato,
Information Ratio annualizzato, Pain Index, Sterling Ratio, Burke Ratio, Jensen Alpha annualizzato,
Treynor Index annualizzato e Treynor-Black Ratio annualizzato dei titoli:');
disp(annualized_results_table);

% Ordina i titoli in base ai punteggi e seleziona i migliori 10
sorted_annualized_stocks = sortrows(annualized_results_table, 'Score', 'descend');
top_10_annualized_stocks = sorted_annualized_stocks(1:min(10, height(sorted_annualized_stocks)), :);

disp('I migliori 10 titoli selezionati sono:');
disp(top_10_annualized_stocks);
```

QUESTION 4 AND 5 NASDAQ SECURITIES SELECTION

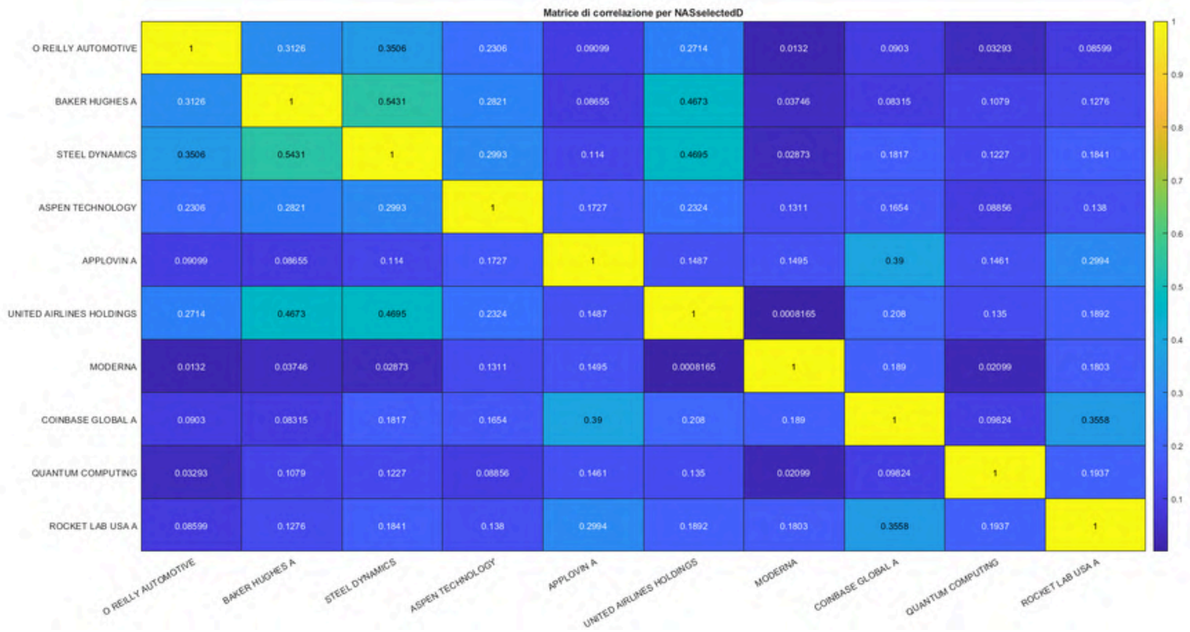
The results of the selection algorithm for the Nasdaq are as follows, after adjusting the weights of some parameters.

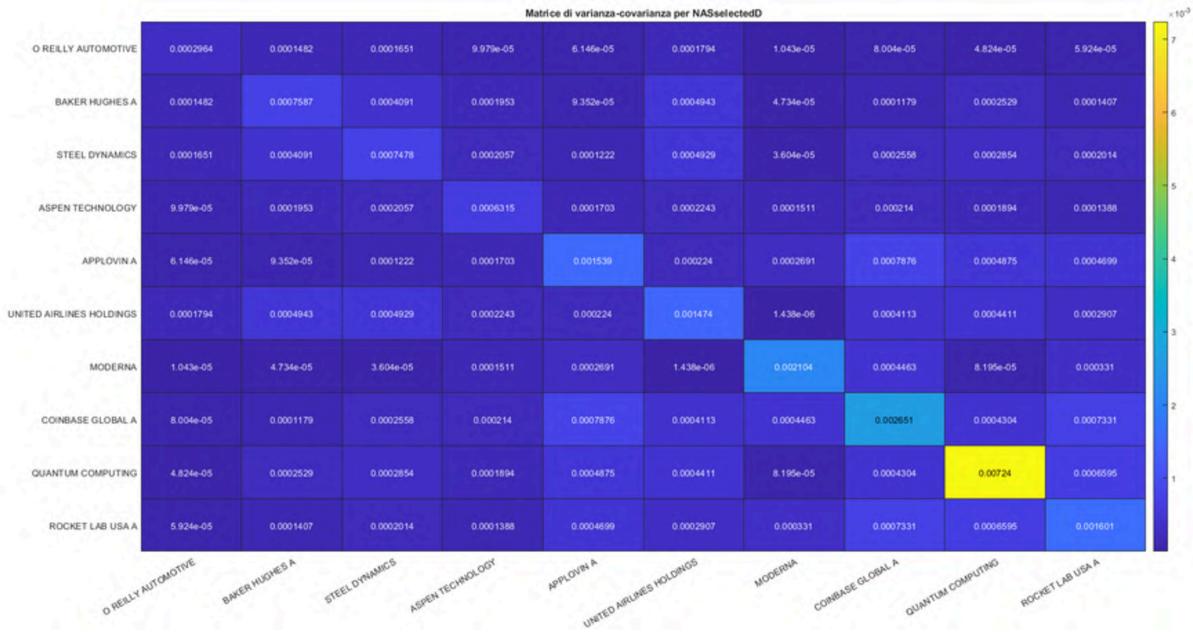
I migliori 10 titoli selezionati sono:

Stock	Beta	Annualized_Mean_Return	Annualized_Std_Dev	Annualized_Sharpe_Ratio	Annualized_Information_Ratio	Pain_Index	Sterling_Ratio
{'ELI LILLY' }	0.65208	0.3898	0.31994	1.1558	0.79973	0.20715	0.0070841
{'KROGER' }	0.25779	0.18062	0.27902	0.57566	0.16732	0.28358	0.0022476
{'WALMART' }	0.46598	0.19348	0.22182	0.78211	0.26846	0.092061	0.007478
{'FTI CONSULTING' }	0.37871	0.15056	0.31891	0.4094	0.052129	0.15274	0.003392
{'CALERES' }	1.3445	0.25488	0.73357	0.32019	0.16487	0.30909	0.0030154
{'TELEPHONE & DATA SYS.'}	0.83556	0.2405	0.64654	0.34105	0.16482	0.32633	0.0026813
{'NEW YORK TIMES 'A'' }	0.75668	0.14603	0.32278	0.39044	0.037465	0.35609	0.0014045
{'MURPHY OIL' }	1.3998	0.24131	0.62641	0.3533	0.17141	0.37805	0.002323
{'MAGNOLIA OIL GAS A' }	1.1909	0.27819	0.54066	0.47755	0.26681	0.4128	0.002482
{'BIOHAVEN' }	0.45429	0.29834	0.62666	0.44417	0.26236	0.4364	0.002531

>>

Burke_Ratio	Annualized_Jensen_Alpha	Annualized_Treynor_Index	Annualized_Treynor_Black_Ratio	Score
0.0042595	0.29551	0.56711	0.45318	5
0.0018092	0.13125	0.62306	0.50913	5
0.0058162	0.12039	0.3723	0.25836	5
0.0028159	0.087411	0.34474	0.23081	5
0.0024882	0.081688	0.17469	0.060756	4.4
0.002326	0.1253	0.26389	0.14996	4.4
0.0011599	0.039816	0.16655	0.052619	4.4
0.0020388	0.061824	0.1581	0.044166	4.2
0.0021842	0.1225	0.2168	0.10286	4.2
0.0022202	0.22658	0.61271	0.49877	4.2





QUESTION 6: NYSE SECURITIES BEHAVIOR

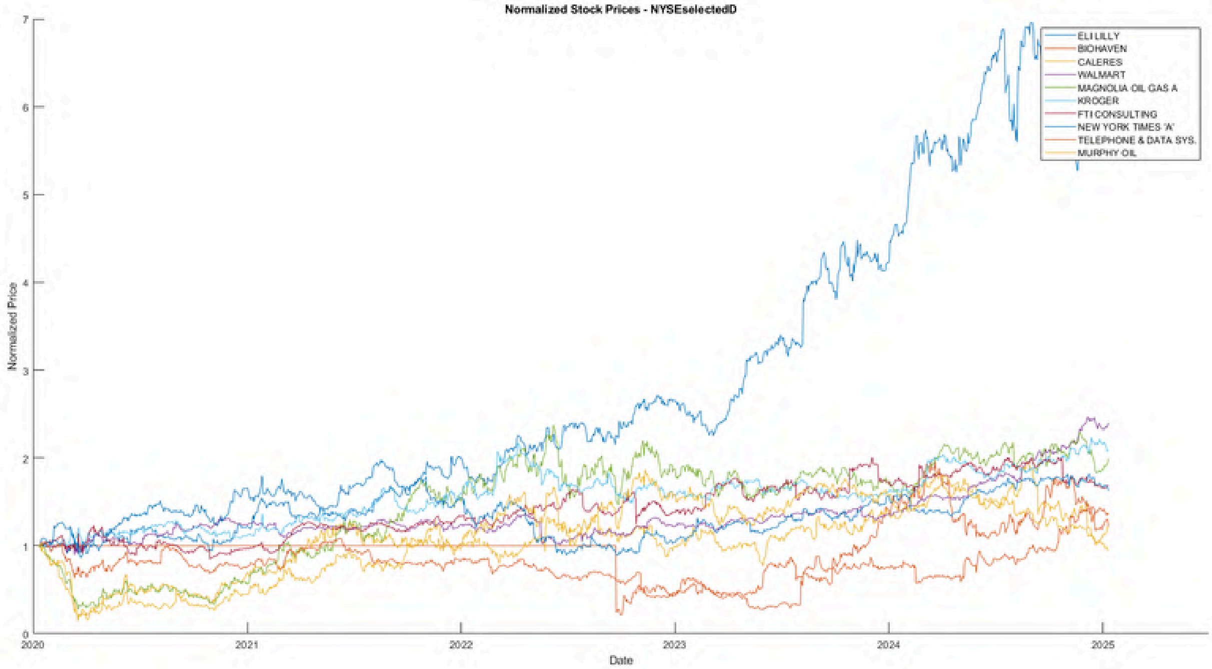
Presented below is the code used to answer this question.

```
% Carica i dati dal worksheet NYSEselectedD
dataD = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'NYSEselectedD',
'VariableNamingRule', 'preserve');

% Normalizza i prezzi per NYSEselectedD
normalized_dataD = dataD;
for i = 2:width(dataD)
    normalized_dataD{:, i} = dataD{:, i} / dataD{1, i};
end

% Plot dei prezzi normalizzati per NYSEselectedD
figure;
hold on;
for i = 2:width(normalized_dataD)
    plot(normalized_dataD.DATE, normalized_dataD{:, i}, 'DisplayName',
normalized_dataD.Properties.VariableNames{i});
end
hold off;
xlabel('Date');
ylabel('Normalized Price');
title('Normalized Stock Prices - NYSEselectedD');
legend;

% Carica i dati dal worksheet NYSEselectedM
dataM = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'NYSEselectedM',
'VariableNamingRule', 'preserve');

% Normalizza i prezzi per NYSEselectedM
normalized_dataM = dataM;
for i = 2:width(dataM)
    normalized_dataM{:, i} = dataM{:, i} / dataM{1, i};
end

% Plot dei prezzi normalizzati per NYSEselectedM
figure;
hold on;
for i = 2:width(normalized_dataM)
    plot(normalized_dataM.DATE, normalized_dataM{:, i}, 'DisplayName',
normalized_dataM.Properties.VariableNames{i});
end
hold off;
xlabel('Date');
ylabel('Normalized Price');
title('Normalized Stock Prices - NYSEselectedM');
legend;
```

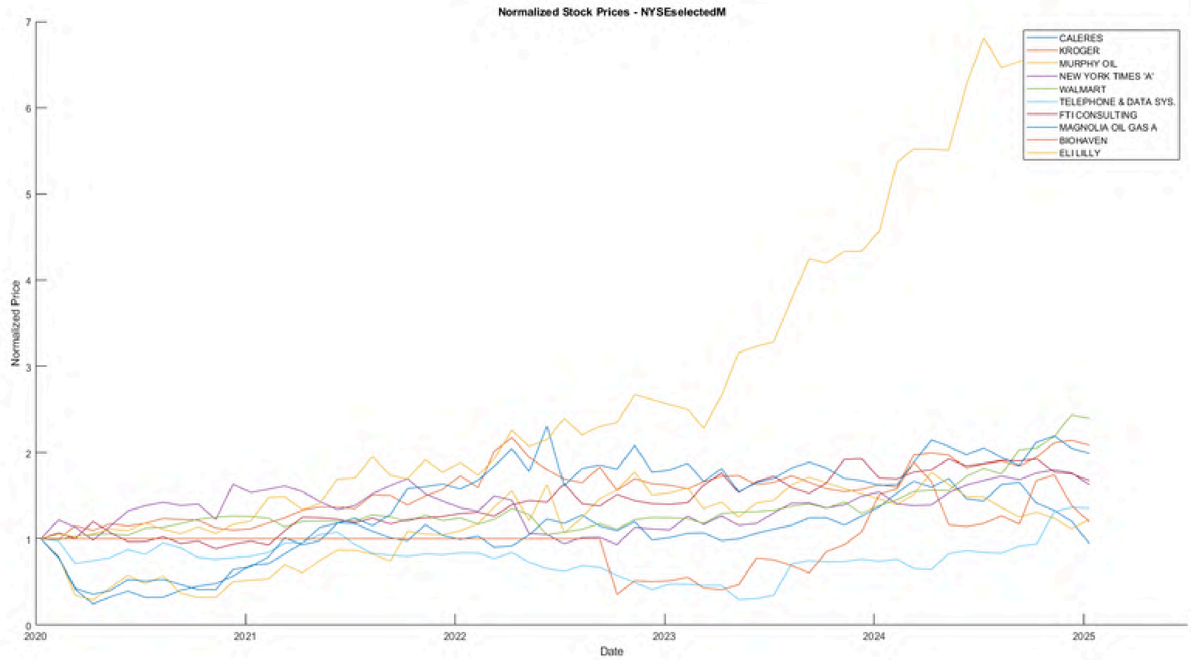
QUESTION 6: NYSE SECURITIES BEHAVIOR

The analysis of historical time series helps us identify the best-performing stocks, which is useful for the logic behind building our efficient portfolios. We can see that ELI LILLY had the best performance.

NORMALIZED STOCK PRICES - NYSE DAILY



NORMALIZED STOCK PRICES - NYSE MONTHLY



QUESTION 6: NASDAQ SECURITIES BEHAVIOR

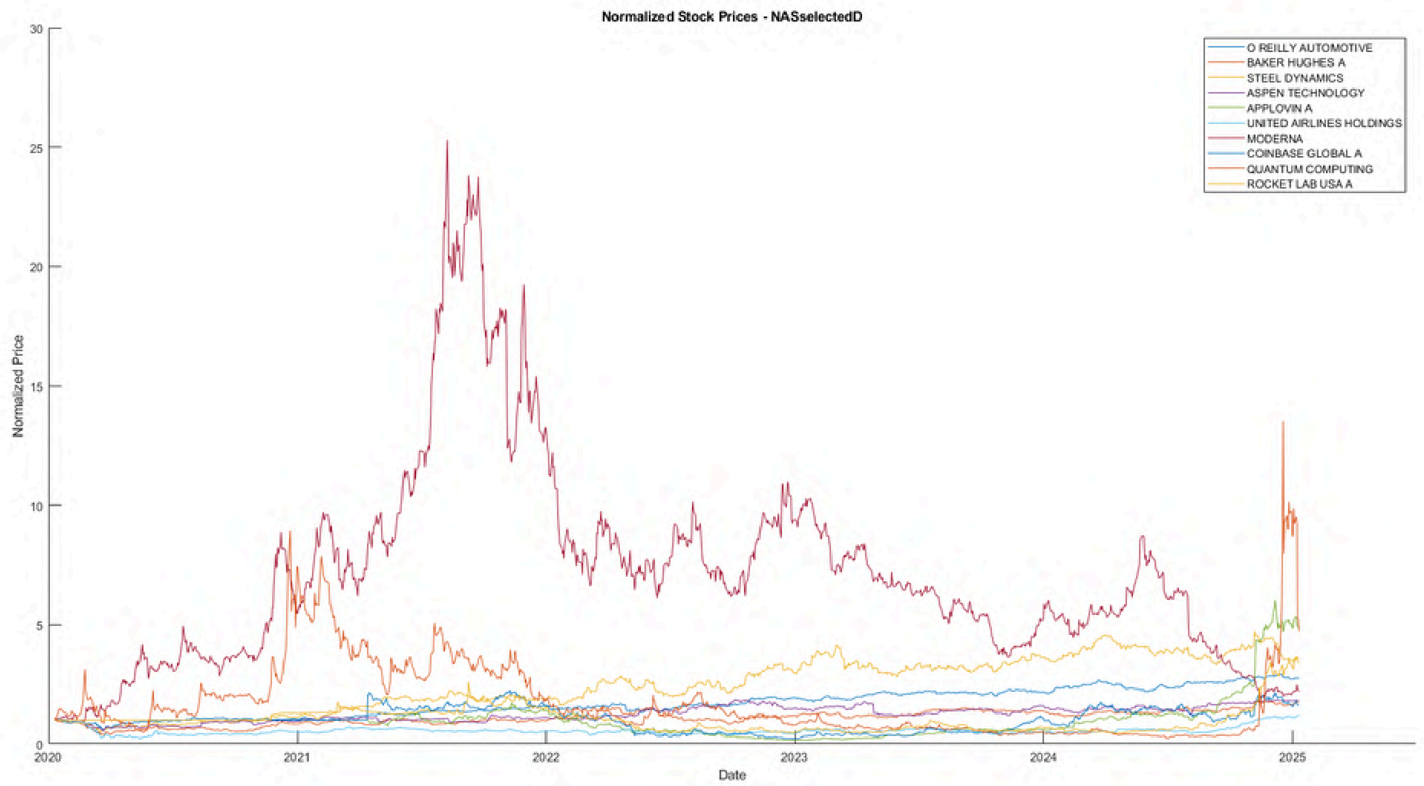
Presented below is the code used to answer this question.

```matlab
% Carica i dati dal worksheet NYSEselectedD
dataD = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'NASselectedD',
'VariableNamingRule', 'preserve');

% Normalizza i prezzi per NYSEselectedD
normalized_dataD = dataD;
for i = 2:width(dataD)
    normalized_dataD{:, i} = dataD{:, i} / dataD{1, i};
end

% Plot dei prezzi normalizzati per NYSEselectedD
figure;
hold on;
for i = 2:width(normalized_dataD)
    plot(normalized_dataD.DATE, normalized_dataD{:, i}, 'DisplayName',
normalized_dataD.Properties.VariableNames{i});
end
hold off;
xlabel('Date');
ylabel('Normalized Price');
title('Normalized Stock Prices - NASselectedD');
legend;

% Carica i dati dal worksheet NYSEselectedM
dataM = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'NASselectedM',
'VariableNamingRule', 'preserve');

% Normalizza i prezzi per NYSEselectedM
normalized_dataM = dataM;
for i = 2:width(dataM)
    normalized_dataM{:, i} = dataM{:, i} / dataM{1, i};
end

% Plot dei prezzi normalizzati per NYSEselectedM
figure;
hold on;
for i = 2:width(normalized_dataM)
    plot(normalized_dataM.DATE, normalized_dataM{:, i}, 'DisplayName',
normalized_dataM.Properties.VariableNames{i});
end
hold off;
xlabel('Date');
ylabel('Normalized Price');
title('Normalized Stock Prices - NASselectedM');
legend;
```

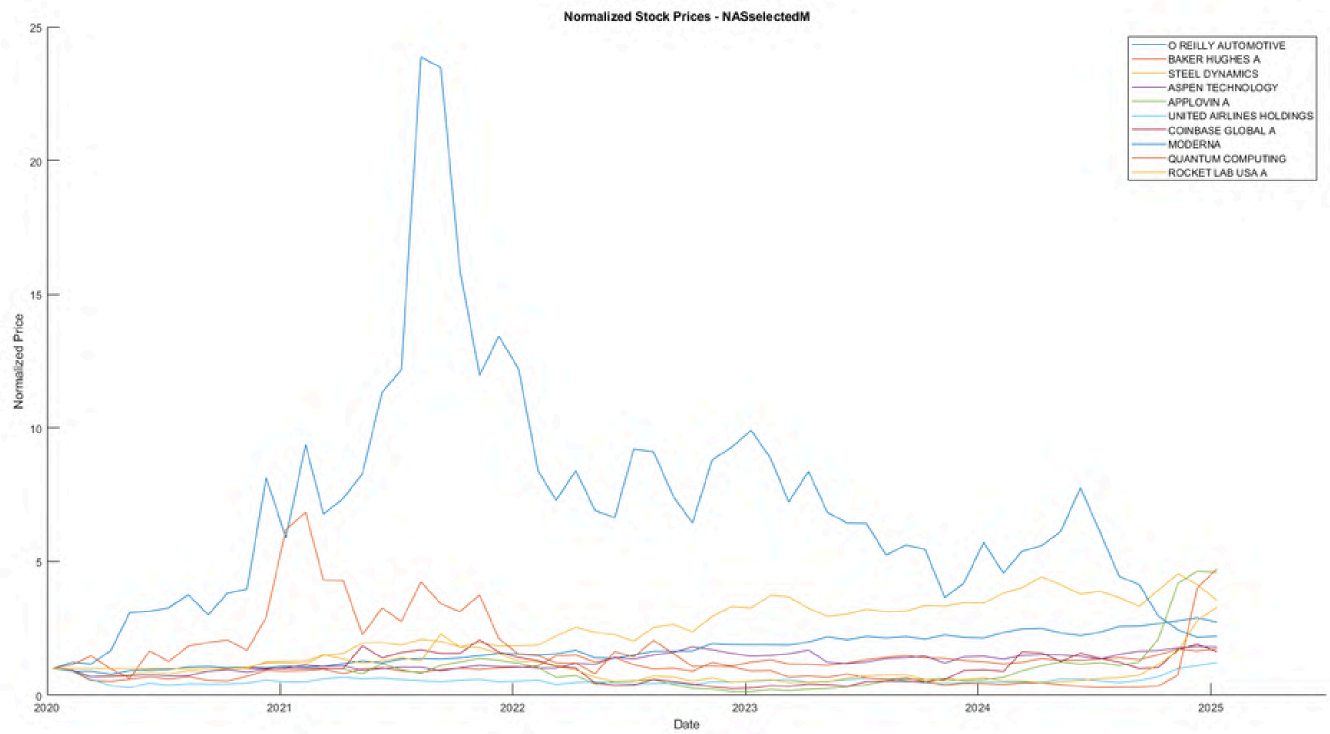
QUESTION 6: NASDAQ SECURITIES BEHAVIOR

It can be noted that MODERNA experienced a peak in the period related to COVID-19 vaccines.

NORMALIZED STOCK PRICES - NASDAQ DAILY



NORMALIZED STOCK PRICES - NASDAQ MONTHLY



QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

We built the first portfolio with the goal of minimizing risk while keeping the return above a certain threshold level (p=0,001). The main script calls the objective function to minimize.

Daily

```matlab
function z = portafoglio1EFM
    % Aggiungi la cartella contenente la funzione obiettivo alla MATLAB path
    addpath('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025');

    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');
    tickers = A.Properties.VariableNames;
    A = table2array(A);

    % Carica i dati di mercato dal file Excel DBEXAM.xlsx, worksheet SP500indexD
    MercatoDati = readtable('DBEXAM.xlsx', 'Sheet', 'SP500indexD', 'ReadRowNames', true,
'VariableNamingRule', 'preserve');
    MercatoDati = table2array(MercatoDati);

    % Assicurati che i dati di mercato e i dati degli asset abbiano lo stesso numero di osservazioni
    min_length = min(size(A, 1), length(MercatoDati));
    A = A(1:min_length, :);
    MercatoDati = MercatoDati(1:min_length);

    % Calcola i rendimenti logaritmici
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));
    MercatoR = log(MercatoDati(2:end) ./ MercatoDati(1:end-1));

    % Calcola i momenti statistici
    m = mean(R);
    V = cov(R);

    % Calcola il beta di ogni asset rispetto al mercato
    beta_assets = zeros(1, size(R, 2));
    var_mercato = var(MercatoR);
    for i = 1:size(R, 2)
        cov_mercato_asset = cov(MercatoR, R(:, i));
        beta_assets(i) = cov_mercato_asset(1, 2) / var_mercato;
    end

    % Ottimizzazione del portafoglio
    z0 = (1/length(m)) * ones(length(m), 1);
    A = -m;
    p = 0.001;
    B = [-p];
    Aeq = ones(1, length(m));
    Beq = [1];
    %LB = zeros(length(m), 1);
    LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
    UB = [];

    options = optimoptions('fmincon', 'MaxFunctionEvaluations', 10000);
    [x, fval, exitflag, output] = fmincon(@(x) PrimaFunzObbP1EFMDQ7(x), z0, A, B, Aeq, Beq, LB, UB, [],
options);

    % Calcola il rendimento del portafoglio
    portfolio_return = m * x;

    % Calcola il rendimento annualizzato
    annualized_return = (1 + portfolio_return) ^ 252 - 1;

    % Calcola il rischio del portafoglio
    portfolio_risk = sqrt(x' * V * x);

    % Calcola il rischio annualizzato
    annualized_risk = portfolio_risk * sqrt(252);

    % Calcola la skewness e la curtosi del portafoglio
    portfolio_skewness = skewness(R * x);
    portfolio_kurtosis = kurtosis(R * x);

    % Calcola il beta del portafoglio rispetto al mercato
    portfolio_beta = sum(x' .* beta_assets);

    % Calcola il rendimento senza rischio (ad esempio, il rendimento dei titoli di stato a breve termine)
    risk_free_rate = (1 + 0.02) ^ (1/252) - 1

    % Calcola il rapporto di Sharpe
    sharpe_ratio = (portfolio_return - risk_free_rate) / portfolio_risk;

    % Calcola il rapporto di Sortino
    downside_risk = sqrt(mean(min(0, R * x).^2));
    sortino_ratio = (portfolio_return - risk_free_rate) / downside_risk;

    % Calcola l'alpha di Jensen
    market_return = mean(MercatoR);
    alpha_jensen = portfolio_return - (risk_free_rate + portfolio_beta * (market_return -
risk_free_rate));

    % Stampa i risultati dell'ottimizzazione
    disp('Risultati dell''ottimizzazione:');
    disp(['Valore della funzione obiettivo: ', num2str(fval)]);
    disp(['Exit flag: ', num2str(exitflag)]);
    disp('Output:');
    disp(output);
    disp('Pesi ottimali del portafoglio:');
    for i = 1:length(x)
        disp([tickers{i}, ': ', num2str(x(i))]);
    end

    % Stampa i risultati aggiuntivi
    disp(['Rendimento del portafoglio: ', num2str(portfolio_return)]);
    disp(['Rendimento annualizzato: ', num2str(annualized_return)]);
    disp(['Rischio del portafoglio: ', num2str(portfolio_risk)]);
    disp(['Rischio annualizzato: ', num2str(annualized_risk)]);
    disp(['Skewness del portafoglio: ', num2str(portfolio_skewness)]);
    disp(['Curtosi del portafoglio: ', num2str(portfolio_kurtosis)]);
    disp(['Beta del portafoglio: ', num2str(portfolio_beta)]);
    disp(['Rapporto di Sharpe: ', num2str(sharpe_ratio)]);
    disp(['Rapporto di Sortino: ', num2str(sortino_ratio)]);
    disp(['Alpha di Jensen: ', num2str(alpha_jensen)]);

    % Stampa il beta di ogni singolo asset
    disp('Beta di ogni singolo asset:');
    for i = 1:length(beta_assets)
        disp([tickers{i}, ': ', num2str(beta_assets(i))]);
    end
```

Monthly

```matlab
function z = portafoglio1EFM
    % Aggiungi la cartella contenente la funzione obiettivo alla MATLAB path
    addpath('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025');

    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');
    tickers = A.Properties.VariableNames;
    A = table2array(A);

    % Carica i dati di mercato dal file Excel DBEXAM.xlsx, worksheet SP500indexD
    MercatoDati = readtable('DBEXAM.xlsx', 'Sheet', 'SP500indexD', 'ReadRowNames', true,
'VariableNamingRule', 'preserve');
    MercatoDati = table2array(MercatoDati);

    % Assicurati che i dati di mercato e i dati degli asset abbiano lo stesso numero di osservazioni
    min_length = min(size(A, 1), length(MercatoDati));
    A = A(1:min_length, :);
    MercatoDati = MercatoDati(1:min_length);

    % Calcola i rendimenti logaritmici mensili
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));
    MercatoR = log(MercatoDati(2:end) ./ MercatoDati(1:end-1));

    % Calcola i momenti statistici
    m = mean(R);
    V = cov(R);

    % Calcola il beta di ogni asset rispetto al mercato
    beta_assets = zeros(1, size(R, 2));
    var_mercato = var(MercatoR);
    for i = 1:size(R, 2)
        cov_mercato_asset = cov(MercatoR, R(:, i));
        beta_assets(i) = cov_mercato_asset(1, 2) / var_mercato;
    end

    % Ottimizzazione del portafoglio
    z0 = (1/length(m)) * ones(length(m), 1);
    A = -m;
    p = 0.001;
    B = [-p];
    Aeq = ones(1, length(m));
    Beq = [1];
    LB = zeros(length(m), 1);
    %LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
    UB = [];

    options = optimoptions('fmincon', 'MaxFunctionEvaluations', 10000);
    [x, fval, exitflag, output] = fmincon(@(x) PrimaFunzObbP1EFM(x), z0, A, B, Aeq, Beq, LB, UB, [],
options);

    % Calcola il rendimento del portafoglio
    portfolio_return = m * x;

    % Calcola il rendimento annualizzato
    annualized_return = (1 + portfolio_return) ^ 12 - 1;

    % Calcola il rischio del portafoglio
    portfolio_risk = sqrt(x' * V * x);

    % Calcola il rischio annualizzato
    annualized_risk = portfolio_risk * sqrt(12);

    % Calcola la skewness e la curtosi del portafoglio
    portfolio_skewness = skewness(R * x);
    portfolio_kurtosis = kurtosis(R * x);

    % Calcola il beta del portafoglio rispetto al mercato
    portfolio_beta = sum(x' .* beta_assets);

    % Calcola il rendimento senza rischio (ad esempio, il rendimento dei titoli di stato a breve termine)
   risk_free_rate = (1 + 0.02)^(1/12) - 1; % Convertito a mensile

    % Calcola il rapporto di Sharpe
    sharpe_ratio = (portfolio_return - risk_free_rate) / portfolio_risk;

    % Calcola il rapporto di Sortino
    downside_risk = sqrt(mean(min(0, R * x).^2));
    sortino_ratio = (portfolio_return - risk_free_rate) / downside_risk;

    % Calcola l'alpha di Jensen
    market_return = mean(MercatoR);
    alpha_jensen = portfolio_return - (risk_free_rate + portfolio_beta * (market_return -
risk_free_rate));

    % Stampa i risultati dell'ottimizzazione
    disp('Risultati dell''ottimizzazione:');
    disp(['Valore della funzione obiettivo: ', num2str(fval)]);
    disp(['Exit flag: ', num2str(exitflag)]);
    disp('Output:');
    disp(output);
    disp('Pesi ottimali del portafoglio:');
    for i = 1:length(x)
        disp([tickers{i}, ': ', num2str(x(i))]);
    end

    % Stampa i risultati aggiuntivi
    disp(['Rendimento del portafoglio: ', num2str(portfolio_return)]);
    disp(['Rendimento annualizzato: ', num2str(annualized_return)]);
    disp(['Rischio del portafoglio: ', num2str(portfolio_risk)]);
    disp(['Rischio annualizzato: ', num2str(annualized_risk)]);
    disp(['Skewness del portafoglio: ', num2str(portfolio_skewness)]);
    disp(['Curtosi del portafoglio: ', num2str(portfolio_kurtosis)]);
    disp(['Beta del portafoglio: ', num2str(portfolio_beta)]);
    disp(['Rapporto di Sharpe: ', num2str(sharpe_ratio)]);
    disp(['Rapporto di Sortino: ', num2str(sortino_ratio)]);
    disp(['Alpha di Jensen: ', num2str(alpha_jensen)]);

    % Stampa il beta di ogni singolo asset
    disp('Beta di ogni singolo asset:');
    for i = 1:length(beta_assets)
        disp([tickers{i}, ': ', num2str(beta_assets(i))]);
    end
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

The first optimization problem concerns finding the optimal weight vector w that allows us to minimize risk, while the return is subject to the constraint $E(X) \geq \Pi$. Other constraints include the total capital employed, which we assume to be unity, and the constraint on short selling, which we exclude at first.

$$\begin{cases} \min \phi(X) \\ \textit{with constraints:} \\ E(X) \geq \Pi \\ \sum_{k=1}^{n} w_k = 1 \\ w_k \geq 0 \end{cases} \longrightarrow \min_{z}(z, Vz) \quad \text{such that} \quad \begin{cases} (m, z) \geq \pi, \\ (e, z) = 1, \\ z \geq 0. \end{cases}$$

Daily Objective Function

```
function f = PrimaFunzObbP1EFMDQ7(x)
    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');

    % Converti la tabella in una matrice di numeri
    A = table2array(A);

    % Calcola i rendimenti
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));

    % Calcola la matrice di covarianza
    V = cov(R);

    % Assicurati che x sia un vettore colonna
    if isrow(x)
        x = x';
    end

    % Calcola la funzione obiettivo
    f = x' * V * x;
end
```

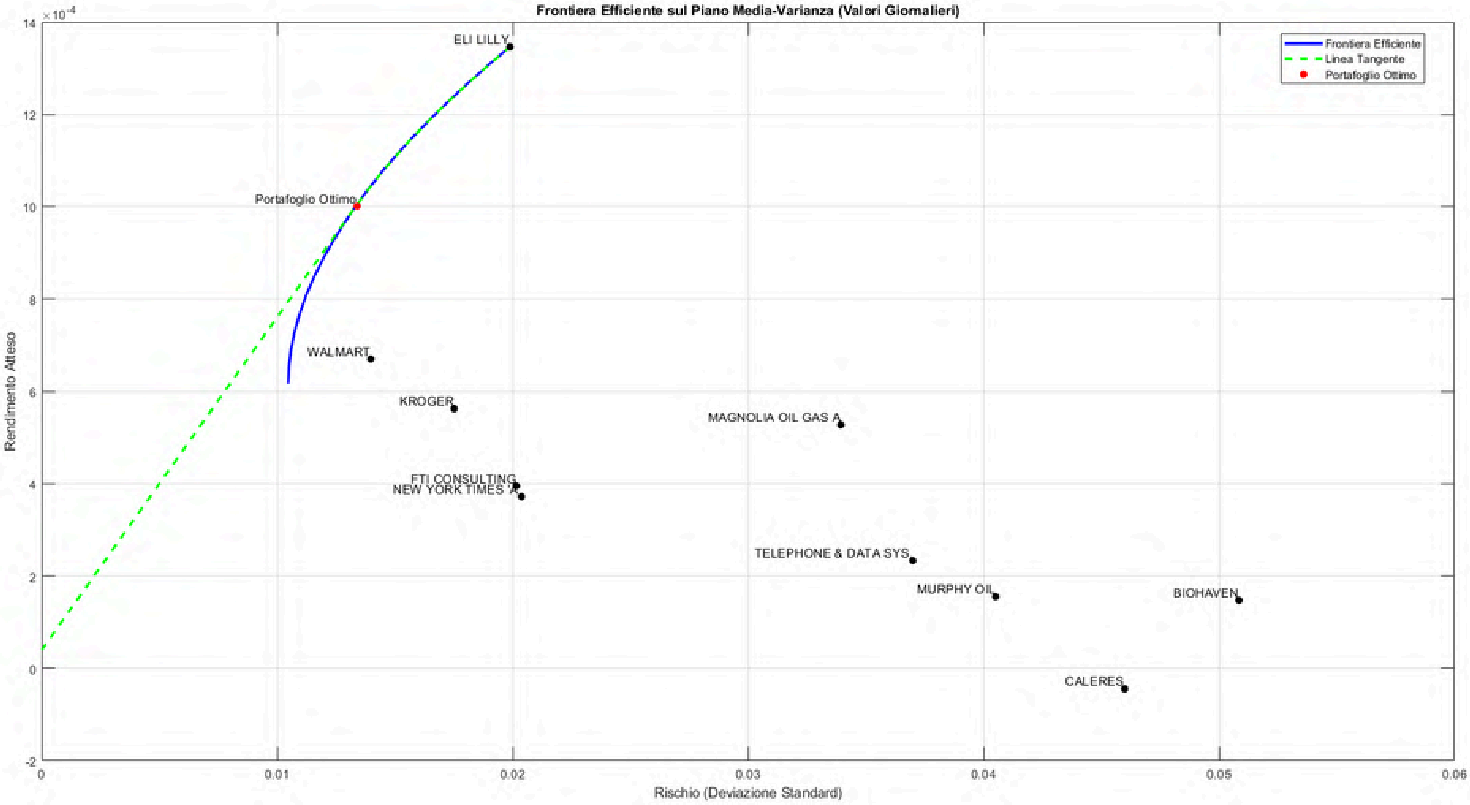
Monthly Objective Function

```
function f = PrimaFunzObbP1EFMM(x)
    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');

    % Converti la tabella in una matrice di numeri
    A = table2array(A);

    % Calcola i rendimenti logaritmici mensili
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));

    % Calcola la matrice di covarianza
    V = cov(R);

    % Assicurati che x sia un vettore colonna
    if isrow(x)
        x = x';
    end

    % Calcola la funzione obiettivo
    f = x' * V * x;
end
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

Nyse Daily




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.00017955
Exit flag: 1
Output:
        iterations: 43
         funcCount: 485
    constrviolation: 2.2204e-16
          stepsize: 0.0014
         algorithm: 'interior-point'
     firstorderopt: 9.8836e-07
      cgiterations: 0
           message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
      bestfeasible: [1x1 struct]
```

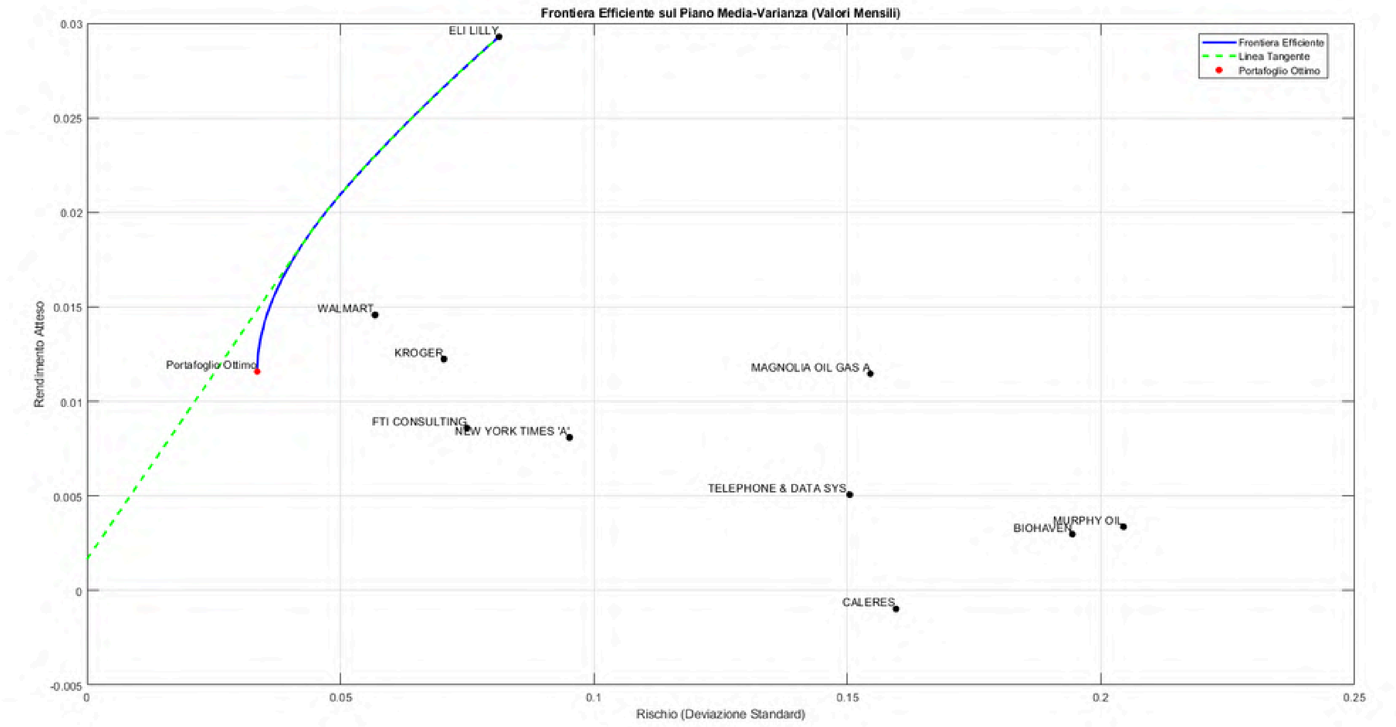
```
Pesi ottimali del portafoglio:
ELI LILLY: 0.53476
BIOHAVEN: 0.0034774
CALERES: 0.0028514
WALMART: 0.28955
MAGNOLIA OIL GAS A: 0.025684
KROGER: 0.10354
FTI CONSULTING: 0.025434
NEW YORK TIMES 'A': 0.010152
TELEPHONE & DATA SYS.: 0.0024661
MURPHY OIL: 0.0020815
Rendimento del portafoglio: 0.001001
Rendimento annualizzato: 0.28676
Rischio del portafoglio: 0.0134
Rischio annualizzato: 0.21271
Skewness del portafoglio: 0.57829
Curtosi del portafoglio: 11.9602
Beta del portafoglio: 0.56424
Rapporto di Sharpe: 0.071758
Rapporto di Sortino: 0.11223
Alpha di Jensen: 0.00073341
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 43 iterations, violating the constraints by a value close to zero. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance. The tangent line has intercept in the daily risk-free rate.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

Nyse Monthly




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.0011279
Exit flag: 1
Output:
         iterations: 53
          funcCount: 594
    constrviolation: 0
           stepsize: 7.1915e-05
          algorithm: 'interior-point'
      firstorderopt: 5.6822e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization complete
       bestfeasible: [1×1 struct]
```

```
Pesi ottimali del portafoglio:
CALERES: 0.073825
KROGER: 0.1346
MURPHY OIL: 0.00073864
NEW YORK TIMES 'A': 0.070974
WALMART: 0.33824
TELEPHONE & DATA SYS.: 0.0090466
FTI CONSULTING: 0.28788
MAGNOLIA OIL GAS A: 0.016856
BIOHAVEN: 0.0077511
ELI LILLY: 0.06009
Rendimento del portafoglio: 0.011579
Rendimento annualizzato: 0.14815
Rischio del portafoglio: 0.033584
Rischio annualizzato: 0.11634
Skewness del portafoglio: -0.091862
Curtosi del portafoglio: 2.6172
Beta del portafoglio: 0.35398
Rapporto di Sharpe: 0.32009
Rapporto di Sortino: 0.59278
Alpha di Jensen: 0.0076267
```

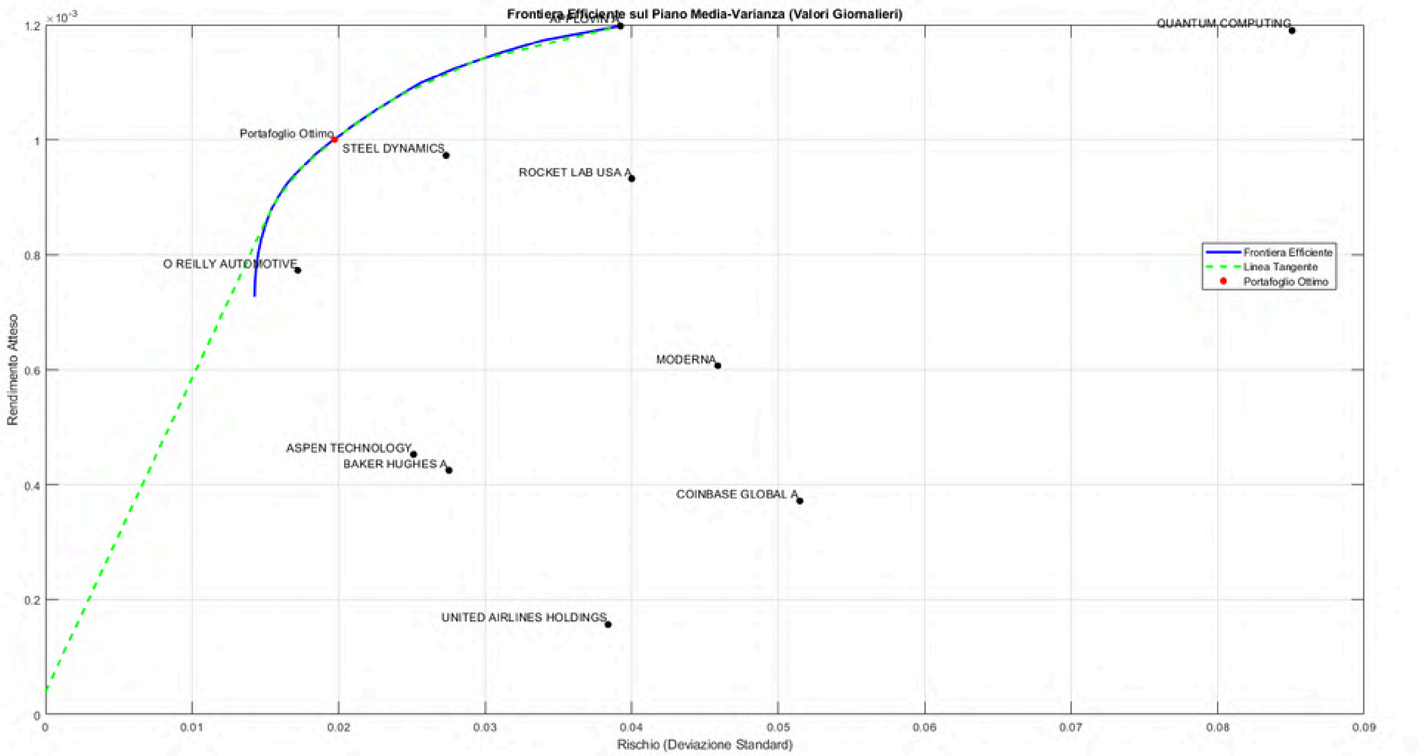
As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 53 iterations, in this case the constraints are not violated. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance.

We can observe that, with monthly frequency data, the optimal portfolio approaches the minimum variance portfolio.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

Nasdaq Daily




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.00038893
Exit flag: 1
Output:
         iterations: 44
          funcCount: 497
    constrviolation: 0
           stepsize: 3.8607e-05
          algorithm: 'interior-point'
      firstorderopt: 4.0000e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
        bestfeasible: [1×1 struct]
```

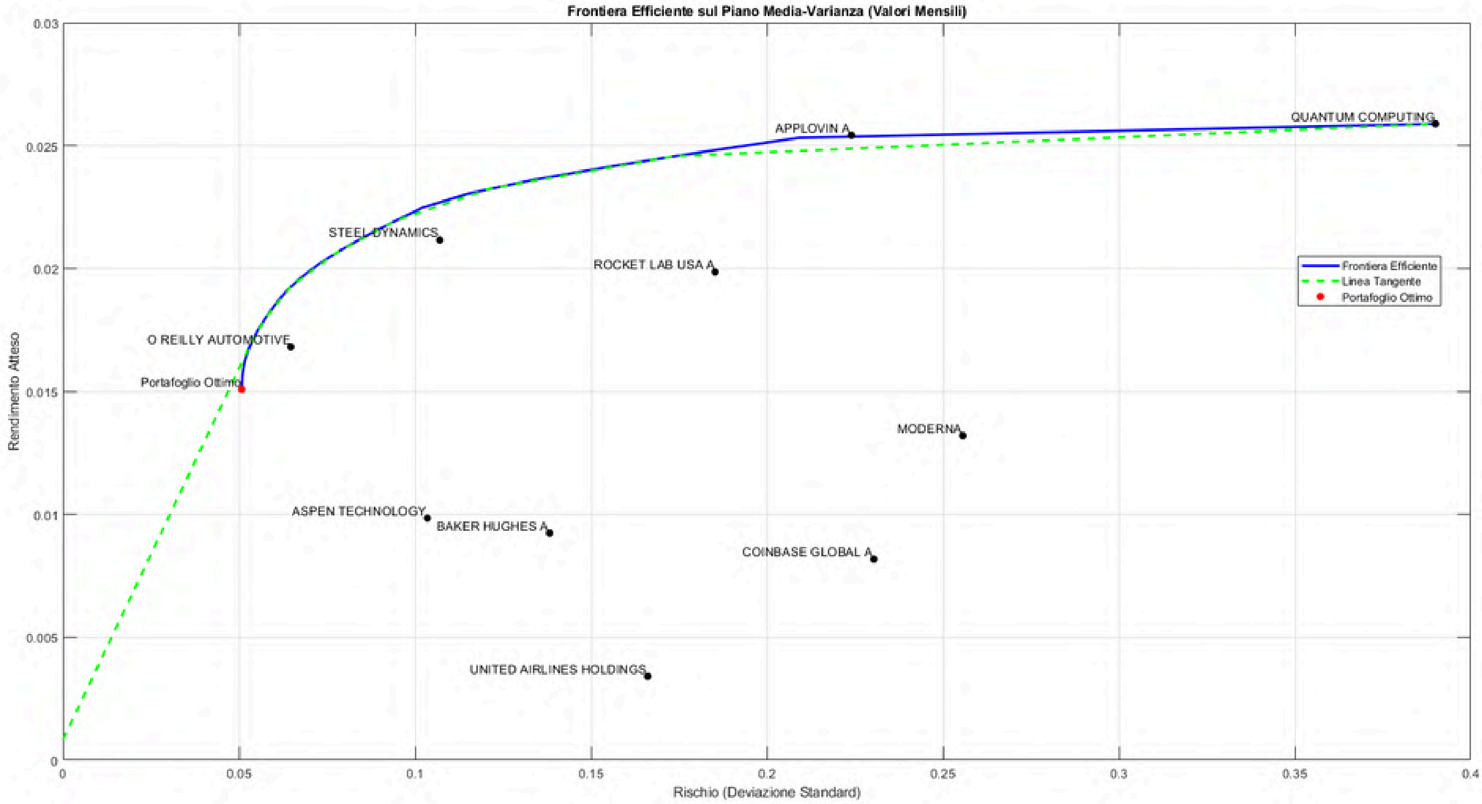
```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.25219
BAKER HUGHES A: 0.00047068
STEEL DYNAMICS: 0.34639
ASPEN TECHNOLOGY: 0.00059581
APPLOVIN A: 0.32035
UNITED AIRLINES HOLDINGS: 0.00025318
MODERNA: 0.0014887
COINBASE GLOBAL A: 0.00030227
QUANTUM COMPUTING: 0.040451
ROCKET LAB USA A: 0.037502
Rendimento del portafoglio: 0.0010002
Rendimento annualizzato: 0.2865
Rischio del portafoglio: 0.019721
Rischio annualizzato: 0.31307
Skewness del portafoglio: 0.15297
Curtosi del portafoglio: 6.4241
Beta del portafoglio: 0.83538
Rapporto di Sharpe: 0.048714
Rapporto di Sortino: 0.072499
Alpha di Jensen: 0.00052255
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 44 iterations, in this case the constraints are not violated. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 1: Min risk

Nasdaq Monthly




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.0025796
Exit flag: 1
Output:
        iterations: 42
         funcCount: 473
   constrviolation: 0
          stepsize: 8.0701e-04
         algorithm: 'interior-point'
     firstorderopt: 7.0644e-07
      cgiterations: 0
           message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
      bestfeasible: [1×1 struct]
```

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.59819
BAKER HUGHES A: 0.011621
STEEL DYNAMICS: 0.054405
ASPEN TECHNOLOGY: 0.23986
APPLOVIN A: 0.00054773
UNITED AIRLINES HOLDINGS: 0.015211
COINBASE GLOBAL A: 6.9803e-05
MODERNA: 0.03699
QUANTUM COMPUTING: 5.6413e-05
ROCKET LAB USA A: 0.04305
Rendimento del portafoglio: 0.015085
Rendimento annualizzato: 0.19682
Rischio del portafoglio: 0.050789
Rischio annualizzato: 0.17594
Skewness del portafoglio: -0.39794
Curtosi del portafoglio: 3.947
Beta del portafoglio: 0.42906
Rapporto di Sharpe: 0.28067
Rapporto di Sortino: 0.47645
Alpha di Jensen: 0.0093478
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 42 iterations, in this case the constraints are not violated. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance.

As before, we can observe that, with monthly frequency data, the optimal portfolio approaches the minimum variance portfolio.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

The second portfolio was constructed with the goal of maximizing return while simultaneously minimizing risk. The main script calls the objective function to be minimized.

Daily

```
function z = portafoglio2EFM
    % Aggiungi la cartella contenente la funzione obiettivo alla MATLAB path
    addpath('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025');

    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');
    tickers = A.Properties.VariableNames;
    A = table2array(A);

    % Carica i dati di mercato dal file Excel DBEXAM.xlsx, worksheet SP500indexD
    MercatoDati = readtable('DBEXAM.xlsx', 'Sheet', 'SP500indexD', 'ReadRowNames', true,
'VariableNamingRule', 'preserve');
    MercatoDati = table2array(MercatoDati);

    % Assicurati che i dati di mercato e i dati degli asset abbiano lo stesso numero di osservazioni
    min_length = min(size(A, 1), length(MercatoDati));
    A = A(1:min_length, :);
    MercatoDati = MercatoDati(1:min_length);

    % Calcola i rendimenti logaritmici giornalieri
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));
    MercatoR = log(MercatoDati(2:end) ./ MercatoDati(1:end-1));

    % Calcola i momenti statistici
    m = mean(R);
    V = cov(R);

    % Calcola il beta di ogni asset rispetto al mercato
    beta_assets = zeros(1, size(R, 2));
    var_mercato = var(MercatoR);
    for i = 1:size(R, 2)
        cov_mercato_asset = cov(MercatoR, R(:, i));
        beta_assets(i) = cov_mercato_asset(1, 2) / var_mercato;
    end

    % Ottimizzazione del portafoglio
    z0 = (1/length(m)) * ones(length(m), 1);
    A = -m;
    p = 0.001;
    B = [-p];
    Aeq = ones(1, length(m));
    Beq = [1];
    LB = zeros(length(m), 1);
    %LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
    UB = [];

    options = optimoptions('fmincon', 'MaxFunctionEvaluations', 10000);
    [x, fval, exitflag, output] = fmincon(@(x) secondaFunzObbP2EFMD_7(x), z0, A, B, Aeq, Beq, LB, UB, [],
options);

    % Calcola il rendimento del portafoglio
    portfolio_return = m * x;

    % Calcola il rendimento annualizzato
    annualized_return = (1 + portfolio_return) ^ 252 - 1;

    % Calcola il rischio del portafoglio
    portfolio_risk = sqrt(x' * V * x);

    % Calcola il rischio annualizzato
    annualized_risk = portfolio_risk * sqrt(252);

    % Calcola la skewness e la curtosi del portafoglio
    portfolio_skewness = skewness(R * x);
    portfolio_kurtosis = kurtosis(R * x);

    % Calcola il beta del portafoglio rispetto al mercato
    portfolio_beta = sum(x' .* beta_assets);

    % Calcola il rendimento senza rischio (ad esempio, il rendimento dei titoli di stato a breve termine)
    risk_free_rate = (1 + 0.01) ^ (1/252) - 1

    % Calcola il rapporto di Sharpe
    sharpe_ratio = (portfolio_return - risk_free_rate) / portfolio_risk;

    % Calcola il rapporto di Sortino
    downside_risk = sqrt(mean(min(0, R * x).^2));
    sortino_ratio = (portfolio_return - risk_free_rate) / downside_risk;

    % Calcola l'alpha di Jensen
    market_return = mean(MercatoR);
    alpha_jensen = portfolio_return - (risk_free_rate + portfolio_beta * (market_return -
risk_free_rate));

    % Stampa i risultati dell'ottimizzazione
    disp('Risultati dell''ottimizzazione:');
    disp(['Valore della funzione obiettivo: ', num2str(fval)]);
    disp(['Exit flag: ', num2str(exitflag)]);
    disp('Output:');
    disp(output);
    disp('Pesi ottimali del portafoglio:');
    for i = 1:length(x)
        disp([tickers{i}, ': ', num2str(x(i))]);
    end

    % Stampa i risultati aggiuntivi
    disp(['Rendimento del portafoglio: ', num2str(portfolio_return)]);
    disp(['Rendimento annualizzato: ', num2str(annualized_return)]);
    disp(['Rischio del portafoglio: ', num2str(portfolio_risk)]);
    disp(['Rischio annualizzato: ', num2str(annualized_risk)]);
    disp(['Skewness del portafoglio: ', num2str(portfolio_skewness)]);
    disp(['Curtosi del portafoglio: ', num2str(portfolio_kurtosis)]);
    disp(['Beta del portafoglio: ', num2str(portfolio_beta)]);
    disp(['Rapporto di Sharpe: ', num2str(sharpe_ratio)]);
    disp(['Rapporto di Sortino: ', num2str(sortino_ratio)]);
    disp(['Alpha di Jensen: ', num2str(alpha_jensen)]);

    % Stampa il beta di ogni singolo asset
    disp('Beta di ogni singolo asset:');
    for i = 1:length(beta_assets)
        disp([tickers{i}, ': ', num2str(beta_assets(i))]);
    end
```

Monthly

```
function z = portafoglio2EFM
    % Aggiungi la cartella contenente la funzione obiettivo alla MATLAB path
    addpath('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025');

    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    A = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedM', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');
    tickers = A.Properties.VariableNames;
    A = table2array(A);

    % Carica i dati di mercato dal file Excel DBEXAM.xlsx, worksheet SP500indexD
    MercatoDati = readtable('DBEXAM.xlsx', 'Sheet', 'SP500indexM', 'ReadRowNames', true,
'VariableNamingRule', 'preserve');
    MercatoDati = table2array(MercatoDati);

    % Assicurati che i dati di mercato e i dati degli asset abbiano lo stesso numero di osservazioni
    min_length = min(size(A, 1), length(MercatoDati));
    A = A(1:min_length, :);
    MercatoDati = MercatoDati(1:min_length);

    % Calcola i rendimenti logaritmici mensili
    n = size(A, 1);
    R = log(A(2:n, :) ./ A(1:n-1, :));
    MercatoR = log(MercatoDati(2:end) ./ MercatoDati(1:end-1));

    % Calcola i momenti statistici
    m = mean(R);
    V = cov(R);

    % Calcola il beta di ogni asset rispetto al mercato
    beta_assets = zeros(1, size(R, 2));
    var_mercato = var(MercatoR);
    for i = 1:size(R, 2)
        cov_mercato_asset = cov(MercatoR, R(:, i));
        beta_assets(i) = cov_mercato_asset(1, 2) / var_mercato;
    end

    % Ottimizzazione del portafoglio
    z0 = (1/length(m)) * ones(length(m), 1);
    A = -m;
    p = 0.001;
    B = [-p];
    Aeq = ones(1, length(m));
    Beq = [1];
    LB = zeros(length(m), 1);
    %LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
    UB = [];

    options = optimoptions('fmincon', 'MaxFunctionEvaluations', 10000);
    [x, fval, exitflag, output] = fmincon(@(x) SecondaFunzObbP2EFMMQ7(x), z0, A, B, Aeq, Beq, LB, UB, [],
options);

    % Calcola il rendimento del portafoglio
    portfolio_return = m * x;

    % Calcola il rendimento annualizzato
    annualized_return = (1 + portfolio_return) ^ 12 - 1;

    % Calcola il rischio del portafoglio
    portfolio_risk = sqrt(x' * V * x);

    % Calcola il rischio annualizzato
    annualized_risk = portfolio_risk * sqrt(12);

    % Calcola la skewness e la curtosi del portafoglio
    portfolio_skewness = skewness(R * x);
    portfolio_kurtosis = kurtosis(R * x);

    % Calcola il beta del portafoglio rispetto al mercato
    portfolio_beta = sum(x' .* beta_assets);

    % Calcola il rendimento senza rischio (ad esempio, il rendimento dei titoli di stato a breve termine)
    risk_free_rate = (1 + 0.02)^(1/12) - 1; % Convertito a mensile

    % Calcola il rapporto di Sharpe
    sharpe_ratio = (portfolio_return - risk_free_rate) / portfolio_risk;

    % Calcola il rapporto di Sortino
    downside_risk = sqrt(mean(min(0, R * x).^2));
    sortino_ratio = (portfolio_return - risk_free_rate) / downside_risk;

    % Calcola l'alpha di Jensen
    market_return = mean(MercatoR);
    alpha_jensen = portfolio_return - (risk_free_rate + portfolio_beta * (market_return -
risk_free_rate));

    % Stampa i risultati dell'ottimizzazione
    disp('Risultati dell''ottimizzazione:');
    disp(['Valore della funzione obiettivo: ', num2str(fval)]);
    disp(['Exit flag: ', num2str(exitflag)]);
    disp('Output:');
    disp(output);
    disp('Pesi ottimali del portafoglio:');
    for i = 1:length(x)
        disp([tickers{i}, ': ', num2str(x(i))]);
    end

    % Stampa i risultati aggiuntivi
    disp(['Rendimento del portafoglio: ', num2str(portfolio_return)]);
    disp(['Rendimento annualizzato: ', num2str(annualized_return)]);
    disp(['Rischio del portafoglio: ', num2str(portfolio_risk)]);
    disp(['Rischio annualizzato: ', num2str(annualized_risk)]);
    disp(['Skewness del portafoglio: ', num2str(portfolio_skewness)]);
    disp(['Curtosi del portafoglio: ', num2str(portfolio_kurtosis)]);
    disp(['Beta del portafoglio: ', num2str(portfolio_beta)]);
    disp(['Rapporto di Sharpe: ', num2str(sharpe_ratio)]);
    disp(['Rapporto di Sortino: ', num2str(sortino_ratio)]);
    disp(['Alpha di Jensen: ', num2str(alpha_jensen)]);

    % Stampa il beta di ogni singolo asset
    disp('Beta di ogni singolo asset:');
    for i = 1:length(beta_assets)
        disp([tickers{i}, ': ', num2str(beta_assets(i))]);
    end
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

Building on what was seen in the previous problem, in this second problem, the objective is to minimize risk while simultaneously maximizing return. The objective function is therefore:

$$f(w) = -E(X) + \frac{a}{2}\phi(X)$$

where the constant a is a coefficient that represents the sensitivity to risk, and it obviously varies based on the subjective risk profile.

The optimization problem can therefore be formulated as follows:

$$\begin{cases} \min -E(X) + \frac{a}{2}\phi(X) \\ \textit{with constraints:} \\ \sum_{k=1}^{n} w_k = 1 \\ w_k \geq 0 \end{cases} \longrightarrow \quad \min_z \left(-(m, z) + \frac{a}{2}(z, Vz)\right) \quad \text{such that} \quad \begin{cases} (e, z) = 1, \\ z \geq 0. \end{cases}$$

Daily

```
function f = secondaFunzObbP2EFMD_7(z)
    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    Dati = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');

    % Converti la tabella in una matrice di numeri
    Dati = table2array(Dati);

    % Calcola i rendimenti logaritmici giornalieri
    n = size(Dati, 1);
    R = log(Dati(2:n, :) ./ Dati(1:n-1, :));
    m = mean(R);
    V = cov(R);

    % Calcola la funzione obiettivo
    f = -m * z + z' * (V * z);
end
```

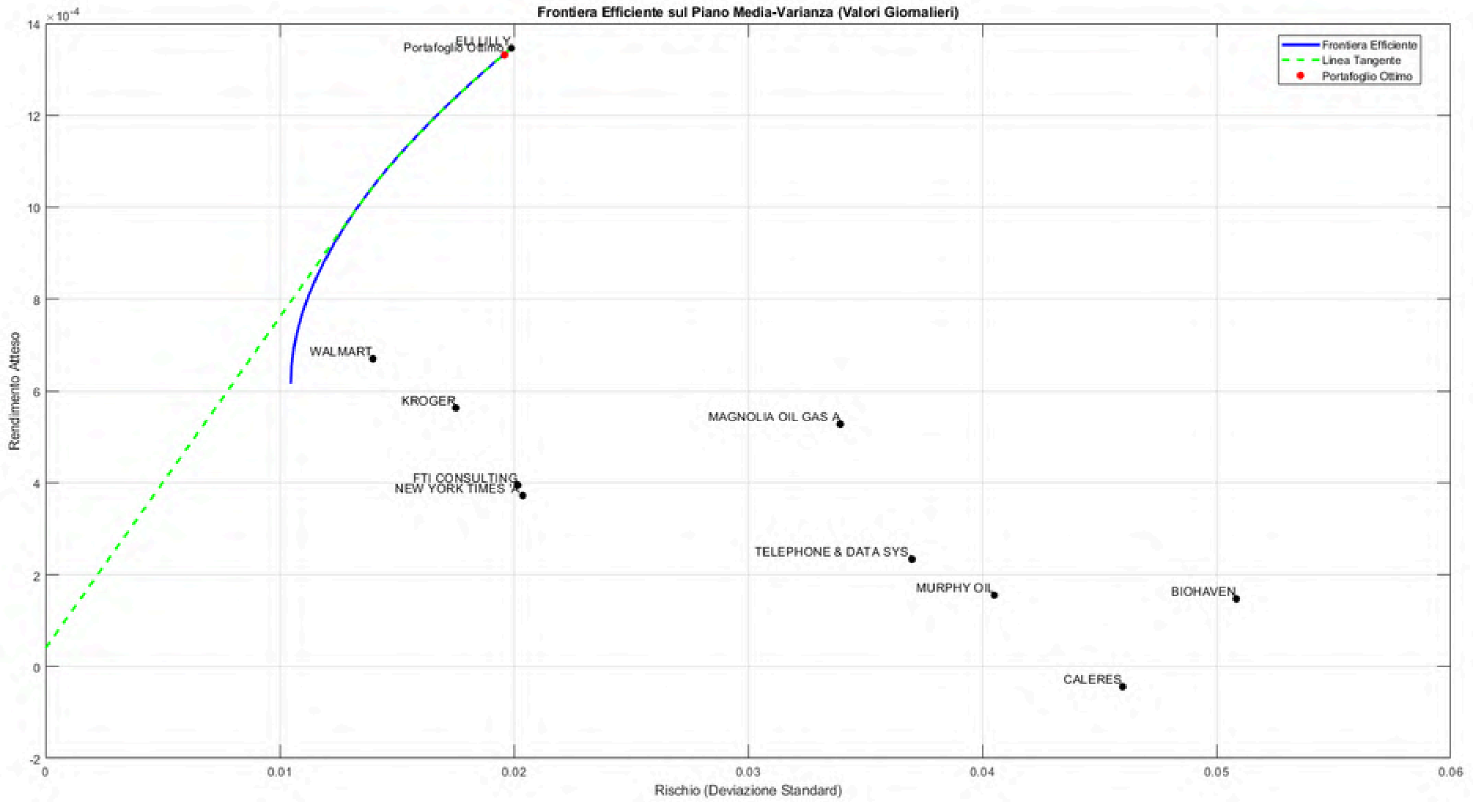
Monthly

```
function f = SecondaFunzObbP2EFMMQ7(z)
    % Carica i dati dal file Excel DBEXAM.xlsx, worksheet NYSEselectedD
    Dati = readtable('DBEXAM.xlsx', 'Sheet', 'NYSEselectedM', 'ReadRowNames', true, 'VariableNamingRule',
'preserve');

    % Converti la tabella in una matrice di numeri
    Dati = table2array(Dati);

    % Calcola i rendimenti logaritmici mensili
    n = size(Dati, 1);
    R = log(Dati(2:n, :) ./ Dati(1:n-1, :));
    m = mean(R);
    V = cov(R);

    % Calcola la funzione obiettivo
    f = -m * z + z' * (V * z);
end
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

Nyse Daily



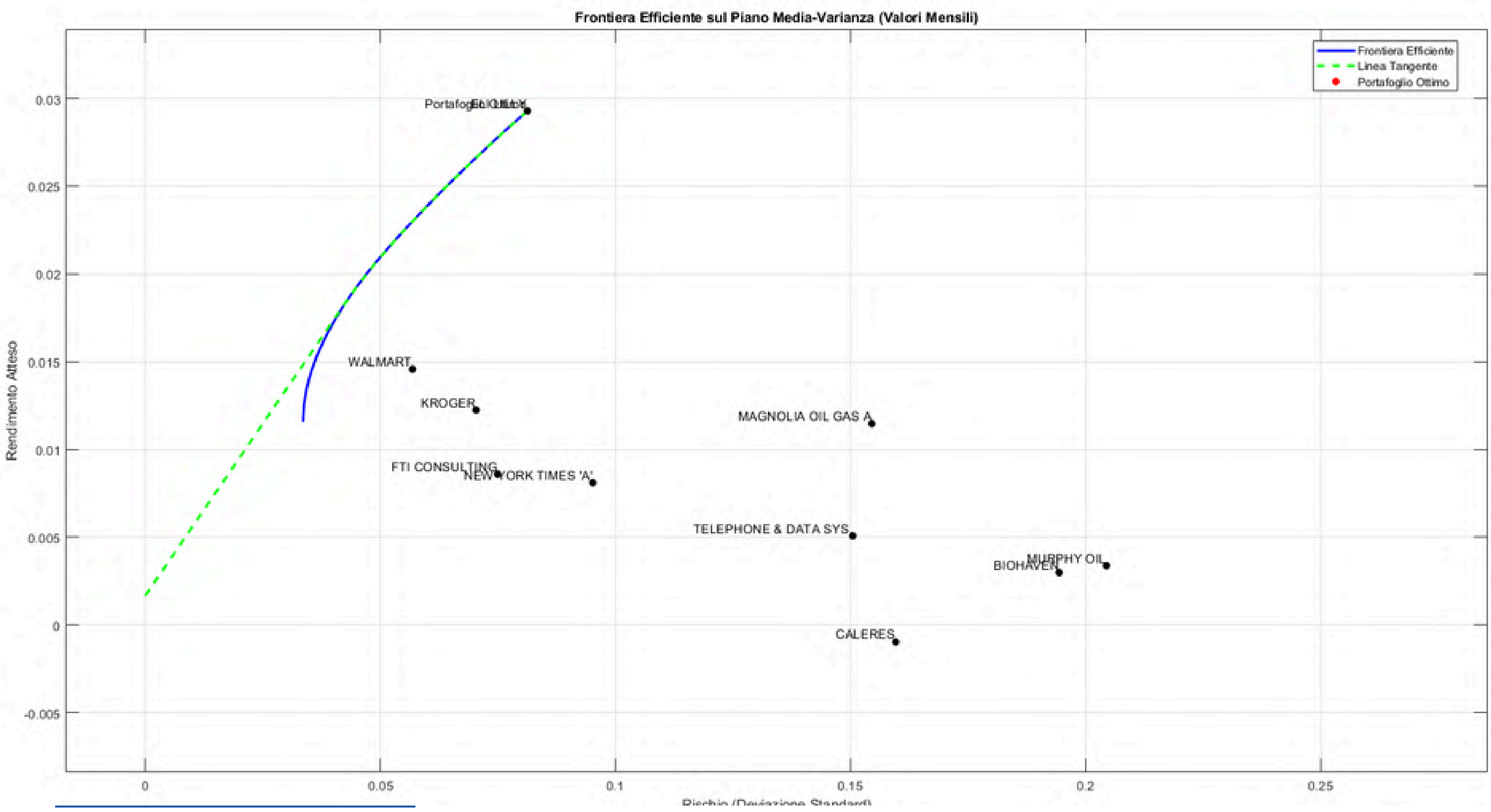

```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.00094749
Exit flag: 1
Output:
         iterations: 39
          funcCount: 441
    constrviolation: 2.2204e-16
           stepsize: 0.0099
          algorithm: 'interior-point'
      firstorderopt: 4.7268e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
       bestfeasible: [1×1 struct]

Pesi ottimali del portafoglio:
ELI LILLY: 0.98221
BIOHAVEN: 0.00072989
CALERES: 0.00061027
WALMART: 0.0069952
MAGNOLIA OIL GAS A: 0.0022792
KROGER: 0.0033487
FTI CONSULTING: 0.0013342
NEW YORK TIMES 'A': 0.0011111
TELEPHONE & DATA SYS.: 0.00071995
MURPHY OIL: 0.0006649
Rendimento del portafoglio: 0.0013316
Rendimento annualizzato: 0.39843
Rischio del portafoglio: 0.0196
Rischio annualizzato: 0.31114
Skewness del portafoglio: 1.0617
Curtosi del portafoglio: 12.3037
Beta del portafoglio: 0.64454
Rapporto di Sharpe: 0.065927
Rapporto di Sortino: 0.10673
Alpha di Jensen: 0.0010316
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 39 iterations, in this case the constraints are violated for a value near 0. The algorithm used is 'Interior Point.The value of the objective function in this case does not provide data on the portfolio parameters.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

Nyse Monthly




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.02268
Exit flag: 1
Output:
         iterations: 27
          funcCount: 308
    constrviolation: 0
           stepsize: 5.9031e-06
          algorithm: 'interior-point'
      firstorderopt: 2.1212e-08
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
        bestfeasible: [1×1 struct]
```

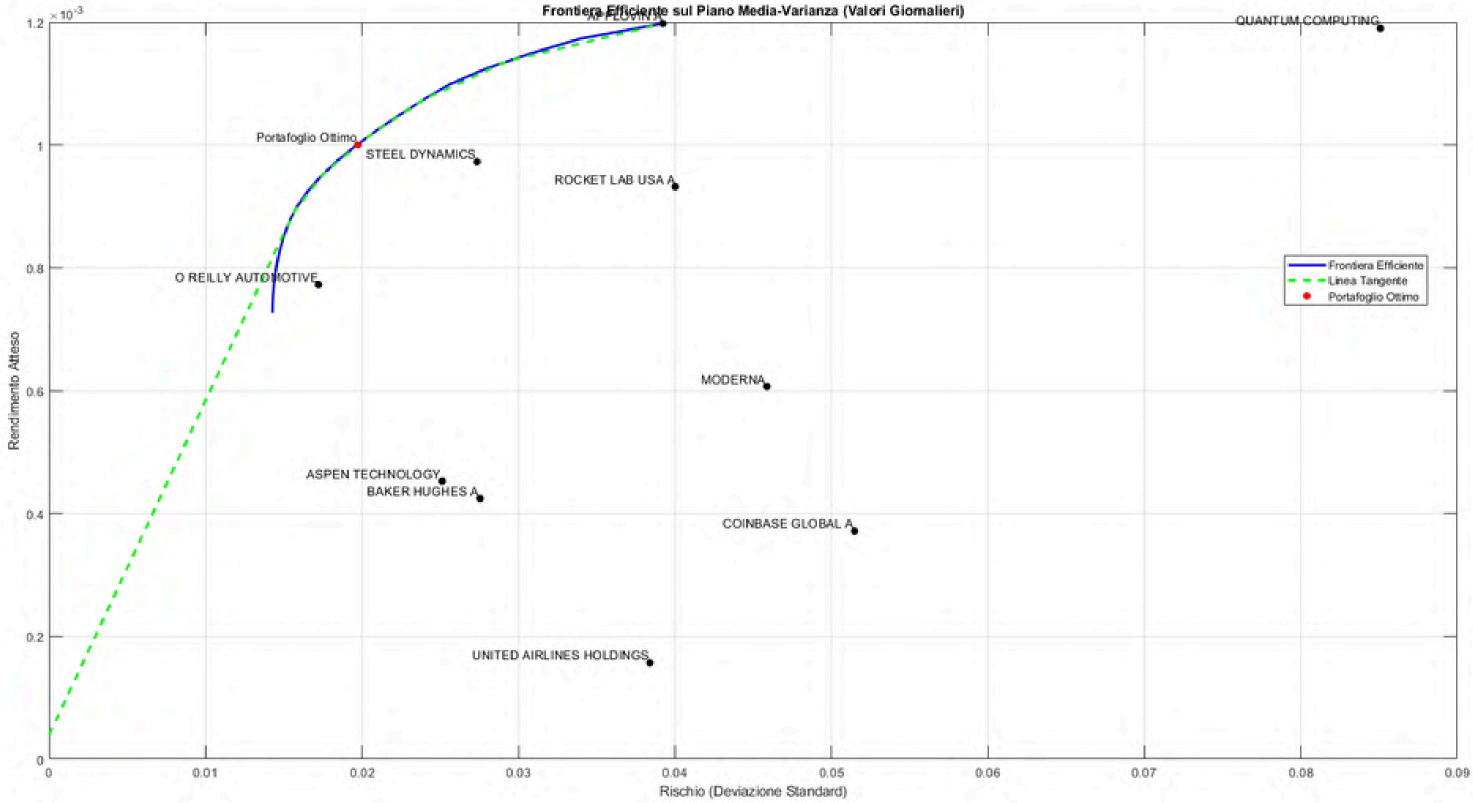
```
Pesi ottimali del portafoglio:
CALERES: 8.9907e-07
KROGER: 2.6779e-06
MURPHY OIL: 8.935e-07
NEW YORK TIMES 'A': 1.5139e-06
WALMART: 3.6416e-06
TELEPHONE & DATA SYS.: 1.5385e-06
FTI CONSULTING: 2.261e-06
MAGNOLIA OIL GAS A: 2.024e-06
BIOHAVEN: 1.0239e-06
ELI LILLY: 0.99998
Rendimento del portafoglio: 0.029287
Rendimento annualizzato: 0.41396
Rischio del portafoglio: 0.081281
Rischio annualizzato: 0.28156
Skewness del portafoglio: 0.22158
Curtosi del portafoglio: 2.2329
Beta del portafoglio: 0.42405
Rapporto di Sharpe: 0.34
Rapporto di Sortino: 0.7211
Alpha di Jensen: 0.024243
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 27 iterations, in this case the constraints are not violated . The algorithm used is 'Interior Point. As before, the value of the objective function in this case does not provide data on the portfolio parameters. In the figure, the optimal portfolio is covered by ELI LILLY.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

Nasdaq Daily




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.00061107
Exit flag: 1
Output:
         iterations: 42
          funcCount: 476
    constrviolation: 0
           stepsize: 2.1675e-04
          algorithm: 'interior-point'
      firstorderopt: 4.0001e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
        bestfeasible: [1×1 struct]
```

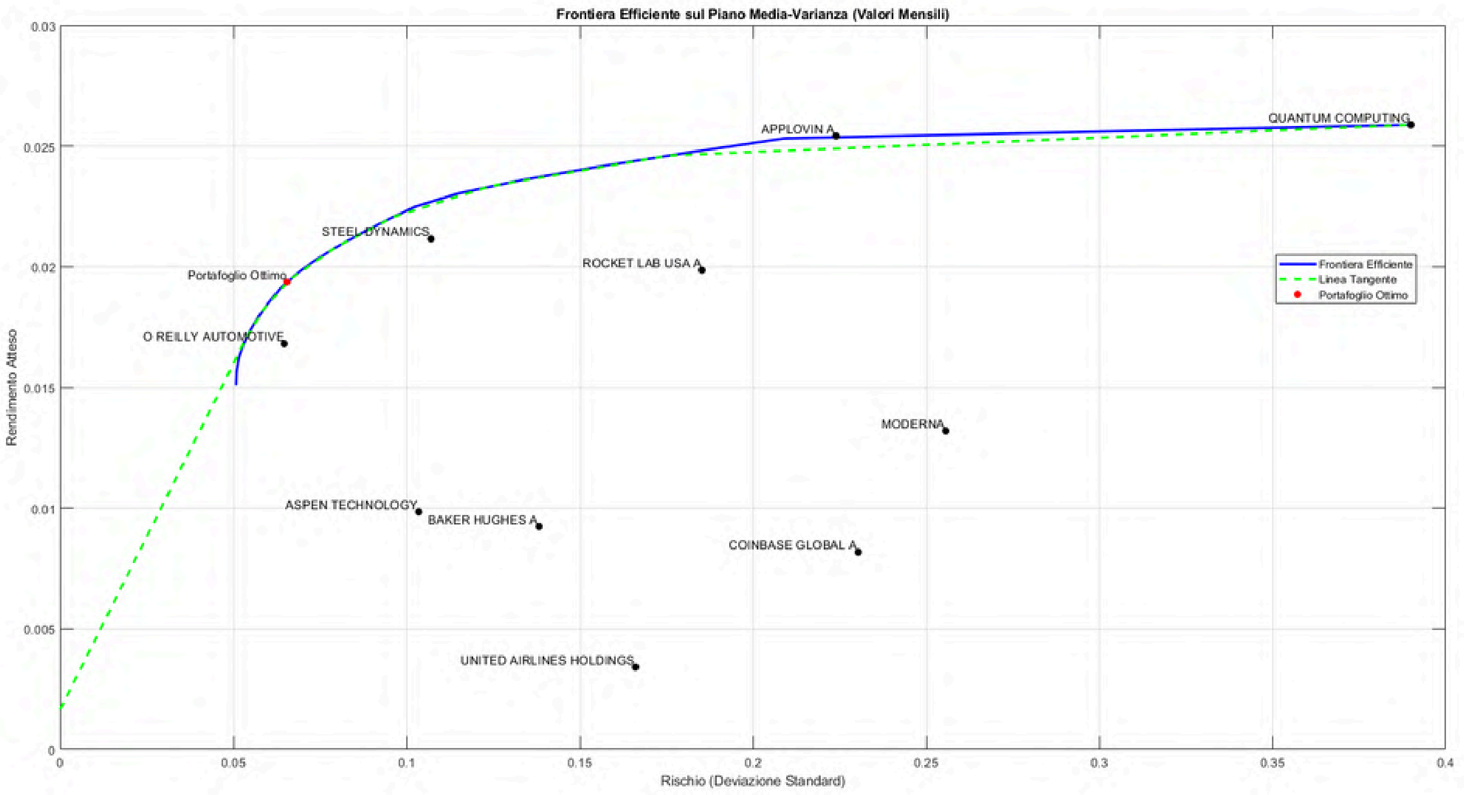
```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.25164
BAKER HUGHES A: 0.00047
STEEL DYNAMICS: 0.34666
ASPEN TECHNOLOGY: 0.00059492
APPLOVIN A: 0.32064
UNITED AIRLINES HOLDINGS: 0.00025284
MODERNA: 0.0014838
COINBASE GLOBAL A: 0.00030189
QUANTUM COMPUTING: 0.040486
ROCKET LAB USA A: 0.037475
Rendimento del portafoglio: 0.0010004
Rendimento annualizzato: 0.28656
Rischio del portafoglio: 0.019731
Rischio annualizzato: 0.31322
Skewness del portafoglio: 0.1539
Curtosi del portafoglio: 6.423
Beta del portafoglio: 0.83561
Rapporto di Sharpe: 0.0487
Rapporto di Sortino: 0.072482
Alpha di Jensen: 0.00052262
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 42 iterations, in this case the constraints are not violated . The algorithm used is 'Interior Point. As before, the value of the objective function in this case does not provide data on the portfolio parameters.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 2: Min risk, Max Ret

Nasdaq Monthly




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.015079
Exit flag: 1
Output:
         iterations: 40
          funcCount: 451
    constrviolation: 0
           stepsize: 4.3548e-05
          algorithm: 'interior-point'
      firstorderopt: 3.2006e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
       bestfeasible: [1×1 struct]
```

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.50529
BAKER HUGHES A: 3.1537e-05
STEEL DYNAMICS: 0.3483
ASPEN TECHNOLOGY: 0.00011189
APPLOVIN A: 0.10299
UNITED AIRLINES HOLDINGS: 2.0133e-05
COINBASE GLOBAL A: 1.8052e-05
MODERNA: 0.015298
QUANTUM COMPUTING: 0.021533
ROCKET LAB USA A: 0.0064159
Rendimento del portafoglio: 0.019368
Rendimento annualizzato: 0.25884
Rischio del portafoglio: 0.06549
Rischio annualizzato: 0.22687
Skewness del portafoglio: -0.26558
Curtosi del portafoglio: 3.6927
Beta del portafoglio: 0.63948
Rapporto di Sharpe: 0.27052
Rapporto di Sortino: 0.47809
Alpha di Jensen: 0.010928
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 40 iterations, in this case the constraints are not violated . The algorithm used is 'Interior Point. As before, the value of the objective function in this case does not provide data on the portfolio parameters.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 3: Hierarchical Risk Parity (HRP)

The Hierarchical Risk Parity (HRP) portfolio is an allocation strategy that aims to overcome some of the limitations of Markowitz's modern portfolio theory. This strategy is based on graph theory and uses machine learning techniques to create a hierarchical structure among risky assets.
Here are the main steps of the HRP model:

- Tree Clustering: Assets are grouped into clusters based on their correlation. This step creates a tree structure (dendrogram) that links the most correlated assets together. The correlation between two assets ii and jj is calculated as:

$$\rho_{ij} = \frac{\mathrm{Cov}(r_i, r_j)}{\sigma_i \sigma_j}$$

- Quasi-Diagonalization: The correlation matrix is reordered based on the clustering information, positioning the most correlated assets around the diagonal of the matrix. This reordering is based on the distance between clusters, which can be calculated using Euclidean distance or other distance metrics

- Recursive Bisection: This step assigns weights to the portfolio assets using the Risk Parity allocation. The recursive bisection algorithm is an iterative function that distributes weights to achieve greater diversification and stability. The portfolio variance calculated as:

$$\sigma_p^2 = w^T \Sigma w$$

where w is the vector of asset weights and Σ is the covariance matrix of asset returns.

The goal of HRP is to minimize portfolio risk while maintaining optimal diversification. This approach offers an alternative to traditional portfolio optimization methods, such as Markowitz's modern portfolio theory, and can be particularly useful in volatile markets or with highly correlated assets.

In the following examples, the HRP portfolio has been compared with a classic mean-variance portfolio.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 3: Hierarchical Risk Parity (HRP)

Presented below is the code used to answer this question.

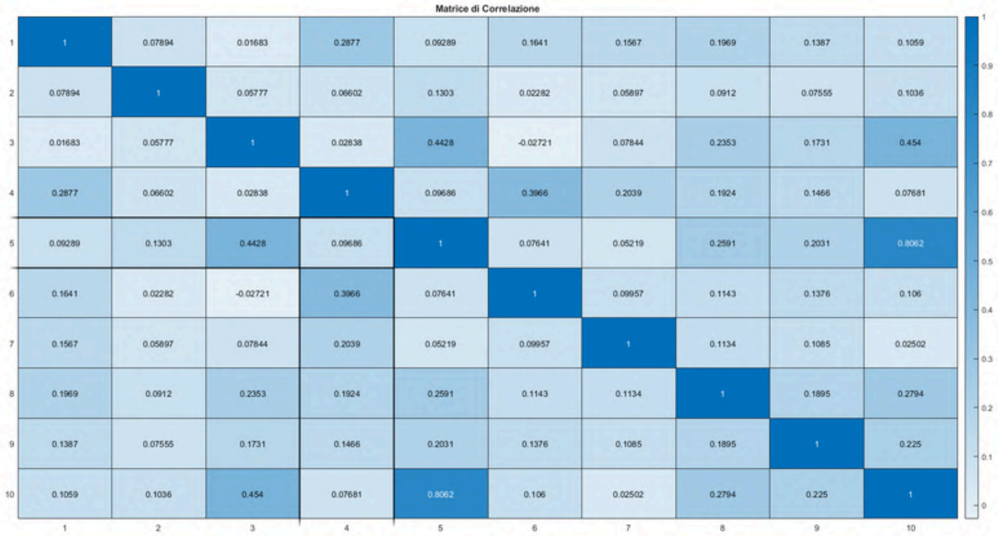
```
function diversificaPortafogliHRP
    % Carica i dati dal file Excel DBEXAM.xlsx
    opts = detectImportOptions('DBEXAM.xlsx', 'Sheet', 'NYSEselectedD');
    opts.VariableNamingRule = 'preserve';
    Dati = readtable('DBEXAM.xlsx', opts);
    tickers = Dati.Properties.VariableNames(2:end); % Escludi la colonna delle date
    Dati = Dati(:, 2:end); % Escludi la colonna delle date
    Dati = table2array(Dati);

    % Calcola i rendimenti giornalieri normali
    n = size(Dati, 1);
    R = (Dati(2:n, :) ./ Dati(1:n-1, :)) - 1;

    % Calcola i rendimenti attesi e la matrice di covarianza
    mu = mean(R)'; % Rendimento atteso (trasposto per ottenere un vettore colonna)
    Sigma = cov(R); % Matrice di covarianza

    % Calcola la matrice di correlazione
    C = corrcov(Sigma);
    figure;
    heatmap(C);
    title('Matrice di Correlazione');

    % Calcola la matrice di distanza di correlazione
    distCorr = ((1 - C) / 2) .^ 0.5;

    % Calcola il linkage
    link = linkage(distCorr);
    figure;
    h = dendrogram(link, 'ColorThreshold', 'default');
    set(h, 'LineWidth', 2);
    title('Default Leaf Order');

    % Ordina gli asset per quasi-diagonalizzazione
    nLeafNodes = size(link, 1) + 1;
    rootNodeId = 2 * nLeafNodes - 1;
    sortedIdx = getLeafNodesInGroup(rootNodeId, link);
    figure;
    heatmap(C(sortedIdx, sortedIdx), 'XData', sortedIdx, 'YData', sortedIdx);
    title('Matrice di Correlazione Ordinata');

    % Ottieni i cluster
    T = cluster(link, 'MaxClust', 6);

    % Calcola il portafoglio HRP
    wHRP = hrpPortfolio(T, Sigma);

    % Crea un oggetto Portfolio
    p = Portfolio('AssetMean', mu, 'AssetCovar', Sigma);
    p = setDefaultConstraints(p); % portafoglio long-only, fully-invested

    % Calcola il portafoglio a varianza minima
    wMV = estimateFrontierLimits(p, 'min');

    % Definisci il numero di asset
    nAssets = size(Sigma, 1);

    % Crea etichette per i grafici a torta
    labels = tickers;

    % Ordina gli asset seguendo l'ordine di quasi-diagonalizzazione
    labels = labels(sortedIdx);
    wMV = wMV(sortedIdx);
    wHRP = wHRP(sortedIdx);

    % Calcola rischio e rendimento dei portafogli
    riskMV = sqrt(wMV' * Sigma * wMV);
    retMV = wMV' * mu * 252; % Annualizza il rendimento
    riskHRP = sqrt(wHRP' * Sigma * wHRP);
    retHRP = wHRP' * mu * 252; % Annualizza il rendimento

    % Annualizza rischio
    annualized_riskMV = riskMV * sqrt(252);
    annualized_riskHRP = riskHRP * sqrt(252);

    % Calcola le statistiche del portafoglio HRP
    meanHRP = mean(R * wHRP);
    stdHRP = std(R * wHRP);
    skewHRP = skewness(R * wHRP);
    kurtHRP = kurtosis(R * wHRP);

    % Calcola il beta del portafoglio HRP
    benchmark_returns = mean(R, 2); % Supponendo che il benchmark sia la media dei rendimenti degli asset
    betaHRP = (cov(R) * wHRP) / var(benchmark_returns);
    betaHRP = sum(betaHRP); % Somma dei beta ponderati per ottenere un valore unico

    % Calcola lo Sharpe Ratio del portafoglio HRP
    rf_annuale = 0.02;
    rf_giornaliero = (1 + rf_annuale)^(1/252) - 1;
    Sharpe_Ratio_HRP = (meanHRP - rf_giornaliero) / stdHRP;

    % Stampa i pesi dei portafogli con i rispettivi ticker
    disp('Pesi del portafoglio a varianza minima:');
    disp(table(labels', wMV, 'VariableNames', {'Ticker', 'Peso'}));
    disp('Pesi del portafoglio HRP:');
    disp(table(labels', wHRP, 'VariableNames', {'Ticker', 'Peso'}));

    % Stampa rischio e rendimento dei portafogli
    disp('Rischio e rendimento del portafoglio a varianza minima:');
    disp(table({'Giornaliero'; 'Annualizzato'}, [riskMV; annualized_riskMV], [retMV / 252; retMV],
'VariableNames', {'Periodo', 'Rischio', 'Rendimento'}));
    disp('Rischio e rendimento del portafoglio HRP:');
    disp(table({'Giornaliero'; 'Annualizzato'}, [riskHRP; annualized_riskHRP], [retHRP / 252; retHRP],
'VariableNames', {'Periodo', 'Rischio', 'Rendimento'}));

    % Stampa le statistiche del portafoglio HRP
    disp('Statistiche del portafoglio HRP:');
    disp(table({'Media'; 'Deviazione Standard'; 'Skewness'; 'Kurtosis'; 'Beta'; 'Sharpe Ratio'},
[meanHRP; stdHRP; skewHRP; kurtHRP; betaHRP; Sharpe_Ratio_HRP], 'VariableNames', {'Statistica',
'Valore'}));

    % Plotta i grafici a torta
    figure;
    tiledlayout(1, 2);
    % Portafoglio a varianza minima
    nexttile
    pie(wMV(wMV >= 1e-8), labels(wMV >= 1e-8))
    title('Min Variance Portfolio', 'Position', [0, 1.5]);
    % Portafoglio HRP
    nexttile
    pie(wHRP, labels)
    title('HRP Portfolio', 'Position', [0, 1.5]);
end

function pwgt = hrpPortfolio(T, Sigma)
    % Funzione che calcola un portafoglio di parità di rischio gerarchico (HRP)
    nAssets = size(Sigma, 1);
    nClusters = max(T);

    % Calcola il portafoglio di parità di rischio all'interno di ogni cluster
    W = zeros(nAssets, nClusters);
    for i = 1:nClusters
        % Identifica gli asset nel cluster i e la sotto-matrice di covarianza
        idx = T == i;
        tempSigma = Sigma(idx, idx);
        % Calcola il portafoglio di parità di rischio del cluster i
        W(idx, i) = riskBudgetingPortfolio(tempSigma);
    end

    % Calcola la covarianza tra i portafogli di parità di rischio di ogni cluster
    covCluster = W' * Sigma * W;

    % Calcola i pesi di ogni cluster
    wBetween = riskBudgetingPortfolio(covCluster);

    % Moltiplica il peso assegnato a ogni cluster con il suo portafoglio e
    % assegna agli asset corrispondenti
    pwgt = W * wBetween;

    % Assicurati che i pesi siano non negativi
    pwgt(pwgt < 0) = 0;
    pwgt = pwgt / sum(pwgt); % Ricalibra i pesi per sommare a 1
end

function idxInGroup = getLeafNodesInGroup(nodeId, link)
    % Trova tutti i nodi foglia per un dato id nodo in una matrice di linkage
    nLeaves = size(link, 1) + 1;
    if nodeId > nLeaves
        tempNodeIds = link(nodeId - nLeaves, 1:2);
        idxInGroup = [getLeafNodesInGroup(tempNodeIds(1), link), ...
                      getLeafNodesInGroup(tempNodeIds(2), link)];
    else
        idxInGroup = nodeId;
    end
end

function w = riskBudgetingPortfolio(Sigma)
    % Funzione che calcola un portafoglio di parità di rischio
    invSigma = inv(Sigma);
    w = invSigma * ones(size(Sigma, 1), 1);
    w = w / sum(w);
end
```

MathWorks, Create Hierarchical Risk Parity Portfolio https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html

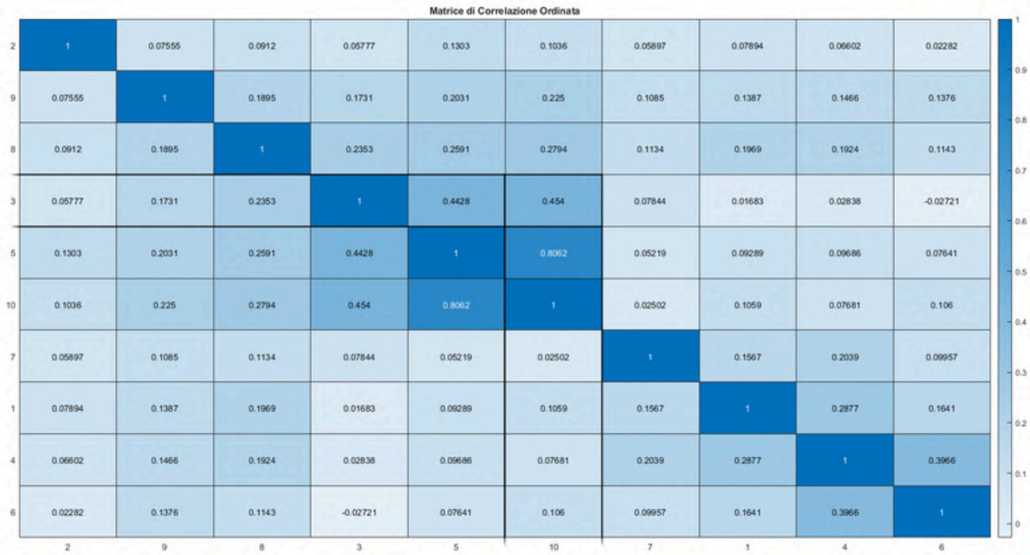
QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 3: Hierarchical Risk Parity (HRP)

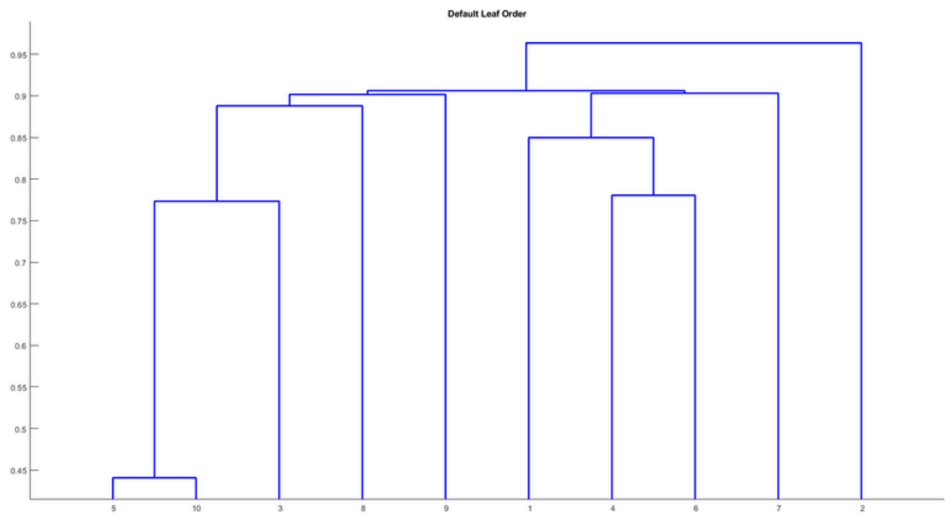
Nyse Daily



The clusters with the highest correlation are condensed towards the diagonal of the matrix, while those with the lowest correlation are moved towards the edges.



In the context of clustering analysis, such as hierarchical clustering, the "leaf nodes" represent the objects or the final elements of the clustering (the individual assets of the portfolio).

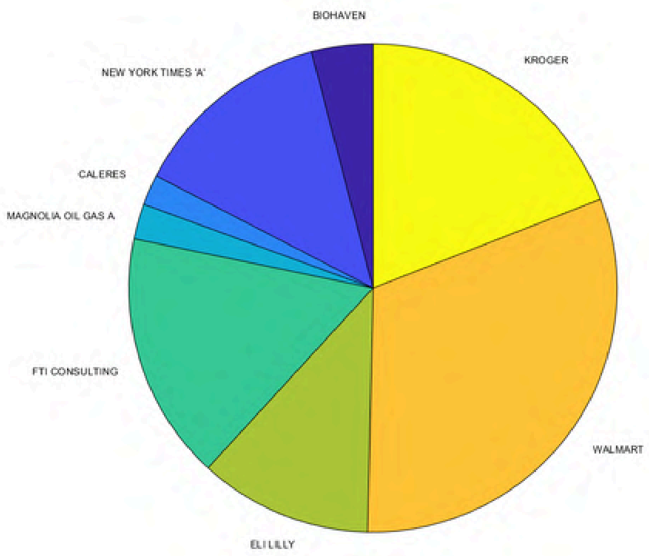


MathWorks, Create Hierarchical Risk Parity Portfolio https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html

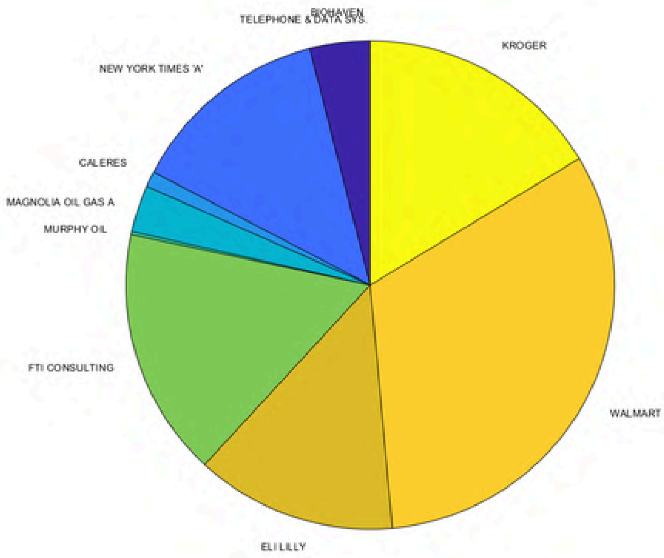
Portfolio 3: Hierarchical Risk Parity (HRP)

Nyse Daily

HRP



Mean Variance



Pesi del portafoglio HRP:

Ticker	Peso
{'BIOHAVEN' }	0.039828
{'TELEPHONE & DATA SYS.'}	0
{'NEW YORK TIMES 'A'' }	0.13366
{'CALERES' }	0.010346
{'MAGNOLIA OIL GAS A' }	0.030955
{'MURPHY OIL' }	0.0021386
{'FTI CONSULTING' }	0.16466
{'ELI LILLY' }	0.1329
{'WALMART' }	0.32214
{'KROGER' }	0.16337

Pesi del portafoglio a varianza minima:

Ticker	Peso
{'BIOHAVEN' }	0.040601
{'TELEPHONE & DATA SYS.'}	0
{'NEW YORK TIMES 'A'' }	0.13345
{'CALERES' }	0.02025
{'MAGNOLIA OIL GAS A' }	0.023328
{'MURPHY OIL' }	0
{'FTI CONSULTING' }	0.16423
{'ELI LILLY' }	0.11467
{'WALMART' }	0.31272
{'KROGER' }	0.19076

Rischio e rendimento del portafoglio HRP:

Periodo	Rischio	Rendimento
{'Giornaliero' }	0.021273	0.00087972
{'Annualizzato'}	0.33769	0.22169

Rischio e rendimento del portafoglio a varianza minima:

Periodo	Rischio	Rendimento
{'Giornaliero' }	0.021399	0.00088476
{'Annualizzato'}	0.3397	0.22296

Statistiche del portafoglio HRP:

Statistica	Valore
{'Media' }	0.00087972
{'Deviazione Standard'}	0.021273
{'Skewness' }	2.0763
{'Kurtosis' }	33.09
{'Beta' }	12.468
{'Sharpe Ratio' }	0.03766

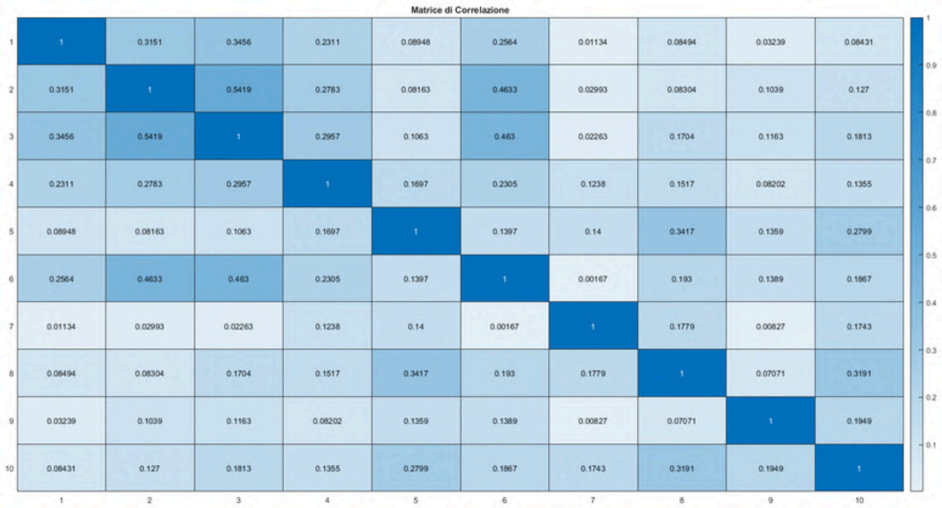
It can be observed that the HRP portfolio is more diversified compared to the mean-variance portfolio, achieving a slightly lower risk at the expense of a similarly lower return.

MathWorks, Create Hierarchical Risk Parity Portfolio https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html

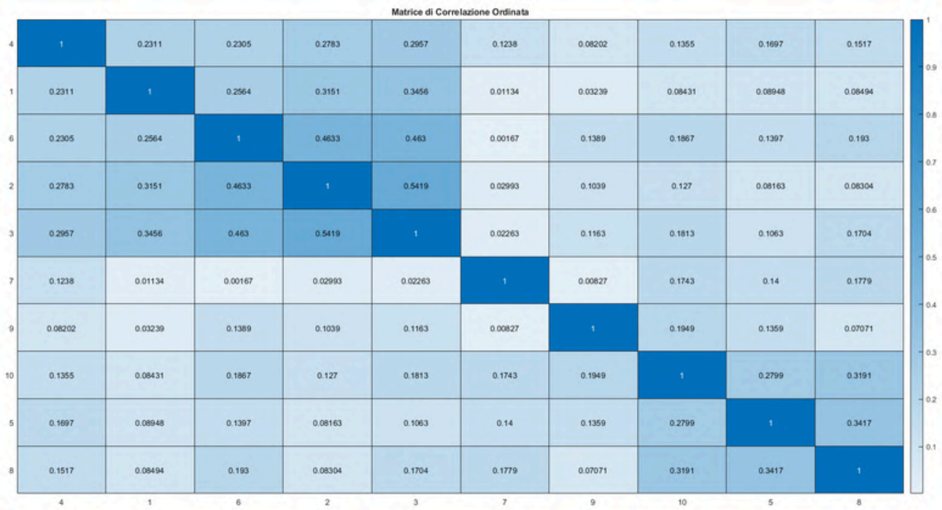
QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 3: Hierarchical Risk Parity (HRP)

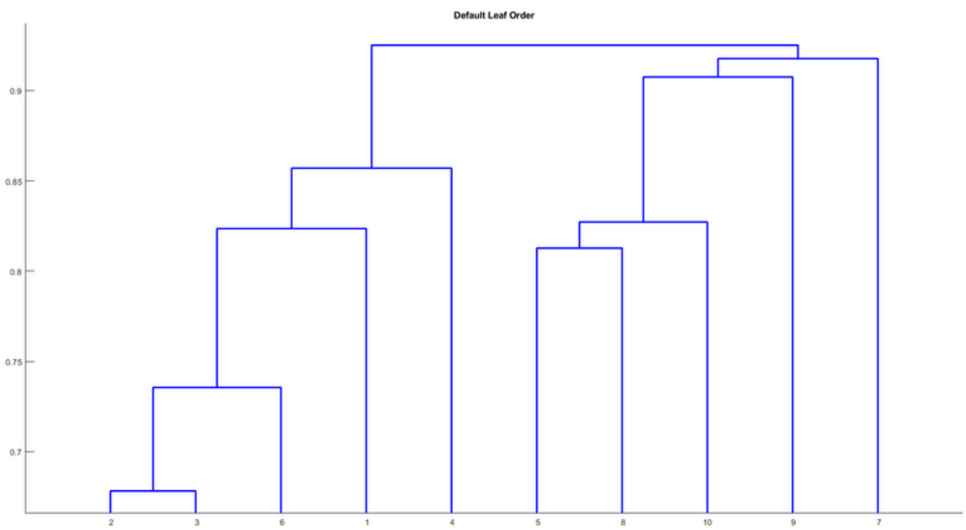
Nasdaq Daily



The clusters with the highest correlation are condensed towards the diagonal of the matrix, while those with the lowest correlation are moved towards the edges.



In the context of clustering analysis, such as hierarchical clustering, the "leaf nodes" represent the objects or the final elements of the clustering (the individual assets of the portfolio).



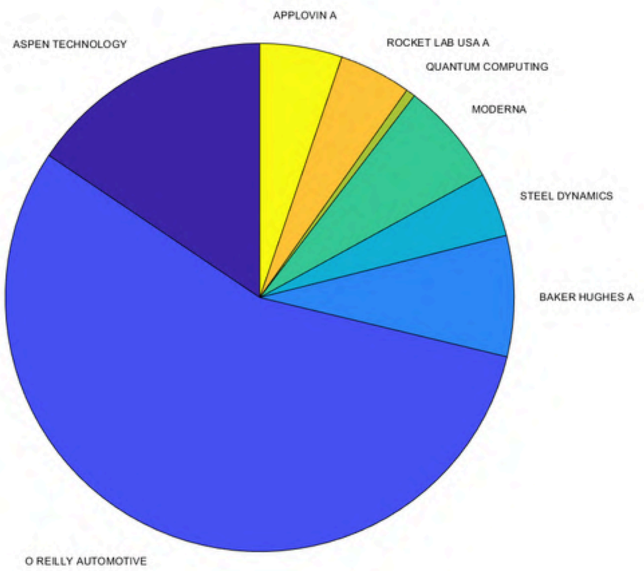
MathWorks, Create Hierarchical Risk Parity Portfolio https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

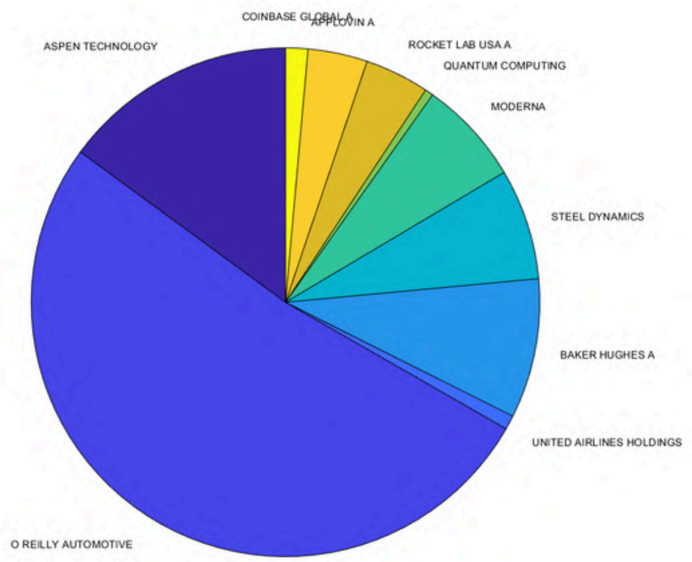
Portfolio 3: Hierarchical Risk Parity (HRP)

Nasdaq Daily

HRP



Mean Variance



Pesi del portafoglio HRP:

Ticker	Peso
{'ASPEN TECHNOLOGY' }	0.14935
{'O REILLY AUTOMOTIVE' }	0.51774
{'UNITED AIRLINES HOLDINGS'}	0.0089793
{'BAKER HUGHES A' }	0.088747
{'STEEL DYNAMICS' }	0.070492
{'MODERNA' }	0.06651
{'QUANTUM COMPUTING' }	0.0053065
{'ROCKET LAB USA A' }	0.040909
{'APPLOVIN A' }	0.037829
{'COINBASE GLOBAL A' }	0.014137

Pesi del portafoglio a varianza minima:

Ticker	Peso
{'ASPEN TECHNOLOGY' }	0.15554
{'O REILLY AUTOMOTIVE' }	0.55694
{'UNITED AIRLINES HOLDINGS'}	0
{'BAKER HUGHES A' }	0.076835
{'STEEL DYNAMICS' }	0.040742
{'MODERNA' }	0.065968
{'QUANTUM COMPUTING' }	0.0058898
{'ROCKET LAB USA A' }	0.045796
{'APPLOVIN A' }	0.052284
{'COINBASE GLOBAL A' }	0

Rischio e rendimento del portafoglio HRP:

Periodo	Rischio	Rendimento
{'Giornaliero' }	0.019677	0.0011256
{'Annualizzato'}	0.31236	0.28366

Rischio e rendimento del portafoglio a varianza minima:

Periodo	Rischio	Rendimento
{'Giornaliero' }	0.02044	0.0011386
{'Annualizzato'}	0.32447	0.28693

Statistiche del portafoglio HRP:

Statistica	Valore
{'Media' }	0.0011256
{'Deviazione Standard'}	0.019677
{'Skewness' }	0.13045
{'Kurtosis' }	12.695
{'Beta' }	7.1807
{'Sharpe Ratio' }	0.053212

As before, it can be observed that the HRP portfolio is more diversified compared to the mean-variance portfolio, achieving a slightly lower risk at the expense of a similarly lower return.

MathWorks, Create Hierarchical Risk Parity Portfolio https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 4: Max Sharpe Ratio

The fourth portfolio aims to maximize the Sharpe ratio, considering an annual risk-free rate of 2%.
The portfolio that maximizes the Sharpe ratio is the one tangent to the line that intersects at the risk-free rate.

Presented below is the code used to answer this question.

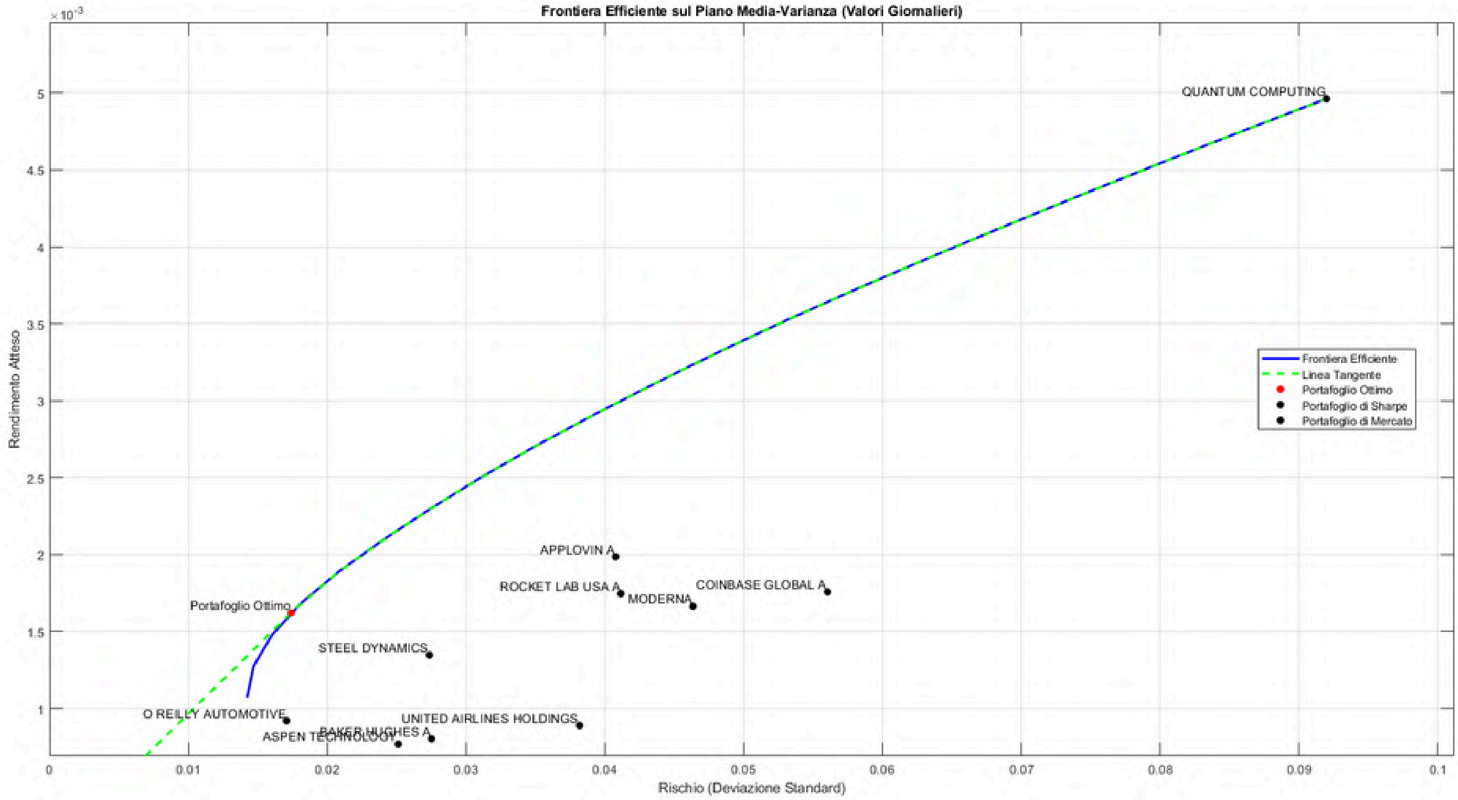
```
filePath = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheetNameAssets = 'NASselectedD';
sheetNameIndex = 'NASindexD';
dataAssets = readtable(filePath, 'Sheet', sheetNameAssets, 'VariableNamingRule', 'preserve');
dataIndex = readtable(filePath, 'Sheet', sheetNameIndex, 'VariableNamingRule', 'preserve');

% Estrai i nomi dei titoli
assetNames = dataAssets.Properties.VariableNames(2:end);

% Calcola i rendimenti giornalieri dei titoli
pricesAssets = dataAssets{:, 2:end}; % Supponendo che la prima colonna sia la data
returnsAssets = diff(pricesAssets) ./ pricesAssets(1:end-1, :);

% Calcola i rendimenti giornalieri dell'indice S&P 500
pricesIndex = dataIndex{:, 2}; % Supponendo che la prima colonna sia la data
returnsIndex = diff(pricesIndex) ./ pricesIndex(1:end-1);

% Allinea le date tra i rendimenti dei titoli e dell'indice
datesAssets = dataAssets{2:end, 1};
datesIndex = dataIndex{2:end, 1};
[commonDates, idxAssets, idxIndex] = intersect(datesAssets, datesIndex);
returnsAssets = returnsAssets(idxAssets, :);
returnsIndex = returnsIndex(idxIndex);

% Calcola le statistiche
meanReturns = mean(returnsAssets);
stdReturns = std(returnsAssets);

% Calcola i beta dei titoli tramite regressione
beta_assets = zeros(1, size(returnsAssets, 2));
for i = 1:size(returnsAssets, 2)
    mdl = fitlm(returnsIndex, returnsAssets(:, i));
    beta_assets(i) = mdl.Coefficients.Estimate(2);
end

% Calcola il tasso risk-free giornaliero
riskFreeRate = 0.02 / 252; % 2% annuo convertito in giornaliero

% Calcola la SML per ogni titolo
marketReturn = mean(returnsIndex);
marketRiskPremium = marketReturn - riskFreeRate;
smlValues = riskFreeRate + marketRiskPremium * beta_assets;

% Stampa i risultati e confronta i rendimenti attesi con i rendimenti effettivi
fprintf('Rendimento atteso dei titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, meanReturns(i));
end
fprintf('Beta dei titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, beta_assets(i));
end
fprintf('Valore della SML per i titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, smlValues(i));
end
fprintf('Confronto tra rendimenti attesi e rendimenti effettivi:\n');
for i = 1:length(assetNames)
    fprintf('%s: Rendimento atteso = %f, Rendimento effettivo = %f\n', assetNames{i}, smlValues(i),
meanReturns(i));
end

% Traccia il piano media-varianza con tutti i titoli e la SML
figure;
scatter(beta_assets, meanReturns, 'b', 'filled');
hold on;
for i = 1:length(assetNames)
    text(beta_assets(i), meanReturns(i), assetNames{i}, 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');
end
plot([0, max(beta_assets)], [riskFreeRate, max(smlValues)], '-r', 'LineWidth', 2);
```

```
% Calcola il portafoglio che massimizza il rapporto di Sharpe
p = Portfolio('AssetMean', meanReturns, 'AssetCovar', cov(returnsAssets));
p = setDefaultConstraints(p);
wts = estimateMaxSharpeRatio(p);

% Stampa i pesi del portafoglio
fprintf('Pesi del portafoglio che massimizza il rapporto di Sharpe:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, wts(i));
end

% Calcola le statistiche del portafoglio
portfolio_return = mean(returnsAssets * wts);
portfolio_std = sqrt(wts' * cov(returnsAssets) * wts);
sharpe_ratio = (portfolio_return - riskFreeRate) / portfolio_std;

% Calcola il beta del portafoglio
beta_portfolio = sum(wts' .* beta_assets);

% Calcola skewness e curtosi del portafoglio
portfolio_skewness = skewness(returnsAssets * wts);
portfolio_kurtosis = kurtosis(returnsAssets * wts);

% Stampa le statistiche del portafoglio
fprintf('Statistiche del portafoglio ottimo:\n');
fprintf('Media: %f\n', portfolio_return);
fprintf('Varianza: %f\n', portfolio_std^2);
fprintf('Beta: %f\n', beta_portfolio);
fprintf('Skewness: %f\n', portfolio_skewness);
fprintf('Curtosi: %f\n', portfolio_kurtosis);
fprintf('Sharpe Ratio: %f\n', sharpe_ratio);

% Aggiungi il portafoglio di Sharpe al grafico SML
scatter(beta_portfolio, portfolio_return, 'r', 'filled');
text(beta_portfolio, portfolio_return, 'Portafoglio di Sharpe', 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');

% Aggiungi il portafoglio di mercato al grafico SML
market_beta = 1; % Il beta del portafoglio di mercato è 1
market_return = marketReturn; % Il rendimento del portafoglio di mercato è il rendimento medio del
mercato
scatter(market_beta, market_return, 100, 'g', '*'); % Evidenzia il portafoglio di mercato con una stella
verde
text(market_beta, market_return, 'Portafoglio di Mercato', 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');

xlabel('Beta');
ylabel('Rendimento Atteso');
title('Piano Media-Varianza con SML, Portafoglio di Sharpe e Portafoglio di Mercato');
legend('Titoli', 'SML', 'Portafoglio di Sharpe', 'Portafoglio di Mercato');

% Calcola la frontiera efficiente
p = Portfolio('AssetList', assetNames, 'RiskFreeRate', riskFreeRate);
p = setAssetMoments(p, meanReturns, cov(returnsAssets));
p = setDefaultConstraints(p);
pwgt = estimateFrontier(p, 20);
[prsk, pret] = estimatePortMoments(p, pwgt);

% Calcola la linea tangente
q = setBudget(p, 0, 1);
qwgt = estimateFrontier(q, 20);
[qrsk, qret] = estimatePortMoments(q, qwgt);

% Grafico della frontiera efficiente (valori giornalieri)
figure;
plot(prsk, pret, 'b-', 'LineWidth', 2);
hold on;
plot(qrsk, qret, 'g--', 'LineWidth', 2); % Linea tangente
scatter(portfolio_std, portfolio_return, 'r', 'filled');
text(portfolio_std, portfolio_return, 'Portafoglio Ottimo', 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');
for i = 1:length(meanReturns)
    scatter(stdReturns(i), meanReturns(i), 'k', 'filled');
    text(stdReturns(i), meanReturns(i), assetNames{i}, 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');
end
scatter(beta_portfolio, portfolio_return, 100, 'r', '*'); % Evidenzia il portafoglio di Sharpe con una
stella
xlabel('Rischio (Deviazione Standard)');
ylabel('Rendimento Atteso');
title('Frontiera Efficiente sul Piano Media-Varianza (Valori Giornalieri)');
legend('Frontiera Efficiente', 'Linea Tangente', 'Portafoglio Ottimo', 'Portafoglio di Sharpe',
'Portafoglio di Mercato', 'Location', 'Best');
grid on;
hold off;
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 4: Max Sharpe Ratio

Nasdaq Daily

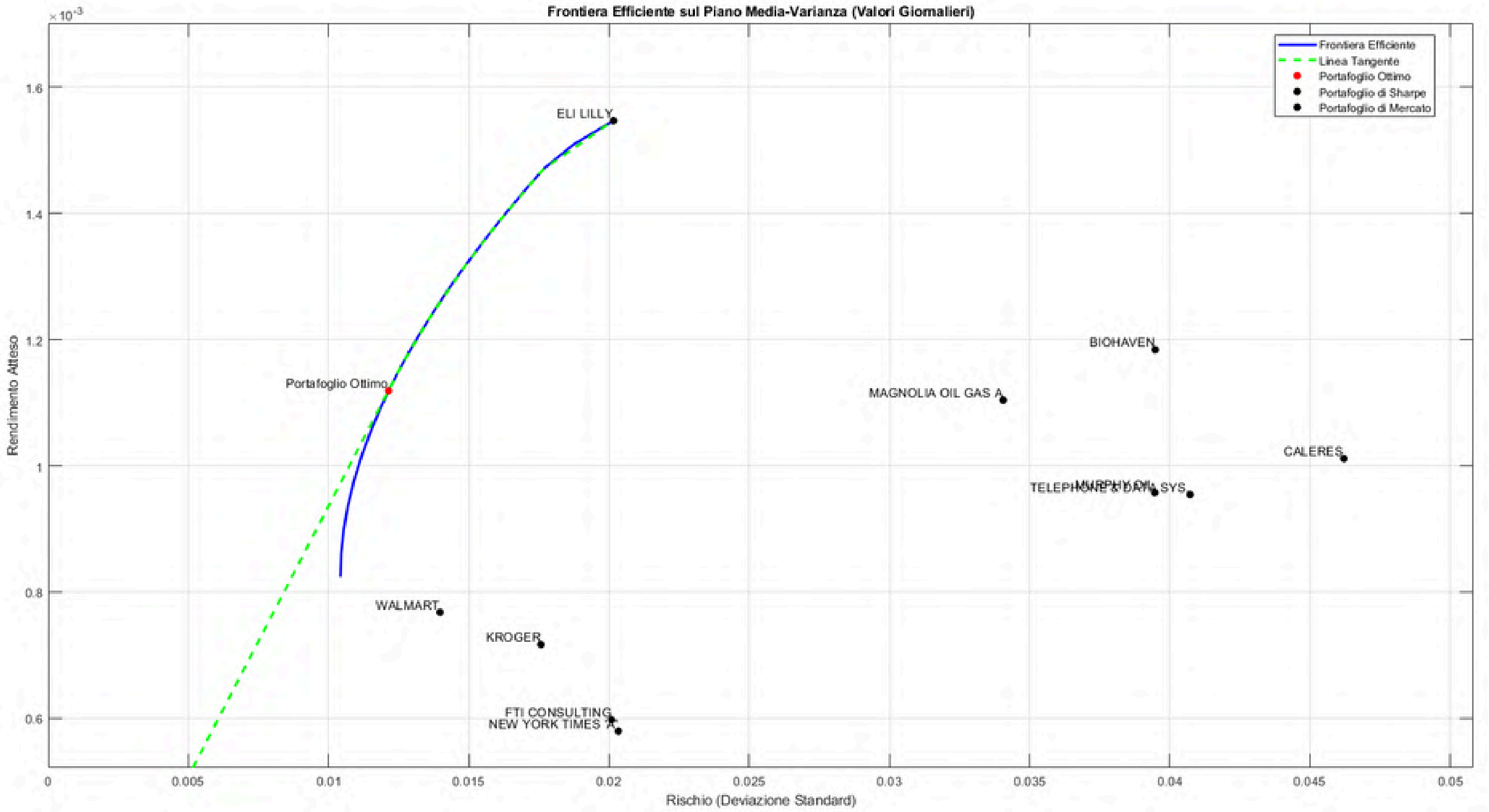



```
Pesi del portafoglio che massimizza il rapporto di Sharpe:
O REILLY AUTOMOTIVE: 0.438354
BAKER HUGHES A: 0.000000
STEEL DYNAMICS: 0.163514
ASPEN TECHNOLOGY: 0.002695
APPLOVIN A: 0.130518
UNITED AIRLINES HOLDINGS: 0.000000
MODERNA: 0.112637
COINBASE GLOBAL A: 0.006619
QUANTUM COMPUTING: 0.087575
ROCKET LAB USA A: 0.058088
Statistiche del portafoglio ottimo:
Media: 0.001620
Varianza: 0.000303
Beta: 0.731001
Skewness: 0.253079
Curtosi: 5.891036
Sharpe Ratio: 0.088553
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 4: Max Sharpe Ratio

Nyse Daily



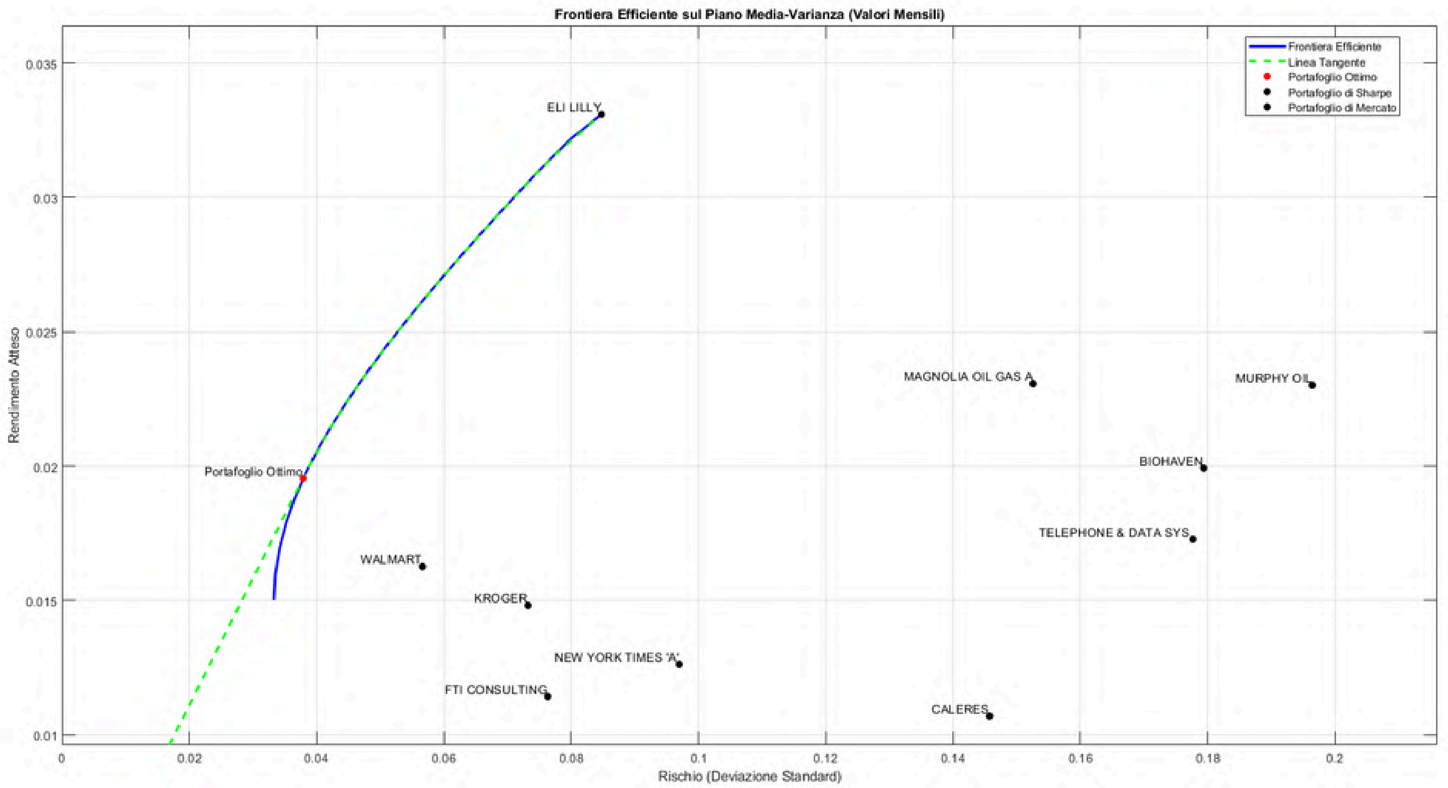

```
Pesi del portafoglio che massimizza il rapporto di Sharpe:
ELI LILLY: 0.403758
BIOHAVEN: 0.066152
CALERES: 0.034958
WALMART: 0.231266
MAGNOLIA OIL GAS A: 0.054507
KROGER: 0.138813
FTI CONSULTING: 0.066927
NEW YORK TIMES 'A': 0.000000
TELEPHONE & DATA SYS.: 0.003619
MURPHY OIL: 0.000000
Statistiche del portafoglio ottimo:
Media: 0.001119
Varianza: 0.000147
Beta: 0.577168
Skewness: 0.322084
Curtosi: 9.902609
Sharpe Ratio: 0.085649
```

The efficient frontier here is slightly more vertical than the previous one, which means that, for the same level of risk, the portfolio offers a higher return compared to a less vertical efficient frontier.

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 4: Max Sharpe Ratio

Nasdaq Monthly Efficient Frontier



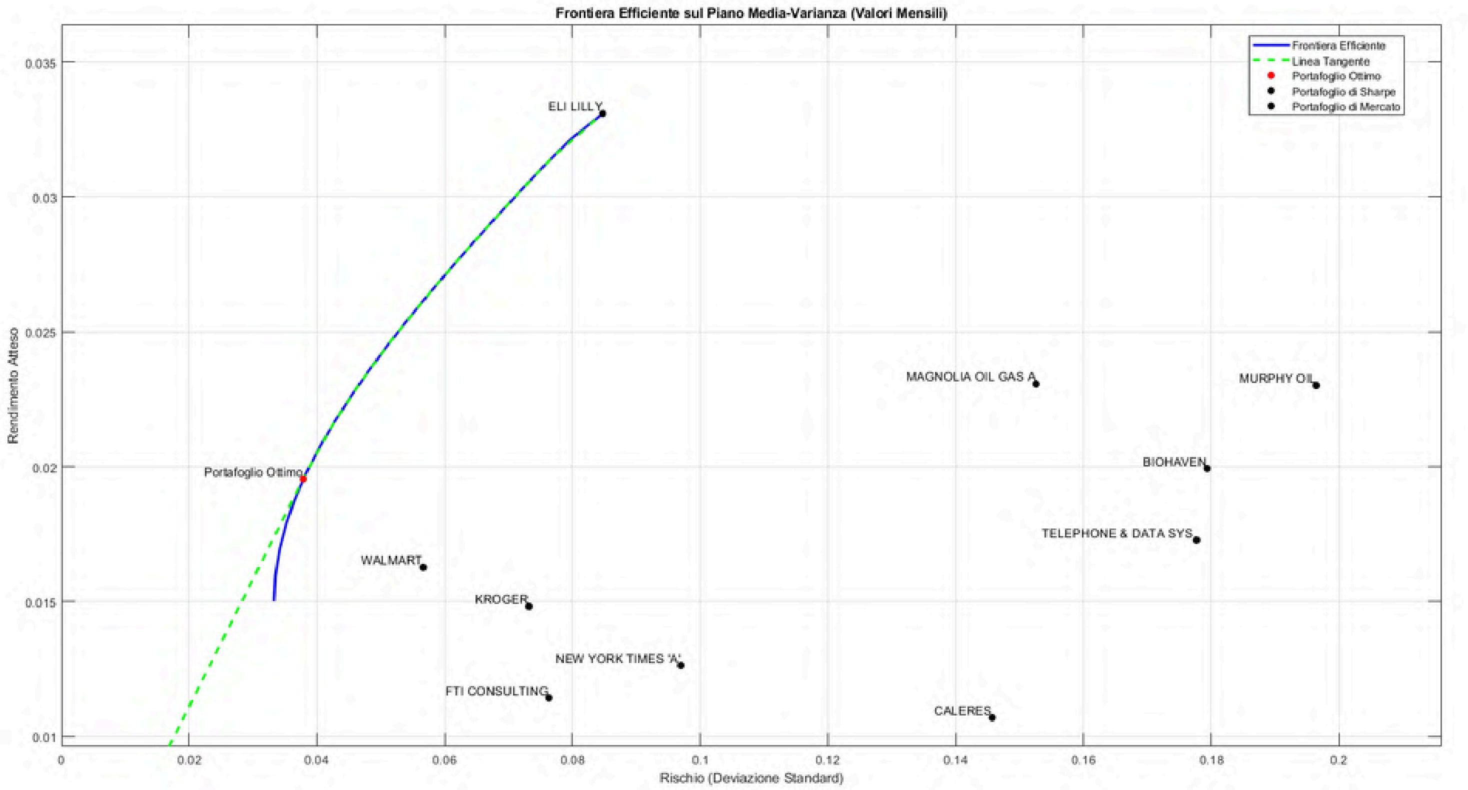
The portfolio weights that maximize the Sharpe ratio are the following:

```
Pesi del portafoglio che massimizza il rapporto di Sharpe:
O REILLY AUTOMOTIVE: 0.516022
BAKER HUGHES A: 0.000000
STEEL DYNAMICS: 0.161976
ASPEN TECHNOLOGY: 0.125393
APPLOVIN A: 0.083858
UNITED AIRLINES HOLDINGS: 0.000000
COINBASE GLOBAL A: 0.000000
MODERNA: 0.074616
QUANTUM COMPUTING: 0.022752
ROCKET LAB USA A: 0.015383
Statistiche del portafoglio ottimo:
Media: 0.027537
Varianza: 0.003782
Beta: 0.654796
Skewness: -0.047584
Curtosi: 3.478208
```

QUESTION 7,8,13,14: COMPUTE THE MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION FOR NYSE AND NASDAQ SECURITIES.

Portfolio 4: Max Sharpe Ratio

Nyse Monthly Efficient Frontier



The portfolio weights that maximize the Sharpe ratio are the following:

```
Pesi del portafoglio che massimizza il rapporto di Sharpe:
CALERES: 0.040878
KROGER: 0.085008
MURPHY OIL: 0.000000
NEW YORK TIMES 'A': 0.000000
WALMART: 0.296405
TELEPHONE & DATA SYS.: 0.020493
FTI CONSULTING: 0.222718
MAGNOLIA OIL GAS A: 0.060430
BIOHAVEN: 0.025595
ELI LILLY: 0.248473
Statistiche del portafoglio ottimo:
Media: 0.019546
Varianza: 0.001435
Beta: 0.391441
Skewness: 0.147646
Curtosi: 2.359311
```

QUESTION 9,10,11,12: COMPUTE THE SAME OPTIMAL PORTFOLIO WITH NON-NEGATIVITY CONSTRAINT ON WEIGHTS FOR YOUR NYSE AND NASDAQ PORTFOLIO.

Portfolio 1: Min Risk

The only modification compared to before is the LB (Lower Bound) constraint. We simply move the % sign (comment) from the lower to the upper LB string.

$$\begin{cases} \min \phi(X) \\ \textit{with constraints:} \\ E(X) \geq \Pi \\ \sum_{k=1}^{n} w_k = 1 \\ w_k \cancel{\geq} 0 \end{cases} \longrightarrow \min_{z} (z, Vz) \quad \text{such that} \quad \begin{cases} (m, z) \geq \pi, \\ (e, z) = 1, \\ z \cancel{\geq} 0. \end{cases}$$

```
% Ottimizzazione del portafoglio
z0 = (1/length(m)) * ones(length(m), 1);
A = -m;
p = 0.001;
B = [-p];
Aeq = ones(1, length(m));
Beq = [1];
LB = zeros(length(m), 1);
%LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
UB = [];
```

Without lower bound constraints, Portfolio 1 on the Nasdaq performs better overall. The daily return slightly increases (from 0.0010002 to 0.001001), and the risk decreases (with standard deviation dropping from 0.019721 to 0.016056). The Sharpe ratio also improves (from 0.048714 to 0.06), meaning the portfolio offers better returns for the level of risk taken. However, the increase in kurtosis (from 6.4241 to 8.1507) suggests more extreme returns are possible, and the shift in skewness (from 0.15297 to -0.32) indicates a higher chance of negative returns. While the portfolio is more efficient, it may be more vulnerable to large downside movements.

While Portfolio 1 on the Nyse shows notable changes in its performance metrics, the daily return slightly increases (from 0.0010000 to 0.0018), while the risk significantly rises, as reflected by the increase in standard deviation from 0.01340 to 0.027. The Sharpe ratio slightly declines (from 0.07176 to 0.068), indicating reduced efficiency in balancing return and risk. Additionally, the decrease in kurtosis (from 11.9602 to 9.92) suggests a lower likelihood of extreme outcomes, while the increase in skewness (from 0.57829 to 0.86) reflects a stronger bias towards positive returns. These changes highlight a trade-off where the portfolio becomes more biased toward positive outcomes but experiences higher risk and slightly reduced risk-adjusted performance.

QUESTION 9,10,11,12: COMPUTE THE SAME OPTIMAL PORTFOLIO WITH NON-NEGATIVITY CONSTRAINT ON WEIGHTS FOR YOUR NYSE AND NASDAQ PORTFOLIO.

Portfolio 1: Min Risk

The optimal portfolio weights for this type of porfolio are the following:

Nyse Daily

```
Pesi ottimali del portafoglio:
ELI LILLY: 0.46173
BIOHAVEN: -0.0081502
CALERES: -0.0076062
WALMART: 0.31242
MAGNOLIA OIL GAS A: 0.14898
KROGER: 0.146
FTI CONSULTING: 0.052134
NEW YORK TIMES 'A': 0.039435
TELEPHONE & DATA SYS.: -0.034556
MURPHY OIL: -0.11039
Rendimento del portafoglio: 0.0010011
Rendimento annualizzato: 0.28678
Rischio del portafoglio: 0.012892
Rischio annualizzato: 0.20465
Skewness del portafoglio: 0.47163
Curtosi del portafoglio: 11.1142
Beta del portafoglio: 0.50585
Rapporto di Sharpe: 0.074589
Rapporto di Sortino: 0.11576
Alpha di Jensen: 0.00075706
```

Nasdaq Daily

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.61063
BAKER HUGHES A: -0.039628
STEEL DYNAMICS: 0.25644
ASPEN TECHNOLOGY: 0.048538
APPLOVIN A: 0.15376
UNITED AIRLINES HOLDINGS: -0.12619
MODERNA: 0.053108
COINBASE GLOBAL A: -0.057725
QUANTUM COMPUTING: 0.019659
ROCKET LAB USA A: 0.081409
Rendimento del portafoglio: 0.001001
Rendimento annualizzato: 0.28675
Rischio del portafoglio: 0.016056
Rischio annualizzato: 0.25488
Skewness del portafoglio: -0.32063
Curtosi del portafoglio: 8.1507
Beta del portafoglio: 0.62717
Rapporto di Sharpe: 0.059885
Rapporto di Sortino: 0.086959
Alpha di Jensen: 0.00063253
```

Nyse Monthly

```
Pesi ottimali del portafoglio:
CALERES: 0.073768
KROGER: 0.13367
MURPHY OIL: -0.026872
NEW YORK TIMES 'A': 0.072603
WALMART: 0.33131
TELEPHONE & DATA SYS.: 0.0095931
FTI CONSULTING: 0.28831
MAGNOLIA OIL GAS A: 0.048129
BIOHAVEN: 0.0055267
ELI LILLY: 0.063966
Rendimento del portafoglio: 0.011859
Rendimento annualizzato: 0.15197
Rischio del portafoglio: 0.033499
Rischio annualizzato: 0.11604
Skewness del portafoglio: -0.072964
Curtosi del portafoglio: 2.6321
Beta del portafoglio: 0.35017
Rapporto di Sharpe: 0.32925
Rapporto di Sortino: 0.61569
Alpha di Jensen: 0.0079402
```

Nasdaq Monthly

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.61631
BAKER HUGHES A: -0.017951
STEEL DYNAMICS: 0.079144
ASPEN TECHNOLOGY: 0.26018
APPLOVIN A: 0.01688
UNITED AIRLINES HOLDINGS: 0.016998
COINBASE GLOBAL A: -0.058922
MODERNA: 0.039215
QUANTUM COMPUTING: -0.025625
ROCKET LAB USA A: 0.073774
Rendimento del portafoglio: 0.015754
Rendimento annualizzato: 0.20631
Rischio del portafoglio: 0.048747
Rischio annualizzato: 0.16886
Skewness del portafoglio: 0.0042211
Curtosi del portafoglio: 3.9589
Beta del portafoglio: 0.37999
Rapporto di Sharpe: 0.30615
Rapporto di Sortino: 0.55856
Alpha di Jensen: 0.010578
```

QUESTION 9,10,11,12: COMPUTE THE SAME OPTIMAL PORTFOLIO WITH NON-NEGATIVITY CONSTRAINT ON WEIGHTS FOR YOUR NYSE AND NASDAQ PORTFOLIO.

Portfolio 2: Min Risk, Max Ret

As before:

$$\begin{cases} \min -E(X) + \frac{a}{2}\phi(X) \\ \textit{with constraints:} \\ \sum_{k=1}^{n} w_k = 1 \\ w_k \cancel{\geq} 0 \end{cases} \longrightarrow \min_{z} \left(-(m,z) + \frac{a}{2}(z, Vz)\right) \quad \text{such that} \quad \begin{cases} (e,z) = 1, \\ z \cancel{\geq} 0. \end{cases}$$

```
   % Ottimizzazione del portafoglio
z0 = (1/length(m)) * ones(length(m), 1);
A = -m;
p = 0.001;
B = [-p];
Aeq = ones(1, length(m));
Beq = [1];
%LB = zeros(length(m), 1);
LB = -inf(length(m), 1); % Permette pesi negativi per le vendite allo scoperto
UB = [];
```

For NASDAQ, the Portfolio Short performs better overall compared to the Portfolio Long Only, as it demonstrates higher returns and improved efficiency in balancing risk and reward, despite certain drawbacks. The daily return increases from 0.0010004 to 0.0013783, reflecting a notable improvement in the portfolio's ability to generate returns. However, the standard deviation rises from 0.019731 to 0.022896, indicating higher risk and greater variability in returns. The Sharpe ratio improves from 0.0487 to 0.058473, highlighting that the Portfolio Short offers better compensation for the level of risk taken, which is a significant advantage. Meanwhile, kurtosis decreases slightly from 6.423 to 6.2676, suggesting a marginal reduction in the likelihood of extreme returns, which could be viewed as a stabilization of the return distribution. On the other hand, skewness shifts from 0.1539 to -0.042623, transitioning from a positive bias towards returns to a slightly negative bias, indicating an increased probability of negative outcomes.
Overall, while the Portfolio Short demonstrates improved return and risk-adjusted efficiency, the higher risk and negative skewness introduce potential vulnerabilities, making it a better option primarily for investors with a higher risk tolerance.

For NYSE, the Portfolio Short demonstrates better overall performance compared to the Portfolio Long Only, primarily due to its higher daily return and improved risk-adjusted efficiency, despite some trade-offs in terms of risk and distribution characteristics. The daily return increases significantly from 0.00133 to 0.0018776, reflecting superior profitability in the Portfolio Short. The Sharpe ratio also improves slightly from 0.06593 to 0.067745, indicating marginally better compensation for the increased risk undertaken. However, the standard deviation rises notably from 0.01960 to 0.027133, suggesting greater volatility and higher risk exposure in the Portfolio Short. At the same time, kurtosis decreases from 12.30370 to 9.9179, pointing to a reduced likelihood of extreme returns, which could be interpreted as a stabilization of the portfolio's performance. The skewness shifts from 1.06170 to 0.85629, reflecting a diminished but still positive bias towards favorable returns in the Portfolio Short.
In conclusion, the Portfolio Short offers higher returns and slightly better risk-adjusted performance, making it more appealing for investors who prioritize returns and are willing to accept increased volatility. Meanwhile, the Portfolio Long Only provides a more stable risk profile, which may be preferable for risk-averse investors. Overall, the Portfolio Short stands out for its profitability and efficiency, despite the higher risk it entails.

QUESTION 9,10,11,12: COMPUTE THE SAME OPTIMAL PORTFOLIO WITH NON-NEGATIVITY CONSTRAINT ON WEIGHTS FOR YOUR NYSE AND NASDAQ PORTFOLIO.

Portfolio 2: Min Risk, Max Ret

Nyse Daily

```
Pesi ottimali del portafoglio:
ELI LILLY: 1.2462
BIOHAVEN: -0.07659
CALERES: -0.080701
WALMART: 0.3169
MAGNOLIA OIL GAS A: 0.39419
KROGER: 0.029149
FTI CONSULTING: -0.20739
NEW YORK TIMES 'A': -0.19229
TELEPHONE & DATA SYS.: -0.11808
MURPHY OIL: -0.31141
Rendimento del portafoglio: 0.0018776
Rendimento annualizzato: 0.60435
Rischio del portafoglio: 0.027133
Rischio annualizzato: 0.43073
Skewness del portafoglio: 0.85629
Curtosi del portafoglio: 9.9179
Beta del portafoglio: 0.5148
Rapporto di Sharpe: 0.067745
Rapporto di Sortino: 0.1081
Alpha di Jensen: 0.00163
```

Nasdaq Daily

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.69426
BAKER HUGHES A: -0.21638
STEEL DYNAMICS: 0.5613
ASPEN TECHNOLOGY: -0.1072
APPLOVIN A: 0.29027
UNITED AIRLINES HOLDINGS: -0.28384
MODERNA: 0.036254
COINBASE GLOBAL A: -0.1386
QUANTUM COMPUTING: 0.037035
ROCKET LAB USA A: 0.1269
Rendimento del portafoglio: 0.0013783
Rendimento annualizzato: 0.41494
Rischio del portafoglio: 0.022896
Rischio annualizzato: 0.36347
Skewness del portafoglio: -0.042623
Curtosi del portafoglio: 6.2676
Beta del portafoglio: 0.60917
Rapporto di Sharpe: 0.058473
Rapporto di Sortino: 0.086876
Alpha di Jensen: 0.0010193
```

Nyse Monthly

```
Pesi ottimali del portafoglio:
CALERES: -0.31529
KROGER: -0.01107
MURPHY OIL: -0.70623
NEW YORK TIMES 'A': -0.35481
WALMART: 0.036483
TELEPHONE & DATA SYS.: -0.020837
FTI CONSULTING: -0.13868
MAGNOLIA OIL GAS A: 1.0656
BIOHAVEN: -0.16371
ELI LILLY: 1.6086
Rendimento del portafoglio: 0.052993
Rendimento annualizzato: 0.85826
Rischio del portafoglio: 0.14728
Rischio annualizzato: 0.51018
Skewness del portafoglio: 0.48548
Curtosi del portafoglio: 2.9696
Beta del portafoglio: 0.00072296
Rapporto di Sharpe: 0.34861
Rapporto di Sortino: 0.78361
Alpha di Jensen: 0.051336
```

Nasdaq Monthly

```
Pesi ottimali del portafoglio:
O REILLY AUTOMOTIVE: 0.7459
BAKER HUGHES A: -0.40601
STEEL DYNAMICS: 0.9688
ASPEN TECHNOLOGY: -0.027444
APPLOVIN A: 0.26233
UNITED AIRLINES HOLDINGS: -0.42926
COINBASE GLOBAL A: -0.33464
MODERNA: 0.014849
QUANTUM COMPUTING: 0.056211
ROCKET LAB USA A: 0.14928
Rendimento del portafoglio: 0.036102
Rendimento annualizzato: 0.53049
Rischio del portafoglio: 0.11203
Rischio annualizzato: 0.38808
Skewness del portafoglio: -0.18171
Curtosi del portafoglio: 2.2465
Beta del portafoglio: 0.5797
Rapporto di Sharpe: 0.30751
Rapporto di Sortino: 0.55777
Alpha di Jensen: 0.028297
```

QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

Presented below is the code used to answer this question.

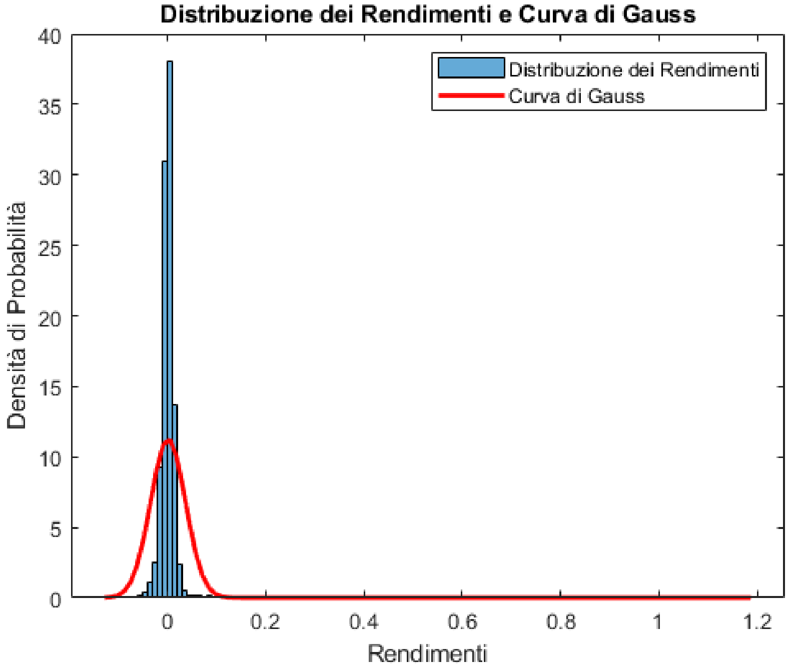
```
      % Path del file
filePath = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';

% Leggi i dati dal worksheet "SP500indexD" mantenendo i nomi originali delle colonne
opts = detectImportOptions(filePath, 'Sheet', 'SP500indexD');
opts.VariableNamingRule = 'preserve';
data = readtable(filePath, opts);

% Calcola i rendimenti giornalieri
returns = diff(log(data.('S&P 500 COMPOSITE - PRICE INDEX')));

% Calcola le statistiche giornaliere
meanReturn = mean(returns);
varianceReturn = var(returns);
stdDevReturn = std(returns);
skewnessReturn = skewness(returns);
kurtosisReturn = kurtosis(returns);

% Crea una tabella con le statistiche giornaliere
dailyStatsTable = table(meanReturn, varianceReturn, stdDevReturn, skewnessReturn, kurtosisReturn, ...
    'VariableNames', {'Media_Giornaliera', 'Varianza_Giornaliera', 'Deviazione_Standard_Giornaliera',
'Skewness_Giornaliera', 'Kurtosi_Giornaliera'});

% Visualizza la tabella
disp('Statistiche Giornaliera:');
disp(dailyStatsTable);

% Plot della distribuzione dei rendimenti giornalieri
figure;
histogram(returns, 'Normalization', 'pdf');
hold on;

% Sovrapposizione della curva di Gauss giornaliera
x = linspace(min(returns), max(returns), 100);
gaussCurve = normpdf(x, meanReturn, stdDevReturn);
plot(x, gaussCurve, 'r', 'LineWidth', 2);

title('Distribuzione dei Rendimenti e Curva di Gauss');
xlabel('Rendimenti');
ylabel('Densità di Probabilità');
legend('Distribuzione dei Rendimenti', 'Curva di Gauss');
hold off;
```

QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

SP500 Price index Daily

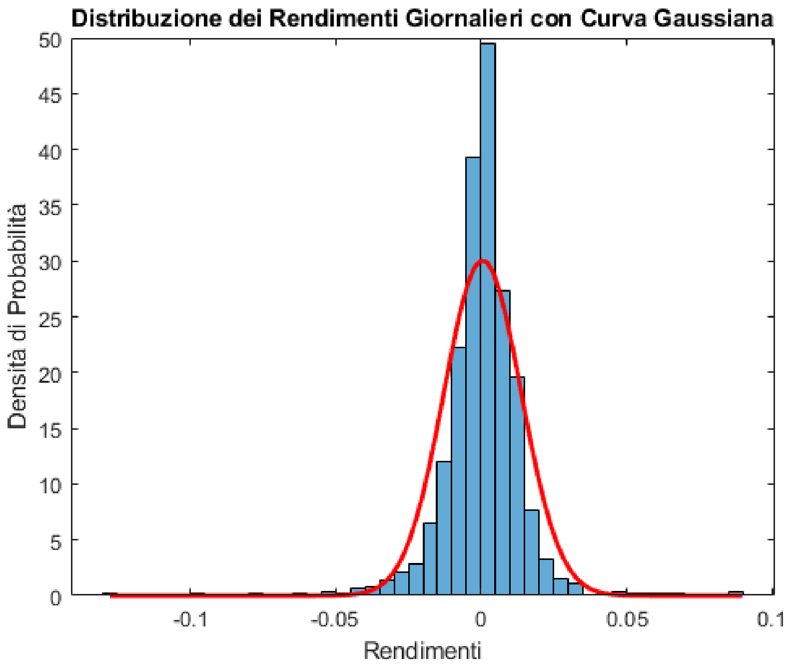
Statistiche Giornaliera:

Media_Giornaliera	Varianza_Giornaliera	Deviazione_Standard_Giornaliera	Skewness_Giornaliera	Kurtosi_Giornaliera
0.0013692	0.0012498	0.035352	28.743	966.15



SP500 Total Return Daily

Frequency	Mean	Variance	StdDev	Skewness	Kurtosis
{'Daily' }	0.00050418	0.00017587	0.013262	-0.8235	17.735



QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

SP500 vs Nyse Min Risk Max Ret portfolio daily (Portfolio 2 Min Risk Max Ret)

For the S&P 500, the average daily return is 0.0013692, which tells us that, on average, the market grows slightly each day. But what really stands out is the standard deviation, which is 0.035352. This is quite high, meaning that the S&P 500 is fairly volatile.

In other words, its returns can fluctuate significantly from day to day. The skewness is impressive: 28.743. This value tells us that the return distribution is extremely unbalanced, with a long "tail" to the right, meaning there is a very high probability of strong gains, even though they are quite rare. Additionally, the kurtosis is very high at 966.15, which suggests that extreme events (like sharp rises or drops) are more likely than one would expect in a normal probability distribution.

The Min Risk, Max Ret portfolio from the NYSE has a similar average return, but with a significantly lower standard deviation (0.01960). This means it is much less volatile, so daily returns tend to vary less compared to those of the S&P 500. The skewness of 1.06170, while still positive, is much more contained compared to the S&P 500, indicating that the return distribution is more symmetrical and doesn't have such a long "tail." Finally, the kurtosis of 12.30370 shows that extreme events are still possible, but they are far less frequent than in the S&P 500.

In practice, the S&P 500 appears to be a much riskier market, with sharp daily fluctuations and a higher probability of rare, but extremely significant, events. On the other hand, the Min Risk, Max Ret portfolio seems more stable and less prone to extreme movements, though, like all strategies, it is not immune to risks.
In summary, if you're looking for more stability and less volatility, the Min Risk, Max Ret portfolio might be the better choice. If you're willing to tolerate more risk for potentially higher returns, the S&P 500 could offer interesting opportunities, but with greater uncertainty due to sudden and unpredictable movements.

SP500 Price index Daily

Statistiche Giornaliera:

Media_Giornaliera	Varianza_Giornaliera	Deviazione_Standard_Giornaliera	Skewness_Giornaliera	Kurtosi_Giornaliera
0.0013692	0.0012498	0.035352	28.743	966.15

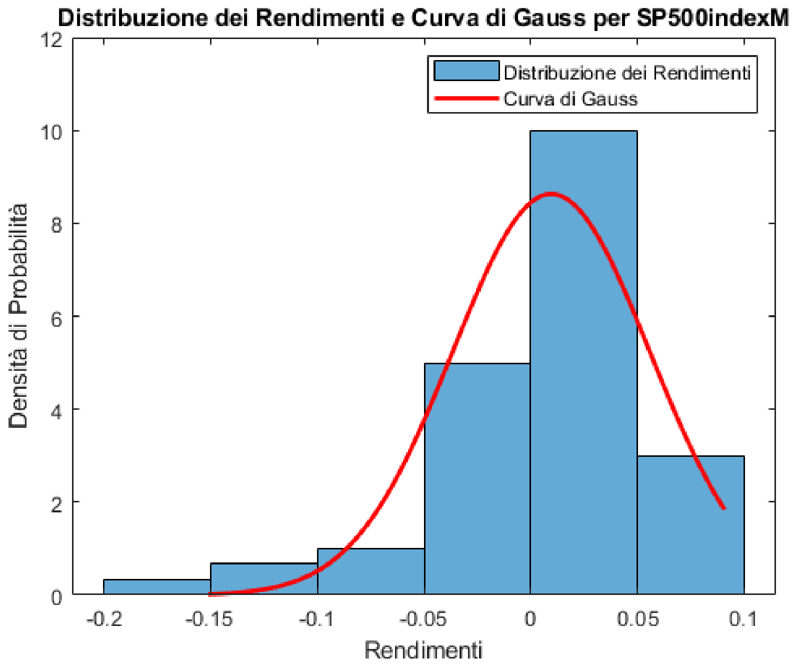
Nyse Min Risk, Max Ret (daily)

```
Rendimento del portafoglio: 0.0013316
Rendimento annualizzato: 0.39843
Rischio del portafoglio: 0.0196
Rischio annualizzato: 0.31114
Skewness del portafoglio: 1.0617
Curtosi del portafoglio: 12.3037
Beta del portafoglio: 0.64454
Rapporto di Sharpe: 0.065927
Rapporto di Sortino: 0.10673
Alpha di Jensen: 0.0010316
```

QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

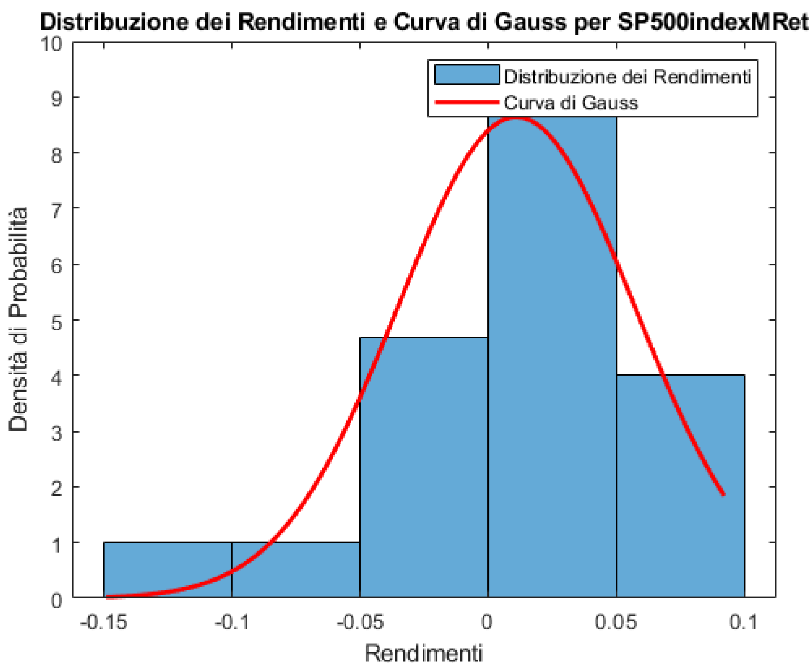
SP500 Price index Monthly

Media_Mensile	Varianza_Mensile	Deviazione_Standard_Mensile	Skewness_Mensile	Kurtosi_Mensile
0.0096524	0.0021367	0.046224	-1.2448	5.2441



SP500 Total Return Daily

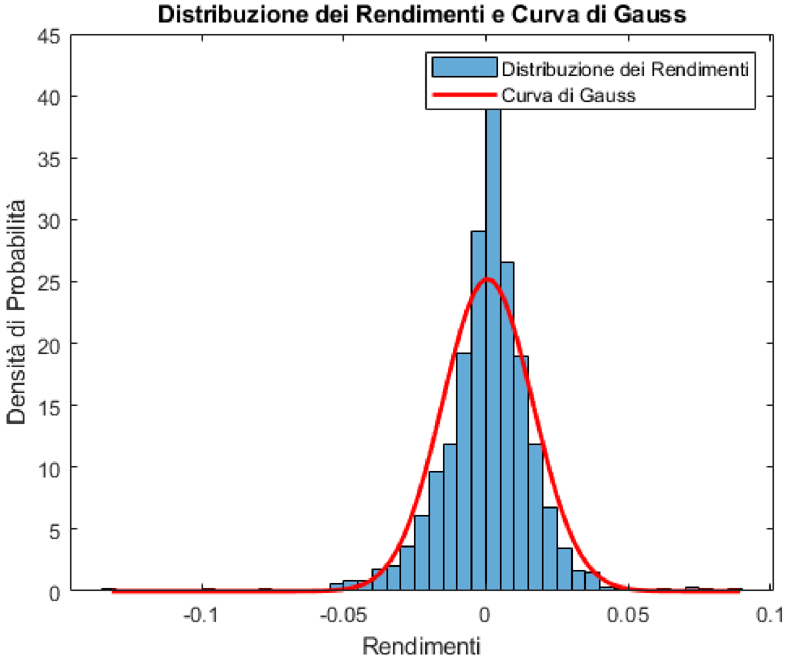
Media_Mensile	Varianza_Mensile	Deviazione_Standard_Mensile	Skewness_Mensile	Kurtosi_Mensile
0.010966	0.002131	0.046163	-1.2439	5.2452



QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

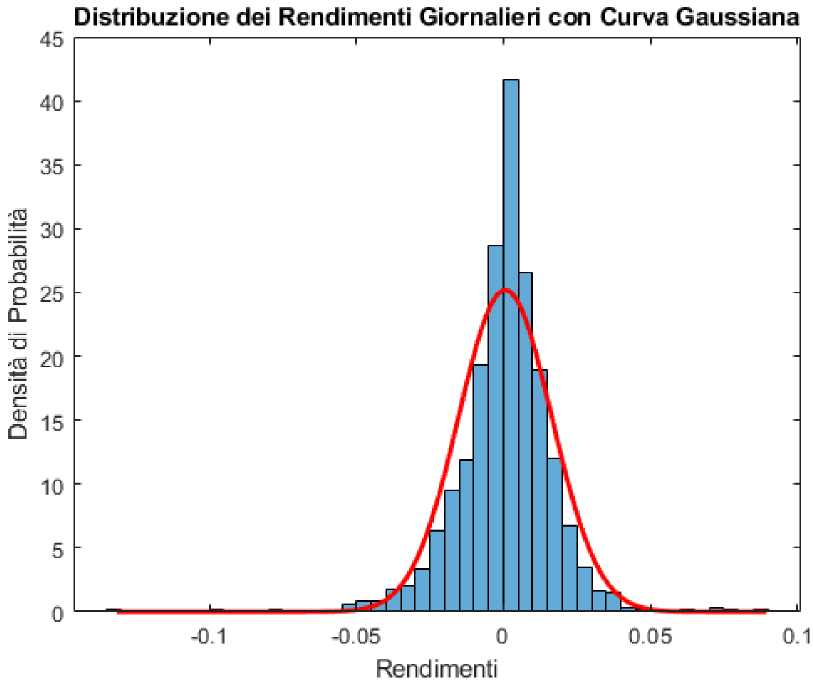
NASDAQ Composite Price index Daily

Media	Varianza	Deviazione_Standard	Skewness	Kurtosi
0.00058028	0.00025027	0.01582	-0.63124	10.171



NASDAQ Composite Total Return Daily

Frequency	Mean	Variance	StdDev	Skewness	Kurtosis
{'Daily'}	0.00061029	0.00025025	0.015819	-0.62955	10.162



QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

Nasdaq Composite vs Nasdaq Min Risk Max Ret portfolio daily (Portfolio 2)

Starting with the Nasdaq Composite, the daily average return is quite low at 0.00058, which means that, on average, the market isn't showing much growth day-to-day. The standard deviation is 0.01582, indicating moderate volatility. This tells us that, while the market doesn't swing as wildly as some other indices, there's still a fair amount of daily fluctuation.

So, it's not completely predictable, but the movements aren't extreme either. The skewness is negative at -0.63124, which suggests that the distribution of returns is slightly off balance, with a longer tail on the left. In other words, the Nasdaq is more likely to experience larger losses than gains, though these bigger losses don't occur that frequently. Lastly, the kurtosis is 10.171, meaning that extreme events—either big positive or negative swings—are less common but still pose a potential risk. Essentially, while the market doesn't have extreme daily moves often, when it does, they can be significant.

Now, turning to the Min Risk, Max Ret portfolio, the daily average return is 0.0010004, which is a bit higher than the Nasdaq's, suggesting that this portfolio has a slightly better daily return overall, but not by much. The standard deviation of 0.019731 is higher than the Nasdaq's, indicating that this portfolio is more volatile. This means that its returns are more unpredictable and likely to experience larger daily fluctuations. The skewness is positive at 0.1539, showing that the portfolio has a higher probability of generating larger positive returns compared to larger losses. However, like the Nasdaq, these big gains are still relatively rare.
The kurtosis is 6.423, lower than the Nasdaq's, meaning that while extreme events (good or bad) can still happen, they are less likely compared to the Nasdaq's higher kurtosis, which suggests a higher frequency of extreme movements.

NASDAQ Composite Total Return Daily

Frequency	Mean	Variance	StdDev	Skewness	Kurtosis
{'Daily'}	0.00061029	0.00025025	0.015819	-0.62955	10.162

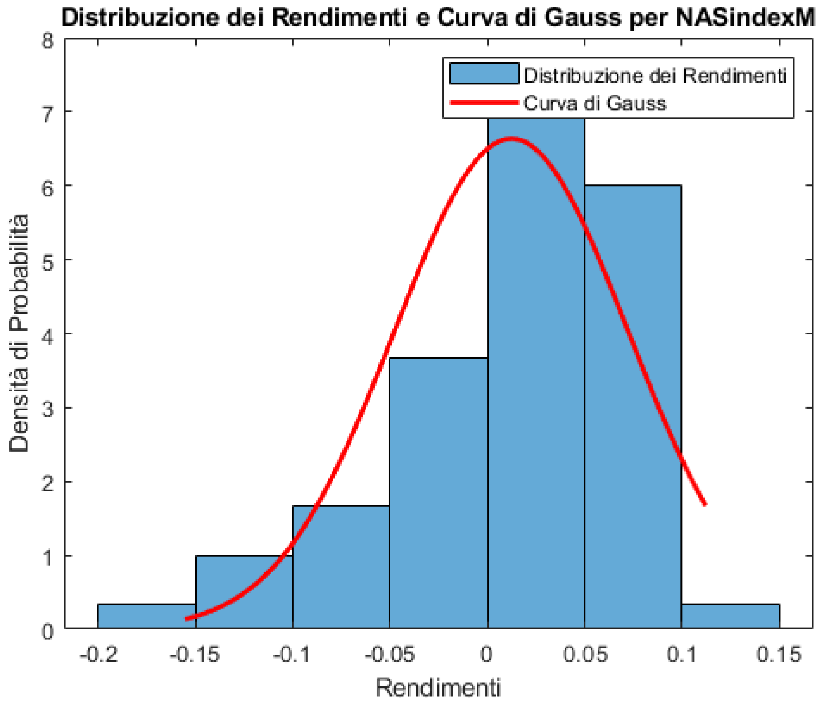
Nasdaq Min Risk, Max Ret (daily)

```
Rendimento del portafoglio: 0.0010004
Rendimento annualizzato: 0.28656
Rischio del portafoglio: 0.019731
Rischio annualizzato: 0.31322
Skewness del portafoglio: 0.1539
Curtosi del portafoglio: 6.423
Beta del portafoglio: 0.83561
Rapporto di Sharpe: 0.0487
Rapporto di Sortino: 0.072482
Alpha di Jensen: 0.00052262
```

QUESTION 15: COMPUTE ALL THE STATISTICS RELATIVE TO SP500 AND NASDAQ INDEX. DISCUSS THE DIFFERENCES BETWEEN SUCH STATISTICS FOR THE INDEXES AND THOSE YOU FOUND FOR BOTH YOUR PORTFOLIOS FOR NYSE AND NASDAQ SECURITIES.

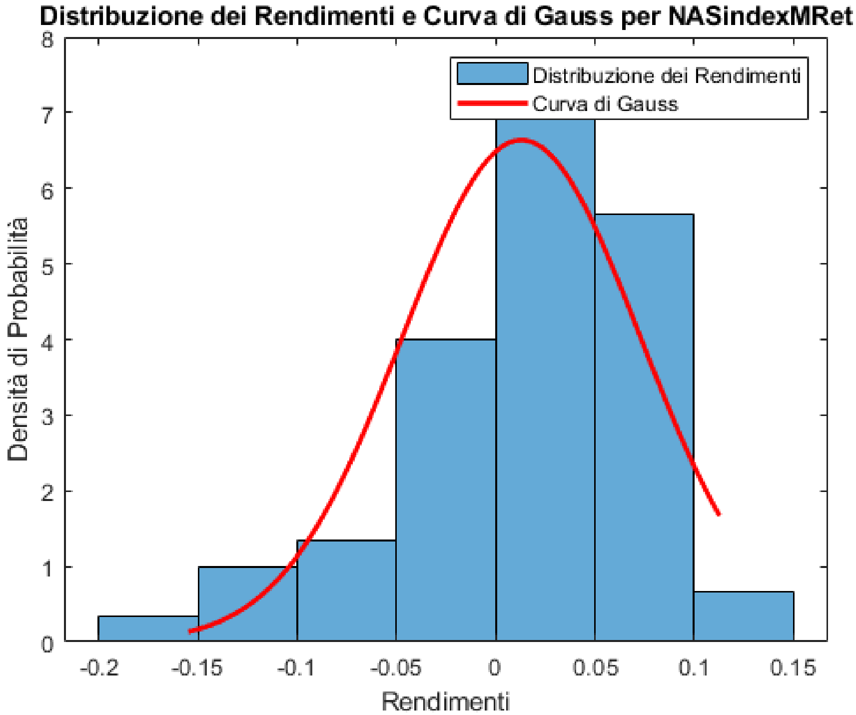
NASDAQ Composite Price index Monthly

Media_Mensile	Varianza_Mensile	Deviazione_Standard_Mensile	Skewness_Mensile	Kurtosi_Mensile
0.012267	0.003613	0.060109	-0.8842	3.5313



NASDAQ Composite Total Return Monthly

Media_Mensile	Varianza_Mensile	Deviazione_Standard_Mensile	Skewness_Mensile	Kurtosi_Mensile
0.012922	0.0036115	0.060096	-0.88477	3.5346



QUESTION 16 AND 17: COMPUTE BETA FOR EACH SECURITY INCLUDED IN YOUR PORTFOLIO NYSE AND NASDAQ AND THE BETA FOR YOUR NYSE AND NASDAQ PORTFOLIOS AS WELL.

(Min risk and Min risk-Max Ret and other portfolios betas were already computed in portfolio statistics)
The beta of a stock measures its volatility in relation to the overall market, helping to estimate its systematic risk. This concept is fundamental in portfolio theory and the Capital Asset Pricing Model (CAPM). A beta of 1 indicates that the stock moves in line with the market: if the market increases or decreases by 10%, the stock is expected to do the same. A beta greater than 1 suggests higher volatility compared to the market, meaning the stock amplifies market movements. For instance, with a beta of 1.5, a 10% market movement would correspond to a 15% change in the stock price. Conversely, a beta less than 1 implies lower volatility, where a stock with a beta of 0.8 would move by 8% for every 10% market fluctuation.
Beta has practical implications for assessing risk. It reflects the systematic risk that cannot be diversified away. In the CAPM framework, beta is used to calculate the expected return of a stock

Nyse Daily

```
Beta di ogni singolo asset:
ELI LILLY: 0.64508
BIOHAVEN: 0.50358
CALERES: 1.3362
WALMART: 0.46281
MAGNOLIA OIL GAS A: 1.2082
KROGER: 0.25555
FTI CONSULTING: 0.37106
NEW YORK TIMES 'A': 0.75927
TELEPHONE & DATA SYS.: 0.83509
MURPHY OIL: 1.4499
```

Nasdaq Daily

```
Beta di ogni singolo asset:
O REILLY AUTOMOTIVE: 0.53139
BAKER HUGHES A: 0.71309
STEEL DYNAMICS: 0.85395
ASPEN TECHNOLOGY: 0.71171
APPLOVIN A: 1.0271
UNITED AIRLINES HOLDINGS: 1.0691
MODERNA: 0.68219
COINBASE GLOBAL A: 1.2884
QUANTUM COMPUTING: 1.002
ROCKET LAB USA A: 0.89465
```

Nyse Monthly

```
Beta di ogni singolo asset:
CALERES: 1.4807
KROGER: 0.1834
MURPHY OIL: 1.7325
NEW YORK TIMES 'A': 0.97651
WALMART: 0.42529
TELEPHONE & DATA SYS.: 1.0344
FTI CONSULTING: -0.23715
MAGNOLIA OIL GAS A: 1.5152
BIOHAVEN: 1.7336
ELI LILLY: 0.42404
```

Nasdaq Monthly

```
Beta di ogni singolo asset:
O REILLY AUTOMOTIVE: 0.34154
BAKER HUGHES A: 0.48693
STEEL DYNAMICS: 0.55675
ASPEN TECHNOLOGY: 0.2685
APPLOVIN A: 1.9372
UNITED AIRLINES HOLDINGS: 0.84058
COINBASE GLOBAL A: 1.4597
MODERNA: 1.436
QUANTUM COMPUTING: 1.9924
ROCKET LAB USA A: 1.3294
```

QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

The Security Market Line (SML) is a graphical representation that illustrates the relationship between the expected return of an asset or portfolio and its systematic risk, which is the portion of risk driven by overall market movements and cannot be diversified away. It is a key component of the Capital Asset Pricing Model (CAPM), a framework that connects an investment's expected return to the risk taken.
The SML model is used to determine the expected return of an asset/portfolio with respect to their systematic risk (beta). The formula for the expected return for an asset, based on the CAPM is:

$$E(R_i) = R_f + \beta_i \cdot (E(R_m) - R_f)$$

Where:

- $E(R_i)$: the expected return of the asset;
- R_f: the risk-free rate;
- $E(R_m)$: the expected return of the market;
- β_i: the beta of the asset, measuring its sensitivity to market movements.

SML Script

```
  % Carica i dati dal file Excel
filePath = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheetNameAssets = 'NASselectedD';
sheetNameIndex = 'NASindexD';
dataAssets = readtable(filePath, 'Sheet', sheetNameAssets, 'VariableNamingRule', 'preserve');
dataIndex = readtable(filePath, 'Sheet', sheetNameIndex, 'VariableNamingRule', 'preserve');

% Estrai i nomi dei titoli
assetNames = dataAssets.Properties.VariableNames(2:end);

% Calcola i rendimenti giornalieri dei titoli
pricesAssets = dataAssets{:, 2:end}; % Supponendo che la prima colonna sia la data
returnsAssets = diff(pricesAssets) ./ pricesAssets(1:end-1, :);

% Calcola i rendimenti giornalieri dell'indice S&P 500
pricesIndex = dataIndex{:, 2}; % Supponendo che la prima colonna sia la data
returnsIndex = diff(pricesIndex) ./ pricesIndex(1:end-1);

% Allinea le date tra i rendimenti dei titoli e dell'indice
datesAssets = dataAssets{2:end, 1};
datesIndex = dataIndex{2:end, 1};
[commonDates, idxAssets, idxIndex] = intersect(datesAssets, datesIndex);
returnsAssets = returnsAssets(idxAssets, :);
returnsIndex = returnsIndex(idxIndex);

% Calcola le statistiche
meanReturns = mean(returnsAssets);
stdReturns = std(returnsAssets);

% Calcola i beta dei titoli tramite regressione
beta_assets = zeros(1, size(returnsAssets, 2));
for i = 1:size(returnsAssets, 2)
    mdl = fitlm(returnsIndex, returnsAssets(:, i));
    beta_assets(i) = mdl.Coefficients.Estimate(2);
end

% Calcola il tasso risk-free giornaliero
riskFreeRate = 0.02 / 252; % 2% annuo convertito in giornaliero

% Calcola la SML per ogni titolo
marketReturn = mean(returnsIndex);
marketRiskPremium = marketReturn - riskFreeRate;
smlValues = riskFreeRate + marketRiskPremium * beta_assets;

% Calcola il portafoglio di mercato
wtsMarket = mean(returnsAssets) / sum(mean(returnsAssets));
marketPortfolioReturn = sum(wtsMarket .* meanReturns);
marketPortfolioBeta = 1; % Il portafoglio di mercato ha un beta pari a 1

% Stampa i risultati e confronta i rendimenti attesi con i rendimenti effettivi
fprintf('Rendimento atteso dei titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, meanReturns(i));
end
fprintf('Beta dei titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, beta_assets(i));
end
fprintf('Valore della SML per i titoli:\n');
for i = 1:length(assetNames)
    fprintf('%s: %f\n', assetNames{i}, smlValues(i));
end
fprintf('Confronto tra rendimenti attesi e rendimenti effettivi:\n');
for i = 1:length(assetNames)
    fprintf('%s: Rendimento atteso = %f, Rendimento effettivo = %f\n', assetNames{i}, smlValues(i),
meanReturns(i));
end

% Traccia il piano media-varianza con tutti i titoli, la SML e il portafoglio di mercato
figure;
scatter(beta_assets, meanReturns, 'b', 'filled');
hold on;
for i = 1:length(assetNames)
    text(beta_assets(i), meanReturns(i), assetNames{i}, 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');
end
plot([0, max(beta_assets)], [riskFreeRate, max(smlValues)], '-r', 'LineWidth', 2);

% Aggiungi il portafoglio di mercato al grafico SML
market_beta = 1; % Il beta del portafoglio di mercato è 1
market_return = marketReturn; % Il rendimento del portafoglio di mercato è il rendimento medio del
mercato
scatter(market_beta, market_return, 100, 'g', '*'); % Evidenzia il portafoglio di mercato con una stella
verde
text(market_beta, market_return, 'Portafoglio di Mercato', 'VerticalAlignment', 'bottom',
'HorizontalAlignment', 'right');

xlabel('Beta');
ylabel('Rendimento Atteso');
title('Piano Media-Varianza con SML e Portafoglio di Mercato');
legend('Titoli', 'SML', 'Portafoglio di Mercato');
grid on;
xlim([0, max(beta_assets) * 1.1]); % Aggiungi un po' di spazio extra sull'asse x
ylim([min(meanReturns) * 0.9, max(meanReturns) * 1.1]); % Aggiungi un po' di spazio extra sull'asse y
```

Normality test script

```
  % Percorso del file Excel
filePath = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';

% Leggi i dati dal worksheet "nasdaq daily" preservando i nomi originali delle colonne
opts = detectImportOptions(filePath, 'Sheet', 'NYSEselectedM');
opts.VariableNamingRule = 'preserve';
data = readtable(filePath, opts);

% Estrai i nomi dei titoli e i prezzi dei titoli (assumendo che siano nella seconda colonna in poi)
stockNames = data.Properties.VariableNames(2:end);
prices = data{:, 2:end};

% Calcola i rendimenti giornalieri
returns = diff(log(prices));

% Esegui i test di normalità per ogni titolo
numStocks = size(returns, 2);
jb_h = zeros(1, numStocks);
jb_p = zeros(1, numStocks);
ad_h = zeros(1, numStocks);
ad_p = zeros(1, numStocks);
ks_h = zeros(1, numStocks);
ks_p = zeros(1, numStocks);

for i = 1:numStocks
    % Test di Jarque-Bera
    [jb_h(i), jb_p(i)] = jbtest(returns(:, i));

    % Test di Anderson-Darling
    [ad_h(i), ad_p(i)] = adtest(returns(:, i));

    % Test di Lilliefors (Kolmogorov-Smirnov)
    [ks_h(i), ks_p(i)] = lillietest(returns(:, i));
end

% Crea una tabella riassuntiva dei risultati
resultsTable = table(stockNames', jb_h', jb_p', ad_h', ad_p', ks_h', ks_p', ...
    'VariableNames', {'Titolo', 'JarqueBera_h', 'JarqueBera_p', 'AndersonDarling_h', 'AndersonDarling_p',
'Lilliefors_h', 'Lilliefors_p'});

% Crea una tabella riassuntiva della normalità
normalitySummary = cell(numStocks, 1);
for i = 1:numStocks
    if jb_h(i) == 0 && ad_h(i) == 0 && ks_h(i) == 0
        normalitySummary{i} = 'Sì';
    else
        normalitySummary{i} = 'No';
    end
end

summaryTable = table(stockNames', normalitySummary, 'VariableNames', {'Titolo', 'Normale'});

% Visualizza le tabelle
disp('Risultati dei test di normalità per ciascun titolo:');
disp(resultsTable);

disp('Tabella riassuntiva della normalità per ciascun titolo:');
disp(summaryTable);

% Commenta i risultati
for i = 1:numStocks
    disp(['Titolo ', stockNames{i}, ':']);
    if jb_h(i) == 0
        disp('  Jarque-Bera: Non possiamo rifiutare l''ipotesi nulla: i rendimenti seguono una
distribuzione normale.');
    else
        disp('  Jarque-Bera: Rifiutiamo l''ipotesi nulla: i rendimenti non seguono una distribuzione
normale.');
    end

    if ad_h(i) == 0
        disp('  Anderson-Darling: Non possiamo rifiutare l''ipotesi nulla: i rendimenti seguono una
distribuzione normale.');
    else
        disp('  Anderson-Darling: Rifiutiamo l''ipotesi nulla: i rendimenti non seguono una distribuzione
normale.');
    end

    if ks_h(i) == 0
        disp('  Lilliefors: Non possiamo rifiutare l''ipotesi nulla: i rendimenti seguono una
distribuzione normale.');
    else
        disp('  Lilliefors: Rifiutiamo l''ipotesi nulla: i rendimenti non seguono una distribuzione
normale.');
    end
end
```

QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

The normal distribution of returns is not a necessary assumption for the SML, but it is often implicit in the theoretical framework supporting the CAPM because it simplifies the calculation of risk and expected returns. However, various normality tests have shown that not all the securities exhibit a normal distribution of returns.

Nyse Monthly

Risultati dei test di normalità per ciascun titolo:

Titolo	JarqueBera_h	JarqueBera_p	AndersonDarling_h	AndersonDarling_p	Lilliefors_h	Lilliefors_p
{'CALERES' }	1	0.001	1	0.0024278	0	0.092343
{'KROGER' }	1	0.022143	0	0.20777	0	0.5
{'MURPHY OIL' }	1	0.001	1	0.015106	0	0.098404
{'NEW YORK TIMES 'A'' }	1	0.030765	0	0.32136	0	0.4518
{'WALMART' }	1	0.0030922	0	0.18662	0	0.19889
{'TELEPHONE & DATA SYS.'}	1	0.001	1	0.0005	1	0.001
{'FTI CONSULTING' }	0	0.5	0	0.80682	0	0.5
{'MAGNOLIA OIL GAS A' }	1	0.001	1	0.012418	0	0.064471
{'BIOHAVEN' }	1	0.001	1	0.0005	1	0.001
{'ELI LILLY' }	0	0.24604	0	0.36441	0	0.5

Tabella riassuntiva della normalità per ciascun titolo:

Titolo	Normale
{'CALERES' }	{'No'}
{'KROGER' }	{'No'}
{'MURPHY OIL' }	{'No'}
{'NEW YORK TIMES 'A'' }	{'No'}
{'WALMART' }	{'No'}
{'TELEPHONE & DATA SYS.'}	{'No'}
{'FTI CONSULTING' }	{'Si'}
{'MAGNOLIA OIL GAS A' }	{'No'}
{'BIOHAVEN' }	{'No'}
{'ELI LILLY' }	{'Si'}

Nasdaq Monthly

Risultati dei test di normalità per ciascun titolo:

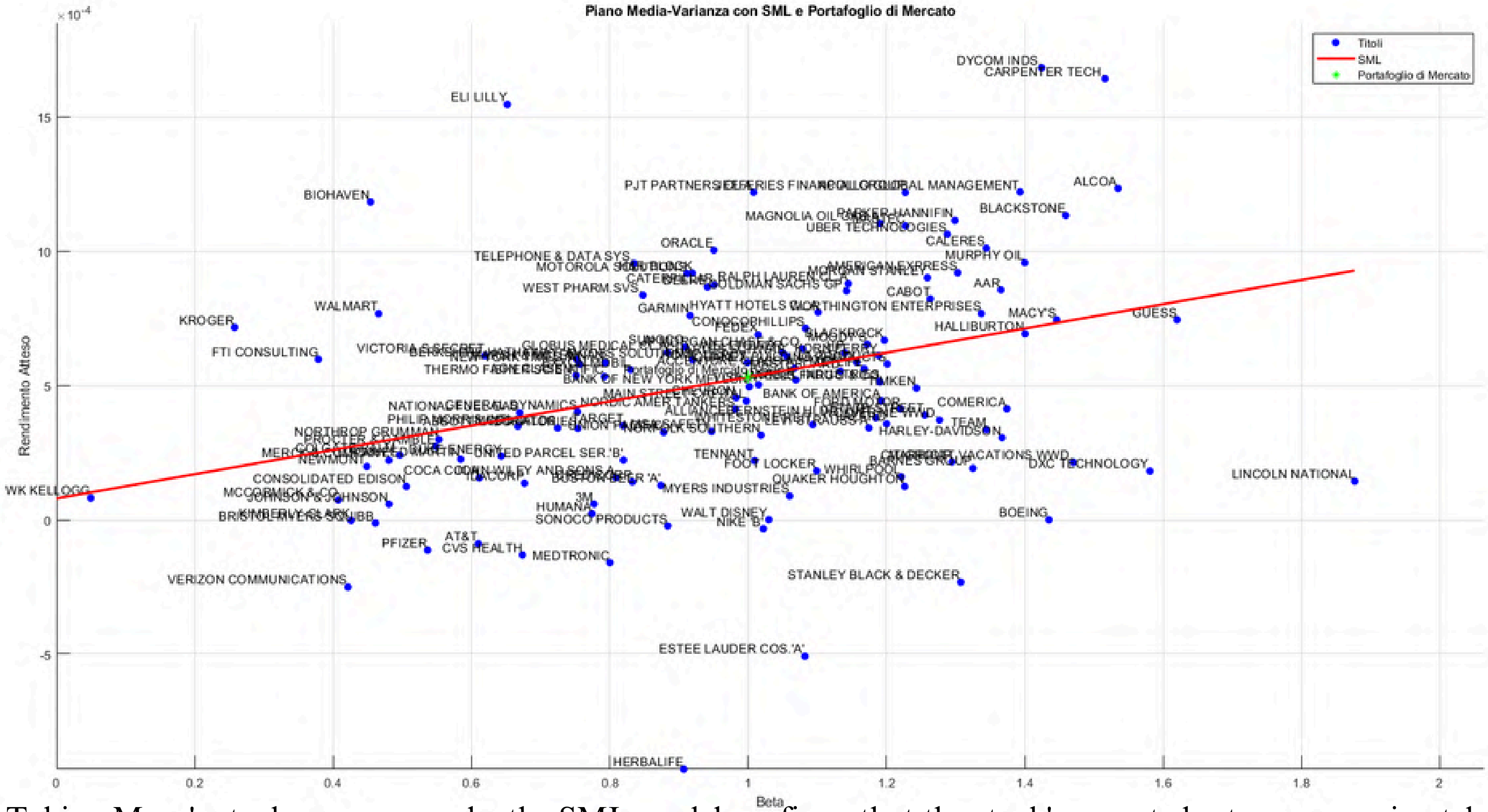
Titolo	JarqueBera_h	JarqueBera_p	AndersonDarling_h	AndersonDarling_p	Lilliefors_h	Lilliefors_p
{'O REILLY AUTOMOTIVE' }	0	0.087306	0	0.49118	0	0.5
{'BAKER HUGHES A' }	1	0.027271	0	0.21034	0	0.45401
{'STEEL DYNAMICS' }	0	0.5	0	0.57104	0	0.5
{'ASPEN TECHNOLOGY' }	1	0.0067934	1	0.033655	0	0.1491
{'APPLOVIN A' }	0	0.075173	1	0.0015766	1	0.001
{'UNITED AIRLINES HOLDINGS'}	1	0.039734	0	0.097662	0	0.22728
{'COINBASE GLOBAL A' }	1	0.0073834	1	0.0005	1	0.001
{'MODERNA' }	0	0.054812	0	0.17329	0	0.34828
{'QUANTUM COMPUTING' }	1	0.001	1	0.0005	1	0.001
{'ROCKET LAB USA A' }	1	0.031193	1	0.0069767	1	0.024121

Tabella riassuntiva della normalità per ciascun titolo:

Titolo	Normale
{'O REILLY AUTOMOTIVE' }	{'Si'}
{'BAKER HUGHES A' }	{'No'}
{'STEEL DYNAMICS' }	{'Si'}
{'ASPEN TECHNOLOGY' }	{'No'}
{'APPLOVIN A' }	{'No'}
{'UNITED AIRLINES HOLDINGS'}	{'No'}
{'COINBASE GLOBAL A' }	{'No'}
{'MODERNA' }	{'Si'}
{'QUANTUM COMPUTING' }	{'No'}
{'ROCKET LAB USA A' }	{'No'}

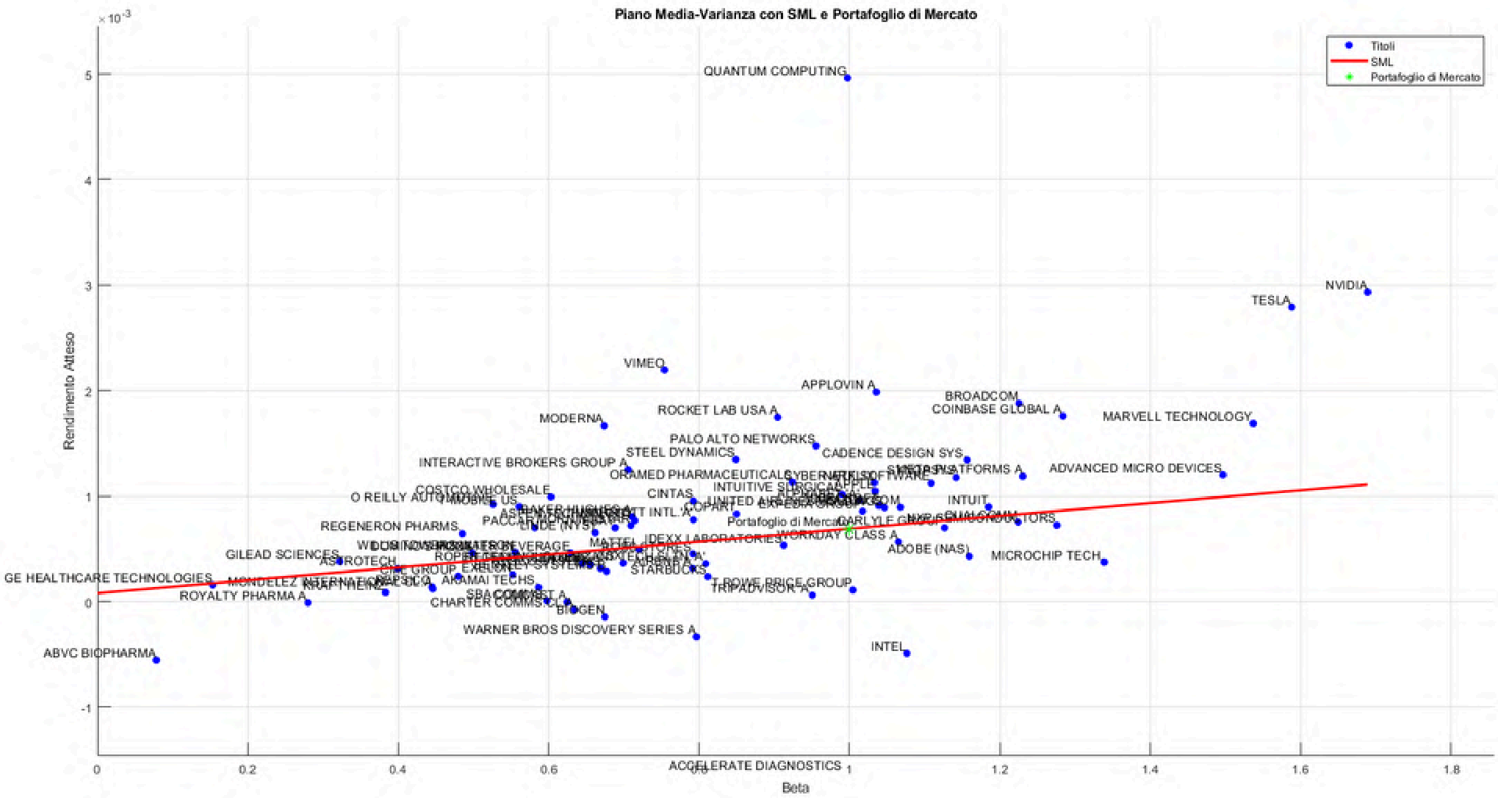
QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

Nyse Daily



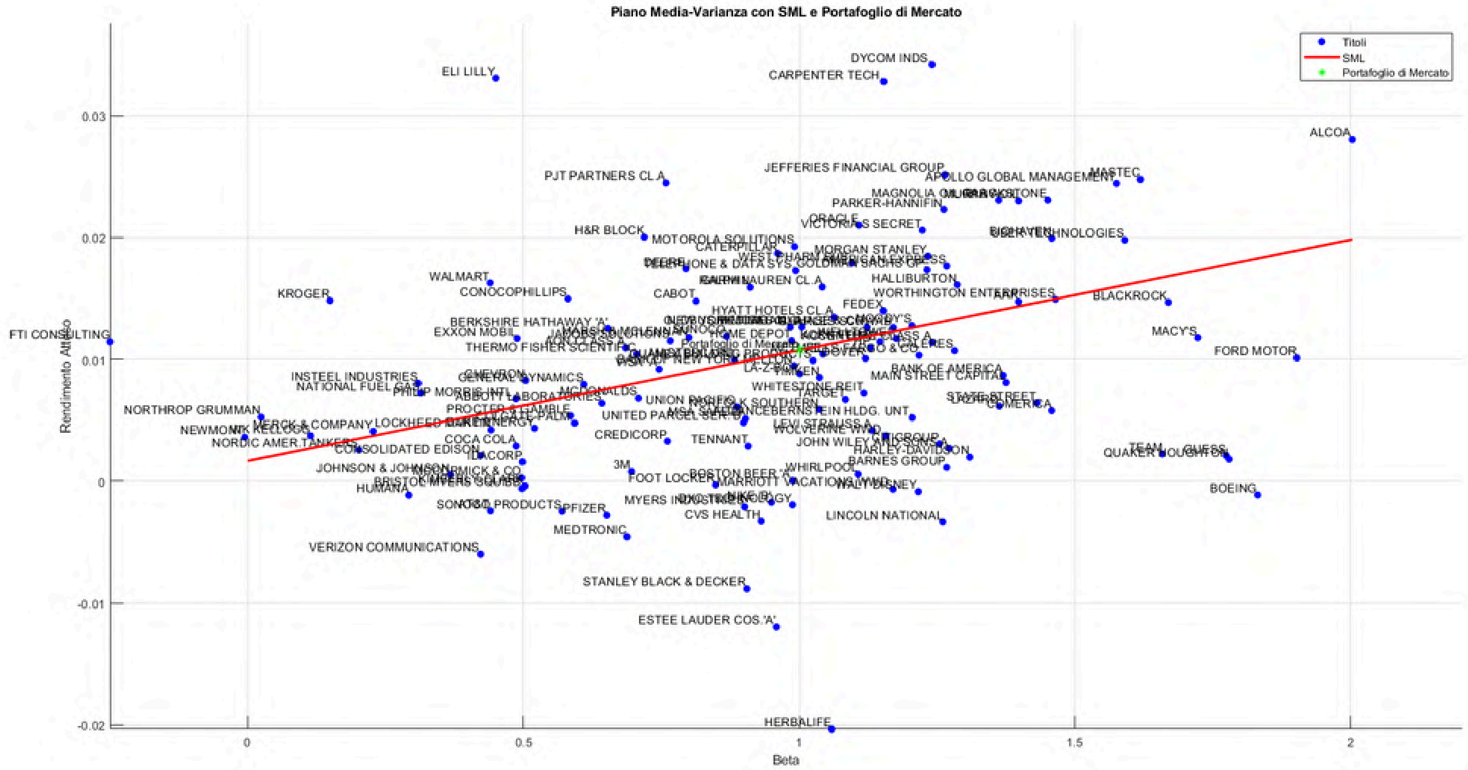
Taking Macy's stock as an example, the SML model confirms that the stock's expected return approximately matches its actual return. The market portfolio (which represents the market) lies on the SML and has a beta equal to 1. `MACY'S: Rendimento atteso = 0.000733, Rendimento effettivo = 0.000745`

Nasdaq Daily



QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

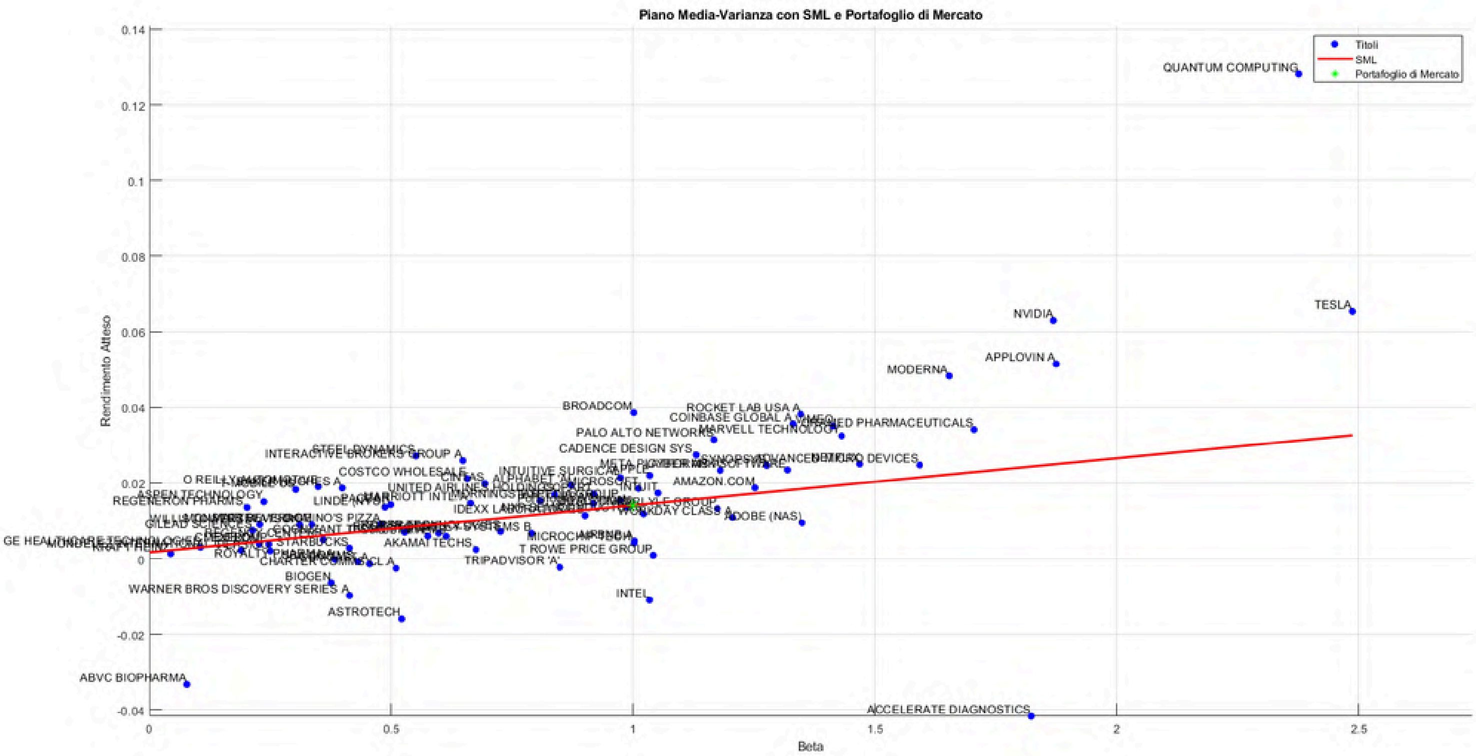
Nyse Monthly



We also verify that, according to the SML model, the HERBALIFE stock appears to be undervalued as it lies below the SML, while the ELI LILLY stock, which is positioned above the SML, appears to be overvalued.

```
HERBALIFE: Rendimento atteso = 0.011275, Rendimento effettivo = -0.020360
ELI LILLY: Rendimento atteso = 0.005747, Rendimento effettivo = 0.033089
```

Nasdaq Monthly



QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

For the selected securities, the model gives:

Nyse Daily

```
Confronto tra rendimenti attesi e rendimenti effettivi:
ELI LILLY: Rendimento atteso = 0.000374, Rendimento effettivo = 0.001547
BIOHAVEN: Rendimento atteso = 0.000285, Rendimento effettivo = 0.001184
CALERES: Rendimento atteso = 0.000687, Rendimento effettivo = 0.001011
WALMART: Rendimento atteso = 0.000290, Rendimento effettivo = 0.000768
MAGNOLIA OIL GAS A: Rendimento atteso = 0.000618, Rendimento effettivo = 0.001104
KROGER: Rendimento atteso = 0.000196, Rendimento effettivo = 0.000717
FTI CONSULTING: Rendimento atteso = 0.000251, Rendimento effettivo = 0.000597
NEW YORK TIMES 'A': Rendimento atteso = 0.000421, Rendimento effettivo = 0.000579
TELEPHONE & DATA SYS.: Rendimento atteso = 0.000457, Rendimento effettivo = 0.000954
MURPHY OIL: Rendimento atteso = 0.000712, Rendimento effettivo = 0.000958
```

Nasdaq Daily

```
Confronto tra rendimenti attesi e rendimenti effettivi:
O REILLY AUTOMOTIVE: Rendimento atteso = 0.000400, Rendimento effettivo = 0.000920
BAKER HUGHES A: Rendimento atteso = 0.000513, Rendimento effettivo = 0.000803
STEEL DYNAMICS: Rendimento atteso = 0.000597, Rendimento effettivo = 0.001347
ASPEN TECHNOLOGY: Rendimento atteso = 0.000515, Rendimento effettivo = 0.000768
APPLOVIN A: Rendimento atteso = 0.000711, Rendimento effettivo = 0.001986
UNITED AIRLINES HOLDINGS: Rendimento atteso = 0.000718, Rendimento effettivo = 0.000889
MODERNA: Rendimento atteso = 0.000490, Rendimento effettivo = 0.001664
COINBASE GLOBAL A: Rendimento atteso = 0.000862, Rendimento effettivo = 0.001757
QUANTUM COMPUTING: Rendimento atteso = 0.000687, Rendimento effettivo = 0.004963
ROCKET LAB USA A: Rendimento atteso = 0.000631, Rendimento effettivo = 0.001746
```

Nyse Monthly

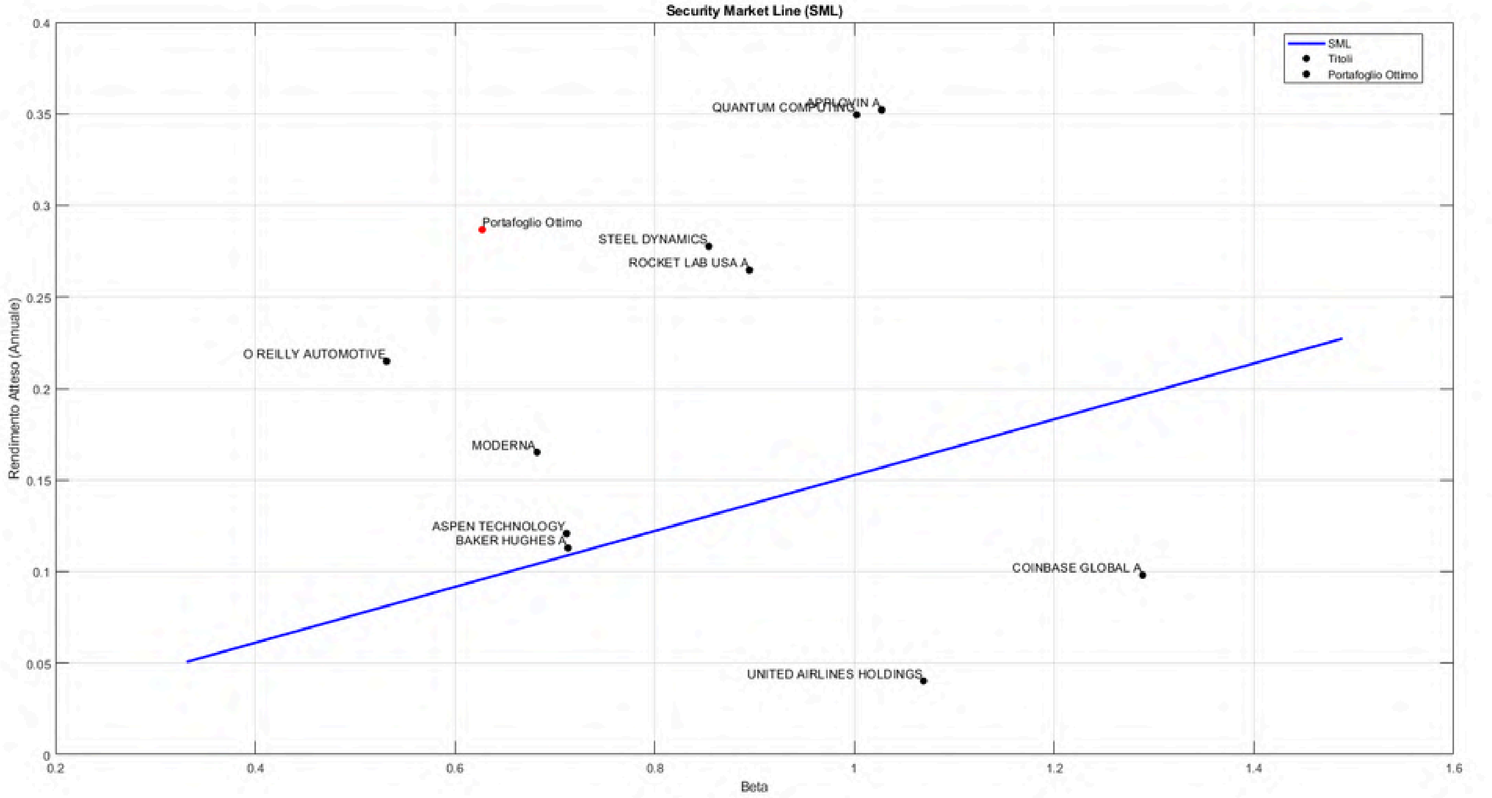
```
Confronto tra rendimenti attesi e rendimenti effettivi:
CALERES: Rendimento atteso = 0.013296, Rendimento effettivo = 0.010701
KROGER: Rendimento atteso = 0.003017, Rendimento effettivo = 0.014825
MURPHY OIL: Rendimento atteso = 0.014354, Rendimento effettivo = 0.023014
NEW YORK TIMES 'A': Rendimento atteso = 0.010592, Rendimento effettivo = 0.012636
WALMART: Rendimento atteso = 0.005654, Rendimento effettivo = 0.016269
TELEPHONE & DATA SYS.: Rendimento atteso = 0.010681, Rendimento effettivo = 0.017283
FTI CONSULTING: Rendimento atteso = -0.000597, Rendimento effettivo = 0.011431
MAGNOLIA OIL GAS A: Rendimento atteso = 0.014023, Rendimento effettivo = 0.023068
BIOHAVEN: Rendimento atteso = 0.014896, Rendimento effettivo = 0.019932
ELI LILLY: Rendimento atteso = 0.005747, Rendimento effettivo = 0.033089
```

Nasdaq Monthly

```
Confronto tra rendimenti attesi e rendimenti effettivi:
O REILLY AUTOMOTIVE: Rendimento atteso = 0.006018, Rendimento effettivo = 0.019028
BAKER HUGHES A: Rendimento atteso = 0.006629, Rendimento effettivo = 0.018661
STEEL DYNAMICS: Rendimento atteso = 0.008526, Rendimento effettivo = 0.027164
ASPEN TECHNOLOGY: Rendimento atteso = 0.004610, Rendimento effettivo = 0.015067
APPLOVIN A: Rendimento atteso = 0.025002, Rendimento effettivo = 0.051492
UNITED AIRLINES HOLDINGS: Rendimento atteso = 0.012092, Rendimento effettivo = 0.016917
COINBASE GLOBAL A: Rendimento atteso = 0.018228, Rendimento effettivo = 0.035661
MODERNA: Rendimento atteso = 0.022246, Rendimento effettivo = 0.048336
QUANTUM COMPUTING: Rendimento atteso = 0.031242, Rendimento effettivo = 0.128209
ROCKET LAB USA A: Rendimento atteso = 0.018427, Rendimento effettivo = 0.038181
```

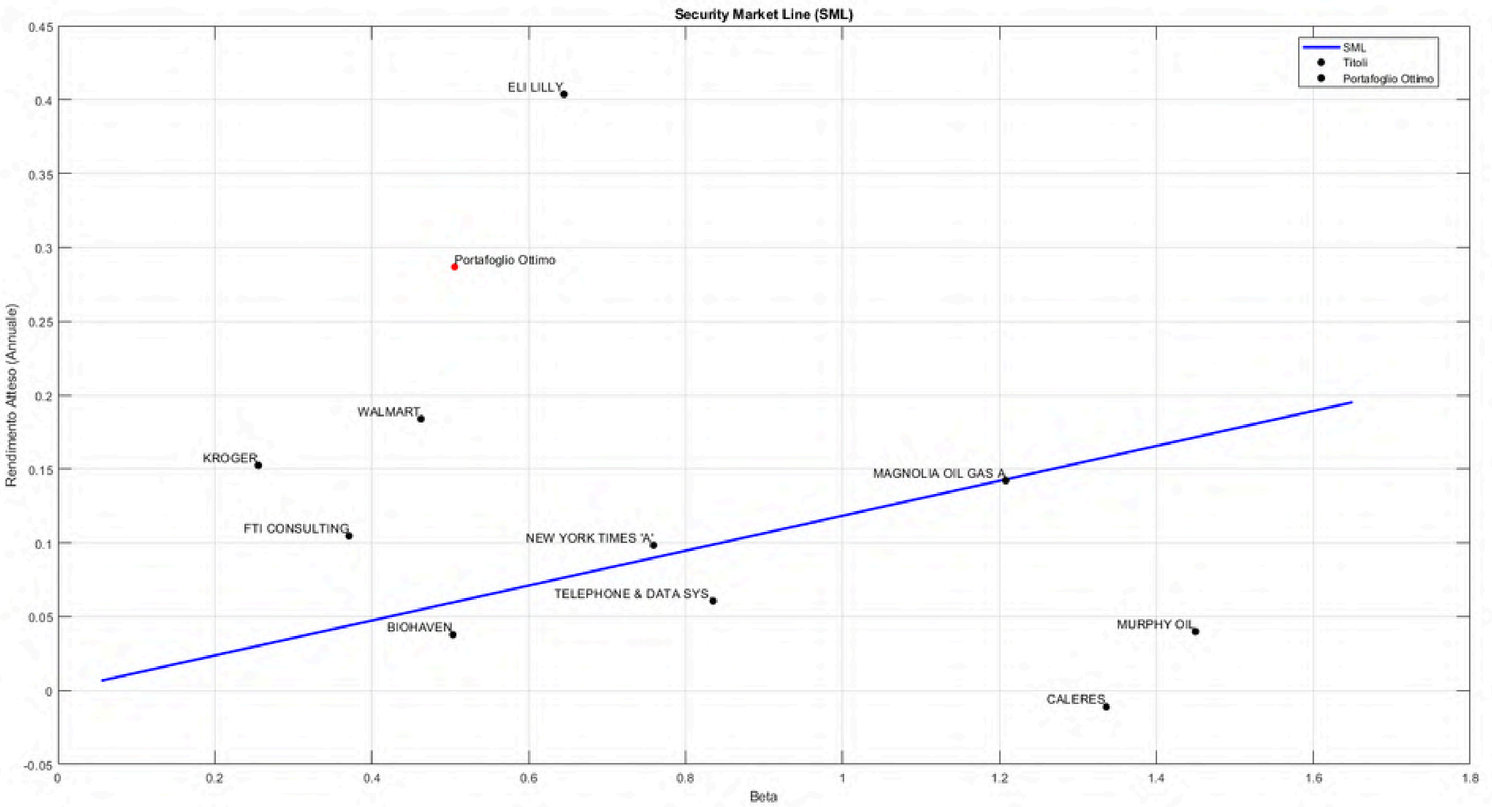
QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

Nasdaq Min risk Portfolio (Daily)



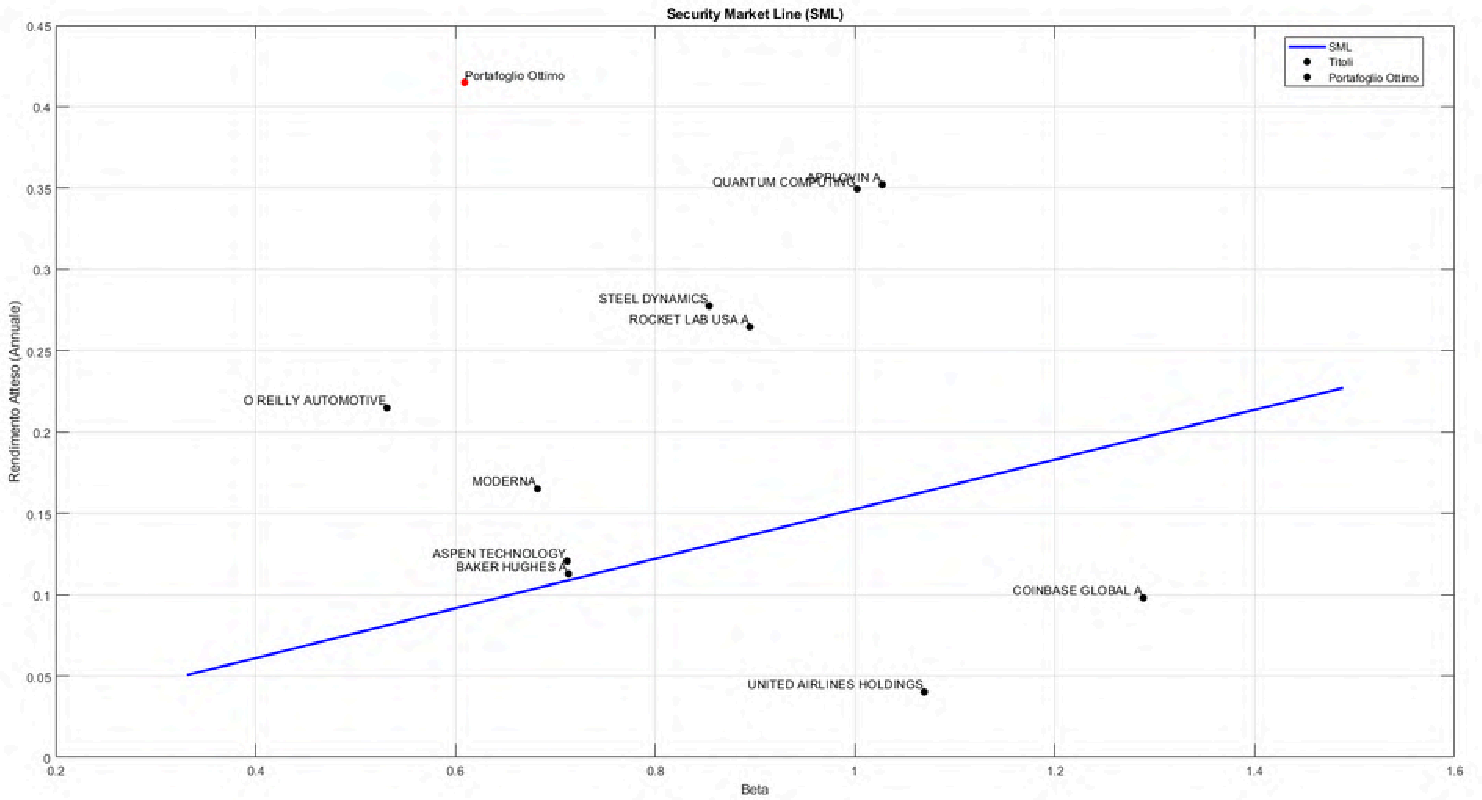
We can see that the portfolio Min Risk (both for daily and monthly frequency) is currently undervalued according to the model.

Nyse Min risk Portfolio (Daily)



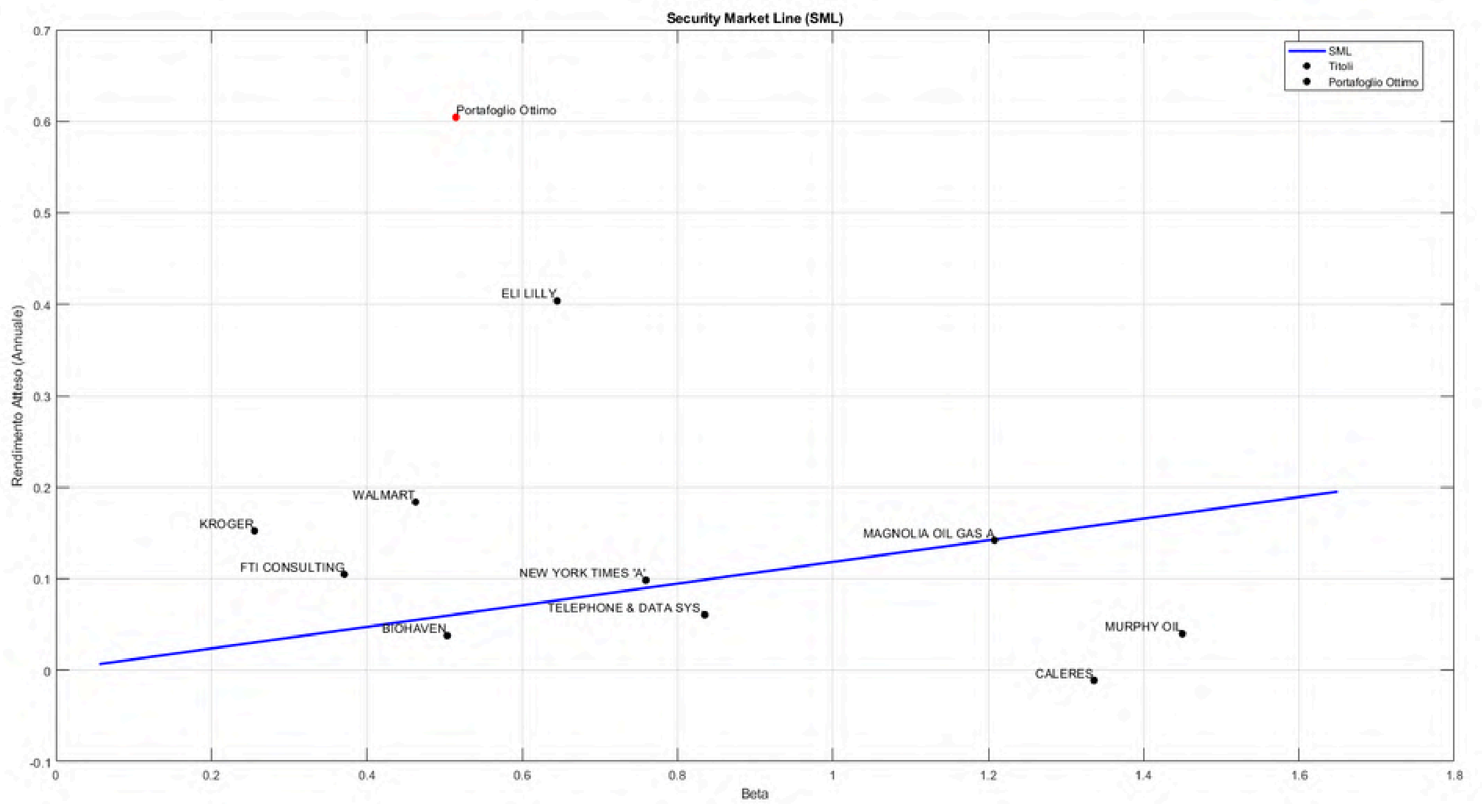
QUESTION 18 AND 19: GIVEN THE RETURN FOR A RISK-FREE SECURITY EQUAL TO 2 PER CENT, COMPUTE THE SECURITY MARKET LINE (SML)FOR TWO SECURITIES OF YOUR NYSE PORTFOLIO AND FOR YOUR PORTFOLIO AS WELL. VERIFY FOR THE TWO CHOSEN SECURITIES IF THE SML IS VERIFIED, FOR BOTH DAILY AND MONTHLY FREQUENCY

Nasdaq Min Risk Max Ret Portfolio (Daily)



We can see that the portfolio Min Risk, Max Ret (both for daily and monthly frequency) is currently undervalued according to the model.

Nyse Min Risk Max Ret Portfolio (Daily)



Assumptions and Views

Assume that the investment universe is composed of k assets and the vector of asset returns r is modeled as a random variable, following a multivariate normal distribution:

$$r \sim N(\mu, \Sigma),$$

where Σ is the covariance matrix from historical asset returns. The unknown model parameter is the expected return μ. From the perspective of Bayesian statistics, the Black-Litterman model attempts to estimate μ by combining the investment analyst views (or "observations of the future") and some prior knowledge about it.

We assume the prior knowledge that μ is a normally distributed random variable:

$$\mu \sim N(\pi, C),$$

where π represents the prior mean and C the uncertainty of the prior. In the absence of any views (observations), the prior mean π is likely to be the equilibrium returns implied from the market equilibrium portfolio. In practice, the assumption portfolio is not necessarily the market equilibrium portfolio but can be a target optimal portfolio, such as a portfolio benchmark, an index, or even the current client portfolio.

The Black-Litterman model assumes the structure of C is $\tau\Sigma$, where τ is a small constant. Detailed discussions about τ can be found in the literature.

Views and Observations

Observations are necessary to perform a statistical inference on μ. In the Black-Litterman model, the observations are views about future asset returns, expressed at the portfolio level. A view represents the expected return of a portfolio composed with certainty, but uncertainty in the view is added.

For a view i, let p_i be a row vector of dimension $1 \times k$ and q_i be a scalar. The relationship is modeled as:

$$q_i = E[p_i \cdot r] + \epsilon_i, \quad i = 1, 2, \ldots, v,$$

where ϵ_i represents the uncertainty of the view. Stacking the v views vertically gives:

$$q = E[P \cdot r] + \epsilon, \quad \epsilon \sim N(0, \Omega),$$

where P is a matrix of dimension $v \times k$ containing the weights of the views, Ω is the covariance matrix of the uncertainties, and $\Omega = \text{diag}(\omega_1, \omega_2, \ldots, \omega_v)$. Note that Ω does not necessarily have to be diagonal, and its structure can reflect the analyst's uncertainty about the views.

Under the assumption that $r \sim N(\mu, \Sigma)$, it follows that:

$$q = P \cdot \mu + \epsilon, \quad \epsilon \sim N(0, \Omega).$$

Bayesian Definition of the Black-Litterman Model

From Bayesian statistics, we know that:

$$f(\mu \mid q) \propto f(q \mid \mu) \cdot f(\mu),$$

for each term defined as:

The Likelihood

$$f(q \mid \mu) \propto \exp\left(-\frac{1}{2}(P\mu - q)^T \Omega^{-1} (P\mu - q)\right)$$

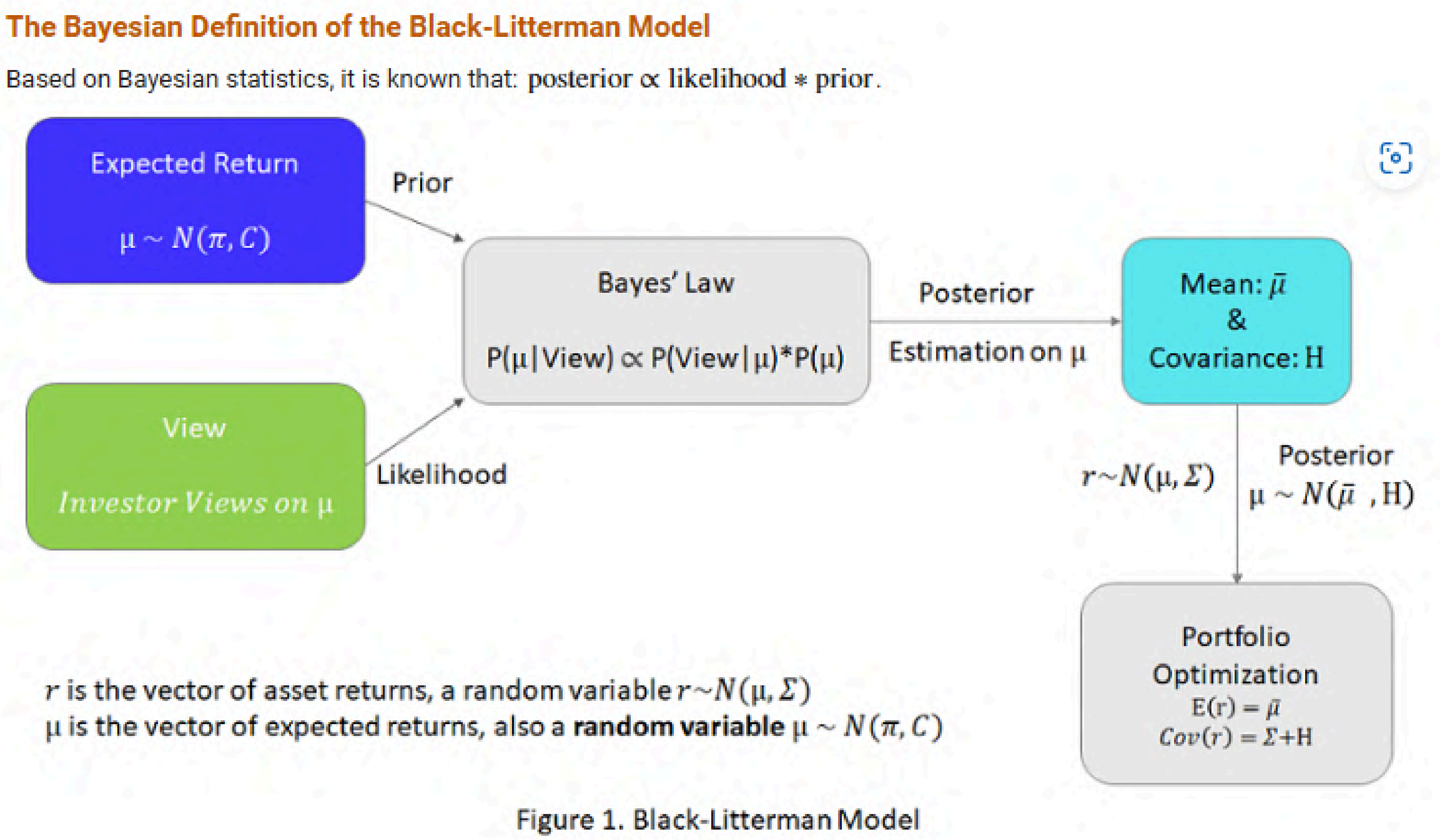
The Prior

$$f(\mu) \propto \exp\left(-\frac{1}{2}(\mu - \pi)^T C^{-1} (\mu - \pi)\right)$$

The Posterior

$$f(\mu \mid q) \propto \exp\left(-\frac{1}{2}(P\mu - q)^T \Omega^{-1} (P\mu - q) - \frac{1}{2}(\mu - \pi)^T C^{-1} (\mu - \pi)\right)$$

MathWorks. "Black-Litterman Portfolio Optimization Using Financial Toolbox". https://it.mathworks.com/help/finance/black-litterman-portfolio-optimization.html. Reported in Latex



MathWorks. . The Bayesian Definition of the Black-Litterman Model. Fonte. https://it.mathworks.com/help/finance/black-litterman-portfolio-optimization.html

Posterior Mean and Covariance

As previously stated, the posterior distribution of $\boldsymbol{\mu}$ is also normal. By completing the squares, the posterior mean and covariance are:

$$\boldsymbol{\mu} = \left[\mathbf{P}^T\boldsymbol{\Omega}^{-1}\mathbf{P} + \mathbf{C}^{-1}\right]^{-1}\left[\mathbf{P}^T\boldsymbol{\Omega}^{-1}\mathbf{q} + \mathbf{C}^{-1}\boldsymbol{\pi}\right],$$

$$\mathrm{cov}(\boldsymbol{\mu}) = \left[\mathbf{P}^T\boldsymbol{\Omega}^{-1}\mathbf{P} + \mathbf{C}^{-1}\right]^{-1}.$$

Finally, by combining the Bayesian posterior distribution of $\boldsymbol{\mu}$ with the model of asset returns $\boldsymbol{r} \sim N(\boldsymbol{\mu}, \boldsymbol{\Sigma})$, the posterior prediction of asset returns is:

$$\boldsymbol{r} \sim N(\boldsymbol{\mu}, \boldsymbol{\Sigma} + \mathrm{cov}(\boldsymbol{\mu})).$$

MathWorks. “Black-Litterman Portfolio Optimization Using Financial Toolbox”. https://it.mathworks.com/help/finance/black-litterman-portfolio-optimization.html. Reported in Latex

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Presented below is the code used to answer this question about the Nasdaq.

```matlab
% Leggi il file Excel
T = readtable('NASBLSELECTEDDaily.xlsx', 'VariableNamingRule', 'preserve');

% Definisci i nomi degli asset e del benchmark
assetNames = ["O REILLY AUTOMOTIVE", "BAKER HUGHES A", "STEEL DYNAMICS", "ASPEN TECHNOLOGY", "APPLOVIN
A", "UNITED AIRLINES HOLDINGS", "MODERNA", "COINBASE GLOBAL A", "QUANTUM COMPUTING", "ROCKET LAB USA A"];
benchmarkName = "NASDAQ COMPOSITE PRICE INDEX";

% Visualizza i nomi delle colonne
disp(T.Properties.VariableNames);

% Trova il nome corretto della colonna per il benchmark
sp500Index = find(contains(T.Properties.VariableNames, 'NASDAQ'), 1);
if ~isempty(sp500Index)
    benchmarkName = T.Properties.VariableNames{sp500Index};
else
    error('Nessuna colonna trovata con "NASDAQ" nel nome.');
end

% Visualizza tutte le righe della tabella
disp(T(:, ["Date", benchmarkName, assetNames]));

% Calcola i rendimenti
retnsT = tick2ret(T(:, 2:end));
assetRetns = retnsT(:, assetNames);
benchRetn = retnsT(:, benchmarkName);
numAssets = size(assetRetns, 2);

% Definisci le viste
v = 4;  % totale 4 viste
P = zeros(v, numAssets);
q = zeros(v, 1);
Omega = zeros(v);

% Vista 1
P(1, assetNames=="UNITED AIRLINES HOLDINGS") = 1;
q(1) = 0.30;
Omega(1, 1) = 1e-4;

% Vista 2
P(2, assetNames=="BAKER HUGHES A") = 1;
q(2) = 0.25;
Omega(2, 2) = 1e-3;

% Vista 3
P(3, assetNames=="O REILLY AUTOMOTIVE") = 1;
P(3, assetNames=="UNITED AIRLINES HOLDINGS") = -1;
q(3) = 0.065;
Omega(3, 3) = 1e-6;

% Vista 4
P(4, assetNames=="STEEL DYNAMICS") = 1;
P(4, assetNames=="UNITED AIRLINES HOLDINGS") = -1;
q(4) = 0.063;
Omega(4, 4) = 1e-6;

% Converti le viste da rendimenti annuali a rendimenti giornalieri
bizyear2bizday = 1/252;
q = q * bizyear2bizday;
Omega = Omega * bizyear2bizday;

% Crea la tabella delle viste
viewTable = array2table([P q diag(Omega)], 'VariableNames', [assetNames "View_Return"
"View_Uncertainty"]);
disp(viewTable);

% Stima la covarianza dai rendimenti storici degli asset
Sigma = cov(assetRetns.Variables);

% Definisci l'incertezza C
tau = 1/size(assetRetns.Variables, 1);
C = tau * Sigma;
disp(C);
```

```matlab
% Trova il portafoglio di mercato e i rendimenti impliciti
[wtsMarket, PI] = findMarketPortfolioAndImpliedReturn(assetRetns.Variables, benchRetn.Variables);

% Calcola il rendimento medio stimato e la covarianza utilizzando il modello Black-Litterman
mu_bl = (P'*(Omega\P) + inv(C)) \ ( C\PI + P'*(Omega\q));
cov_mu = inv(P'*(Omega\P) + inv(C));

% Ottimizzazione del portafoglio
port = Portfolio('NumAssets', numAssets, 'lb', 0, 'budget', 1, 'Name', 'Mean Variance');
port = setAssetMoments(port, mean(assetRetns.Variables), Sigma);
wts = estimateMaxSharpeRatio(port);

portBL = Portfolio('NumAssets', numAssets, 'lb', 0, 'budget', 1, 'Name', 'Mean Variance with Black-
Litterman');
portBL = setAssetMoments(portBL, mu_bl, Sigma + cov_mu);
wtsBL = estimateMaxSharpeRatio(portBL);

disp('Pesi del portafoglio Black-Litterman:');
for i = 1:length(wtsBL)
    disp([assetNames{i}, ': ', num2str(wtsBL(i))]);
end

% Calcola le statistiche del portafoglio media-varianza
meanMV = mean(assetRetns.Variables * wts);
stdMV = std(assetRetns.Variables * wts);
skewMV = skewness(assetRetns.Variables * wts);
kurtMV = kurtosis(assetRetns.Variables * wts);

% Calcola le statistiche del portafoglio Black-Litterman
meanBL = mean(assetRetns.Variables * wtsBL);
stdBL = std(assetRetns.Variables * wtsBL);
skewBL = skewness(assetRetns.Variables * wtsBL);
kurtBL = kurtosis(assetRetns.Variables * wtsBL);

% Calcola il tasso risk-free giornaliero
risk_free_rate_daily = (1 + 0.02)^(1/252) - 1;

% Calcola lo Sharpe ratio del portafoglio Black-Litterman
sharpe_ratio_BL = (meanBL - risk_free_rate_daily) / stdBL;

% Stampa le statistiche a schermo
fprintf('Statistiche del Portafoglio Media-Varianza:\n');
fprintf('Media: %f\n', meanMV);
fprintf('Deviazione Standard: %f\n', stdMV);
fprintf('Skewness: %f\n', skewMV);
fprintf('Curtosi: %f\n', kurtMV);

fprintf('\nStatistiche del Portafoglio Black-Litterman:\n');
fprintf('Media: %f\n', meanBL);
fprintf('Deviazione Standard: %f\n', stdBL);
fprintf('Skewness: %f\n', skewBL);
fprintf('Curtosi: %f\n', kurtBL);
fprintf('Sharpe Ratio: %f\n', sharpe_ratio_BL);

% Visualizza la matrice di covarianza utilizzando l'approccio Black-Litterman
figure;
imagesc(cov_mu);
colorbar;
title('Covarianza dei Rendimenti Stimati con Black-Litterman');
xlabel('Asset');
ylabel('Asset');
set(gca, 'XTick', 1:numAssets, 'XTickLabel', assetNames, 'YTick', 1:numAssets, 'YTickLabel', assetNames);

% Funzione locale per trovare il portafoglio di mercato e i rendimenti impliciti
function [wtsMarket, PI] = findMarketPortfolioAndImpliedReturn(assetRetn, benchRetn)
    % Trova la matrice di covarianza
    Sigma = cov(assetRetn);

    % Trova il portafoglio di mercato
    numAssets = size(assetRetn, 2);
    LB = zeros(1, numAssets);
    Aeq = ones(1, numAssets);
    Beq = 1;
    opts = optimoptions('lsqlin', 'Algorithm', 'interior-point', 'Display', 'off');
    wtsMarket = lsqlin(assetRetn, benchRetn, [], [], Aeq, Beq, LB, [], [], opts);

    % Trova delta
    shpr = mean(benchRetn) / std(benchRetn);
    delta = shpr / sqrt(wtsMarket' * Sigma * wtsMarket);

    % Calcola i rendimenti impliciti
    PI = delta * Sigma * wtsMarket;
end
```

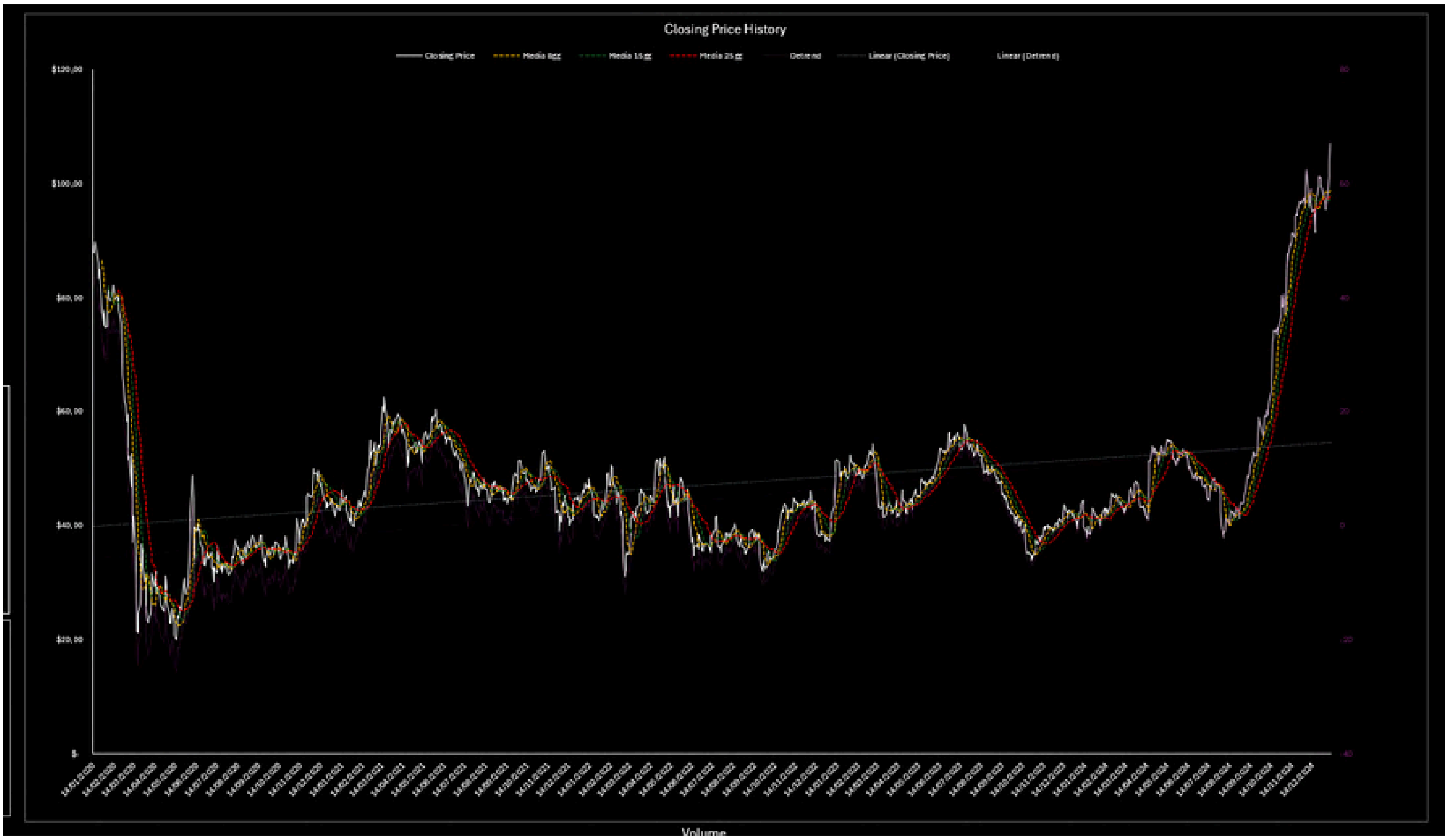
QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nasdaq stocks: United Airlines Holdings

In order to analyze individual stocks and define the views, we have built an analysis model in Excel. (See resources)

```
% Vista 1
P(1, assetNames=="UNITED AIRLINES HOLDINGS") = 1;
q(1) = 0.30;
Omega(1, 1) = 1e-4;
```

The first line indicates that the first view is specifically about "UNITED AIRLINES HOLDINGS".
The matrix P assigns a weight of 1 to this asset in the view.
The vector q represents the expected returns of the views. Here, it indicates an expected return of 30% for "UNITED AIRLINES HOLDINGS".
The matrix Omega represents the uncertainty associated with the views. A value of 1e-4 indicates very low uncertainty, meaning high confidence in the expected return of 30%.



QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

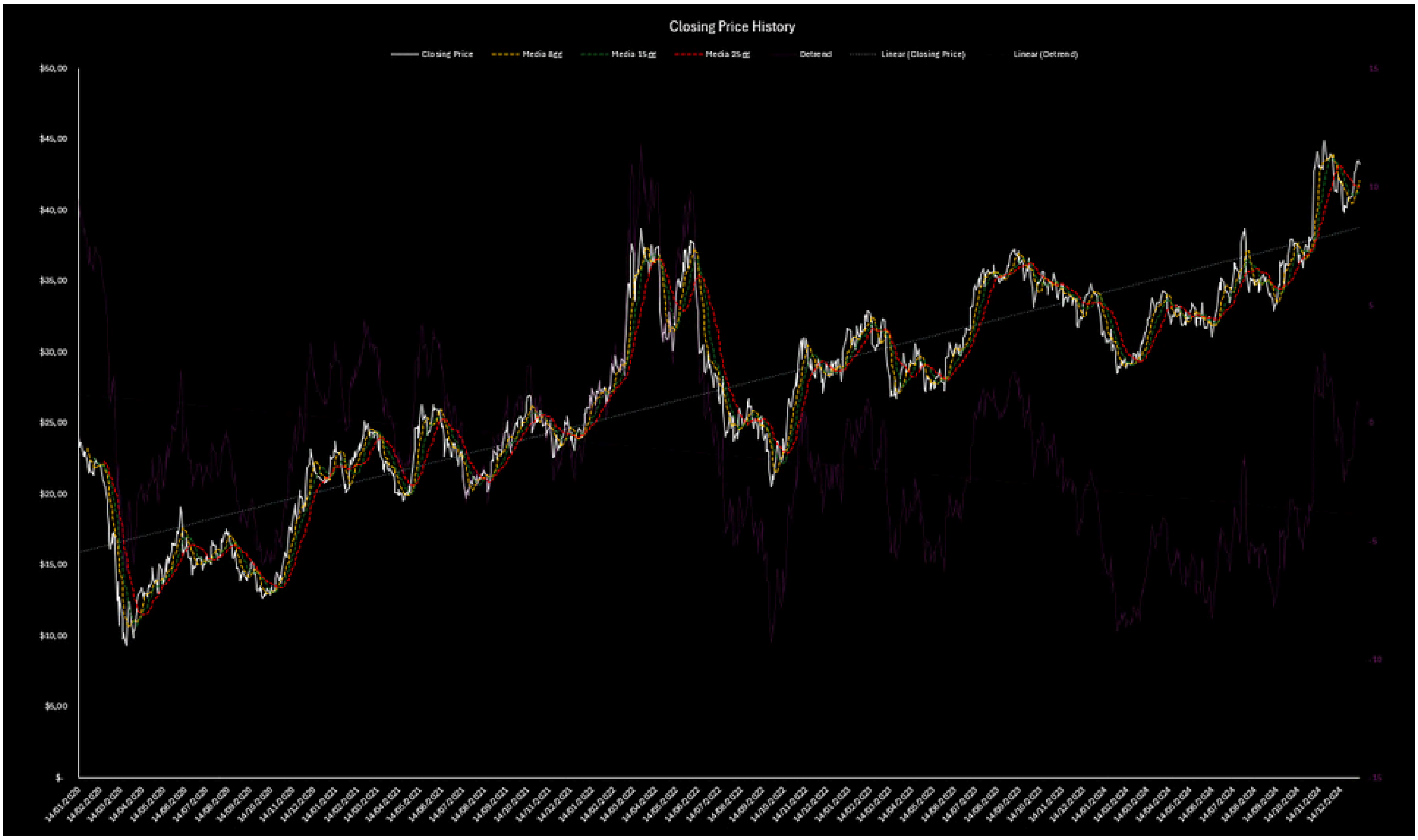
The charts show that the price of the historical series has had a generally positive trend over the past 5 years, while the rolling volatility has stabilized on average, particularly in the recent period. This suggests that the asset's returns are less volatile and that the stock is likely to maintain its average return in the coming year. For this reason, we have incorporated a view with a low degree of uncertainty.

Start Date	14/01/2020
End Date	10/01/2025
Symbol	NES HOLDINGS, INC. (XNAS:UAL)
Ticker	UAL
Beta	1,4369
Market CAP	$ 34.630.632.270
Price per Share	$ 105,30
Currency	USD
Mean (Y)	26%
Variance (Y)	38%
Stdev (Y)	62%

Our views on Nasdaq stocks: United Airlines Holdings

```
% Vista 2
P(2, assetNames=="BAKER HUGHES A") = 1;
q(2) = 0.25;
Omega(2, 2) = 1e-3;
```

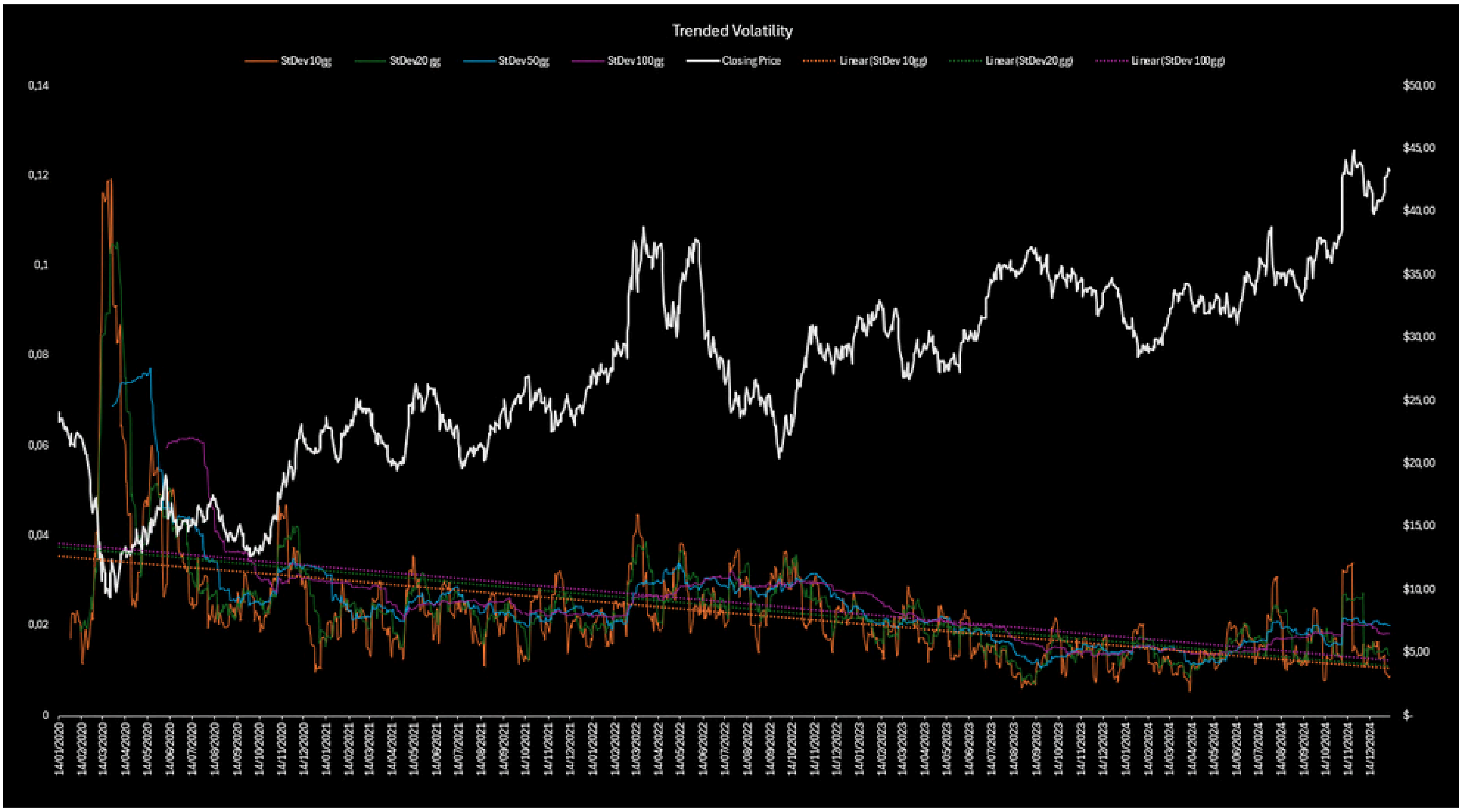
The view represents a specific opinion on Baker Hughes indicating an expected return of 25% with a high degree of confidence, given the low associated uncertainty.



QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

The same considerations as before apply to the BAKER HUGHES stock as well.

Start Date	14/01/2020
End Date	10/01/2025
Symbol	Baker Hughes (XNAS:BKR)
Ticker	BKR
Beta	1,377
Market CAP	$ 45.092.690.706
Price per Share	$ 45,57
Currency	USD
Mean (Y)	24%
Variance (Y)	20%
Stdev (Y)	44%

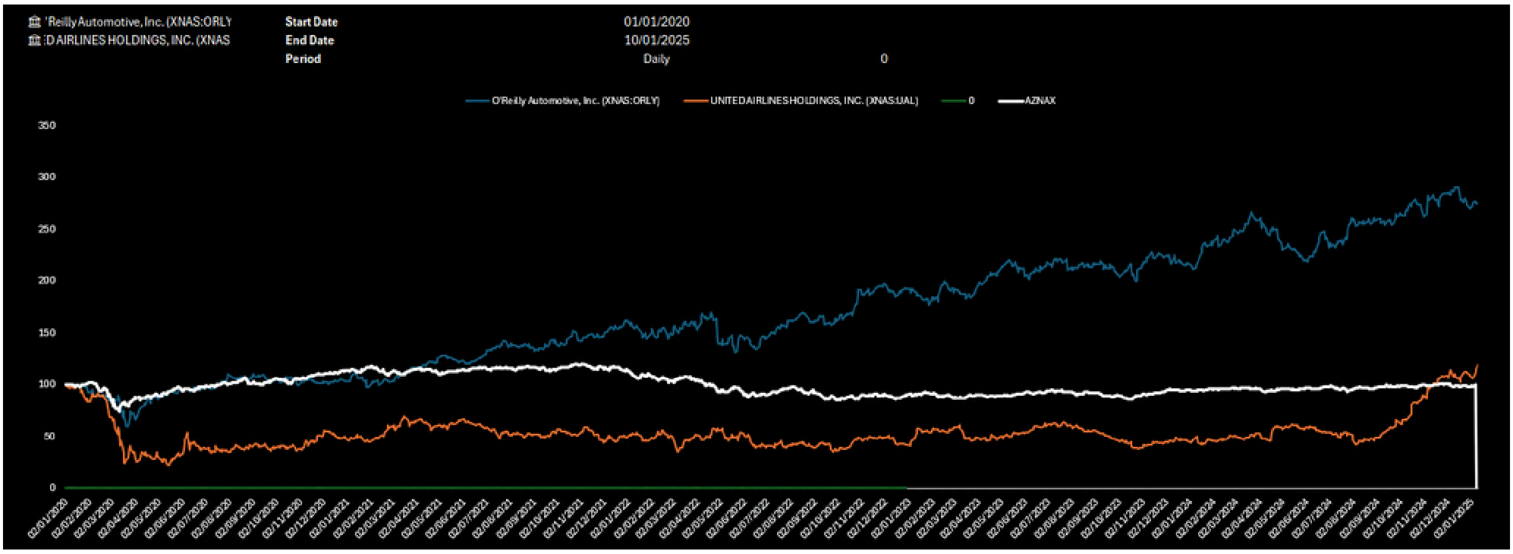


QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nasdaq stocks: O Reilly Automotive VS United Airlines Holdings

```
% Vista 3
P(3, assetNames=="O REILLY AUTOMOTIVE") = 1;
P(3, assetNames=="UNITED AIRLINES HOLDINGS") = -1;
q(3) = 0.065;
Omega(3, 3) = 1e-6;
```

The view represents a specific opinion on two assets: O Reilly Automotive and United Airlines Holdings It indicates an expected return of 6.5% for O Reilly Automotive relative to United Airlines Holdings with a high degree of confidence given the low associated uncertainty.



(AZNAX Historical series is only plotted for didactic purposes)

Rendimento differenziale medio	6,5548

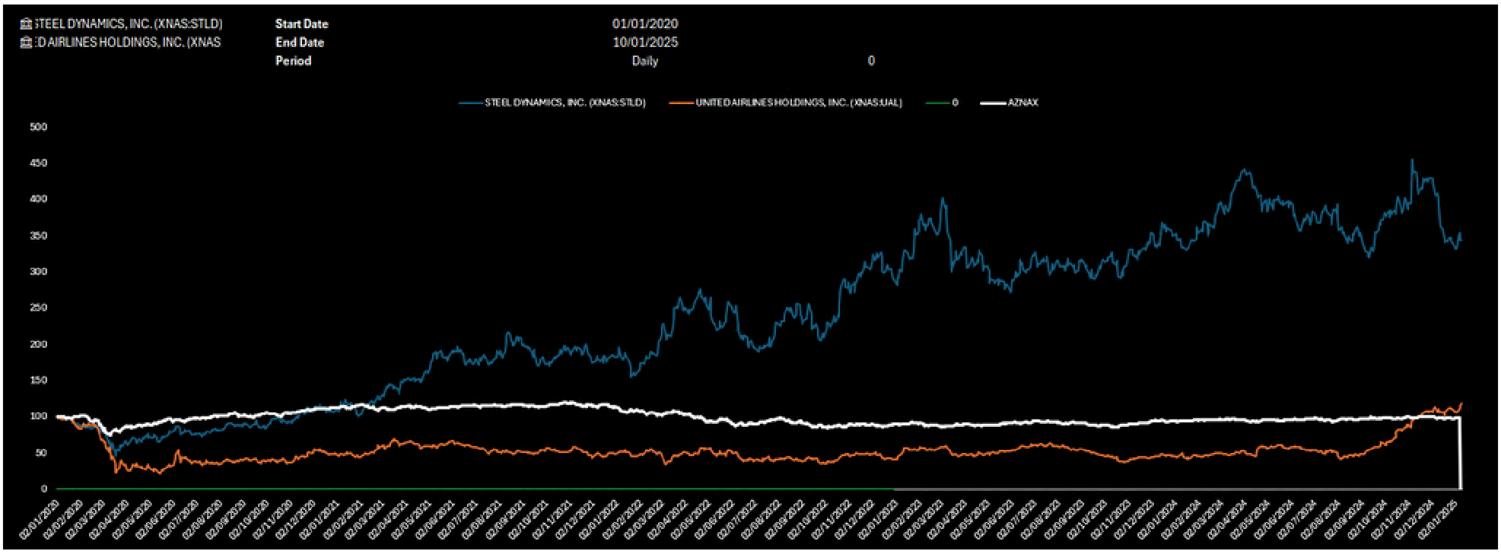
The chart shows that O'Reilly Automotive outperforms Airlines Holdings Inc. with an average differential return of 6,5548 over the past 5 years.

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nasdaq stocks: Steel Dynamics VS United Airlines Holdings

```
% Vista 4
P(4, assetNames=="STEEL DYNAMICS") = 1;
P(4, assetNames=="UNITED AIRLINES HOLDINGS") = -1;
q(4) = 0.063;
Omega(4, 4) = 1e-6;
```

The view represents a specific opinion on two assets: Steel Dynamics and United Airlines Holdings It indicates an expected return of 6.3% for Steel Dynamics relative to United Airlines Holdings with a high degree of confidence given the low associated uncertainty.



(AZNAX Historical series is only plotted for didactic purposes)

Rendimento differenziale medio	6,3202

The chart shows that O'Reilly Automotive outperforms Airlines Holdings Inc. with an average differential return of 6,5548 over the past 5 years.

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

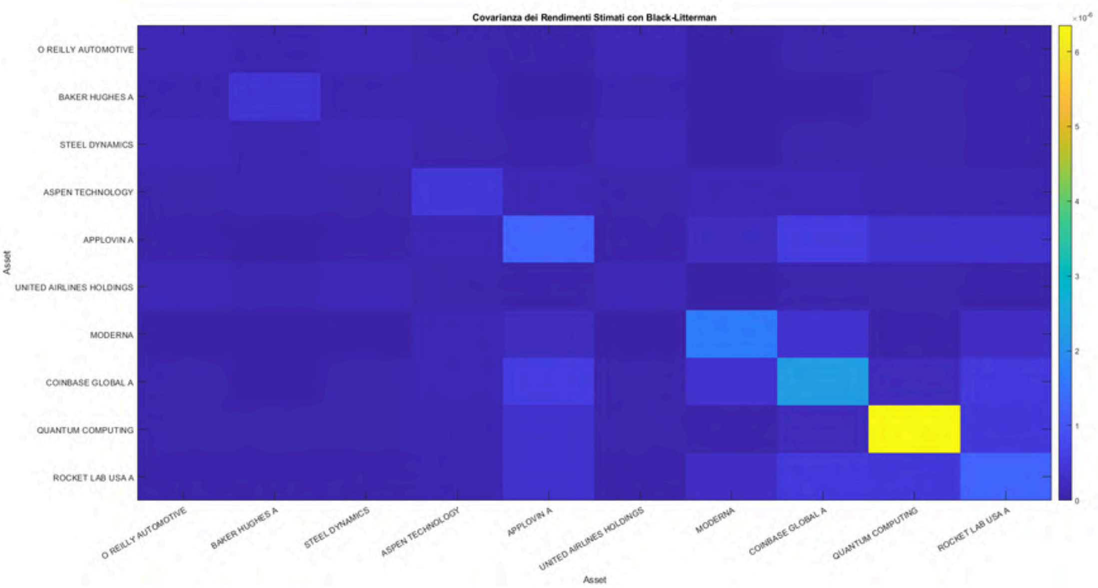
Nasdaq Daily

```
Pesi del portafoglio Black-Litterman:
O REILLY AUTOMOTIVE: 0.61597
BAKER HUGHES A: 0.027612
STEEL DYNAMICS: 0.080028
ASPEN TECHNOLOGY: 0.11061
APPLOVIN A: 0.063785
UNITED AIRLINES HOLDINGS: 1.3432e-12
MODERNA: 0.043611
COINBASE GLOBAL A: 0.01987
QUANTUM COMPUTING: 0.0047664
ROCKET LAB USA A: 0.033752
Statistiche del Portafoglio Media-Varianza:
Media: 0.001620
Deviazione Standard: 0.017398
Skewness: 0.253079
Curtosi: 5.891036

Statistiche del Portafoglio Black-Litterman:
Media: 0.001098
Deviazione Standard: 0.014435
Skewness: -0.379968
Curtosi: 11.127131
Sharpe Ratio: 0.070656
Statistiche del Portafoglio Media-Varianza:
Media: 0.001620
Deviazione Standard: 0.017398
Varianza: 0.000303
Skewness: 0.253079
Curtosi: 5.891036
```

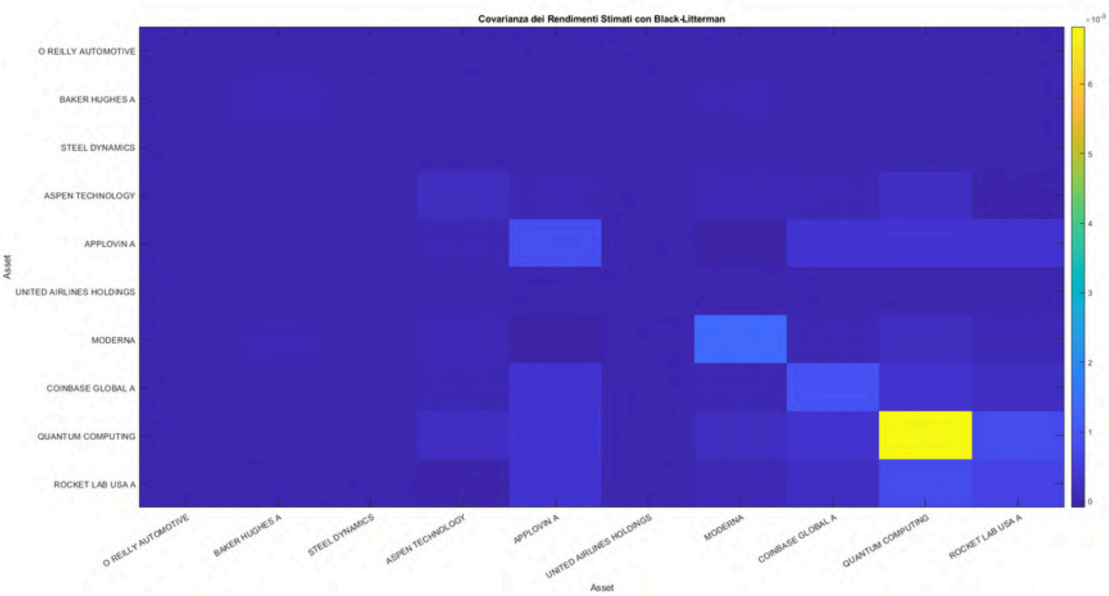
Nasdaq Monthly

```
Pesi del portafoglio Black-Litterman:
O REILLY AUTOMOTIVE: 0.70899
BAKER HUGHES A: 1.4212e-13
STEEL DYNAMICS: 0.10094
ASPEN TECHNOLOGY: 0.074538
APPLOVIN A: 0.035468
UNITED AIRLINES HOLDINGS: 0.017778
MODERNA: 0.035592
COINBASE GLOBAL A: 0.00255
QUANTUM COMPUTING: 0.00037954
ROCKET LAB USA A: 0.023765
Statistiche del Portafoglio Media-Varianza:
Media: 0.027537
Deviazione Standard: 0.061495
Skewness: -0.047584
Curtosi: 3.478208

Statistiche del Portafoglio Black-Litterman:
Media: 0.022250
Deviazione Standard: 0.055752
Skewness: -0.174644
Curtosi: 4.139494
Sharpe Ratio: 0.369459
Statistiche del Portafoglio Media-Varianza:
Media: 0.027537
Deviazione Standard: 0.061495
Varianza: 0.003782
Skewness: -0.047584
Curtosi: 3.478208
```

Nasdaq Daily



Nasdaq Monthly



QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Presented below is the code used to answer this question about the Nyse.

```matlab
% Leggi il file Excel
T = readtable('NYSEBLSELECTEDDaily.xlsx', 'VariableNamingRule', 'preserve');

% Definisci i nomi degli asset e del benchmark
assetNames = ["ELI LILLY", "BIOHAVEN", "CALERES", "WALMART", "MAGNOLIA OIL GAS A", "KROGER", "FTI
CONSULTING", "NEW YORK TIMES 'A'", "TELEPHONE & DATA SYS.", "MURPHY OIL"];
benchmarkName = "S&P 500 COMPOSITE PRICE INDEX";

% Visualizza i nomi delle colonne
disp(T.Properties.VariableNames);

% Trova il nome corretto della colonna per il benchmark
sp500Index = find(contains(T.Properties.VariableNames, 'S&P 500'), 1);
if ~isempty(sp500Index)
    benchmarkName = T.Properties.VariableNames{sp500Index};
else
    error('Nessuna colonna trovata con "S&P 500" nel nome.');
end

% Visualizza tutte le righe della tabella
disp(T(:, ["Date", benchmarkName, assetNames]));

% Calcola i rendimenti
retnsT = tick2ret(T(:, 2:end));
assetRetns = retnsT(:, assetNames);
benchRetn = retnsT(:, benchmarkName);
numAssets = size(assetRetns, 2);

% Definisci le viste
v = 4;  % totale 4 viste
P = zeros(v, numAssets);
q = zeros(v, 1);
Omega = zeros(v);

% Vista 1
P(1, assetNames=="NEW YORK TIMES 'A'") = 1;
q(1) = 0.18;
Omega(1, 1) = 1e-3;

% Vista 2
P(2, assetNames=="MAGNOLIA OIL GAS A") = 1;
q(2) = 0.4;
Omega(2, 2) = 1e-5;

% Vista 3
P(3, assetNames=="MAGNOLIA OIL GAS A") = 1;
P(3, assetNames=="MURPHY OIL") = -1;
q(3) = 0.04;
Omega(3, 3) = 1e-5;

% Vista 4
P(4, assetNames=="KROGER") = 1;
P(4, assetNames=="CALERES") = -1;
q(4) = 0.081209;
Omega(4, 4) = 1e-3;

% Converti le viste da rendimenti annuali a rendimenti giornalieri
bizyear2bizday = 1/252;
q = q * bizyear2bizday;
Omega = Omega * bizyear2bizday;

% Crea la tabella delle viste
viewTable = array2table([P q diag(Omega)], 'VariableNames', [assetNames "View_Return"
"View_Uncertainty"]);
disp(viewTable);

% Stima la covarianza dai rendimenti storici degli asset
Sigma = cov(assetRetns.Variables);

% Definisci l'incertezza C
tau = 1/size(assetRetns.Variables, 1);
C = tau * Sigma;
disp(C);
```

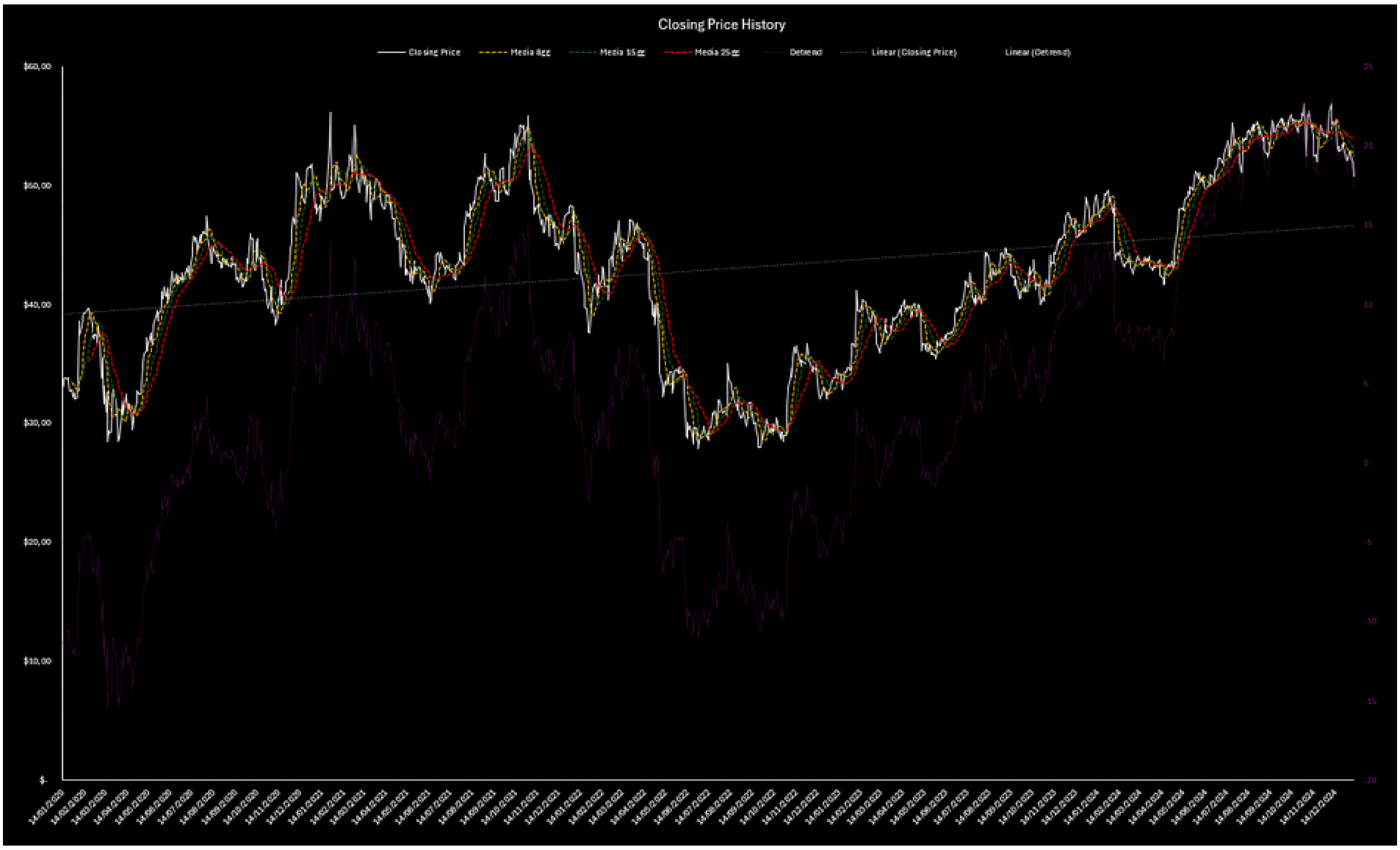
```matlab
% Trova il portafoglio di mercato e i rendimenti impliciti
[wtsMarket, PI] = findMarketPortfolioAndImpliedReturn(assetRetns.Variables, benchRetn.Variables);

% Calcola il rendimento medio stimato e la covarianza utilizzando il modello Black-Litterman
mu_bl = (P'*(Omega\P) + inv(C)) \ ( C\PI + P'*(Omega\q));
cov_mu = inv(P'*(Omega\P) + inv(C));

% Ottimizzazione del portafoglio
port = Portfolio('NumAssets', numAssets, 'lb', 0, 'budget', 1, 'Name', 'Mean Variance');
port = setAssetMoments(port, mean(assetRetns.Variables), Sigma);
wts = estimateMaxSharpeRatio(port);

portBL = Portfolio('NumAssets', numAssets, 'lb', 0, 'budget', 1, 'Name', 'Mean Variance with Black-
Litterman');
portBL = setAssetMoments(portBL, mu_bl, Sigma + cov_mu);
wtsBL = estimateMaxSharpeRatio(portBL);

disp('Pesi del portafoglio Black-Litterman:');
for i = 1:length(wtsBL)
    disp([assetNames{i}, ': ', num2str(wtsBL(i))]);
end

% Calcola le statistiche del portafoglio media-varianza
meanMV = mean(assetRetns.Variables * wts);
stdMV = std(assetRetns.Variables * wts);
skewMV = skewness(assetRetns.Variables * wts);
kurtMV = kurtosis(assetRetns.Variables * wts);

% Calcola le statistiche del portafoglio Black-Litterman
meanBL = mean(assetRetns.Variables * wtsBL);
stdBL = std(assetRetns.Variables * wtsBL);
skewBL = skewness(assetRetns.Variables * wtsBL);
kurtBL = kurtosis(assetRetns.Variables * wtsBL);

% Calcola il tasso risk-free giornaliero
risk_free_rate_daily = (1 + 0.02)^(1/252) - 1;

% Calcola lo Sharpe ratio del portafoglio Black-Litterman
sharpe_ratio_BL = (meanBL - risk_free_rate_daily) / stdBL;

% Stampa le statistiche a schermo
fprintf('Statistiche del Portafoglio Media-Varianza:\n');
fprintf('Media: %f\n', meanMV);
fprintf('Deviazione Standard: %f\n', stdMV);
fprintf('Skewness: %f\n', skewMV);
fprintf('Curtosi: %f\n', kurtMV);

fprintf('\nStatistiche del Portafoglio Black-Litterman:\n');
fprintf('Media: %f\n', meanBL);
fprintf('Deviazione Standard: %f\n', stdBL);
fprintf('Skewness: %f\n', skewBL);
fprintf('Curtosi: %f\n', kurtBL);
fprintf('Sharpe Ratio: %f\n', sharpe_ratio_BL);

% Visualizza la matrice di covarianza utilizzando l'approccio Black-Litterman
figure;
imagesc(cov_mu);
colorbar;
title('Covarianza dei Rendimenti Stimati con Black-Litterman');
xlabel('Asset');
ylabel('Asset');
set(gca, 'XTick', 1:numAssets, 'XTickLabel', assetNames, 'YTick', 1:numAssets, 'YTickLabel', assetNames);

% Funzione locale per trovare il portafoglio di mercato e i rendimenti impliciti
function [wtsMarket, PI] = findMarketPortfolioAndImpliedReturn(assetRetn, benchRetn)
    % Trova la matrice di covarianza
    Sigma = cov(assetRetn);

    % Trova il portafoglio di mercato
    numAssets = size(assetRetn, 2);
    LB = zeros(1, numAssets);
    Aeq = ones(1, numAssets);
    Beq = 1;
    opts = optimoptions('lsqlin', 'Algorithm', 'interior-point', 'Display', 'off');
    wtsMarket = lsqlin(assetRetn, benchRetn, [], [], Aeq, Beq, LB, [], [], opts);

    % Trova delta
    shpr = mean(benchRetn) / std(benchRetn);
    delta = shpr / sqrt(wtsMarket' * Sigma * wtsMarket);

    % Calcola i rendimenti impliciti
    PI = delta * Sigma * wtsMarket;
end
```

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nyse stocks: New York Times

```
% Vista 1
P(1, assetNames=="NEW YORK TIMES 'A'") = 1;
q(1) = 0.18;
Omega(1, 1) = 1e-3;
```

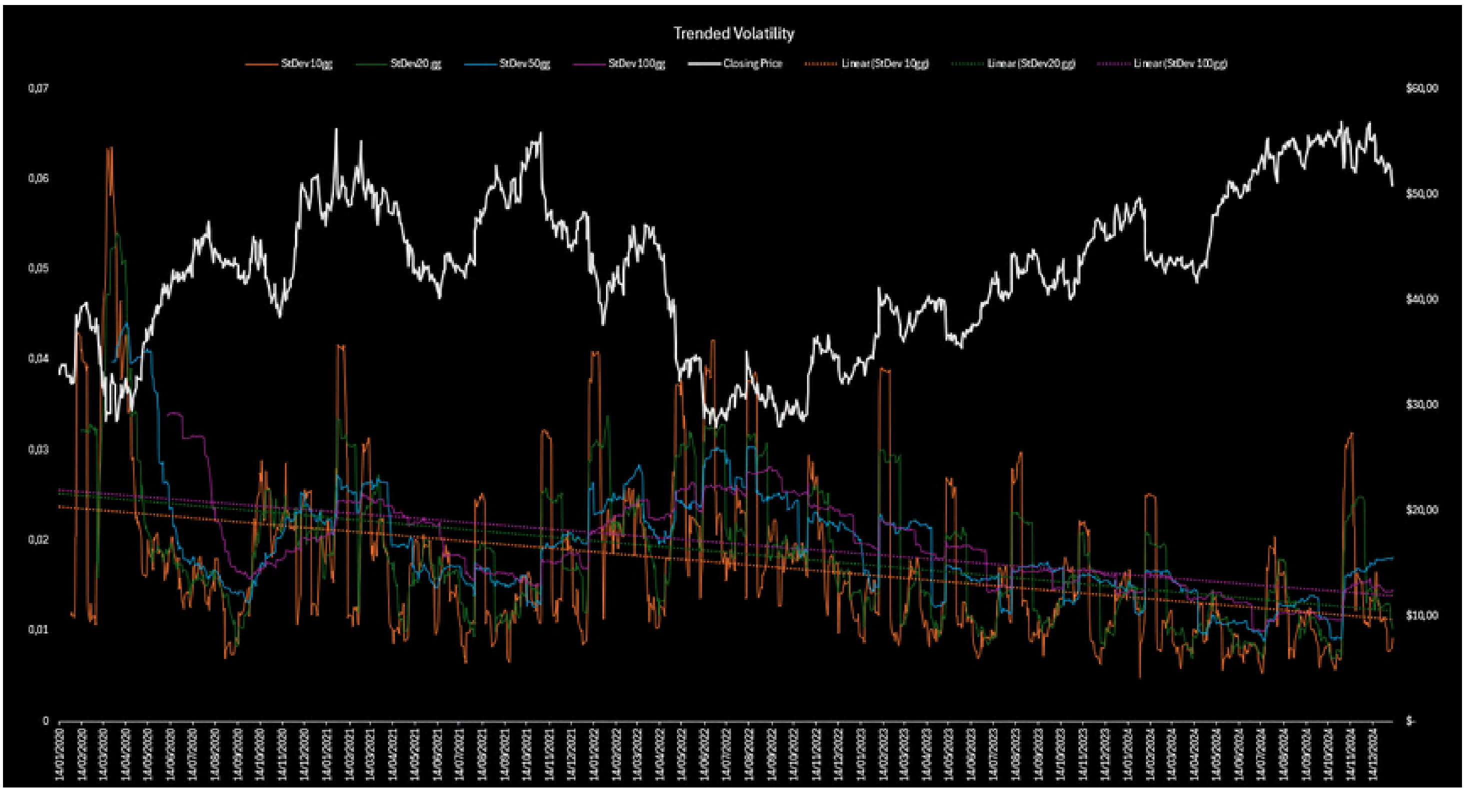
The view represents a specific opinion on "NEW YORK TIMES 'A'," indicating an expected return of 18% with a high degree of confidence, given the low associated uncertainty



QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

The chart shows a generally positive trend over the past 5 years, but with modest return volatility (the rolling volatility increased particularly in the recent period). For this reason, the view has been set with a medium level of uncertainty.

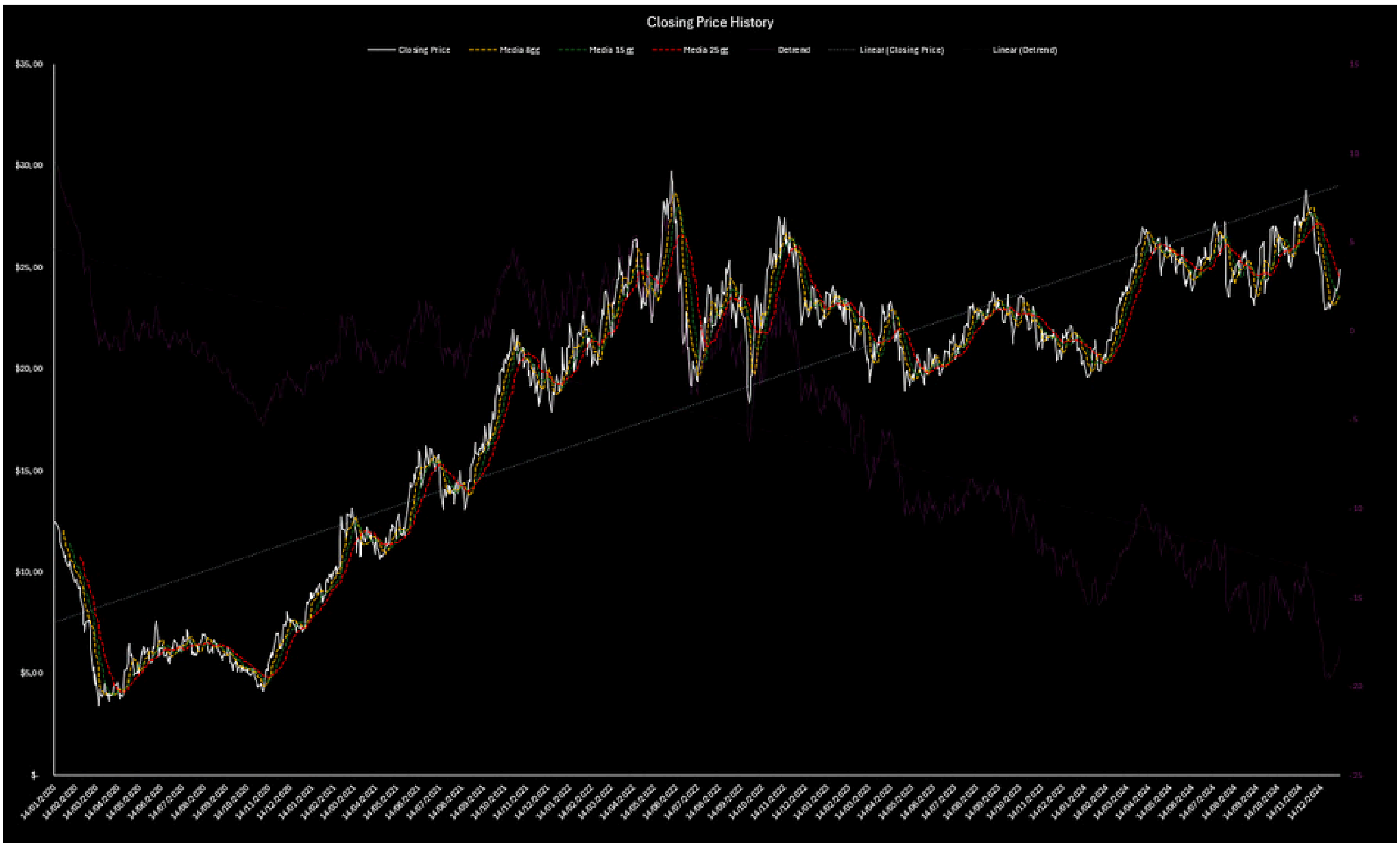
Start Date	14/01/2020
End Date	10/01/2025
Symbol	YORK TIMES COMPANY (XNYS:NYT)
Ticker	NYT
Beta	0,9971
Market CAP	$ 8.738.774.850
Price per Share	$ 53,30
Currency	USD
Mean (Y)	15%
Variance (Y)	11%
Stdev (Y)	33%



Our views on Nyse stocks: Magnolia Oil Gas

```
% Vista 2
P(2, assetNames=="MAGNOLIA OIL GAS A") = 1;
q(2) = 0.4;
Omega(2, 2) = 1e-5;
```

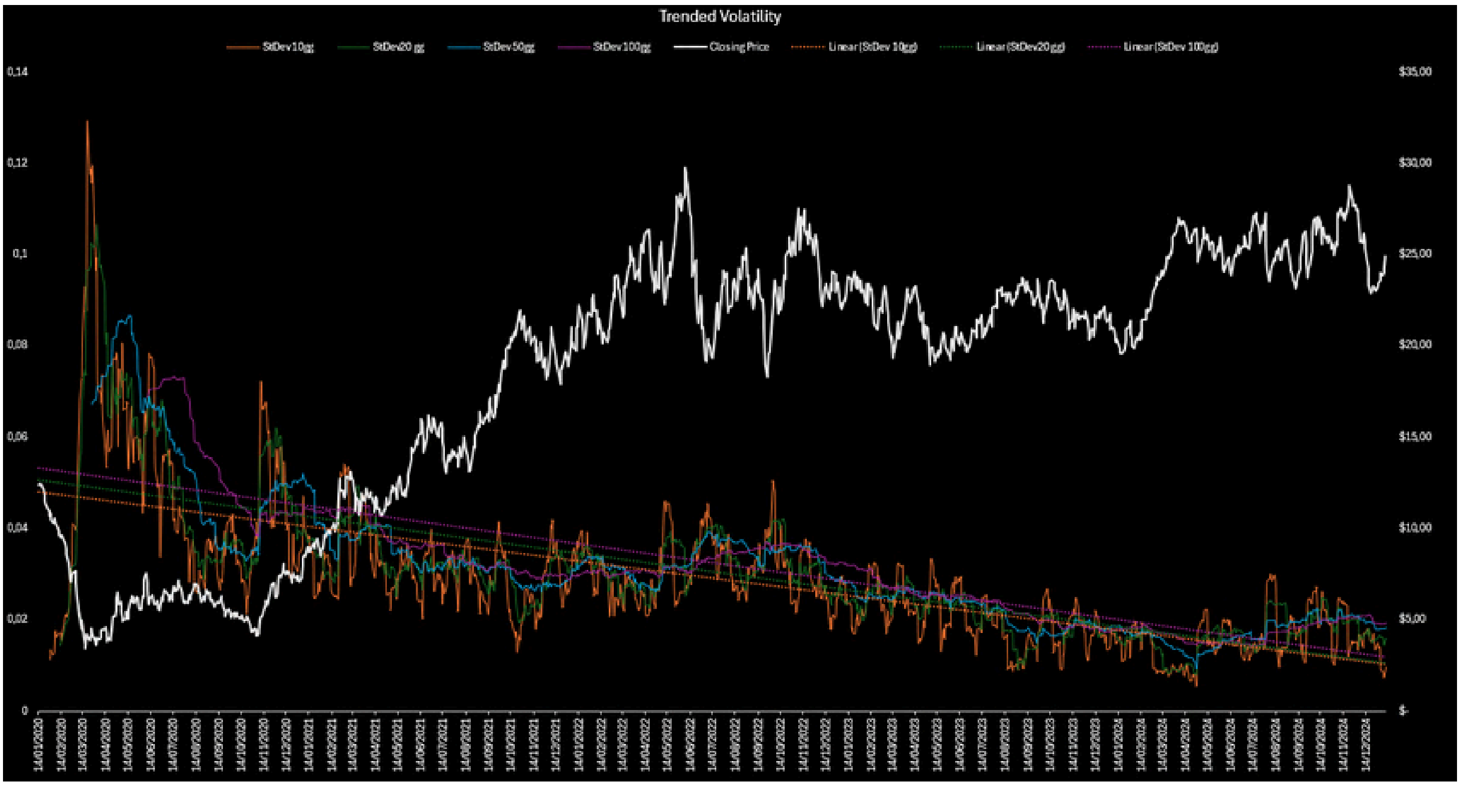
The view represents a specific opinion on "MAGNOLIA OIL GAS A," indicating an expected return of 40% with a high degree of confidence, given the low associated uncertainty.



QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

The chart of closing prices shows an extremely positive trend, with a significant increase, especially in the last year. The rolling volatility has decreased, particularly at the beginning of 2024, with a small increase starting from mid-year. For these reasons, we have established a positive view with a low degree of uncertainty.

Start Date	14/01/2020
End Date	10/01/2025
Symbol	Magnolia Oil (XNYS:MGY)
Ticker	MGY
Beta	1,9965
Market CAP	$ 4.997.530.372
Price per Share	$ 25,43
Currency	USD
Mean (Y)	34%
Variance (Y)	30%
Stdev (Y)	55%

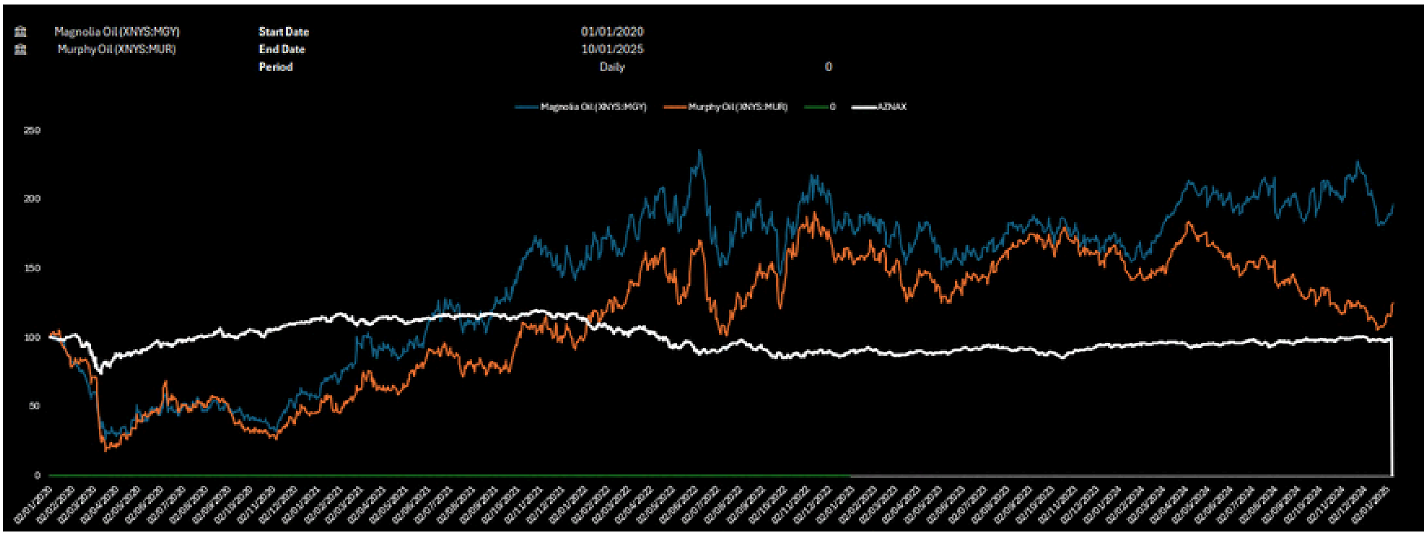


QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nyse stocks: Magnolia Oil Gas VS Murphy Oil

```
% Vista 3
P(3, assetNames=="MAGNOLIA OIL GAS A") = 1;
P(3, assetNames=="MURPHY OIL") = -1;
q(3) = 0.04;
Omega(3, 3) = 1e-5;
```

The view represents a specific opinion on two assets: "MAGNOLIA OIL GAS A" and "MURPHY OIL." It indicates an expected return of 4% for "MAGNOLIA OIL GAS A" relative to "MURPHY OIL," with a high degree of confidence given the low associated uncertainty.



(AZNAX Historical series is only plotted for didactic purposes)

Rendimento differenziale medio	3,9633

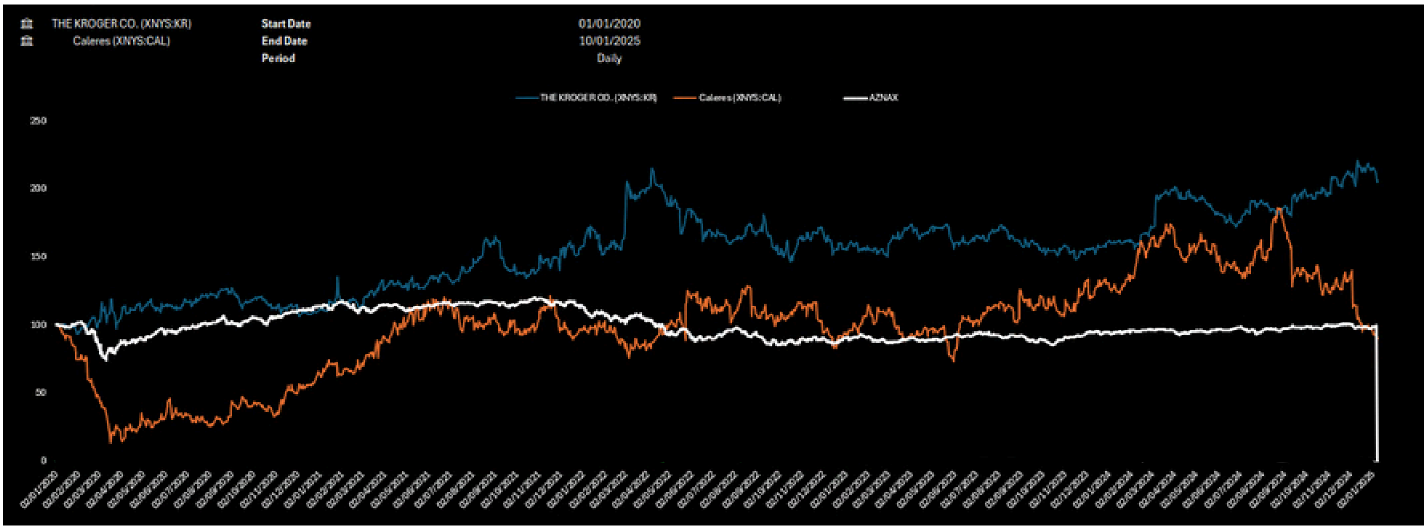
The average differential return between Magnolia Oil Gas and Murphy Oil stands around 4%, and the chart suggests it has been increasing, particularly in the last period.

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

Our views on Nyse stocks: Kroger VS Caleres

```
% Vista 4
P(4, assetNames=="KROGER") = 1;
P(4, assetNames=="CALERES") = -1;
q(4) = 0.081209;
Omega(4, 4) = 1e-3;
```

The view represents a specific opinion on two assets: "KROGER" and "CALERES." It indicates an expected return of 8.1209% for "KROGER" relative to "CALERES," with a high degree of confidence given the low associated uncertainty.



(AZNAX Historical series is only plotted for didactic purposes)

Rendimento differenziale medio	8,1209

The average differential return between The Kroger and Caleres is approximately 8% per year. We have decided to assign a medium degree of uncertainty to make the view more conservative

QUESTION 20 AND 21: BLACK-LITTERMAN PORTFOLIO OPTIMIZATION

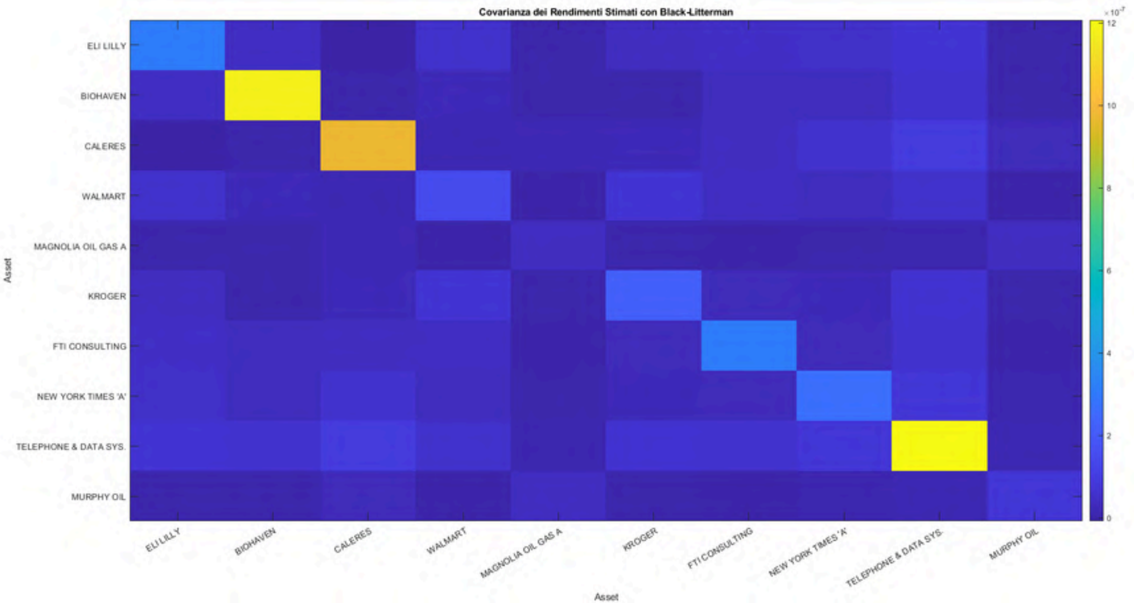
Nyse Daily

```
Pesi del portafoglio Black-Litterman:
ELI LILLY: 0.14832
BIOHAVEN: 0.017573
CALERES: 5.2791e-20
WALMART: 0.26313
MAGNOLIA OIL GAS A: 0.26866
KROGER: 0.057207
FTI CONSULTING: 0.080379
NEW YORK TIMES 'A': 0.15453
TELEPHONE & DATA SYS.: 0.010198
MURPHY OIL: 9.0054e-21
Statistiche del Portafoglio Media-Varianza:
Media: 0.001119
Deviazione Standard: 0.012137
Skewness: 0.322084
Curtosi: 9.902609

Statistiche del Portafoglio Black-Litterman:
Media: 0.000937
Deviazione Standard: 0.013428
Skewness: -0.218994
Curtosi: 8.532294
Sharpe Ratio: 0.063939
Statistiche del Portafoglio Media-Varianza:
Media: 0.001119
Deviazione Standard: 0.012137
Varianza: 0.000147
Skewness: 0.322084
Curtosi: 9.902609
```

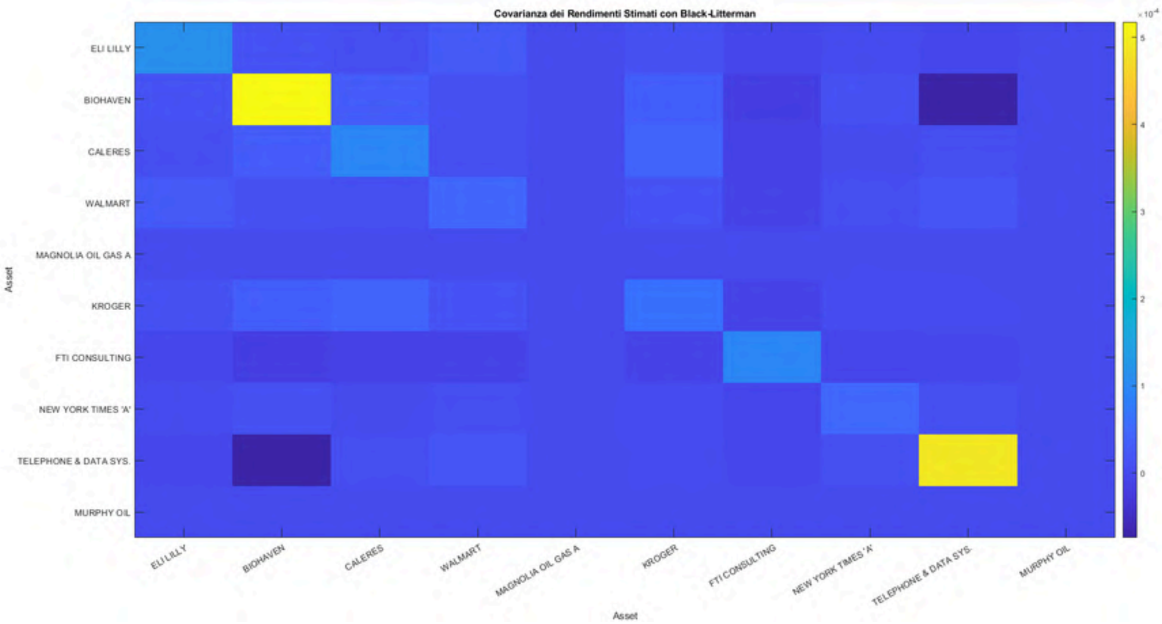
Nyse Monthly

```
Pesi del portafoglio Black-Litterman:
ELI LILLY: 0.0052386
BIOHAVEN: 0.064079
CALERES: 4.1038e-16
WALMART: 0.39772
MAGNOLIA OIL GAS A: 0.22227
KROGER: 0.14208
FTI CONSULTING: 0.097089
NEW YORK TIMES 'A': 0.048251
TELEPHONE & DATA SYS.: 0.023276
MURPHY OIL: 2.5007e-16
Statistiche del Portafoglio Media-Varianza:
Media: 0.019546
Deviazione Standard: 0.037887
Skewness: 0.147646
Curtosi: 2.359311

Statistiche del Portafoglio Black-Litterman:
Media: 0.017276
Deviazione Standard: 0.046542
Skewness: 0.150052
Curtosi: 3.412359
Sharpe Ratio: 0.335711
Statistiche del Portafoglio Media-Varianza:
Media: 0.019546
Deviazione Standard: 0.037887
Varianza: 0.001435
Skewness: 0.147646
Curtosi: 2.359311
```

Nyse Daily



Nyse Monthly



QUESTION 22 AND 23: GLOBAL MINIMUM VARIANCE PORTFOLIO

The global minimum variance portfolio (GMVP) allocates a given budget among financial assets such that the risk for the rate of expected portfolio return is minimized. In contrast to the classical mean-variance optimal portfolio of Markowitz previously utilized, the weights of the GMVP do not depend on the expected returns of the assets, but only depend on the covariance matrix of the asset returns, as the aim of this latter is to capture the portfolio with the lowest volatility possible among efficient portfolios.

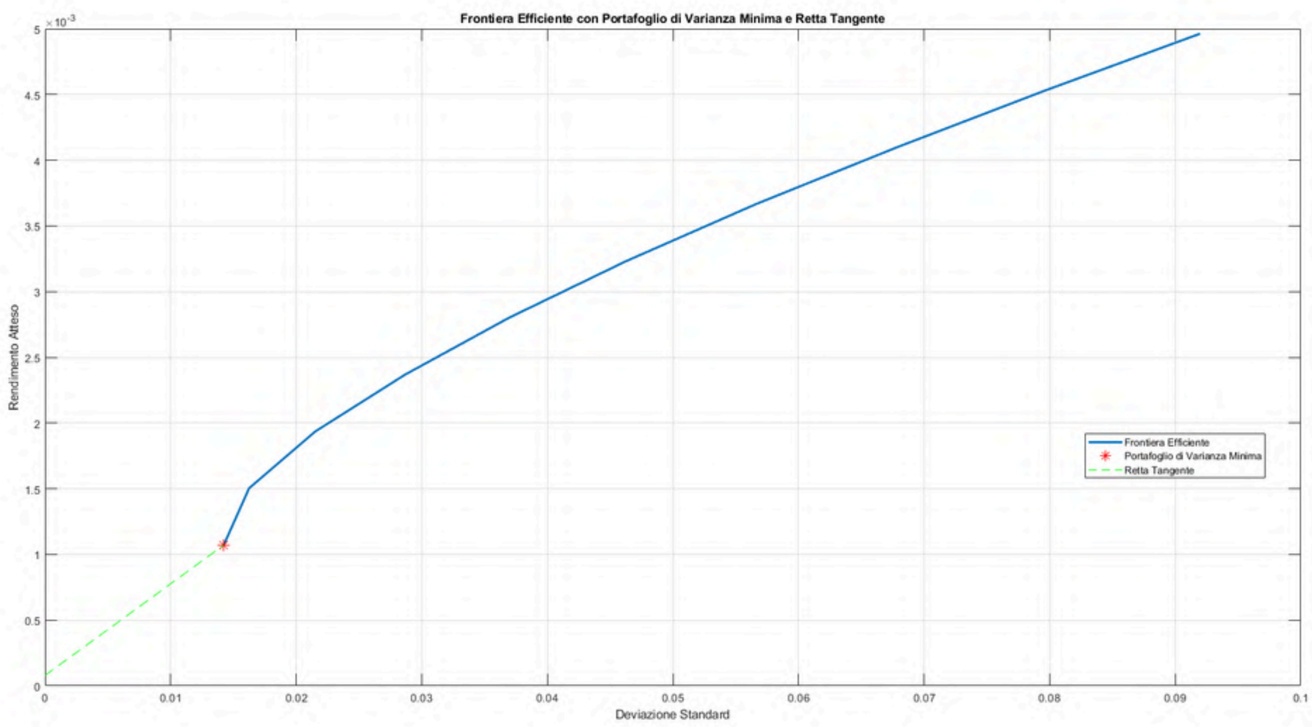
Presented below is the code used to answer this question.

```
% Vista 4
% Carica i dati dal file DBEXAM.xlsx con la regola di denominazione delle variabili impostata su
'preserve'
opts = detectImportOptions('DBEXAM.xlsx', 'Sheet', 'NASselectedD');
opts.VariableNamingRule = 'preserve';
data = readtable('DBEXAM.xlsx', opts);

% Calcola i rendimenti giornalieri
prices = data{:, 2:end}; % Supponendo che la prima colonna sia la data
returns = diff(prices) ./ prices(1:end-1, :);

% Definisci il problema del portafoglio
p = Portfolio('AssetList', data.Properties.VariableNames(2:end));
p = estimateAssetMoments(p, returns, 'missingdata', true);
p = setDefaultConstraints(p);

% Trova il portafoglio di varianza minima
w = estimateFrontierLimits(p, 'min');

% Calcola il rendimento atteso e la deviazione standard del portafoglio
portfolio_return = mean(returns * w);
portfolio_std = sqrt(w' * cov(returns) * w);

% Calcola skewness e kurtosis del portafoglio
portfolio_skewness = skewness(returns * w);
portfolio_kurtosis = kurtosis(returns * w);

% Calcola il rapporto di Sharpe
risk_free_rate = 0.02 / 252; % Tasso privo di rischio giornaliero
sharpe_ratio = (portfolio_return - risk_free_rate) / portfolio_std;

% Calcola il beta del portafoglio
benchmark_returns = mean(returns, 2); % Supponendo che il benchmark sia la media dei rendimenti degli
asset
cov_matrix = cov(returns);
beta_portfolio = (cov_matrix * w) / var(benchmark_returns);
beta_portfolio = sum(beta_portfolio); % Somma dei beta ponderati per ottenere un valore unico

% Mostra i risultati
fprintf('Rendimento atteso del portafoglio: %.4f\n', portfolio_return);
fprintf('Deviazione standard del portafoglio: %.4f\n', portfolio_std);
fprintf('Skewness del portafoglio: %.4f\n', portfolio_skewness);
fprintf('Kurtosis del portafoglio: %.4f\n', portfolio_kurtosis);
fprintf('Rapporto di Sharpe: %.4f\n', sharpe_ratio);
fprintf('Beta del portafoglio: %.4f\n', beta_portfolio);

% Mostra i pesi dei titoli nel portafoglio
fprintf('Pesi dei titoli nel portafoglio:\n');
for i = 1:length(w)
    fprintf('%s: %.4f\n', data.Properties.VariableNames{i+1}, w(i));
end

% Plot della frontiera efficiente
figure;
plotFrontier(p);
hold on;
plot(portfolio_std, portfolio_return, 'r*', 'MarkerSize', 10);

% Aggiungi la retta tangente
slope = (portfolio_return - risk_free_rate) / portfolio_std;
x = linspace(0, max(portfolio_std), 100);
y = risk_free_rate + slope * x;
plot(x, y, 'g--');

title('Frontiera Efficiente con Portafoglio di Varianza Minima e Retta Tangente');
xlabel('Deviazione Standard');
ylabel('Rendimento Atteso');
legend('Frontiera Efficiente', 'Portafoglio di Varianza Minima', 'Retta Tangente', 'Location', 'best');
grid on;
```

QUESTION 22 AND 23: GLOBAL MINIMUM VARIANCE PORTFOLIO

For the sake of general contextualization and in order to have a better understanding of the return-risk metrics analysis, we plot the previous graph of the efficient frontier with our mean variance optimized portfolio and we include the new GMVP to emphasize the differences in terms of optimization purposes. As graphically interpretable, the GMVP portfolio lies perfectly in the position of the efficient frontier able to minimize volatility. However, in order to achieve its goal, it had to sacrifice sharply its return performance by hugely decreasing them. Overall, we find these results first of all consistent with the whole analysis and secondly enriching in terms of optimization processes to be compared.

Nasdaq daily

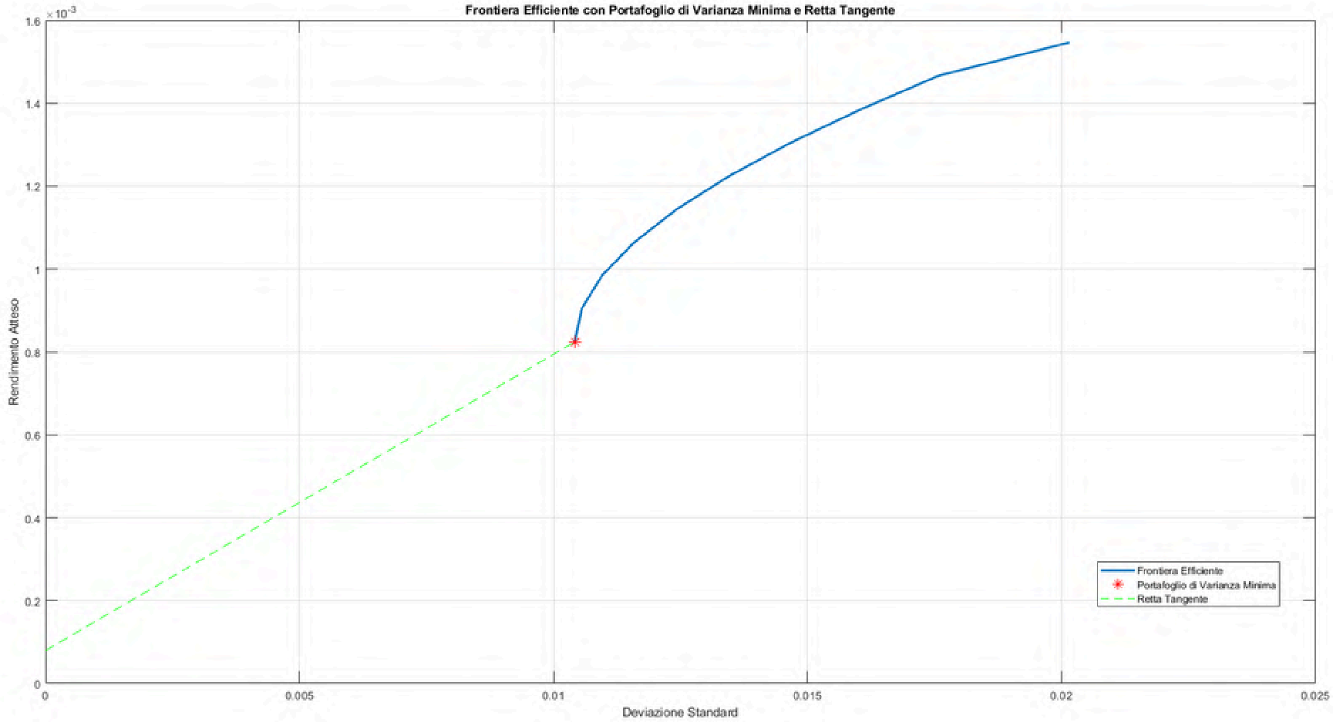


The statistics are the following:

```
Rendimento atteso del portafoglio: 0.0011
Deviazione standard del portafoglio: 0.0142
Varianza del portafoglio: 0.0002
Skewness del portafoglio: -0.2334
Kurtosis del portafoglio: 10.1552
Rapporto di Sharpe: 0.0697
Beta del portafoglio: 4.6615
Pesi dei titoli nel portafoglio:
O REILLY AUTOMOTIVE: 0.5569
BAKER HUGHES A: 0.0768
STEEL DYNAMICS: 0.0407
ASPEN TECHNOLOGY: 0.1555
APPLOVIN A: 0.0523
UNITED AIRLINES HOLDINGS: 0.0000
MODERNA: 0.0660
COINBASE GLOBAL A: 0.0000
QUANTUM COMPUTING: 0.0059
ROCKET LAB USA A: 0.0458
>>
```

QUESTION 22 AND 23: GLOBAL MINIMUM VARIANCE PORTFOLIO

Nyse daily

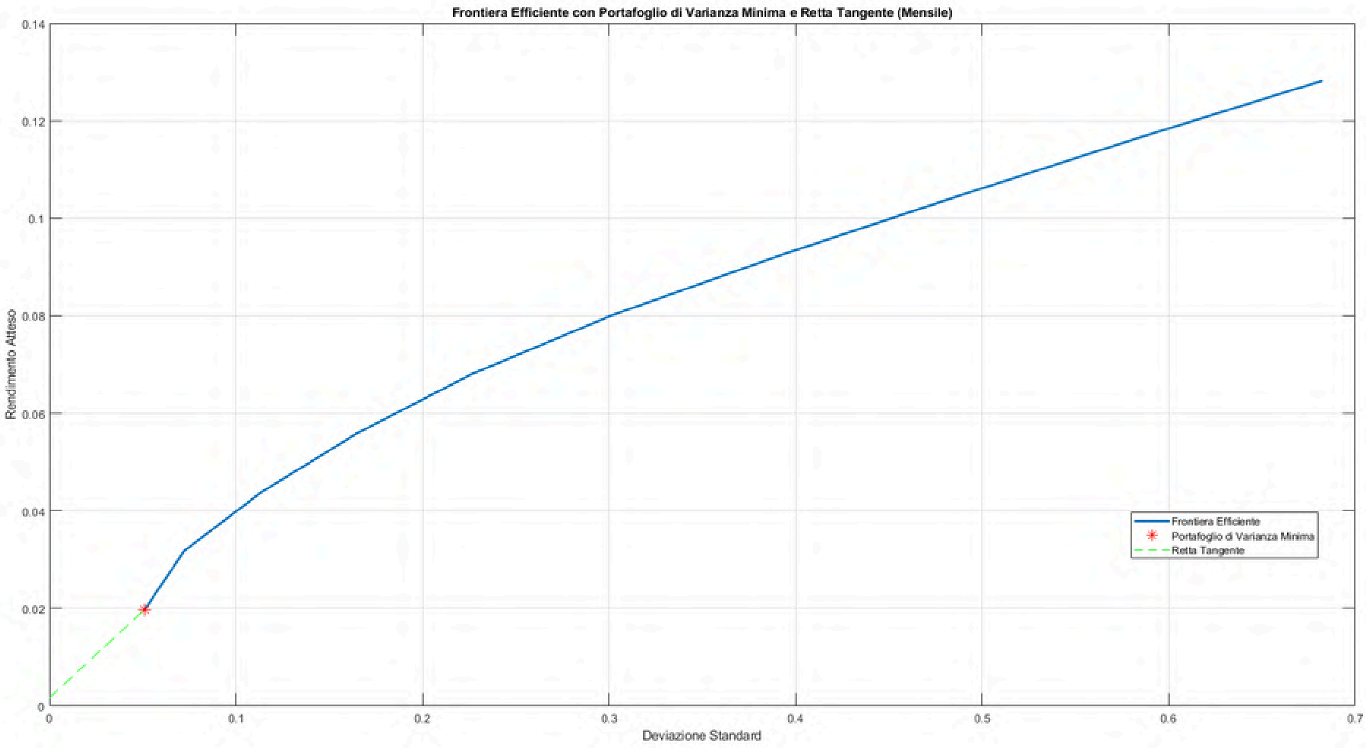


The statistics are the following:

```
Rendimento atteso del portafoglio: 0.0008
Deviazione standard del portafoglio: 0.0104
Varianza del portafoglio: 0.0001
Skewness del portafoglio: -0.0172
Kurtosis del portafoglio: 9.5292
Rapporto di Sharpe: 0.0715
Beta del portafoglio: 4.7555
Pesi dei titoli nel portafoglio:
ELI LILLY: 0.1147
BIOHAVEN: 0.0406
CALERES: 0.0202
WALMART: 0.3127
MAGNOLIA OIL GAS A: 0.0233
KROGER: 0.1908
FTI CONSULTING: 0.1642
NEW YORK TIMES 'A': 0.1334
TELEPHONE & DATA SYS.: 0.0000
MURPHY OIL: 0.0000
```

QUESTION 22 AND 23: GLOBAL MINIMUM VARIANCE PORTFOLIO

Nasdaq Monthly

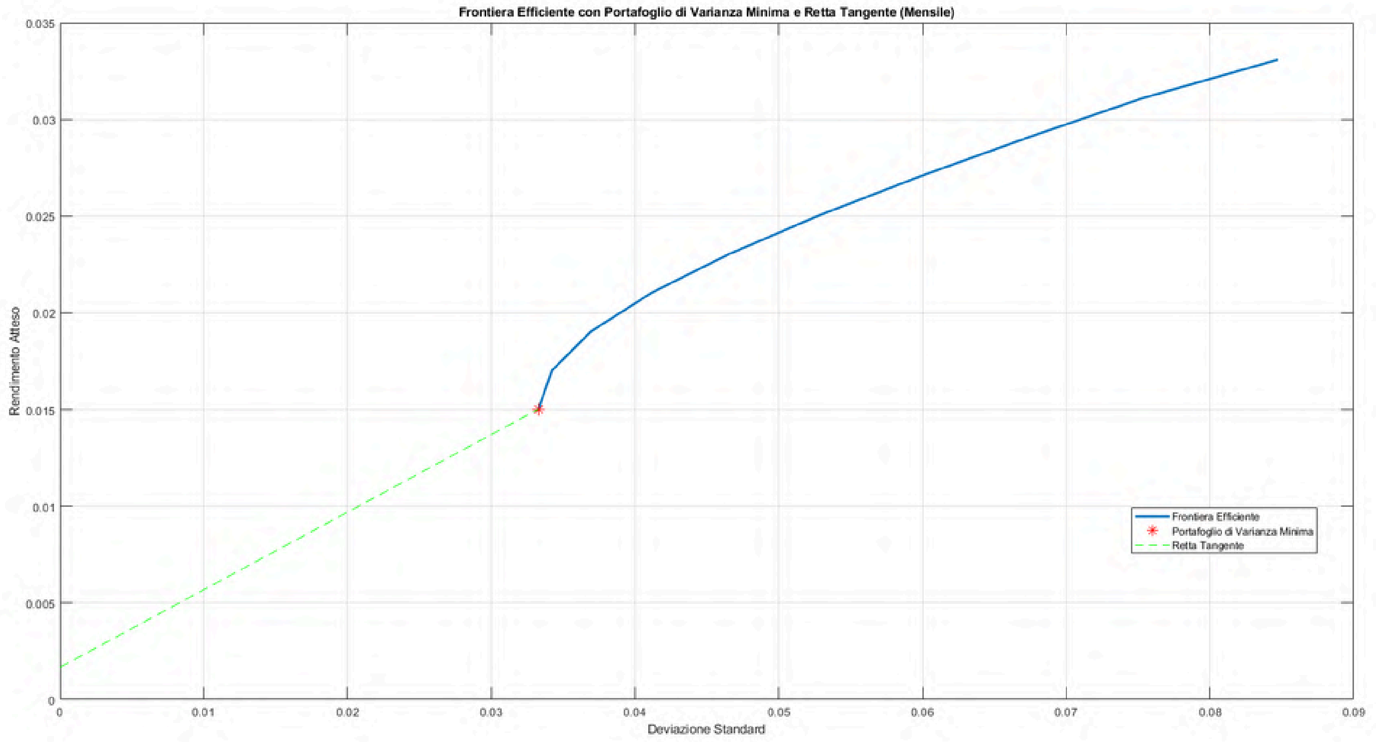


The statistics are the following:

```
Rendimento atteso del portafoglio: 0.0197
Deviazione standard del portafoglio: 0.0511
Varianza del portafoglio: 0.0026
Skewness del portafoglio: -0.2705
Kurtosis del portafoglio: 3.5322
Rapporto di Sharpe: 0.3539
Beta del portafoglio: 4.7555
Pesi dei titoli nel portafoglio:
O REILLY AUTOMOTIVE: 0.5907
BAKER HUGHES A: 0.0240
STEEL DYNAMICS: 0.0456
ASPEN TECHNOLOGY: 0.2626
APPLOVIN A: 0.0000
UNITED AIRLINES HOLDINGS: 0.0143
COINBASE GLOBAL A: 0.0000
MODERNA: 0.0221
QUANTUM COMPUTING: 0.0000
ROCKET LAB USA A: 0.0407
```

QUESTION 22 AND 23: GLOBAL MINIMUM VARIANCE PORTFOLIO

Nyse Monthly



The statistics are the following:

```
Rendimento atteso del portafoglio: 0.0150
Deviazione standard del portafoglio: 0.0333
Varianza del portafoglio: 0.0011
Skewness del portafoglio: 0.0245
Kurtosis del portafoglio: 2.5577
Rapporto di Sharpe: 0.4012
Beta del portafoglio: 4.7555
Pesi dei titoli nel portafoglio:
CALERES: 0.0873
KROGER: 0.1214
MURPHY OIL: 0.0000
NEW YORK TIMES 'A': 0.0651
WALMART: 0.3511
TELEPHONE & DATA SYS.: 0.0113
FTI CONSULTING: 0.2813
MAGNOLIA OIL GAS A: 0.0209
BIOHAVEN: 0.0136
ELI LILLY: 0.0480
```

QUESTION 24: PORTFOLIOS COMBINATION

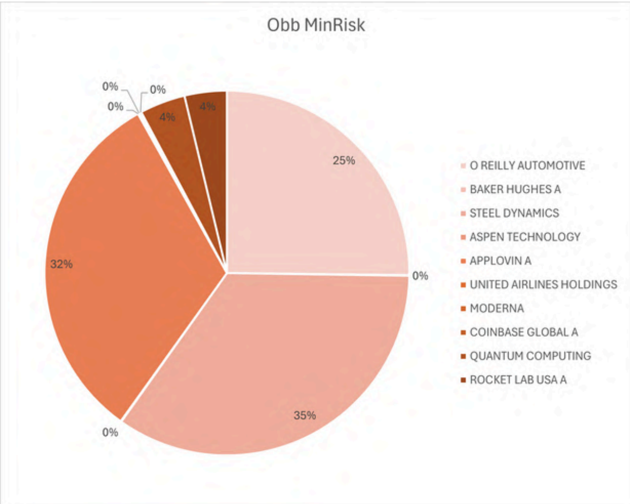
Presented below is the code used to answer this question.

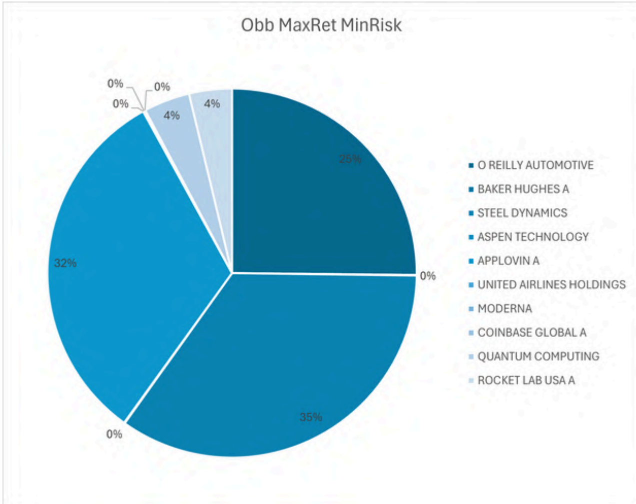
```
% Carica i dati dal file Excel
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\PortfolioCombinations_24.xlsx';
opts = detectImportOptions(filename, 'Sheet', 'nasdaq statisticsD');
opts.VariableNamingRule = 'preserve';
nasdaqStatistics = readtable(filename, opts);

% Definisci i pesi personalizzati per ciascun tipo di portafoglio
pesi = struct(...
    'MinRisk', 0.1, ...          % Peso per MinRisk
    'MaxRet_MinRisk', 0.2, ...  % Peso per MaxRet MinRisk
    'HRP', 0.05, ...             % Peso per HRP
    'BL', 0.1, ...              % Peso per BL
    'GMVP', 0.05, ...            % Peso per GMVP
    'Sharpe', 0.1 ...           % Peso per Sharpe
);

% Mappatura dei nomi dei portafogli ai nomi validi per i campi della struttura
% Nota: I nomi nella mappatura devono corrispondere esattamente ai nomi nel file Excel.
mappaturaNomi = containers.Map(...
    {'MinRisk', 'MaxRet_MinRisk', 'HRP', 'BL', 'GMVP', 'Sharpe'}, ...
    {'MinRisk', 'MaxRet_MinRisk', 'HRP', 'BL', 'GMVP', 'Sharpe'} ...
);

% Estrai i nomi dei portafogli e le statistiche
nomiPortafogli = nasdaqStatistics{:, 1};  % Prima colonna: nomi dei portafogli
statistiche = nasdaqStatistics{:, 2:end}; % Restanti colonne: statistiche

% Stampa i nomi dei portafogli per verificare la corrispondenza
disp('Nomi dei portafogli:');
disp(nomiPortafogli);

% Inizializza il vettore delle statistiche combinate
statisticheCombinazione = zeros(1, size(statistiche, 2));

% Calcola la combinazione lineare
for i = 1:length(nomiPortafogli)
    nomePortafoglio = nomiPortafogli{i};

    % Verifica se il nome del portafoglio è presente nella mappatura
    if isKey(mappaturaNomi, nomePortafoglio)
        nomeValido = mappaturaNomi(nomePortafoglio);  % Ottieni il nome valido per il campo
        peso = pesi.(nomeValido);  % Ottieni il peso corrispondente
        statisticheCombinazione = statisticheCombinazione + peso * statistiche(i, :);
    else
        warning('Portafoglio "%s" non trovato nella mappatura. Verifica il nome.', nomePortafoglio);
    end
end

% Aggiungi il portafoglio combinato alla lista dei portafogli
nomiPortafogli{end+1} = 'Combinazione';
statistiche = [statistiche; statisticheCombinazione];

% Estrai media e deviazione standard (Mean e Stdev) per il plot
media = statistiche(:, 1);  % Prima colonna: Mean
deviazioneStandard = statistiche(:, 2);  % Seconda colonna: Stdev

% Plot del piano media-varianza
figure;
hold on;
grid on;

% Plot dei portafogli
scatter(deviazioneStandard(1:end-1), media(1:end-1), 100, 'filled', 'b'); % Portafogli esistenti
text(deviazioneStandard(1:end-1), media(1:end-1), nomiPortafogli(1:end-1), ...
    'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'right'); % Etichette

% Evidenzia il portafoglio combinato
scatter(deviazioneStandard(end), media(end), 150, 'r', 'filled'); % Portafoglio combinato in rosso
text(deviazioneStandard(end), media(end), nomiPortafogli(end), ...
    'VerticalAlignment', 'bottom', 'HorizontalAlignment', 'right', 'Color', 'red'); % Etichetta

% Aggiungi titoli e legenda
xlabel('Deviazione Standard (Rischio)');
ylabel('Media (Rendimento Atteso)');
title('Piano Media-Varianza');
legend('Portafogli', 'Portafoglio Combinato', 'Location', 'best');

hold off;

% Stampa le statistiche del portafoglio di combinazione
disp('Statistiche del portafoglio di combinazione:');
disp(array2table(statisticheCombinazione, ...
    'VariableNames', nasdaqStatistics.Properties.VariableNames(2:end), ...
    'RowNames', {'Combinazione'}));
% Calcola i beta dei titoli
num_stocks = size(funds_returns, 2);
beta = zeros(num_stocks, 1);
mean_returns = zeros(num_stocks, 1);
std_returns = zeros(num_stocks, 1);
sharpe_ratio = zeros(num_stocks, 1);
i
```

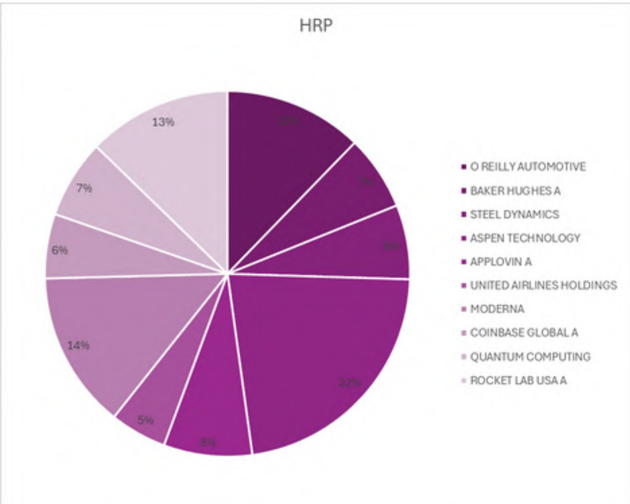
QUESTION 24: PORTFOLIOS COMBINATION

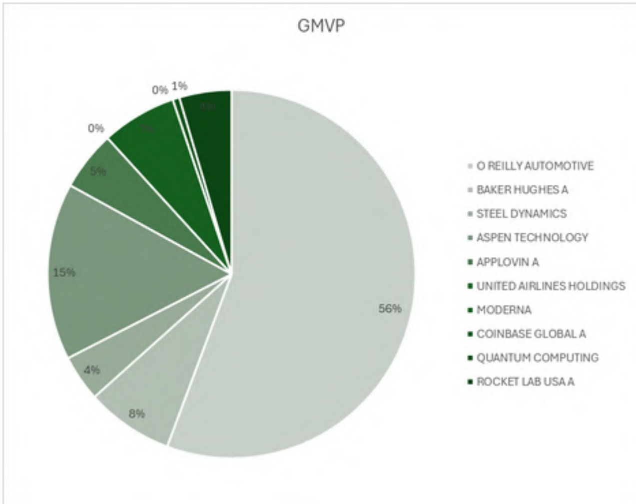
Nasdaq Portfolios summary (daily values)

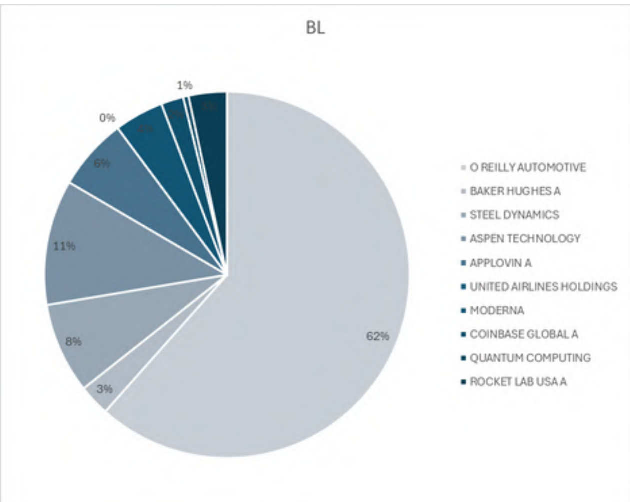
The portfolio weights for Nasdaq are the following:

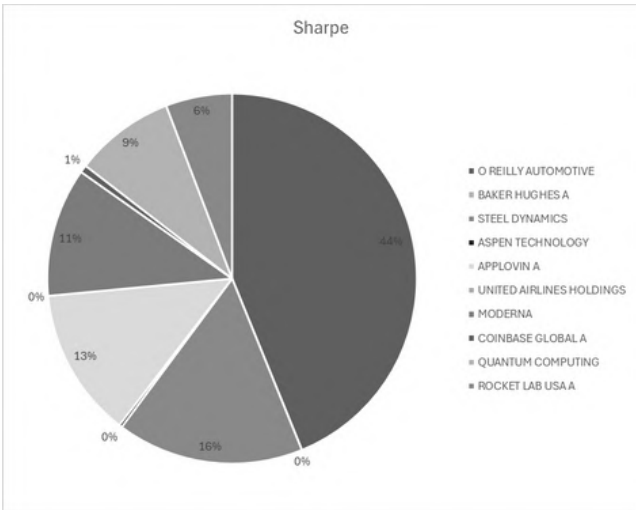












QUESTION 24: PORTFOLIOS COMBINATION

Nasdaq Portfolios summary (daily values)

The portfolio weights for Nasdaq previously displayed are the following:

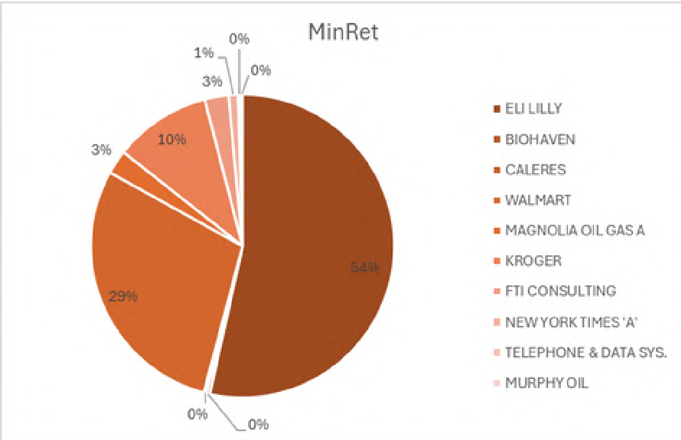
NASDAQ Securities	MinRisk	MinRisk MaxRet	HRP	BL	GMVP	Sharpe
O REILLY AUTOMOTIVE	0,25219	0,25164	0,12272	0,61597	0,5569	0,438354
BAKER HUGHES A	0,00047068	0,00047	0,066271	0,027612	0,0768	0
STEEL DYNAMICS	0,34639	0,34666	0,065824	0,080028	0,0407	0,163514
ASPEN TECHNOLOGY	0,00059581	0,00059492	0,22341	0,11061	0,1555	0,002695
APPLOVIN A	0,32035	0,32064	0,078327	0,063785	0,0523	0,130518
UNITED AIRLINES HOLDINGS	0,00025318	0,00025284	0,050225	0	0	0
MODERNA	0,0014887	0,0014838	0,13921	0,043611	0,066	0,112637
COINBASE GLOBAL A	0,0014887	0,00030189	0,05699	0,01987	0	0,006619
QUANTUM COMPUTING	0,040451	0,040486	0,069577	0,0047664	0,0059	0,087575
ROCKET LAB USA A	0,037502	0,037475	0,12745	0,033752	0,0458	0,058088

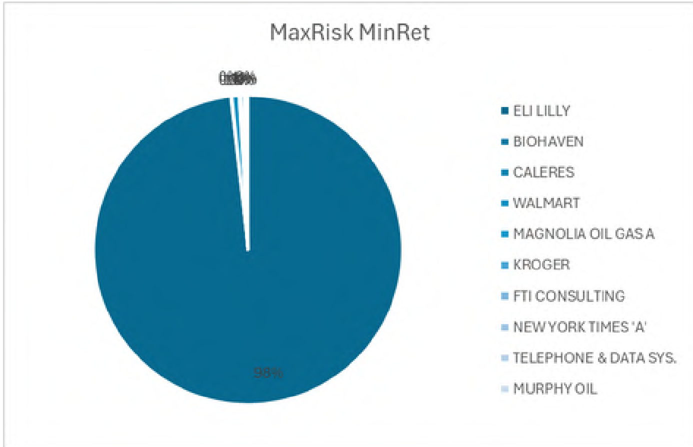
Type	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
MinRisk	0,0010002	0,019721	0,048714	6,4241	0,15297
MinRisk_Max Re	0,0010004	0,019731	0,0487	6,423	0,1539
HRP	0,0011256	0,019677	0,053212	7,8664	0,43404
BL	0,001098	0,014435	0,070656	11,12713	-0,379968
GMVP	0,0011	0,0142	0,0679	10,1552	-0,2334
Sharpe	0,00162	0,017406895	0,088553	5,891036	0,253079

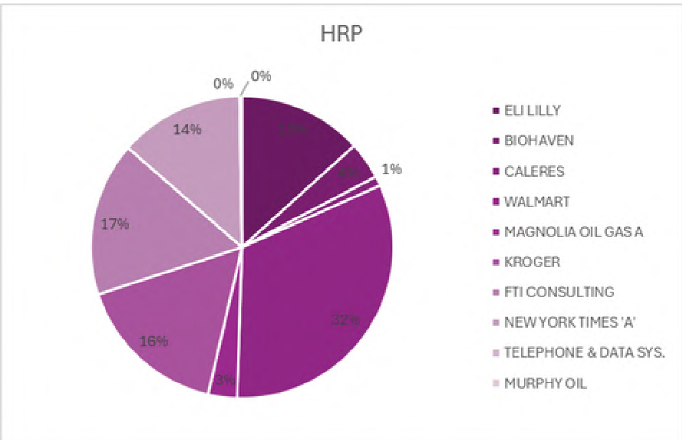
QUESTION 24: PORTFOLIOS COMBINATION

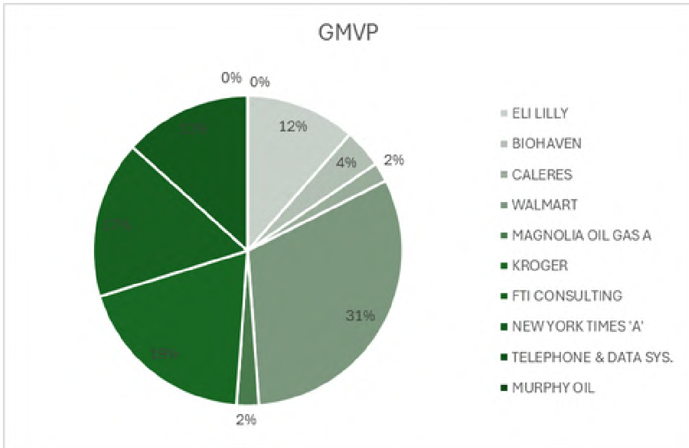
Nyse Portfolios summary (daily values)

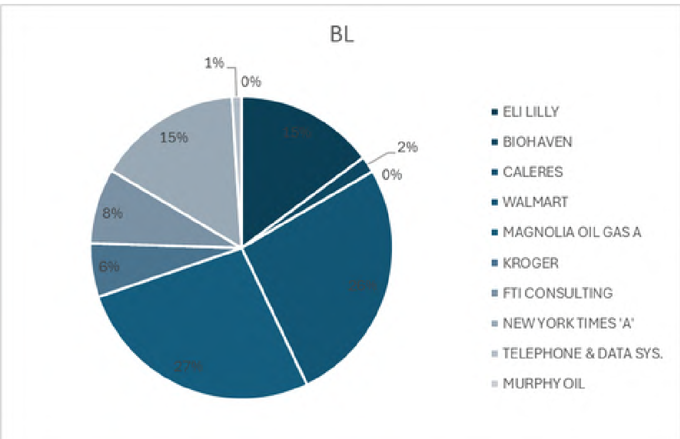
The portfolio weights for Nyse are the following:

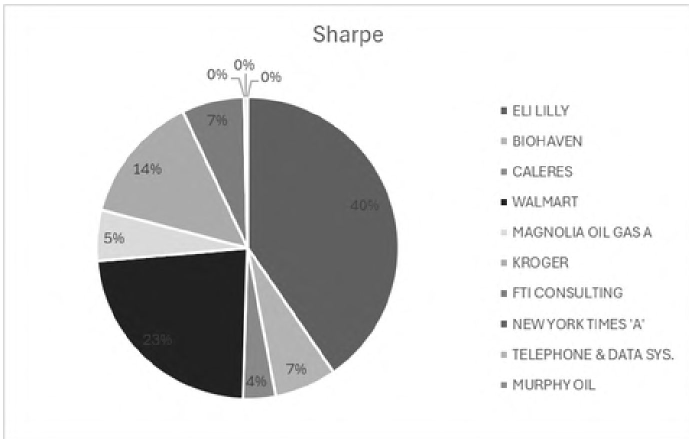












QUESTION 24: PORTFOLIOS COMBINATION

Nyse Portfolios summary (daily values)

The portfolio weights for Nyse previously displayed are the following:

NYSE Securities	MinRisk	MinRisk MaxRet	HRP	BL	GMVP	Sharpe
ELI LILLY	0,53476	0,98221	0,1329	0,14832	0,1147	0,403758
BIOHAVEN	0,003477	0,00072989	0,039838	0,017573	0,0406	0,066152
CALERES	0,002851	0,00061027	0,010346	0	0,0202	0,034958
WALMART	0,28955	0,0069952	0,32214	0,26313	0,3127	0,231266
MAGNOLIA OIL GAS A	0,025684	0,0022792	0,030955	0,26866	0,0233	0,054507
KROGER	0,10354	0,0033487	0,16337	0,057207	0,1908	0,138813
FTI CONSULTING	0,025434	0,0013342	0,16466	0,080379	0,1642	0,066927
NEW YORK TIMES 'A'	0,010152	0,0011111	0,13366	0,15453	0,1334	0
TELEPHONE & DATA SYS.	0,002466	0,00071995	0	0,010198	0	0,003619
MURPHY OIL	0,002082	0,0006649	0,002139	0	0	0

Type	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
MinRisk	0,00100	0,01340	0,07176	11,96020	0,57829
MaxRet_MinRisk	0,00133	0,01960	0,06593	12,30370	1,06170
HRP	0,00088	0,02127	0,03766	33,09000	2,07630
BL	0,00094	0,01343	0,06394	8,53229	-0,21899
GMVP	0,00080	0,01040	0,07150	9,52920	-0,01720
Sharpe	0,00112	0,01212	0,08565	9,90261	0,32208

QUESTION 24: PORTFOLIOS COMBINATION

First of all, we carefully analyzed the main differences between the various asset allocations performed during this report. As previously mentioned, the primary distinction between the Mean-Variance and Global Minimum Variance optimizations lies in the assets' selection purpose. While the former aims to maximize the Sharpe ratio by finding a balance between risk and return, the latter focuses on minimizing variance, often at the cost of returns. The results obtained meet the targets set. On the other hand, the Black-Litterman and Bayesian methods incorporate the investors' perspectives on portfolio performance.

By doing so, they introduce a subjective component into portfolio construction, which may or may not result in favorable outcomes. Nonetheless, it is crucial to emphasize that historical data do not necessarily predict future results; thus, employing prior-based Black-Litterman and Bayesian vectors derived from forward-looking views on past data could lead to poorer performance. This happens because the weights generated from future perspectives are applied to historical data to produce the final summary statistics.

The first approach was to determine the correct weight balancing in order to achieve the best possible result. After some analysis, our decision led us to create three different portfolios, each with a different objective: the first one aiming for a balanced result, the second for a riskier profile, and the third, the most conservative.

The weights for the three combinations of portfolios are displayed in the following table.

Weights Table

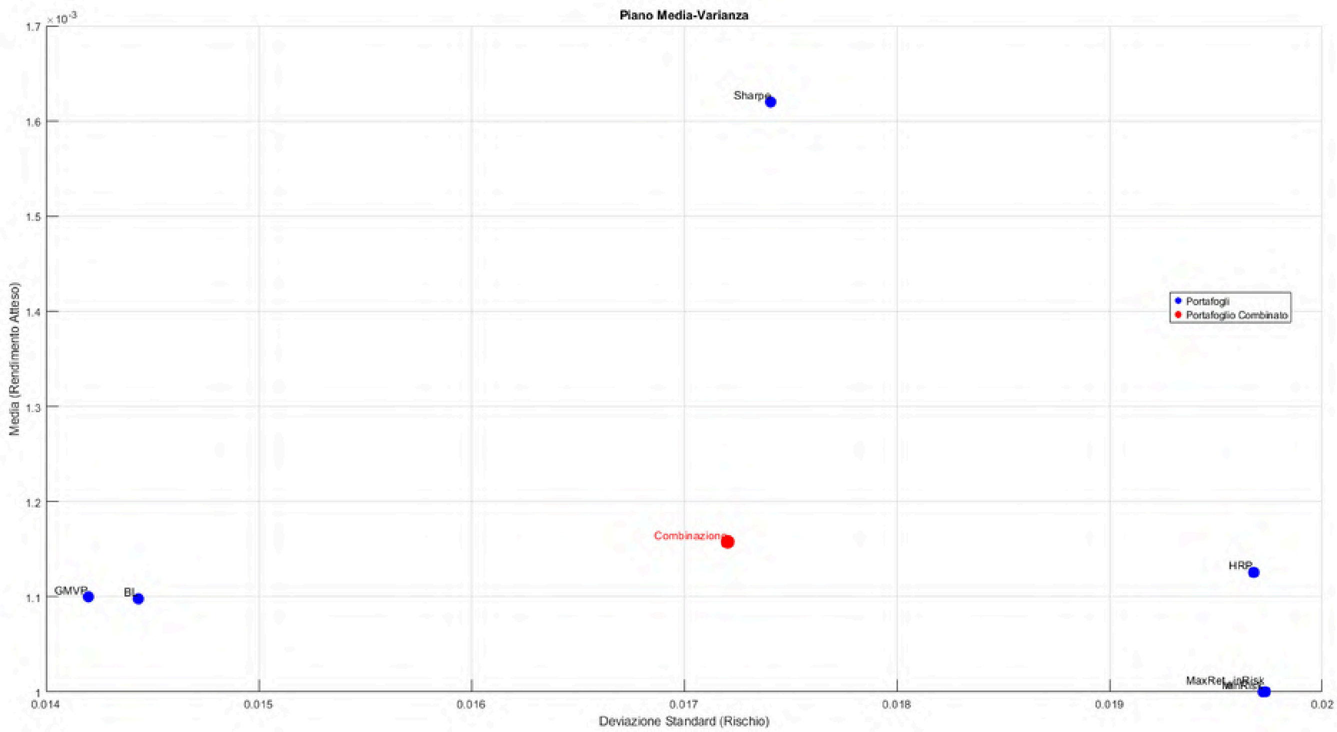
	CONSERVATIVE	BALANCED	RISKY
MIN RISK	0.35	0.2	0.05
MAX RET-MIN RISK	0.02	0.05	0.3
RISK PARITY	0.2	0.2	0.1
BLACK-LITTERMAN	0.1	0.2	0.15
GMVP	0.3	0.2	0.05
SHARPE	0.03	0.15	0.35

QUESTION 24: PORTFOLIOS COMBINATION

Nasdaq Portfolios Combination: (daily values)

NASDAQ BALANCED PORTFOLIO

The Mean-Variance plane for the Nasdaq Balanced Portfolio is the following:



The statistics for the Nasdaq Balanced Portfolio are the following:

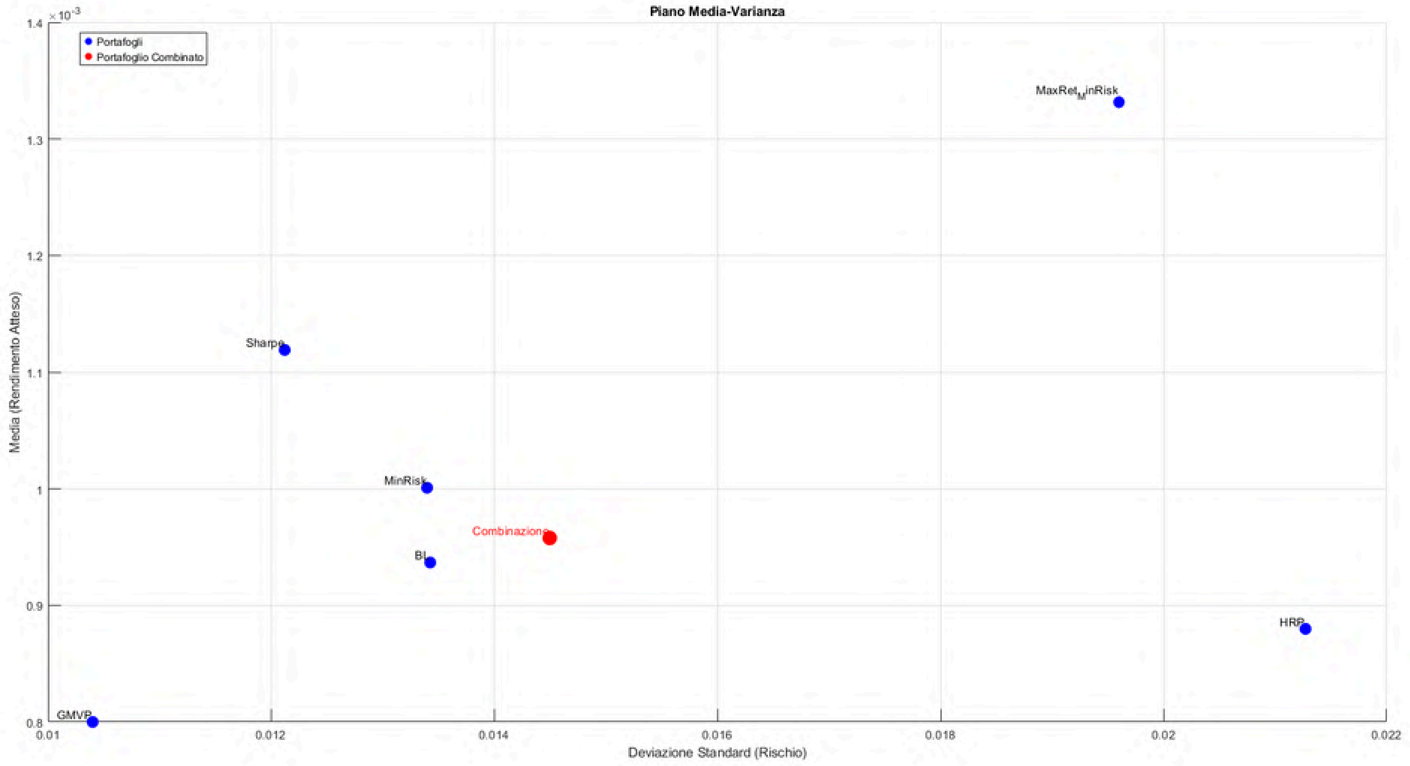
```
Statistiche del portafoglio di combinazione:
                     Mean        Stdev      Sharpe ratio    Kurtosis    Skeweness
                  _________    ________    ____________    ________    _________

    Combinazione  0.0011578    0.017204      0.063814       8.3194     0.040385
>>
```

QUESTION 24: PORTFOLIOS COMBINATION

Nyse Portfolios Combination (daily values)

NYSE BALANCED PORTFOLIO

The Mean-Variance plane for the Nyse Balanced Portfolio is the following:



The statistics for the Nyse Balanced Portfolio are the following:

```
Statistiche del portafoglio di combinazione:
```

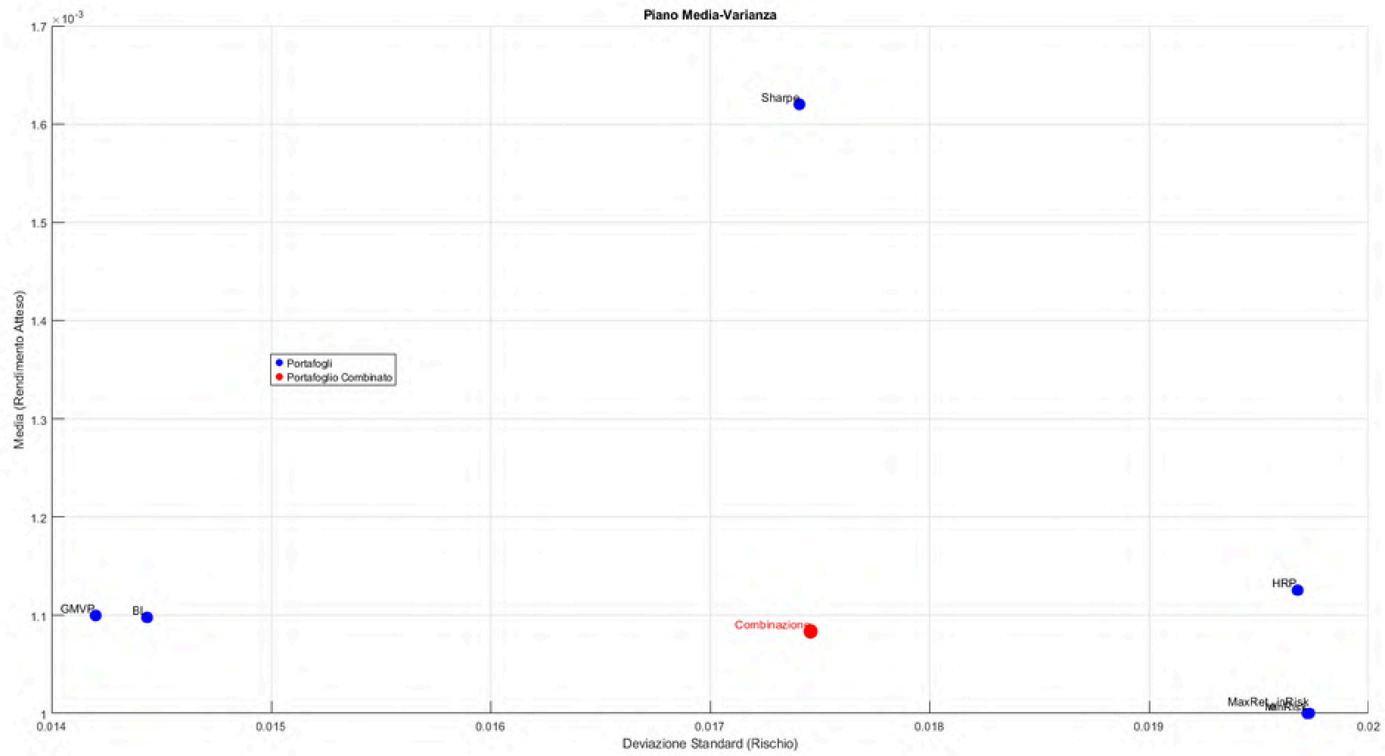
	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
Combinazione	0.00095797	0.014499	0.065115	14.723	0.58508

QUESTION 24: PORTFOLIOS COMBINATION

Nasdaq Portfolios Combination (daily values)

NASDAQ CONSERVATIVE PORTFOLIO

The Mean-Variance plane for the Nasdaq Conservative Portfolio is the following:



The statistics for the Nasdaq Conservative Portfolio are the following:

Statistiche del portafoglio di combinazione:

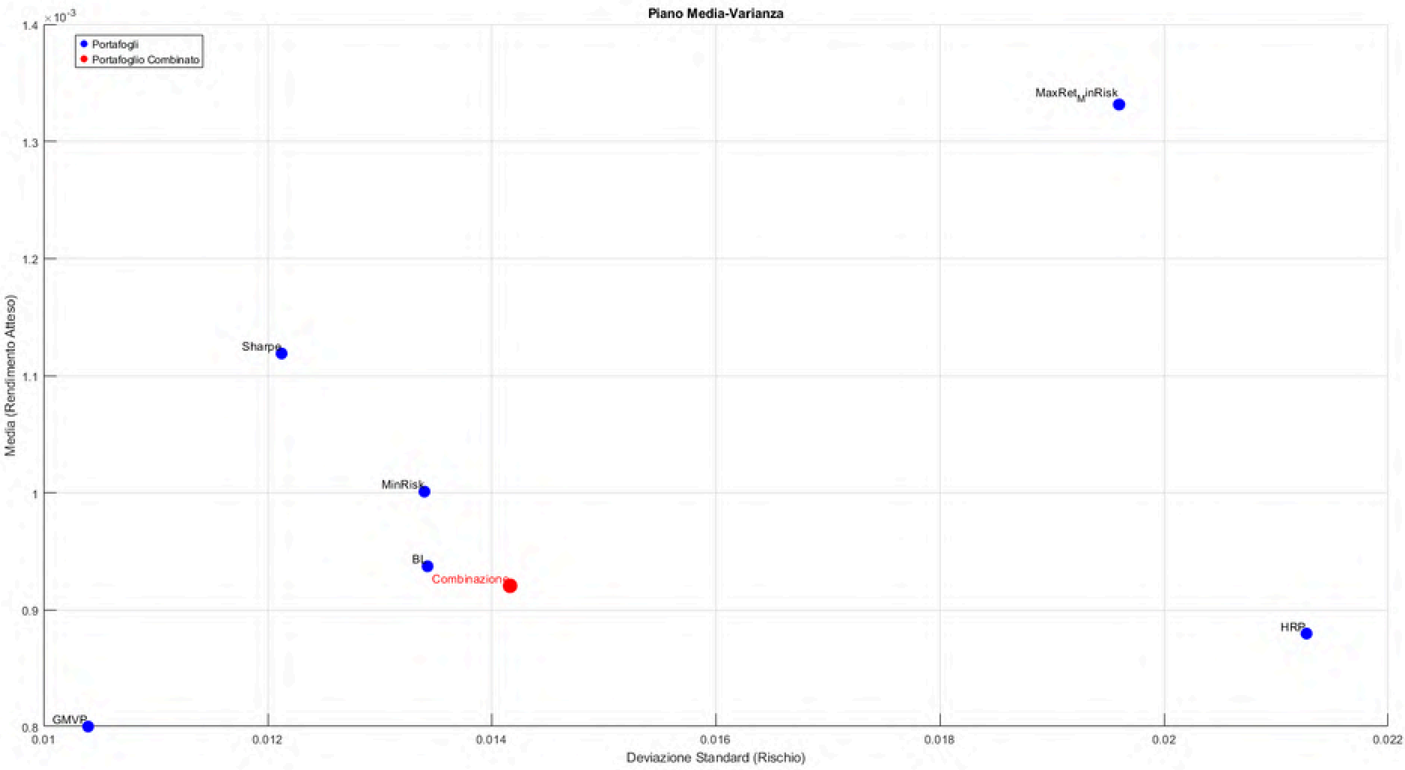
	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
Combinazione	0.0010836	0.017458	0.058758	8.2862	0.043001

QUESTION 24: PORTFOLIOS COMBINATION

Nyse Portfolios Combination (daily values)

NYSE CONSERVATIVE PORTFOLIO

The Mean-Variance plane for the Nyse Conservative Portfolio is the following:



The statistics for the Nyse Conservative Portfolio are the following:

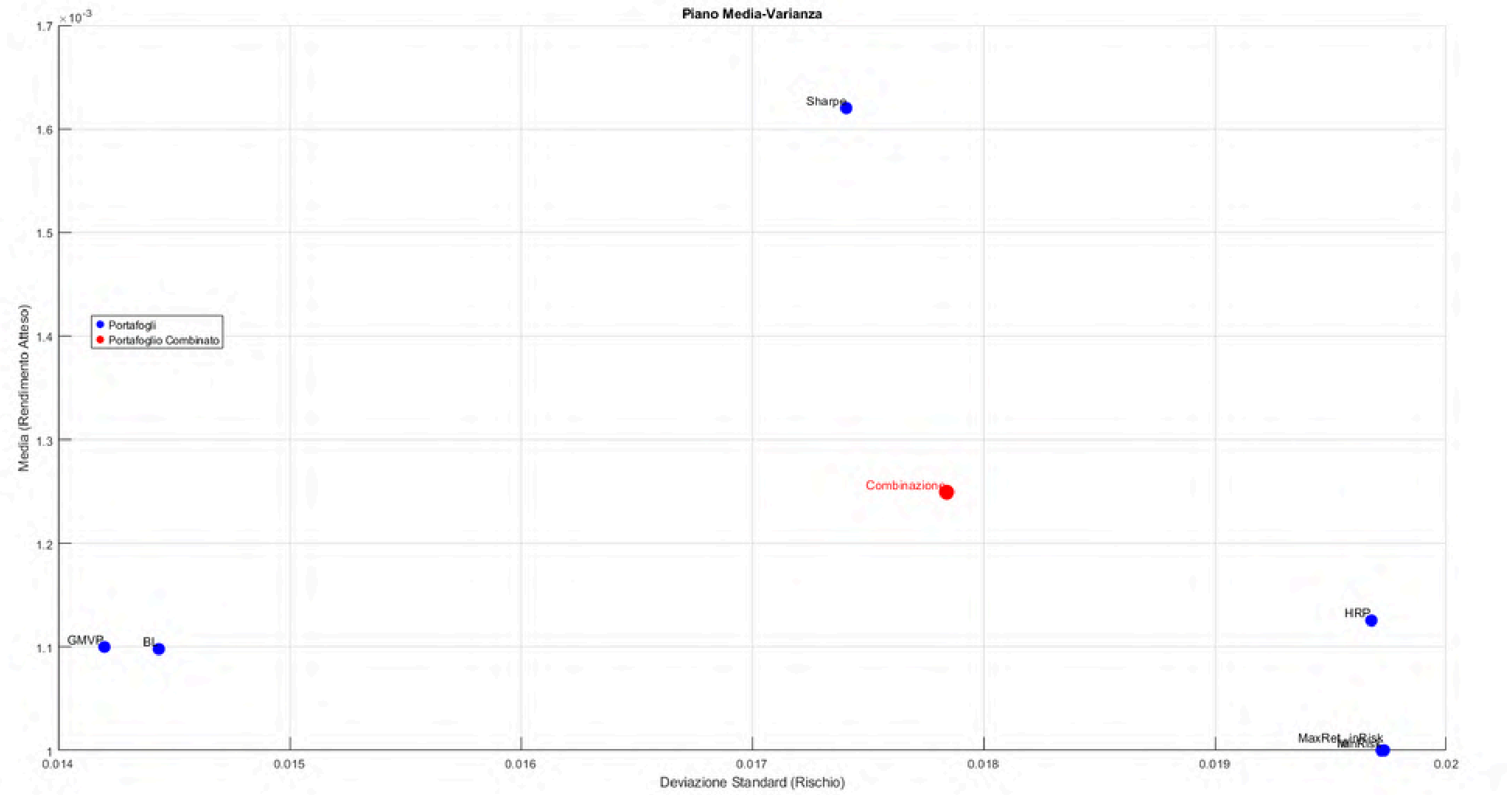
```
Statistiche del portafoglio di combinazione:
                    Mean        Stdev      Sharpe ratio    Kurtosis    Skeweness
                 _________    ________    ____________    ________    _________

    Combinazione    0.0009202    0.014163      0.064379       15.059       0.6215
>>
```

QUESTION 24: PORTFOLIOS COMBINATION

Nasdaq Portfolios Combination (daily values)

NASDAQ RISKY PORTFOLIO

The Mean-Variance plane for the Nasdaq Risky Portfolio is the following:



The statistics for the Nasdaq Risky Portfolio are the following:

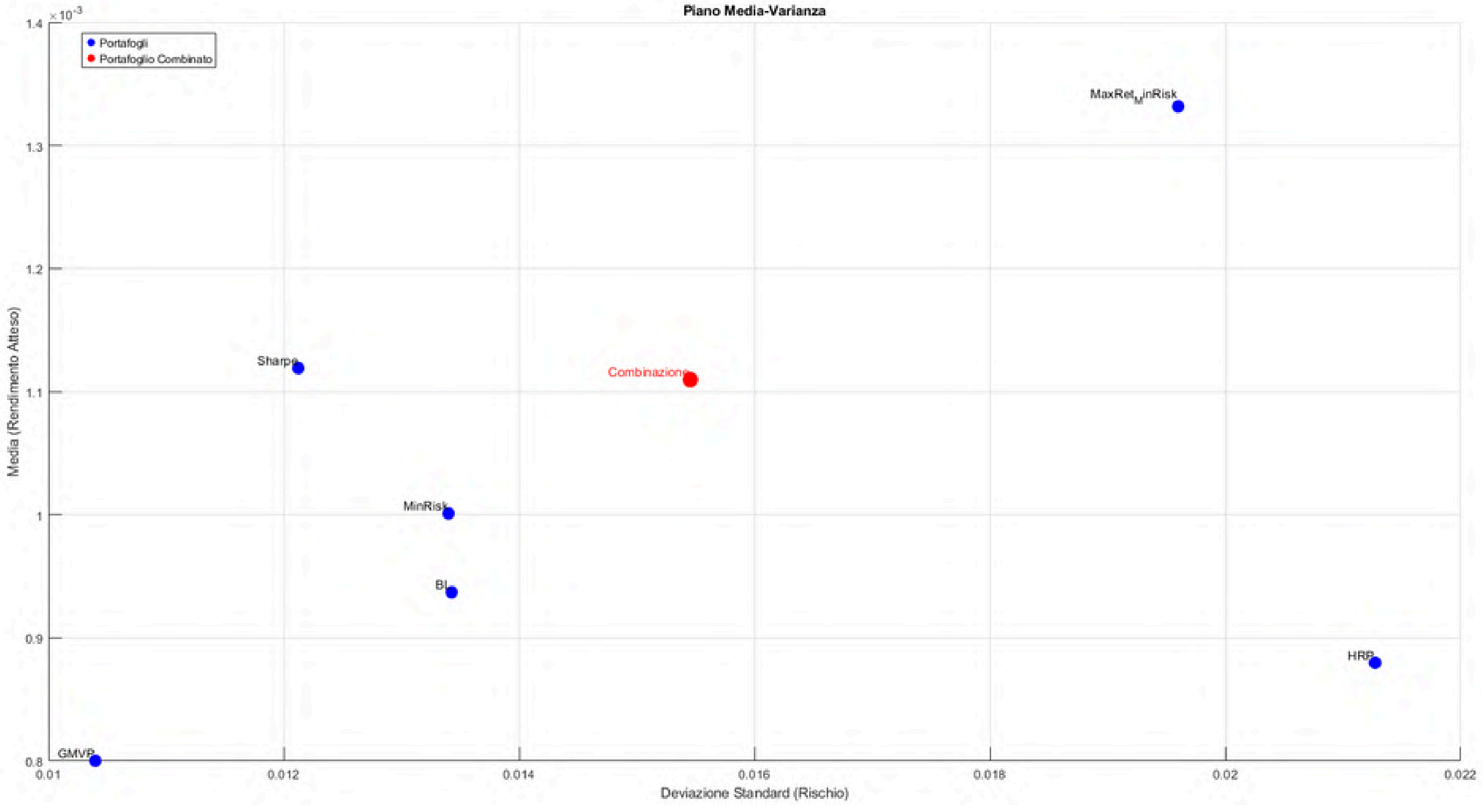
Statistiche del portafoglio di combinazione:

	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
Combinazione	0.0012494	0.017841	0.067354	7.2734	0.11713

Nyse Portfolios Combination (daily values)

NYSE RISKY PORTFOLIO

The Mean-Variance plane for the Nyse Risky Portfolio is the following:



The statistics for the Nyse Risky Portfolio are the following:

Statistiche del portafoglio di combinazione:

	Mean	Stdev	Sharpe ratio	Kurtosis	Skeweness
Combinazione	0.0011097	0.015455	0.070275	12.82	0.63407

References

- *Black-Litterman Portfolio Optimization Using Financial Toolbox (no date) MathWorks. Available at: https://it.mathworks.com/help/finance/black-litterman-portfolio-optimization.html (Accessed: 26 January 2025).*
- *Create Hierarchical Risk Parity Portfolio (no date) MathWorks. Available at: https://it.mathworks.com/help/finance/create-hierarchical-risk-parity-portfolio.html (Accessed: 26 January 2025).*
- *Pocci, C., Rotundo, G. and De Kok, R. (2016) Matlab per le Applicazioni Economiche e Finanziarie. Santarcangelo di Romagna: Maggioli Editore.*
- *Professor Marzo's lectures*

ALMA MATER STUDIORUM, UNIVERSITÀ DI BOLOGNA

Statistical Sciences Department
Second Cycle Degree in Quantitative Finance

Economics of Financial Markets
Take Home Exam

January 20th - 27th, 2025

QUESTION 3: ASSET ALLOCATION PROBLEM - FUNDS

using MATLAB and EXCEL

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- **QUESTION 1 : FUNDS DAILY STATISTICS** AND **MONTHLY STATISTICS** (P.6)
- **QUESTION 2, 3 AND 4: SAMPLE OF 7 FUNDS AND PERFORMANCE STATISTICS** (P.13)
- **QUESTION 5: PLOT THE BEHAVIOR OF SELECTED FUND PRICES** (P.17)
- **QUESTION 6,7,8: MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION** (P.21)
- **QUESTION 9,10: FUNDS PERFORMANCE RANKING** (P.29)

Resources

Github Repository (Scritps)
https://github.com/tommasozeri/Economics-Of-Financial-Markets-exam-2025-code

Disclaimer

- The data with NaN values were handled by taking the arithmetic mean of the known values.
- For question 3, the same scripts as in question 1 were used. The only changes involved adjusting the weights of the algorithm to select the best funds and the script related to point 9 of Q3. For this reason, the codes are not included in the presentation.

Abstract

This report presents all the results of the MATLAB scripts developed for Question 3, illustrating the code, the results from the Command Window, and the relevant figures for each question.
The analyses are conducted on a sample of mutual funds, focusing on daily and monthly performance statistics. The study examines key metrics such as mean, standard deviation, skewness, and kurtosis to evaluate fund returns and volatility. Specific attention is given to the performance of selected funds, with comparisons highlighting the highest and lowest performers across these metrics.
The funds are chosen according to a specific algorithm we implemented.
The report also includes plots of fund price behaviors, which reveal patterns of correlation among funds, particularly their similar movements due to a common focus on U.S. large-cap stocks.
A different behavior is observed for a few funds, such as Blackrock Mid Cap and Morgan Stanley Insight Fund A.
Additionally, efficient frontiers for the funds are plotted to illustrate the construction of Mean-Variance optimal portfolios.

Introduction

Many of the funds listed can be considered overexposed to the technology sector or large-cap companies. This overexposure stems from their investment strategies, which often prioritize high-growth industries or focus on stability and strong market positions typically associated with large-cap firms.

Funds like the Morgan Stanley Insight Fund or the Columbia Large Cap Growth Fund heavily emphasize high-growth companies, which are predominantly found in the technology sector. These funds tend to include companies like Apple, Microsoft, or Amazon, all of which dominate the tech industry. Moreover, growth-focused funds, such as those by Janus Henderson or Vanguard Explorer, naturally gravitate towards technology-driven innovation, including areas like biotech and fintech.

In addition, a significant number of these funds target large-cap companies, as seen with funds like the BlackRock Advantage Large Cap Core Fund and the JP Morgan US Equity Fund. Large-cap firms offer stability and predictable growth, making them attractive to core or blend funds. Companies such as Alphabet (Google), Meta, and Tesla often dominate the portfolios of these funds due to their market influence and consistent performance.

This overexposure, however, comes with implications. On one hand, it provides an opportunity to benefit from the dominance of large-cap companies and the rapid innovation of the tech sector, both of which have historically driven market growth. On the other hand, it creates vulnerabilities. If the tech sector faces regulatory pressures or economic downturns, or if large-cap companies underperform, these funds might experience significant drawbacks.

In conclusion, while these funds are well-positioned to capitalize on the continued growth of technology and large-cap companies, their concentration in these areas could pose risks in a less favorable market environment. Understanding the extent of this exposure is crucial for investors seeking balanced and diversified portfolios.

Key statistics

Throughout the report, the following key statistical metrics are extensively utilized.

$$\textbf{Portfolio Mean} = \sum_{i=1}^{n}(w_i \times R_i)$$

- w_i: The weight of asset i in the portfolio, which represents the proportion of capital invested in that asset.
- R_i: The expected return of asset i.
- The summation $\sum_{i=1}^{n}$ aggregates the contributions of all n assets in the portfolio.
- This formula provides the weighted average return of the portfolio, taking into account the relative allocation to each asset.

$$\textbf{Portfolio Variance} = \mathbb{E}\left[\sum_{i=1}^{n}\left(w_i \times (\tilde{R}_i - \mu_i)\right)\right]^2$$

- w_i: The weight of asset i in the portfolio, as defined above.
- $\tilde{R}_i$: The realized (or stochastic) return of asset i, which can deviate from its expected return.
- μ_i: The expected return of asset i.
- $\mathbb{E}$: The expectation operator, denoting the mean or expected value of the quantity enclosed.
- This formula measures the portfolio variance, capturing the total risk arising from the volatility of returns across all assets in the portfolio.

$$\textbf{Portfolio Skewness} = \frac{\sum_{i=1}^{n}\left(w_i^3 \times \text{Skew}(R_i)\right)}{\left(\sum_{i=1}^{n} w_i^2\right)^{3/2}}$$

- w_i^3: The cube of the weight of asset i, which increases the relative influence of more heavily weighted assets in the portfolio.
- $\text{Skew}(R_i)$: The skewness coefficient of the return of asset i. This measures the asymmetry of the return distribution.
  - Positive skewness indicates a distribution with a longer tail on the right, meaning more extreme positive returns.
  - Negative skewness implies a longer tail on the left, suggesting more extreme negative returns.
- The denominator $\left(\sum_{i=1}^{n} w_i^2\right)^{3/2}$: Normalizes the overall portfolio skewness to provide a consistent measure.
- This formula computes the asymmetry of the portfolio's return distribution, which is important for understanding deviations from normality.

$$\textbf{Portfolio Kurtosis} = \frac{\sum_{i=1}^{n}\left(w_i^4 \times \text{Kurt}(R_i)\right)}{\left(\sum_{i=1}^{n} w_i^2\right)^{2}}$$

- w_i^4: The fourth power of the weight of asset i, assigning greater importance to dominant assets in the portfolio.
- $\text{Kurt}(R_i)$: The kurtosis coefficient of the return of asset i. This measures the "tailedness" or extremity of the return distribution compared to a normal distribution.
  - Higher kurtosis indicates heavier tails, meaning a higher likelihood of extreme returns (both positive and negative).
  - Lower kurtosis suggests lighter tails, where extreme returns are less likely.
- The denominator $\left(\sum_{i=1}^{n} w_i^2\right)^{2}$: Normalizes the kurtosis for the portfolio.
- This formula provides a measure of the portfolio's return distribution shape, with particular emphasis on the presence of outliers and extreme values.

QUESTION 1 : FUNDS DAILY STATISTICS

Presented below is the code used to answer this question.

```
% Definisci il percorso del file
filename = 'C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx';
sheet = 'funds daily';

% Carica il file Excel
opts = detectImportOptions(filename, 'Sheet', sheet);
opts.VariableNamingRule = 'preserve';
data = readtable(filename, opts);

% Visualizza i dati
disp(data);

% Estrai le date e i ticker
dates = data{:, 1};
tickers = data.Properties.VariableNames(2:end);

% Converti i dati delle celle in valori numerici se necessario
for i = 2:width(data)
    if iscell(data{:, i})
        data{:, i} = str2double(data{:, i});
    end
end

% Calcola i rendimenti giornalieri
returns = diff(log(data{:, 2:end}));

% Inizializza le variabili per i risultati
mean_values = mean(returns);
variance_values = var(returns);
std_dev_values = std(returns);
skewness_values = skewness(returns);
kurtosis_values = kurtosis(returns);

% Crea una tabella con i risultati
results = table(tickers', mean_values', variance_values', std_dev_values', skewness_values',
kurtosis_values', ...
    'VariableNames', {'Ticker', 'Mean', 'Variance', 'StandardDeviation', 'Skewness', 'Kurtosis'});

% Visualizza i risultati
disp(results);
```

QUESTION 1 : FUNDS DAILY STATISTICS

The command window results display a table with all the statistics for each asset.

- The mean represents the average return of the asset,
- The standard deviation is a measure of the volatility of the asset's returns
- The skewness indicates the asymmetry of the return distribution relative to the mean. If skewness is positive, extreme gains are more likely; if it is negative, extreme losses are more probable, which happens in this case.
- The kurtosis measures the concentration and the tails of the return distribution. High kurtosis indicates heavier tails, meaning extreme events are more frequent compared to a normal distribution, whereas low kurtosis implies that extreme events are less likely.

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'FIDELITY MAGELLAN' }	0.00026854	0.00022729	0.015076	-0.78846	13.928
{'JANUS HENDERSON FORTY FUND I' }	0.00026083	0.00025849	0.016078	-0.95504	11.756
{'VANGUARD EXPLORER FD.' }	6.2201e-05	0.00028158	0.01678	-1.7077	19.997
{'VANGUARD PRIMECAP FD.' }	0.00010739	0.00021725	0.014739	-1.6297	18.442
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R' }	-5.639e-05	0.00023992	0.015489	-3.2692	47.86
{'BLACKROCK FD.MID CAP' }	0.00021985	0.0002804	0.016745	-0.58437	9.9157
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	0.00047112	0.00018156	0.013474	-0.88589	17.984
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I' }	0.00031221	0.00016686	0.012918	-1.175	18.821
{'FIDELITY MAGELLAN_1' }	0.00026854	0.00022729	0.015076	-0.78846	13.928
{'FIDELITY FD.' }	0.00046659	0.00020243	0.014228	-0.66054	13.721
{'JANUS HENDERSON RESEARCH FUND A' }	0.00037687	0.0002569	0.016028	-1.1213	14.342
{'JANUS HENDERSON ENTERPRISE FUND A' }	-4.3661e-05	0.00023242	0.015245	-2.2398	27.937
{'CAPITAL GROUP US EQUITY FUND' }	0.00022494	0.00014545	0.01206	-1.0474	17.008
{'FRANKLIN TEMPLETON SMACS: SERIES E' }	7.7772e-05	0.00013382	0.011568	-1.5566	28.77
{'PIMCO RAE US FUND A' }	8.7106e-05	0.00020581	0.014346	-1.3045	18.162
{'NEUBERGER BERMAN GENESIS FUND' }	5.6454e-05	0.0002418	0.01555	-1.2123	15.843
{'COLUMBIA LARGE CAP GROWTH FUND I' }	0.00037165	0.00024601	0.015685	-0.8496	11.959
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.00030095	0.00017879	0.013371	-0.88929	16.228
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE' }	0.00031546	0.00017822	0.01335	-0.88381	16.335
{'MORGAN STANLEY INSIGHT FUND A' }	-8.6064e-05	0.00075871	0.027545	-2.0577	27.447
{'JP MORGAN US EQUITY FUND I' }	0.00031101	0.00019505	0.013966	-1.1776	17.863
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	0.00033145	0.00019637	0.014013	-1.3605	20.409
{'GOLDMAN SACHS LARGE CAP CORE FUND A' }	0.00020987	0.0002106	0.014512	-1.5862	20.294

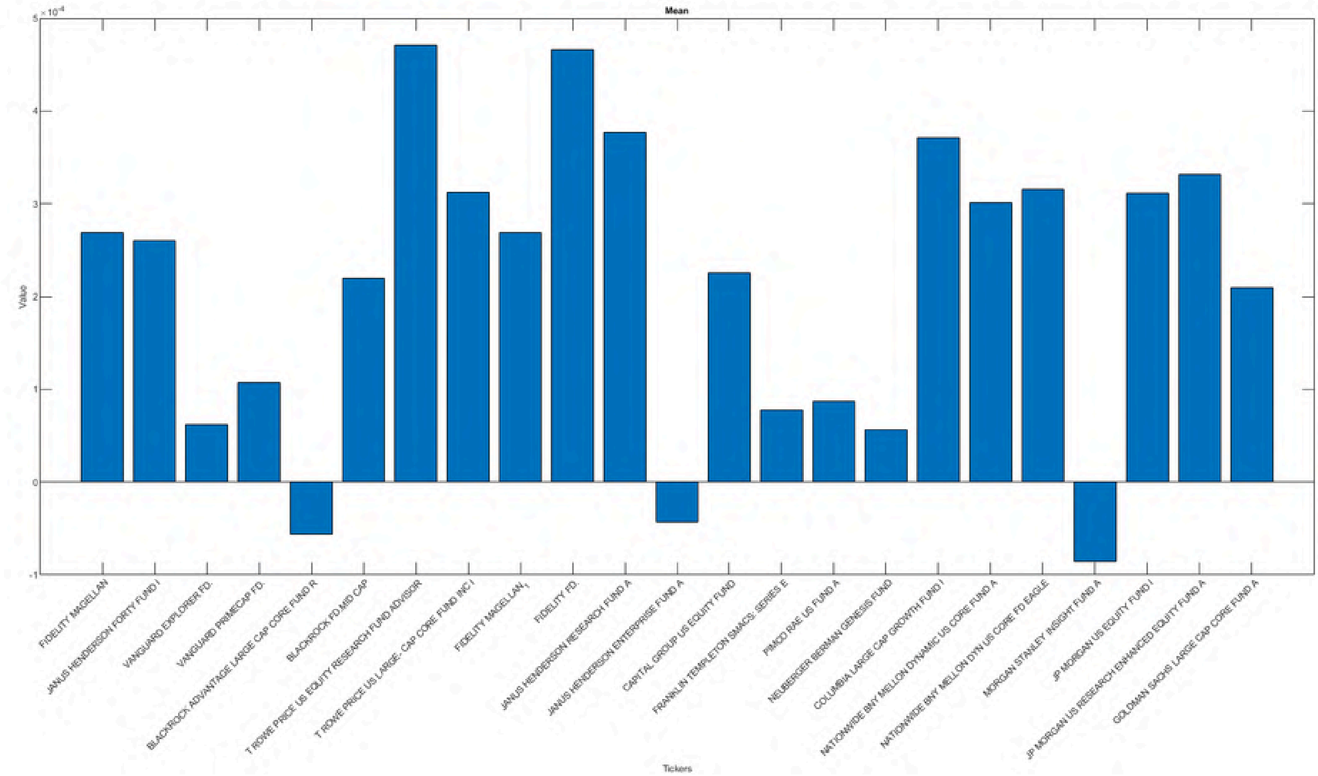
```
higher and lowest performers for each category:
Mean: higher = T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR (0.0005), lowest = MORGAN STANLEY INSIGHT FUND A (-0.0001)
Variance: higher = MORGAN STANLEY INSIGHT FUND A (0.0008), lowest = FRANKLIN TEMPLETON SMACS: SERIES E (0.0001)
Standard Deviation: higher = MORGAN STANLEY INSIGHT FUND A (0.0275), lowest = FRANKLIN TEMPLETON SMACS: SERIES E (0.0116)
Skewness: higher = BLACKROCK FD.MID CAP (-0.5844), lowest = BLACKROCK ADVANTAGE LARGE CAP CORE FUND R (-3.2692)
Kurtosis: higher = BLACKROCK ADVANTAGE LARGE CAP CORE FUND R (47.8601), lowest = BLACKROCK FD.MID CAP (9.9157)
```

Presented below are the histograms related to the **daily** statistics.

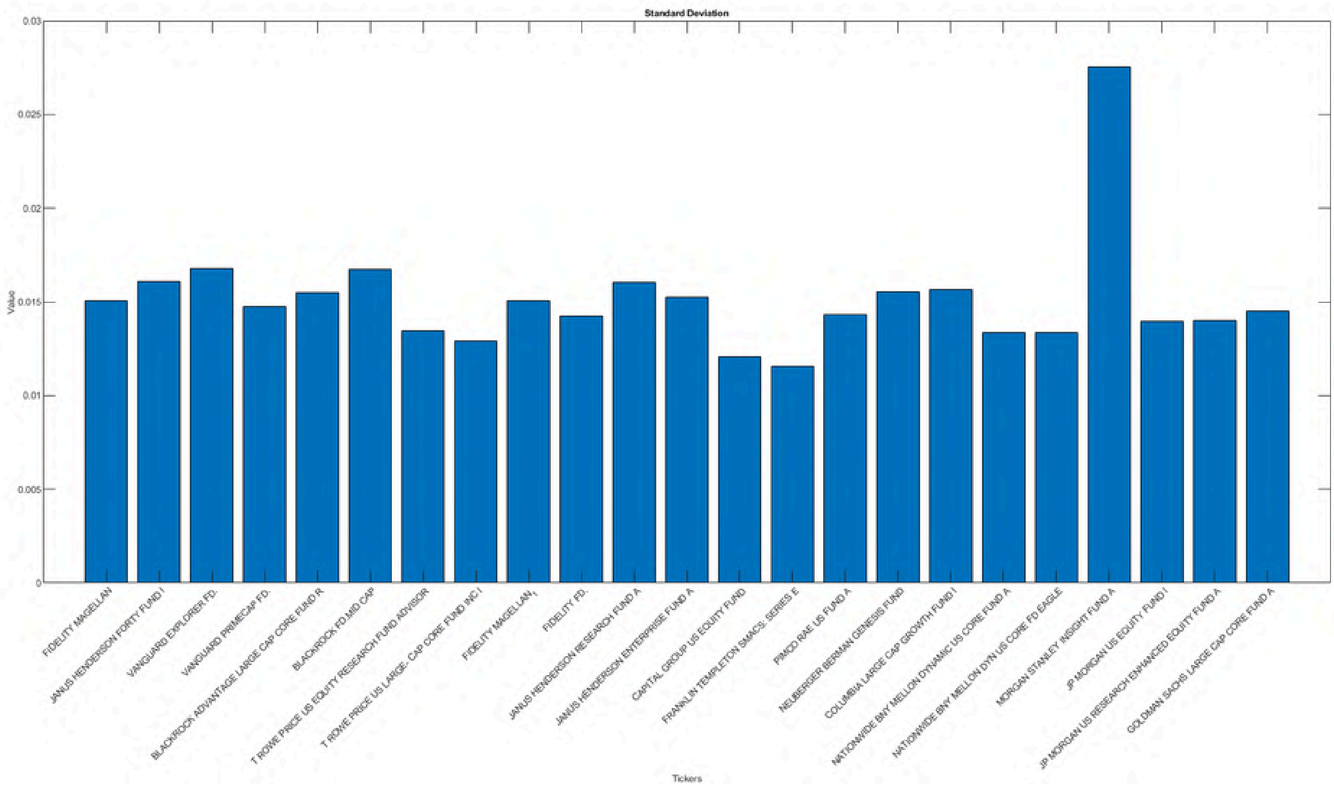
The analysis of the performance statistics highlights that the fund with the highest mean return was T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR (0.0102), while the fund with the lowest mean return was NEUBERGER BERMAN GENESIS FUND (-0.0050). In terms of risk, as measured by standard deviation, the highest risk was observed in the MORGAN STANLEY INSIGHT FUND A (0.1338), whereas the NEUBERGER BERMAN GENESIS FUND had the lowest risk (0.0373). Regarding skewness, the fund with the highest value was BLACKROCK FD.MID CAP (-0.2762), and the lowest skewness was noted for BLACKROCK ADVANTAGE LARGE CAP CORE FUND R (-1.3245). Lastly, the fund with the highest kurtosis was FRANKLIN TEMPLETON SMACS: SERIES E (6.2647), while the one with the lowest kurtosis was COLUMBIA LARGE CAP GROWTH FUND I (3.1232).

QUESTION 1 : FUNDS DAILY STATISTICS

MEAN

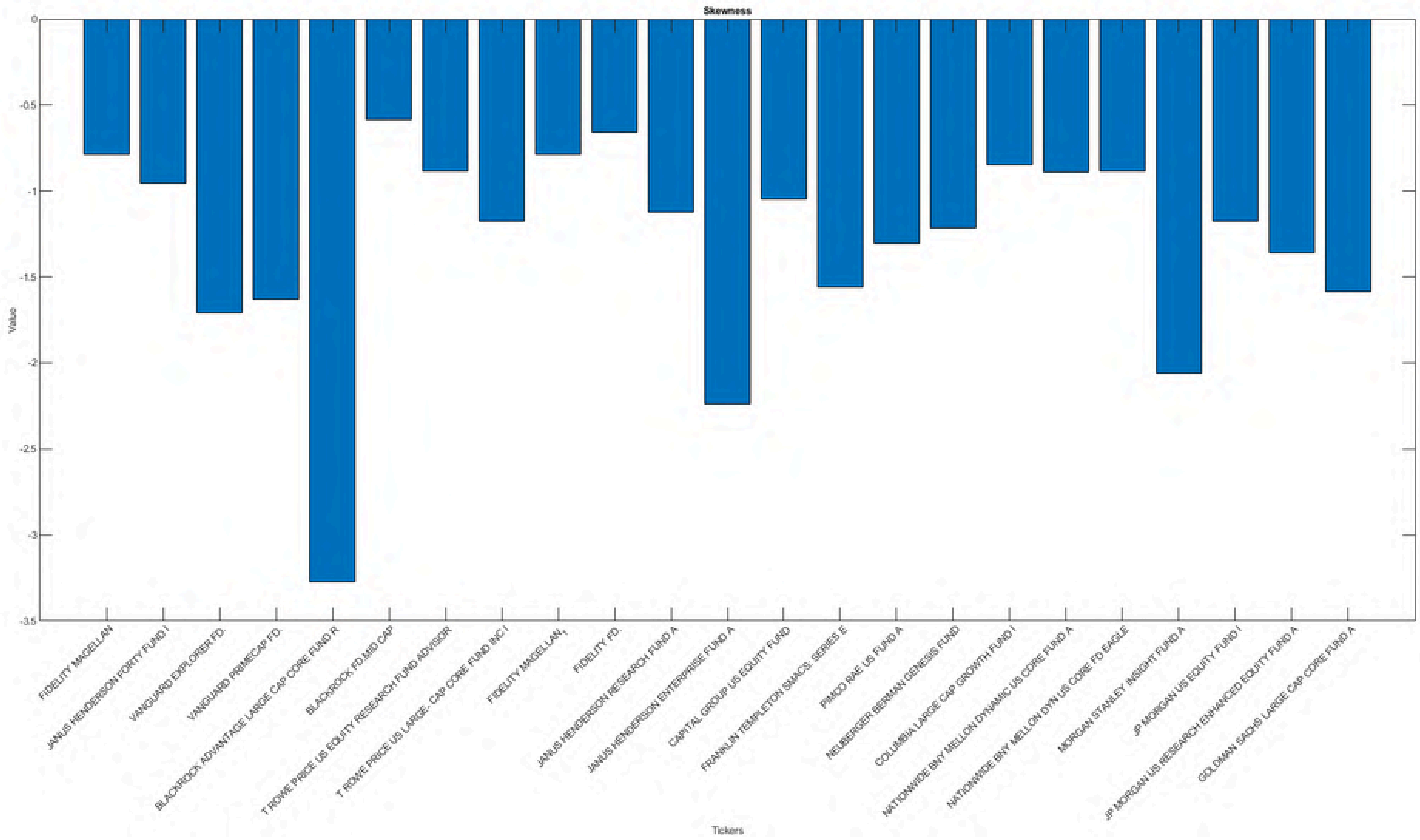


STANDARD DEVIATION

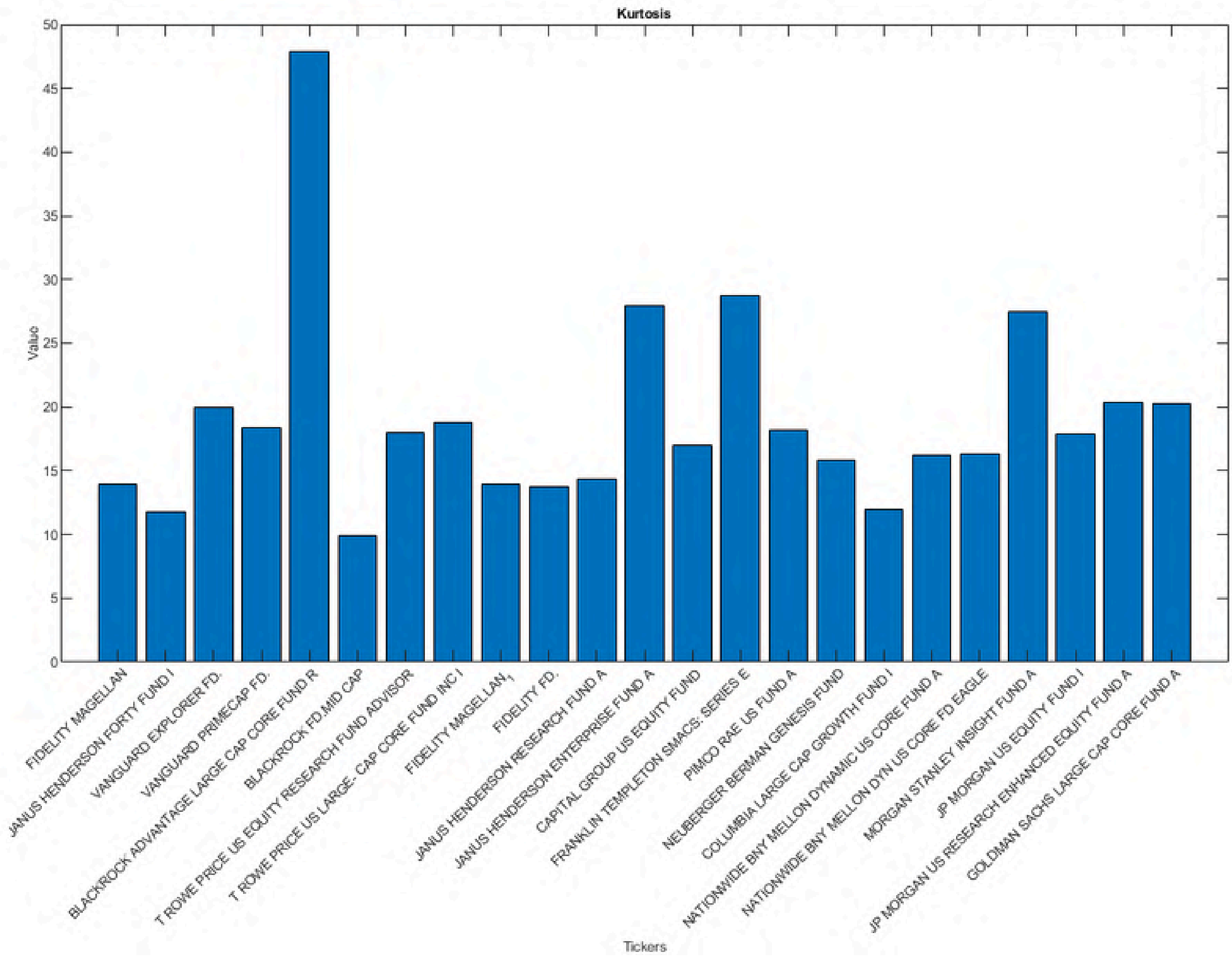


QUESTION 1 : FUNDS DAILY STATISTICS

SKEWNESS



KURTOSIS



QUESTION 1 : FUNDS MONTHLY STATISTICS

The results below are the **monthly** statistics for our funds.
As for the code, we used the one already shown in the previous section.
Also the performance statistics are the same: mean, variance, standard deviation, skewness, kurtosis, and they are shown in the following table.

Ticker	Mean	Variance	StandardDeviation	Skewness	Kurtosis
{'FIDELITY MAGELLAN' }	0.0058407	0.0034718	0.058922	-0.94424	4.157
{'JANUS HENDERSON FORTY FUND I' }	0.0056731	0.0040396	0.063558	-1.1136	4.0002
{'VANGUARD EXPLORER FD.' }	0.0013529	0.0039887	0.063156	-0.89377	4.2284
{'VANGUARD PRIMECAP FD.' }	0.0023358	0.0027436	0.052379	-0.83803	3.8081
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R' }	0.0025798	0.0042187	0.064952	-1.3245	5.8896
{'BLACKROCK FD.MID CAP' }	0.0060439	0.0053994	0.073481	-0.27619	3.5996
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	0.010247	0.0022742	0.047689	-1.2432	5.1057
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I' }	0.0067905	0.0023573	0.048552	-1.256	4.5296
{'FIDELITY MAGELLAN_1' }	0.0058407	0.0034718	0.058922	-0.94424	4.157
{'FIDELITY FD.' }	0.010148	0.0024372	0.049368	-0.90598	3.7231
{'JANUS HENDERSON RESEARCH FUND A' }	0.008197	0.0038984	0.062438	-1.1293	4.2375
{'JANUS HENDERSON ENTERPRISE FUND A' }	-0.00094962	0.0029552	0.054361	-0.91404	4.1717
{'CAPITAL GROUP US EQUITY FUND' }	0.0048923	0.0017907	0.042317	-1.0242	4.404
{'FRANKLIN TEMPLETON SMACS: SERIES E' }	0.0016916	0.0017671	0.042037	-1.1037	6.2647
{'PIMCO RAE US FUND A' }	0.0018946	0.0028138	0.053045	-0.81834	4.5884
{'NEUBERGER BERMAN GENESIS FUND' }	-0.0049989	0.0013901	0.037285	-0.41526	4.8566
{'NEUBERGER BERMAN GENESIS FUND_1' }	0.0012279	0.003173	0.056329	-0.64424	3.5219
{'COLUMBIA LARGE CAP GROWTH FUND I' }	0.0080833	0.0034076	0.058375	-0.78604	3.1232
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.0065456	0.0023607	0.048587	-1.0383	3.8411
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE' }	0.0068613	0.0023295	0.048265	-1.0352	3.8666
{'MORGAN STANLEY INSIGHT FUND A' }	-0.0018719	0.01791	0.13383	-1.0963	4.8181
{'JP MORGAN US EQUITY FUND I' }	0.0067645	0.0026416	0.051396	-1.1295	4.147
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	0.007209	0.0026173	0.051159	-1.2062	4.436
{'GOLDMAN SACHS LARGE CAP CORE FUND A' }	0.0045647	0.003016	0.054918	-1.151	4.1076

In the following chart, the best fund for each performance statistic is highlighted,.

```
higher and lowest performers for each category:
Mean: higher = T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR (0.0102), lowest = NEUBERGER BERMAN GENESIS FUND (-0.0050)
Variance: higher = MORGAN STANLEY INSIGHT FUND A (0.0179), lowest = NEUBERGER BERMAN GENESIS FUND (0.0014)
Standard Deviation: higher = MORGAN STANLEY INSIGHT FUND A (0.1338), lowest = NEUBERGER BERMAN GENESIS FUND (0.0373)
Skewness: higher = BLACKROCK FD.MID CAP (-0.2762), lowest = BLACKROCK ADVANTAGE LARGE CAP CORE FUND R (-1.3245)
Kurtosis: higher = FRANKLIN TEMPLETON SMACS: SERIES E (6.2647), lowest = COLUMBIA LARGE CAP GROWTH FUND I (3.1232)
```

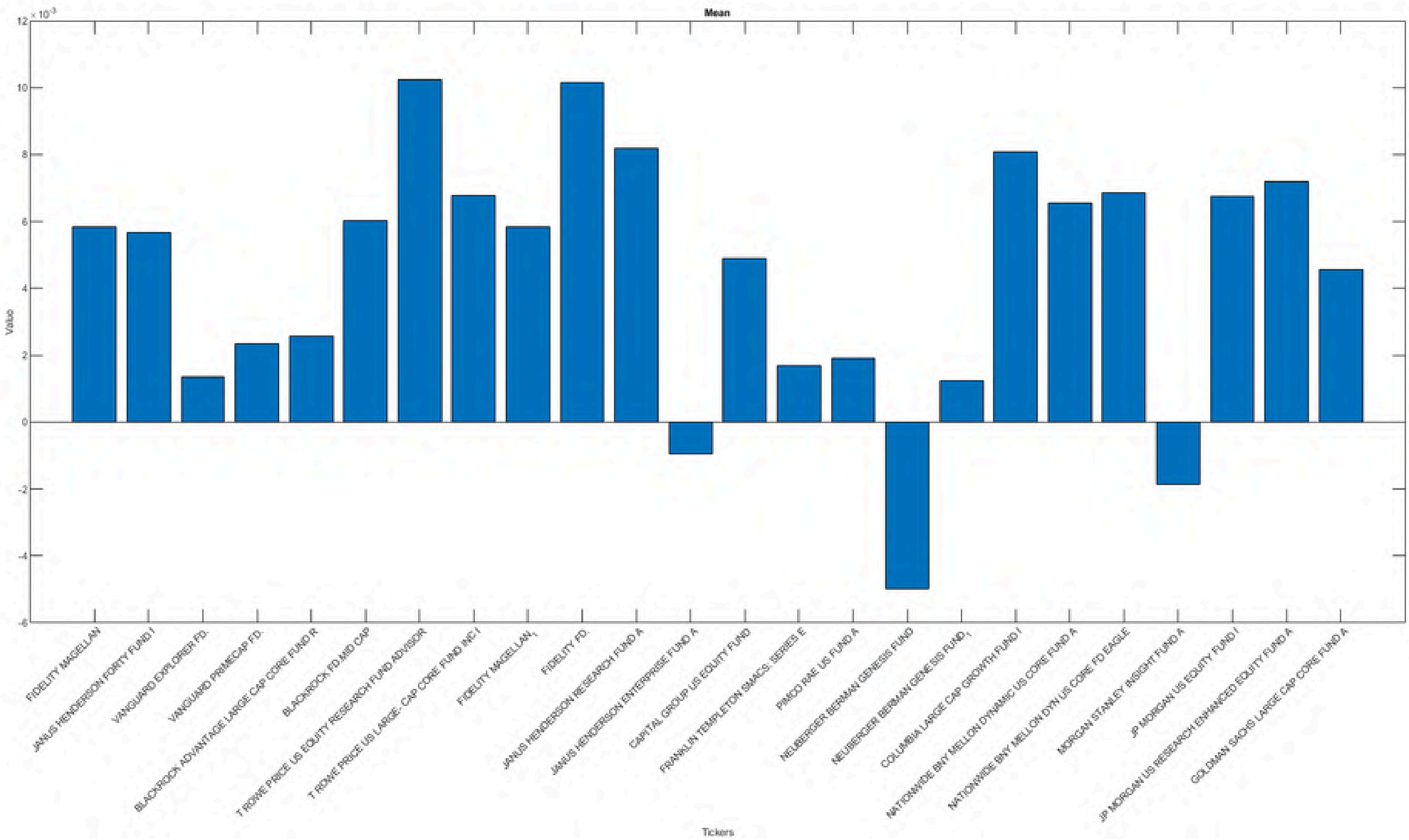
The data presented highlights the best and worst performing funds across various performance metrics. For mean returns, the T Rowe Price US Equity Research Fund Advisor stands out with the highest value of 0.0102, while the Neuberger Berman Genesis Fund trails with the lowest return of -0.0050. In terms of variance, the Morgan Stanley Insight Fund A leads with a higher variance of 0.0179, indicating more fluctuation in returns, while the Neuberger Berman Genesis Fund remains at the bottom with a much lower variance of 0.0014, signaling less risk. For standard deviation, the Morgan Stanley Insight Fund A also exhibits the highest level of risk at 0.1338, compared to the Neuberger Berman Genesis Fund, which has the lowest standard deviation of 0.0373, reflecting a more stable investment.

As for skewness, the BlackRock FD. Mid Cap fund shows the highest negative skew (-0.2762), suggesting its returns tend to be more negative, whereas the BlackRock Advantage Large Cap Core Fund R presents the lowest skewness at -1.3245, indicating a stronger tendency toward negative returns. Finally, when looking at kurtosis, the Franklin Templeton SMACS: Series E fund has the highest value of 6.2647, which implies more extreme returns compared to a normal distribution, while the Columbia Large Cap Growth Fund I shows the lowest kurtosis of 3.1232, indicating returns closer to a typical distribution.

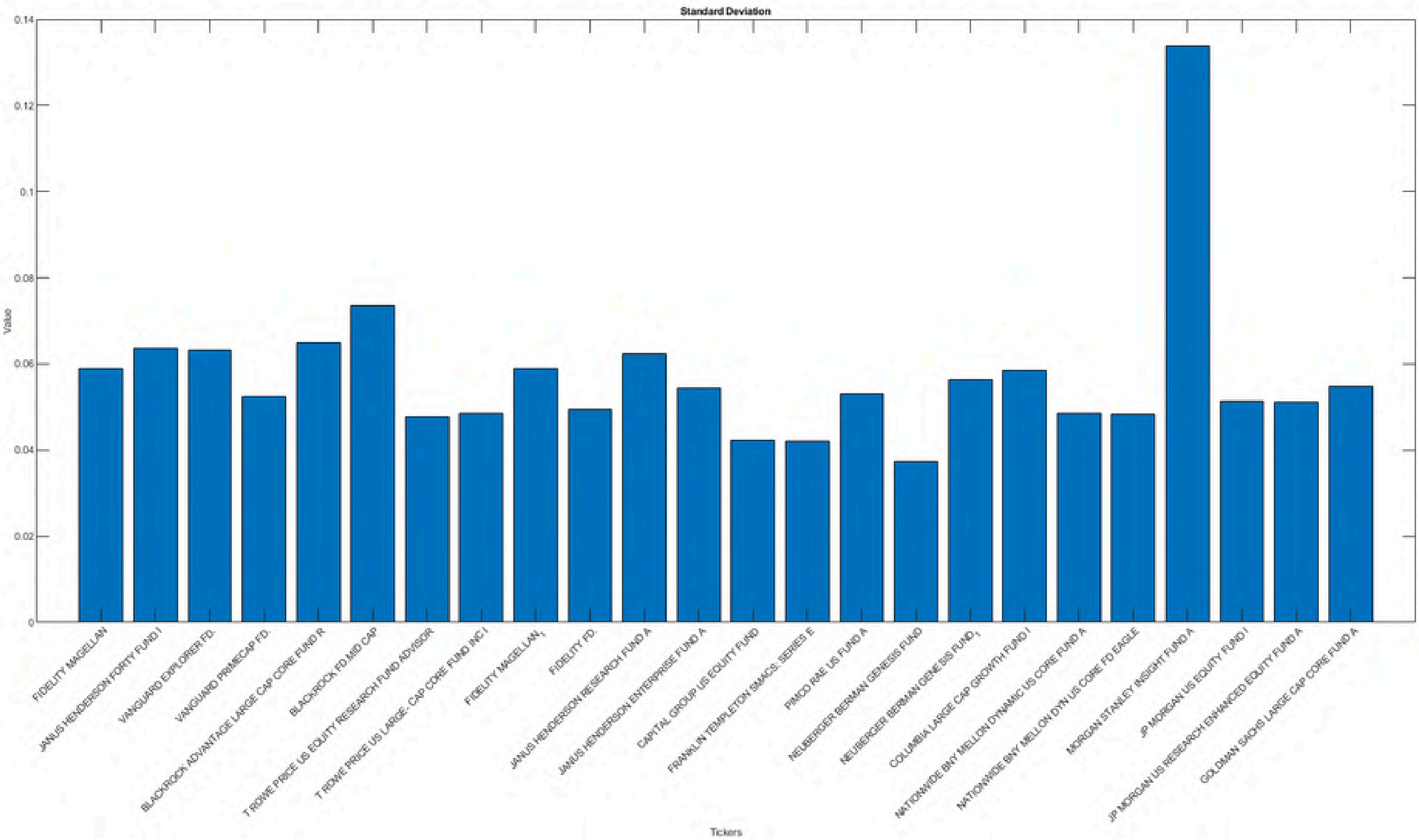
These findings provide useful insights for constructing a well-rounded portfolio. For instance, combining funds with high kurtosis and negative skewness (like Franklin Templeton SMACS: Series E) with those exhibiting low standard deviation and variance (like Neuberger Berman Genesis Fund) could help balance high-risk and low-risk assets, potentially improving the overall risk-return profile of the portfolio.

QUESTION 1 : FUNDS MONTHLY STATISTICS

MEAN

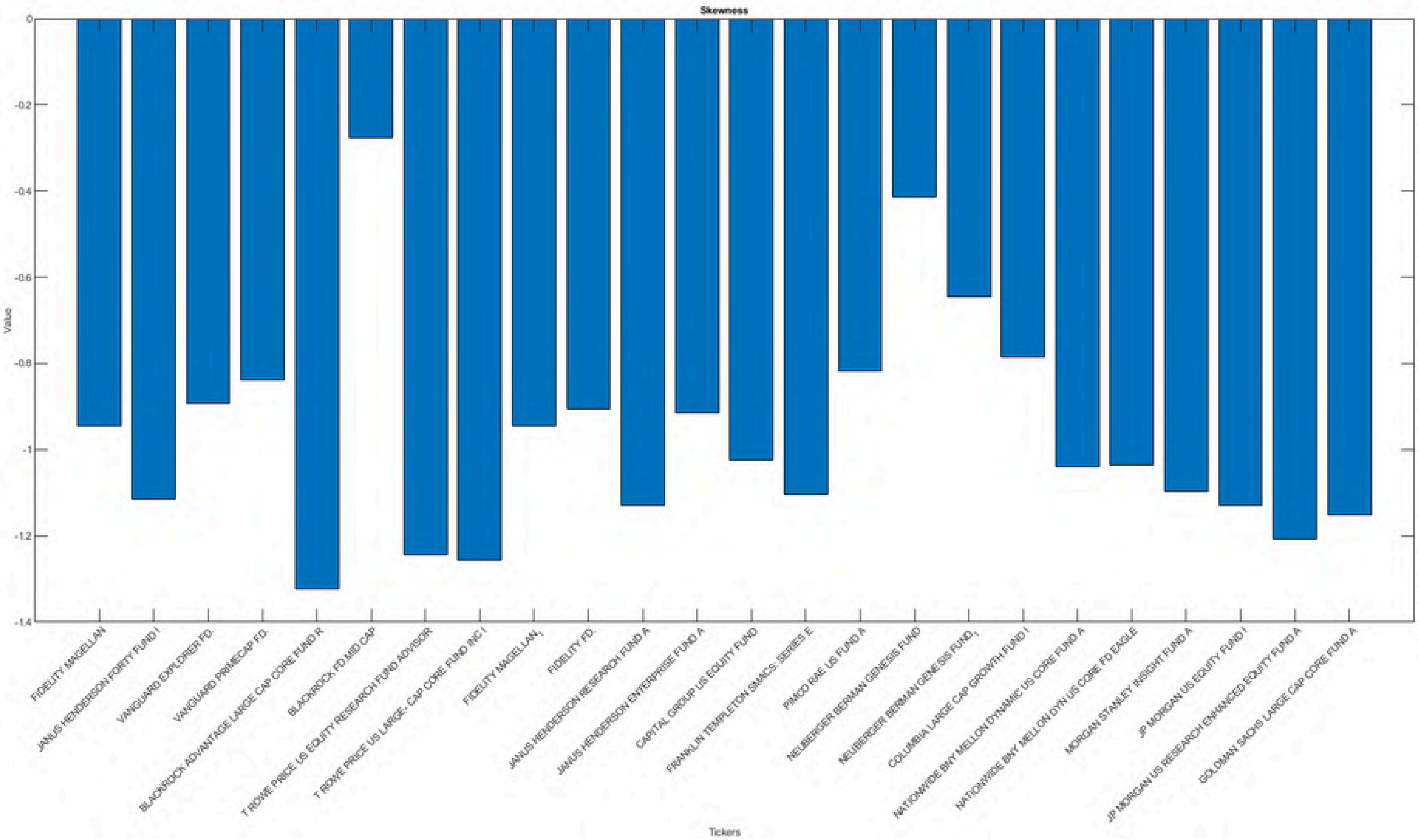


STANDARD DEVIATION

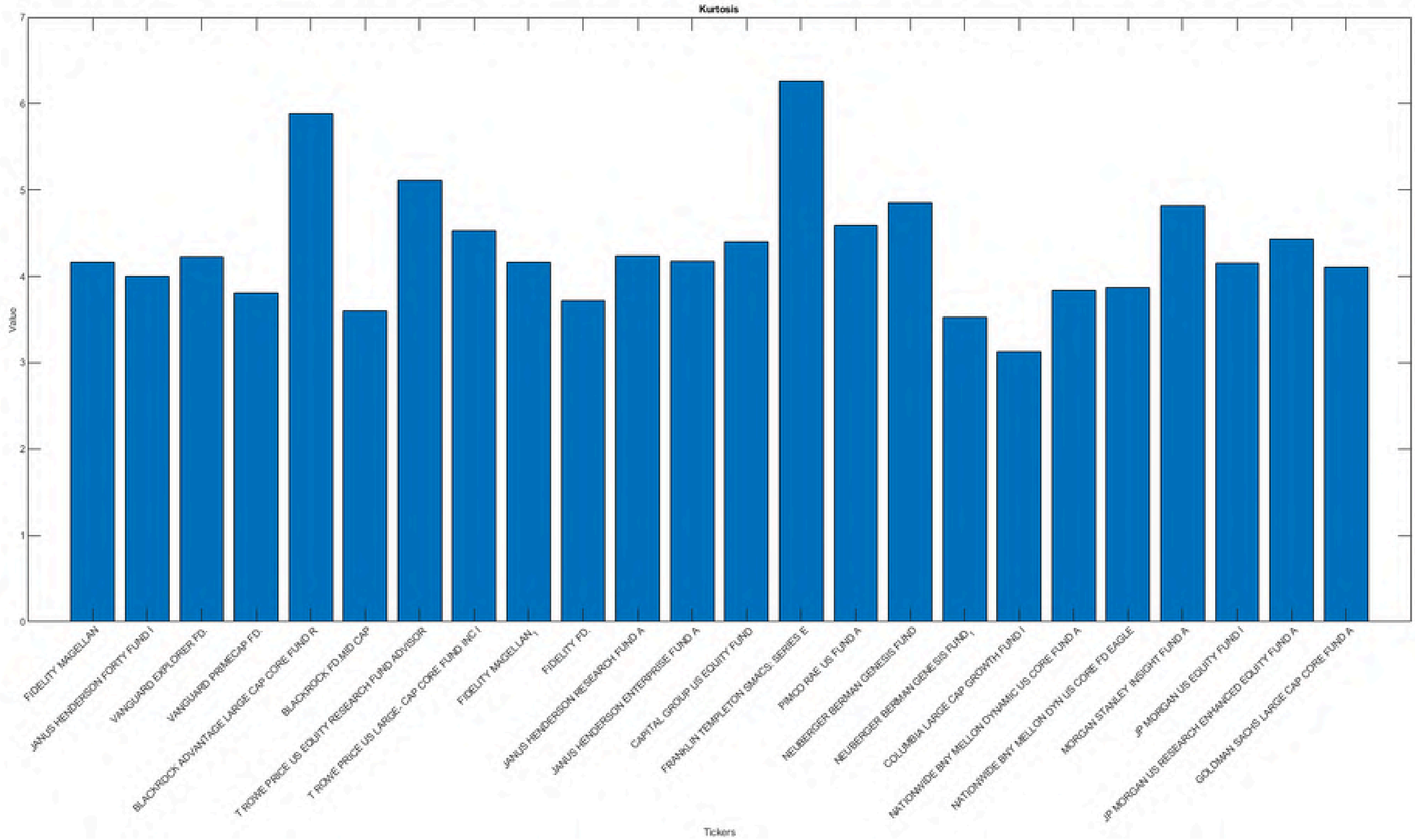


QUESTION 1 : FUNDS MONTHLY STATISTICS

SKEWNESS



KURTOSIS



QUESTION 2, 3 AND 4: SAMPLE OF 7 FUNDS AND PERFORMANCE STATISTICS

We have chosen 7 funds considering their higher diversification comparing to single stocks.

The funds are focused on U.S. equities, particularly on large-cap stocks and core strategies. The most appropriate benchmark to compare their performance is the S&P 500.

In the algorithm that we designed, the scoring system evaluates funds by assigning weighted scores to different categories, each focusing on a distinct aspect of performance. This ensures a well-rounded assessment of each stock's merits. Starting with return metrics, stocks are scored based on their mean returns, rewarding higher returns with higher scores. Jensen's alpha further evaluates excess returns beyond what is expected based on the fund's beta, giving additional points to those that generate significant outperformance. Returns are a primary driver of investment decisions, so this category typically carries substantial weight.
Risk metrics are another critical component of the scoring system, incorporating standard deviation, beta, and drawdown. Standard deviation assesses volatility, with lower volatility stocks receiving better scores due to their stability. Beta measures sensitivity to market movements, rewarding stocks with values closer to the desired range based on the portfolio's risk tolerance. Drawdowns, including average drawdown, maximum drawdown, and the pain index, are used to penalize stocks prone to deep or prolonged losses, ensuring that the risk of substantial downside is minimized. Together, these risk metrics balance the returns to maintain a prudent approach.

Risk-adjusted performance is assessed through metrics like the Sharpe ratio, Treynor ratio, and Burke ratio. These measurements emphasize how effectively a fund compensates investors for the risks undertaken. The Sharpe ratio evaluates risk-adjusted returns by considering volatility, while the Treynor ratio focuses on the reward for systematic risk relative to beta. The Burke ratio penalizes stocks with high drawdowns, rewarding those that demonstrate resilience against downside risk. This category often carries significant weight, reflecting its importance in identifying stocks that achieve a favorable balance between risk and reward.

The scoring system also accounts for diversification, examining how each stock correlates with the broader market or other portfolio components. Stocks with lower correlations are favored, as they improve diversification and reduce overall portfolio risk. Although this category typically has a smaller weight in the overall score, it plays a vital role in constructing a well-diversified portfolio.
Long-term stability is considered by analyzing annualized metrics for return, risk, and risk-adjusted performance. Funds that exhibit consistent performance over time are rewarded, emphasizing their suitability for long-term investment strategies. These metrics add an additional layer of reliability to the evaluation.

Each metric in the scoring system is normalized to assign a relative score between zero and one. A weighted sum of these scores is then calculated to derive the final score for each fund. Return metrics might account for around thirty percent of the total weight, risk metrics twenty-five percent, risk-adjusted performance thirty-five percent, and diversification and stability the remaining ten percent combined. This weighting structure highlights the importance of balancing high returns, controlled risk, consistent performance, and diversification. Stocks with the highest total scores emerge as the top candidates for inclusion in the portfolio.

QUESTION 2, 3 AND 4: SAMPLE OF 7 FUNDS AND PERFORMANCE STATISTICS

The algorithm we have implemented to select the 7 funds takes into account the mean, standard deviation, correlation matrix, and the following financial indexes:

$$\textbf{Sharpe Ratio:} \quad SR = \frac{\mu_p - \mu_f}{\sigma_p}$$

where: μ_p = portfolio return, μ_f = risk-free rate, σ_p = portfolio standard deviation.

The **Sharpe Ratio** is a widely used financial metric that measures the performance of an investment compared to a risk-free asset, after adjusting for its risk. It was developed by Nobel laureate William F. Sharpe and is instrumental in assessing the risk-adjusted return of an investment portfolio.

$$\textbf{Sterling Ratio:} \quad SR = \frac{\mu_p - \mu_f}{D_{\max}}$$

where: μ_p = portfolio return, μ_f = risk-free rate, $D_{\max}$ = maximum drawdown.

The **Sterling Ratio** is a risk-adjusted performance metric that evaluates the returns of an investment relative to its drawdowns. It measures how much excess return an investment generates over a risk-free rate for each unit of downside risk taken.

$$\textbf{Burke Ratio:} \quad BR = \frac{\mu_p - \mu_f}{\sqrt{\sum_{i=1}^{d} D_i^2}}$$

where: μ_p = portfolio return, μ_f = risk-free rate, D_i = drawdown for period i.

The **Burke Ratio** is a risk-adjusted performance metric introduced by G. Timothy Burke in 1994. It evaluates an investment's excess return relative to its drawdown risk, providing insight into how well an investment compensates for the risk of significant losses.

$$\textbf{Jensen's Alpha:} \quad \alpha = \mu_p - \mu_f - \beta_p(\mu_m - \mu_f)$$

where: μ_p = portfolio return, μ_f = risk-free rate, β_p = portfolio beta, μ_m = market return.

Jensen's alpha is a risk-adjusted performance metric that evaluates how much a portfolio or investment outperforms or underperforms its expected return, as predicted by the Capital Asset Pricing Model (CAPM). It measures the abnormal return of an investment, indicating the value added or subtracted by a portfolio manager's decisions beyond market movements.

$$\textbf{Treynor Index:} \quad T = \frac{\mu_p - \mu_f}{\beta_p}$$

where: μ_p = portfolio return, μ_f = risk-free rate, β_p = portfolio beta (systematic risk).

Treynor index measures returns earned in excess of that which could have been earned on a risk-free investment per unit of market risk.

$$\textbf{Information Ratio:} \quad IR = \frac{\mu_p - \mu_b}{TE}$$

where: μ_p = portfolio return, μ_b = benchmark return, TE = tracking error.

The **Information Ratio** (IR) is a performance metric that evaluates the excess return of a portfolio or investment relative to a benchmark, adjusted for the volatility of that excess return. It measures the consistency with which a portfolio manager outperforms a benchmark index, providing insight into the manager's skill in generating superior risk-adjusted returns.

$$\textbf{Pain Ratio:} \quad PR = \frac{\mu_p - \mu_f}{\sum_{i=1}^{n} D_i}$$

where: μ_p = portfolio return, μ_f = risk-free rate, D_i = drawdown for period i.

The **Pain Ratio** is a risk-adjusted performance metric that evaluates the return of an investment relative to the drawdowns it experiences. he Pain Ratio offers insight into how effectively an investment compensates for the risk of declines in value.

QUESTION 2, 3 AND 4: SAMPLE OF 7 FUNDS AND PERFORMANCE STATISTICS

The 7 best funds and their statistics are the following:

I migliori 7 titoli annualizzati selezionati sono:

Stock
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}
{'FIDELITY FD.'}
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}
{'JP MORGAN US EQUITY FUND I'}
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}

Beta	Annualized_Mean_Return	Annualized_Std_Dev	Annualized_Sharpe_Ratio	Annualized_Information_Ratio	Pain_Index	Sterling_Ratio
1.0101	0.14153	0.21292	0.57081	0.035688	0.11559	0.0041723
0.93644	0.099603	0.20374	0.3907	-0.16851	0.13955	0.0022636
1.0353	0.14303	0.22507	0.54664	0.04042	0.15317	0.0031875
0.98498	0.098283	0.21123	0.3706	-0.16878	0.16904	0.0018378
0.98742	0.10187	0.21091	0.38818	-0.15203	0.16424	0.0019781
1.0079	0.10282	0.22016	0.37621	-0.14131	0.17152	0.0019162
1.0173	0.10812	0.22065	0.39938	-0.11699	0.16821	0.0020788

Burke_Ratio	Annualized_Jensen_Alpha	Annualized_Treynor_Index	Annualized_Treynor_Black_Ratio	Score
0.0030622	0.0064455	0.12032	0.0063809	6.475
0.0017479	-0.027091	0.085006	-0.02893	6.475
0.0023696	0.0050763	0.11884	0.0049032	6.475
0.0014139	-0.033941	0.079477	-0.034458	6.475
0.0015156	-0.030631	0.082915	-0.031021	6.475
0.001474	-0.03201	0.082176	-0.031759	6.475
0.0015856	-0.027779	0.086627	-0.027308	6.475

Whereas, the scores for the totality of the funds are:

Stock	Beta	Annualized_Mean_Return	Annualized_Std_Dev	Annualized_Sharpe_Ratio	Annualized_Information_Ratio	Pain_Index	Sterling_Ratio
{'FIDELITY MAGELLAN'}	1.0574	0.096199	0.23818	0.31993	-0.15844	0.2365	0.0012786
{'JANUS HENDERSON FORTY FUND I'}	1.0971	0.098134	0.25354	0.30817	-0.14121	0.29356	0.0010562
{'VANGUARD EXPLORER FD.'}	1.095	0.050807	0.26297	0.11715	-0.31612	0.3269	0.00037397
{'VANGUARD PRIMECAP FD.'}	1.0019	0.05421	0.23144	0.14781	-0.34448	0.17335	0.00078313
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R'}	-0.01055	0.015513	0.24034	-0.018668	-0.49273	0.1749	-0.0001018
{'BLACKROCK FD.MID CAP'}	-0.020795	0.090612	0.26478	0.26668	-0.16362	0.24873	0.0011266
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	1.0101	0.14153	0.21292	0.57081	0.035688	0.11559	0.0041723
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}	0.93644	0.099603	0.20374	0.3907	-0.16851	0.13955	0.0022636
{'FIDELITY MAGELLAN_1'}	1.0574	0.096199	0.23818	0.31993	-0.15844	0.2365	0.0012786
{'FIDELITY FD.'}	1.0353	0.14303	0.22507	0.54664	0.04042	0.15317	0.0031875
{'JANUS HENDERSON RESEARCH FUND A'}	1.1137	0.12716	0.25249	0.42441	-0.026827	0.24938	0.0017052
{'JANUS HENDERSON ENTERPRISE FUND A'}	0.97799	0.017941	0.23827	-0.0006415	-0.40682	0.25214	-3.2405e-05
{'CAPITAL GROUP US EQUITY FUND'}	0.86645	0.074933	0.19041	0.2885	-0.30987	0.11046	0.0019735
{'FRANKLIN TEMPLETON SMACS: SERIES E'}	0.79032	0.036353	0.18219	0.08976	-0.5356	0.090977	0.00071331
{'PIMCO RAE US FUND A'}	0.9473	0.047712	0.22585	0.1227	-0.38177	0.12453	0.00088311
{'NEUBERGER BERMAN GENESIS FUND'}	1.0267	0.044491	0.24479	0.10005	-0.36539	0.27706	0.00035078
{'COLUMBIA LARGE CAP GROWTH FUND I'}	1.0832	0.12453	0.24762	0.42213	-0.037992	0.22576	0.0018373
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.98498	0.098283	0.21123	0.3706	-0.16878	0.16904	0.0018378
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}	0.98742	0.10187	0.21091	0.38818	-0.15203	0.16424	0.0019781
{'MORGAN STANLEY INSIGHT FUND A'}	1.2662	0.072181	0.42701	0.1222	-0.14462	1.1057	0.00018728
{'JP MORGAN US EQUITY FUND I'}	1.0079	0.10282	0.22016	0.37621	-0.14131	0.17152	0.0019162
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	1.0173	0.10812	0.22065	0.39938	-0.11699	0.16821	0.0020788
{'GOLDMAN SACHS LARGE CAP CORE FUND A'}	1.0213	0.07922	0.22803	0.2597	-0.23995	0.204	0.001152

Stock	Sterling_Ratio	Burke_Ratio	Annualized_Jensen_Alpha	Annualized_Treynor_Index	Annualized_Treynor_Black_Ratio	Score
{'FIDELITY MAGELLAN'}	0.0012786	0.0010143	-0.04428	0.072061	-0.041875	2.675
{'JANUS HENDERSON FORTY FUND I'}	0.0010562	0.00083503	-0.046867	0.071217	-0.042718	2.675
{'VANGUARD EXPLORER FD.'}	0.00037397	0.00031402	-0.09395	0.028135	-0.085801	1.575
{'VANGUARD PRIMECAP FD.'}	0.00078313	0.00063935	-0.079945	0.034144	-0.079791	1.975
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R'}	-0.0001018	-6.9021e-05	-0.0032846	0.42527	0.31133	5.175
{'BLACKROCK FD.MID CAP'}	0.0011266	0.00069116	0.072981	-3.3957	-3.5096	5.775
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	0.0041723	0.0030622	0.0064455	0.12032	0.0063809	6.475
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}	0.0022636	0.0017479	-0.027091	0.085006	-0.02893	6.475
{'FIDELITY MAGELLAN_1'}	0.0012786	0.0010143	-0.04428	0.072061	-0.041875	2.675
{'FIDELITY FD.'}	0.0031875	0.0023696	0.0050763	0.11884	0.0049032	6.475
{'JANUS HENDERSON RESEARCH FUND A'}	0.0017052	0.0012798	-0.019724	0.096225	-0.017711	6.075
{'JANUS HENDERSON ENTERPRISE FUND A'}	-3.2405e-05	-2.7623e-05	-0.11349	-0.0021054	-0.11604	1.575
{'CAPITAL GROUP US EQUITY FUND'}	0.0019735	0.0015368	-0.043786	0.0634	-0.050535	2.475
{'FRANKLIN TEMPLETON SMACS: SERIES E'}	0.00071331	0.00058817	-0.073692	0.020692	-0.093243	1.975
{'PIMCO RAE US FUND A'}	0.00088311	0.00073092	-0.080219	0.029254	-0.084682	1.975
{'NEUBERGER BERMAN GENESIS FUND'}	0.00035078	0.00029597	-0.092486	0.023854	-0.090081	1.575
{'COLUMBIA LARGE CAP GROWTH FUND I'}	0.0018373	0.0014037	-0.018885	0.096501	-0.017435	6.275
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.0018378	0.0014139	-0.033941	0.079477	-0.034458	6.475
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}	0.0019781	0.0015156	-0.030631	0.082915	-0.031021	6.475
{'MORGAN STANLEY INSIGHT FUND A'}	0.00018728	0.00015849	-0.092081	0.041212	-0.072724	2.375
{'JP MORGAN US EQUITY FUND I'}	0.0019162	0.001474	-0.03201	0.082176	-0.031759	6.475
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	0.0020788	0.0015856	-0.027779	0.086627	-0.027308	6.475
{'GOLDMAN SACHS LARGE CAP CORE FUND A'}	0.001152	0.00091207	-0.057145	0.057984	-0.055952	1.975

QUESTION 2, 3 AND 4: SAMPLE OF 7 FUNDS AND PERFORMANCE STATISTICS

For monthly freqency the algorithm works in the same way, selecting the same 7 funds.
The performance and the normal distribution test results are the following:

Stock	Beta	Mean_Return	Std_Dev	Sharpe_Ratio	Information_Ratio	Pain_Index
{'FIDELITY MAGELLAN'}	1.1125	0.0081068	0.058153	0.11074	-0.058461	0.24646
{'JANUS HENDERSON FORTY FUND I'}	1.154	0.008329	0.062193	0.10712	-0.05109	0.32419
{'VANGUARD EXPLORER FD.'}	1.0873	0.0052632	0.060291	0.059652	-0.10355	0.36026
{'VANGUARD PRIMECAP FD.'}	0.97605	0.005178	0.050574	0.069429	-0.12513	0.17559
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R'}	0.77275	0.0062671	0.06189	0.074333	-0.084656	0.29822
{'BLACKROCK FD.MID CAP'}	0.96594	0.009893	0.073593	0.11178	-0.021924	0.38909
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	1.0249	0.012162	0.04692	0.22368	0.013964	0.16012
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}	0.9595	0.0097363	0.045864	0.17595	-0.038594	0.17646
{'FIDELITY MAGELLAN_1'}	1.1125	0.0081068	0.058153	0.11074	-0.058461	0.24646
{'FIDELITY FD.'}	1.0052	0.012037	0.049027	0.21152	0.010824	0.19567
{'JANUS HENDERSON RESEARCH FUND A'}	1.1722	0.010688	0.061336	0.14708	-0.013347	0.28678
{'JANUS HENDERSON ENTERPRISE FUND A'}	0.94783	0.0013416	0.053155	-0.006115	-0.19123	0.27238
{'CAPITAL GROUP US EQUITY FUND'}	0.82585	0.00741	0.040062	0.14336	-0.10225	0.12448
{'FRANKLIN TEMPLETON SMACS: SERIES E'}	0.75277	0.0031394	0.041348	0.035618	-0.20236	0.092643
{'PIMCO RAE US FUND A'}	0.89003	0.0041535	0.05215	0.047686	-0.141	0.1321
{'NEUBERGER BERMAN GENESIS FUND'}	-0.055101	-0.0040153	0.037123	-0.15306	-0.41811	0.13204
{'NEUBERGER BERMAN GENESIS FUND_1'}	0.94188	0.0046814	0.053986	0.055843	-0.12642	0.28612
{'COLUMBIA LARGE CAP GROWTH FUND I'}	1.1014	0.010422	0.057924	0.15116	-0.018716	0.23504
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.99833	0.009148	0.046873	0.15961	-0.050316	0.21192
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}	0.99761	0.0094005	0.046665	0.16573	-0.045129	0.20477
{'MORGAN STANLEY INSIGHT FUND A'}	1.6923	0.0073714	0.12723	0.044838	-0.032501	1.1981
{'JP MORGAN US EQUITY FUND I'}	1.0113	0.0097936	0.048995	0.16587	-0.03496	0.2018
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	1.0211	0.010095	0.04896	0.17215	-0.028827	0.22253
{'GOLDMAN SACHS LARGE CAP CORE FUND A'}	1.0319	0.008486	0.050539	0.13493	-0.059764	0.24413

Stock	Sterling_Ratio	Burke_Ratio	Jensen_Alpha	Treynor_Index	Treynor_Black_Ratio	Score
{'FIDELITY MAGELLAN'}	0.026131	0.022088	-0.004507	0.0057887	-0.0040511	1.925
{'JANUS HENDERSON FORTY FUND I'}	0.020551	0.017519	-0.0046926	0.0057734	-0.0040664	1.525
{'VANGUARD EXPLORER FD.'}	0.009983	0.00892	-0.0071021	0.0033078	-0.006532	0.425
{'VANGUARD PRIMECAP FD.'}	0.019998	0.01677	-0.0060928	0.0035975	-0.0062423	0.825
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R'}	0.015426	0.013636	-0.0030032	0.0059534	-0.0038864	0.425
{'BLACKROCK FD.MID CAP'}	0.021143	0.018355	-0.0012783	0.0085164	-0.0013234	1.525
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	0.065546	0.056042	0.00040987	0.01024	0.0003999	2.125
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}	0.04573	0.039685	-0.0013716	0.0084103	-0.0014295	2.125
{'FIDELITY MAGELLAN_1'}	0.026131	0.022088	-0.004507	0.0057887	-0.0040511	1.925
{'FIDELITY FD.'}	0.052999	0.044554	0.00047978	0.010317	0.00047731	2.125
{'JANUS HENDERSON RESEARCH FUND A'}	0.031456	0.025795	-0.0025129	0.007696	-0.0021438	1.725
{'JANUS HENDERSON ENTERPRISE FUND A'}	-0.0011933	-0.0010739	-0.0096515	-0.00034293	-0.010183	0.625
{'CAPITAL GROUP US EQUITY FUND'}	0.046138	0.038581	-0.0023828	0.0069545	-0.0028853	1.325
{'FRANKLIN TEMPLETON SMACS: SERIES E'}	0.015897	0.013863	-0.0059344	0.0019564	-0.0078834	0.825
{'PIMCO RAE US FUND A'}	0.018825	0.016664	-0.0062709	0.0027941	-0.0070457	0.825
{'NEUBERGER BERMAN GENESIS FUND'}	-0.043033	-0.031608	-0.0051398	0.10312	0.09328	0.825
{'NEUBERGER BERMAN GENESIS FUND_1'}	0.010537	0.0092528	-0.0062531	0.0032007	-0.006639	0.625
{'COLUMBIA LARGE CAP GROWTH FUND I'}	0.037251	0.029748	-0.0020823	0.0079493	-0.0018905	1.925
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	0.035302	0.029965	-0.0023421	0.0074938	-0.002346	2.125
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}	0.037769	0.031818	-0.0020825	0.0077523	-0.0020875	2.125
{'MORGAN STANLEY INSIGHT FUND A'}	0.0047615	0.0042188	-0.010947	0.003371	-0.0064688	1.225
{'JP MORGAN US EQUITY FUND I'}	0.040272	0.032962	-0.0018243	0.0080359	-0.0018039	2.125
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	0.037876	0.032613	-0.0016186	0.0082546	-0.0015852	2.125
{'GOLDMAN SACHS LARGE CAP CORE FUND A'}	0.027933	0.024374	-0.0033344	0.0066085	-0.0032313	2.125

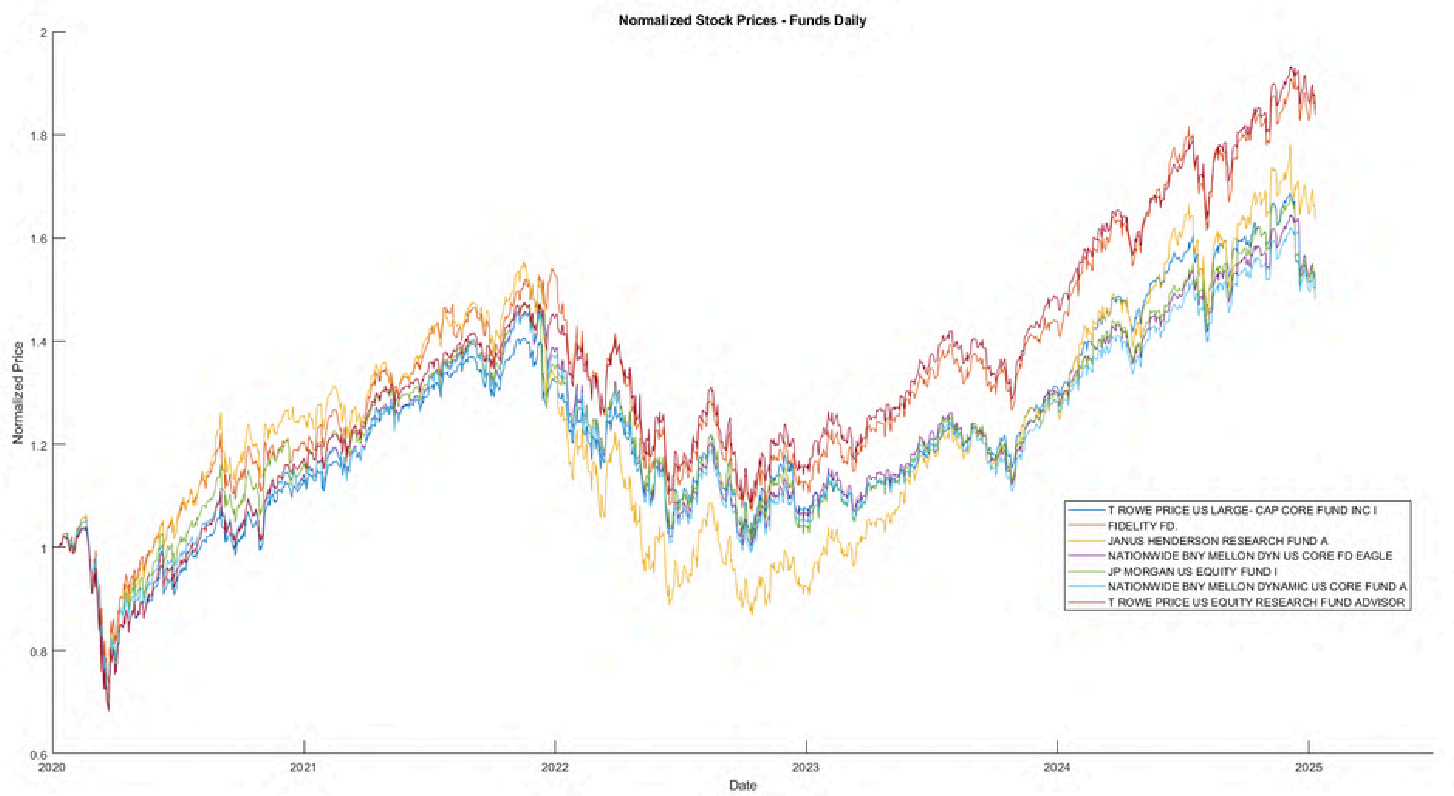
Tabella riassuntiva della normalità per ciascun titolo:

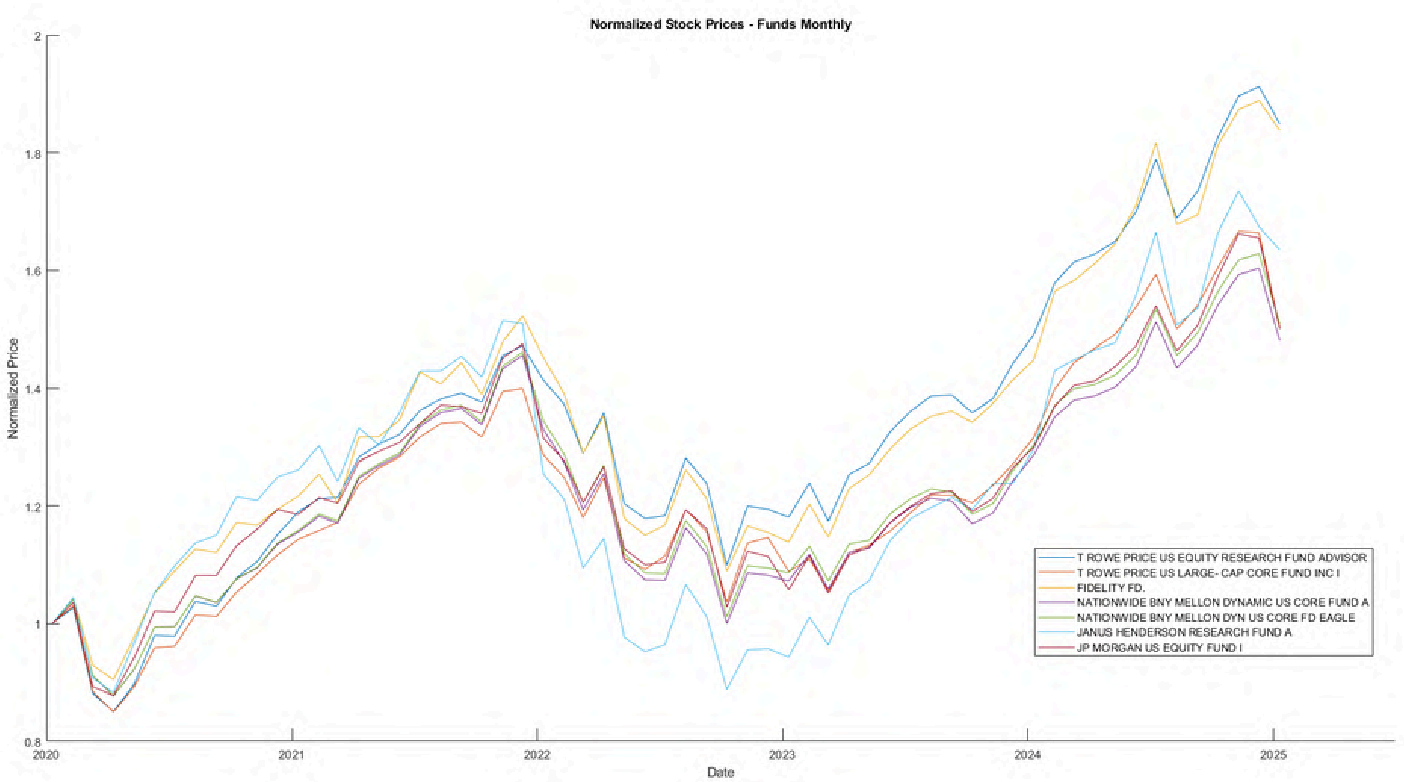
Titolo	Normale
{'FIDELITY MAGELLAN'}	{'No'}
{'JANUS HENDERSON FORTY FUND I'}	{'No'}
{'VANGUARD EXPLORER FD.'}	{'No'}
{'VANGUARD PRIMECAP FD.'}	{'No'}
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R'}	{'No'}
{'BLACKROCK FD.MID CAP'}	{'Si'}
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	{'No'}
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I'}	{'No'}
{'FIDELITY MAGELLAN_1'}	{'No'}
{'FIDELITY FD.'}	{'No'}
{'JANUS HENDERSON RESEARCH FUND A'}	{'No'}
{'JANUS HENDERSON ENTERPRISE FUND A'}	{'No'}
{'CAPITAL GROUP US EQUITY FUND'}	{'No'}
{'FRANKLIN TEMPLETON SMACS: SERIES E'}	{'No'}
{'PIMCO RAE US FUND A'}	{'No'}
{'NEUBERGER BERMAN GENESIS FUND'}	{'No'}
{'NEUBERGER BERMAN GENESIS FUND_1'}	{'Si'}
{'COLUMBIA LARGE CAP GROWTH FUND I'}	{'No'}
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	{'No'}
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE'}	{'No'}
{'MORGAN STANLEY INSIGHT FUND A'}	{'No'}
{'JP MORGAN US EQUITY FUND I'}	{'No'}
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	{'No'}
{'GOLDMAN SACHS LARGE CAP CORE FUND A'}	{'No'}

Different normality tests were conducted (Jarque-Bera, Anderson-Darling, Lilliefors). Only the BlackRock FD Mid Cap and Neuberger Berman Genesis Fund_1 showed a normal distribution in their returns.

QUESTION 5: PLOT THE BEHAVIOR OF SELECTED FUND PRICES

Due to the fact that the algorithm selects funds that are similar to one another, it is reasonable to expect that their correlation is high, since their normalized price follows the same trend, as shown in the following chart. This hypothesis is confirmed by the correlation matrices in the following pages of this document. Therefore, it is important to notice that such funds are not intended to form a unique portfolio; they are the best ones on a stand-alone basis according to our selection algorithm instead.





QUESTION 5: PLOT THE BEHAVIOR OF SELECTED FUND PRICES

As previously mentioned, the funds tend to move quite similarly, likely due to the exposure to U.S. large-cap stocks. The only funds displaying anomalous behavior are Blackrock Mid Cap and Morgan Stanley Insight Fund A.
In the following chart, the evolution of the **normalized price** from 2020 to the present day is displayed.

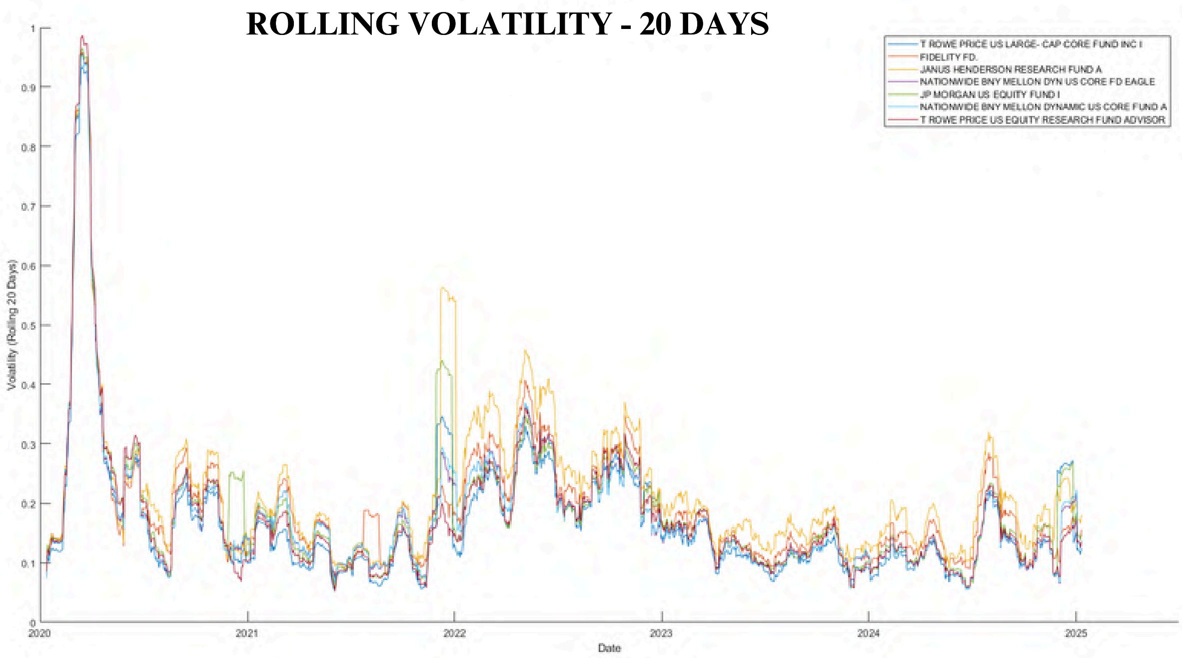
The following three charts display the **rolling volatility** at 20, 50 and 100 days respectively.
Rolling Volatility is a measure of the dispersion of an asset's returns, calculated over a moving time window (rolling window), and is used to analyze changes in volatility over time. It provides a dynamic view of an investment's risk by capturing how volatility evolves in response to market conditions. The length of the time window plays a critical role in determining the sensitivity of the volatility measure. A shorter time window will respond more quickly to recent market fluctuations, capturing short-term changes in volatility, while a longer time window smooths out short-term volatility, providing a more stable view of the asset's risk over a longer horizon.
Therefore, it is computed through the following formula, where the return of the asset is computed through the natural logarithm of the ratio of the asset's price at the current period to the price at the previous, consecutive period, as follows:

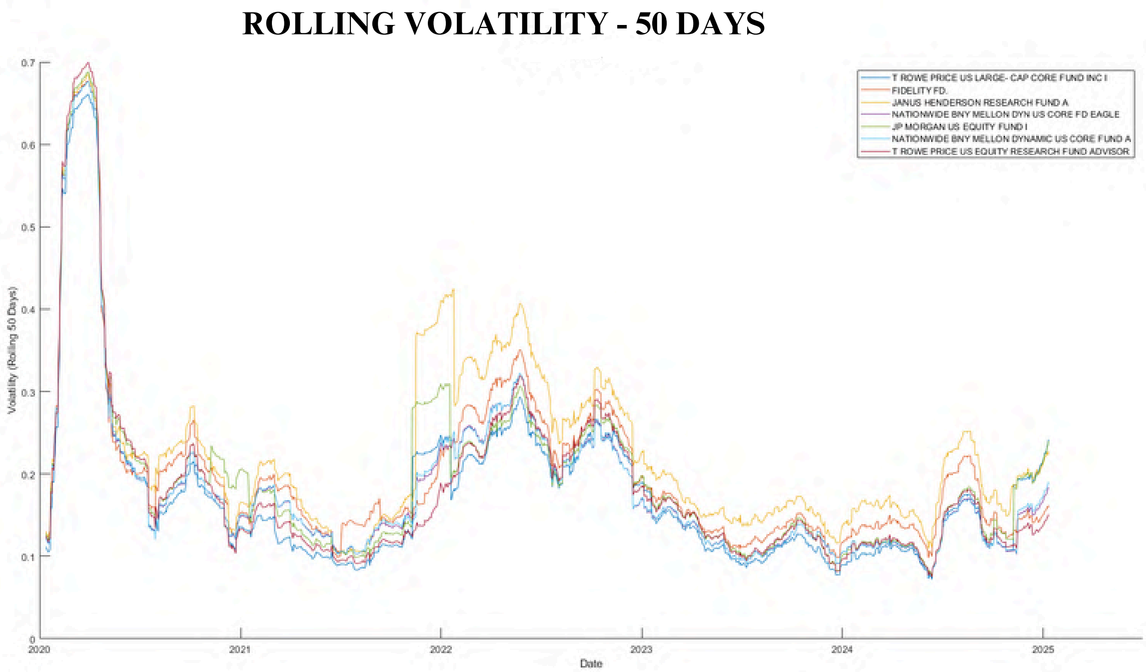
$$\sigma_t = \sqrt{\frac{1}{N}\sum_{i=t-N}^{t}(R_i - \bar{R})^2}$$

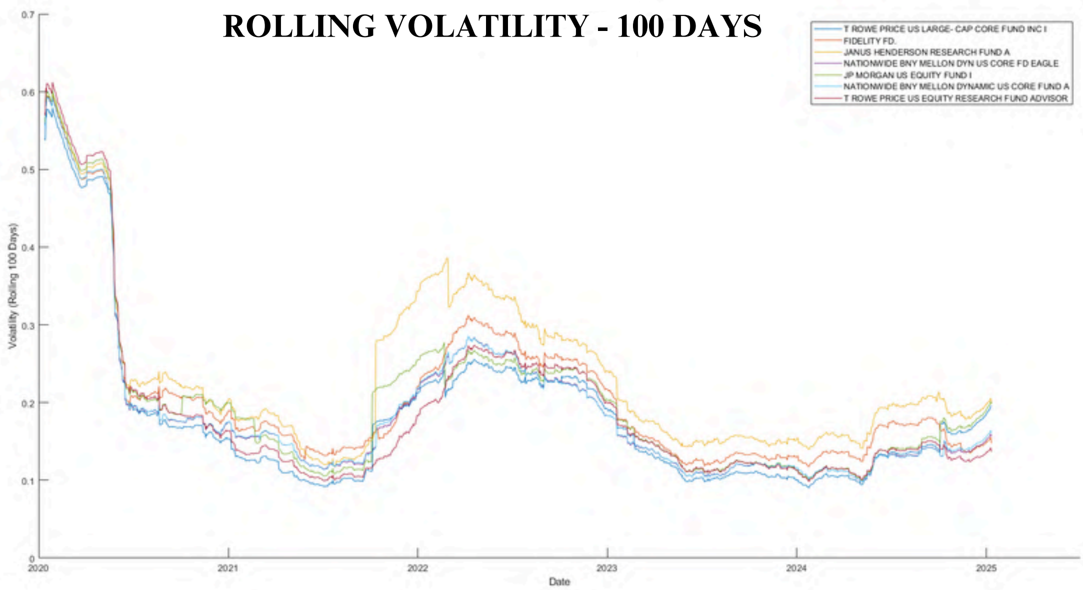
σ_t : Rolling volatility at time t
N : Number of periods in the rolling window
R_i : Return of the asset at time i
$\bar{R}$: Average return within the rolling window

The three charts present similar trends but with varying sensitivities based on the time period considered.
In the **20-day rolling volatility** chart, volatility is more responsive to short-term market fluctuations, capturing rapid changes and showing notable spikes during market stress, such as the events of 2020 and 2022. This shorter time frame emphasizes the immediate risk exposure of the funds.
In the **50-day rolling volatility** chart, the view expands to encompass medium-term volatility, smoothing out some of the short-term noise but still capturing fluctuations from major market events. While the volatility remains elevated during periods of market stress, it is less erratic than in the 20-day chart, giving a broader perspective on risk.
The **100-day rolling volatility** chart provides a longer-term perspective, which smooths out even more of the short-term volatility. The trend here shows lower overall volatility for most funds, reflecting a more stable risk profile over a longer horizon. Despite this, significant spikes still appear in 2020 and 2022, but the longer time frame reduces their impact, offering a clearer view of the funds' risk profiles over a sustained period.

QUESTION 5: PLOT THE BEHAVIOR OF SELECTED FUND PRICES



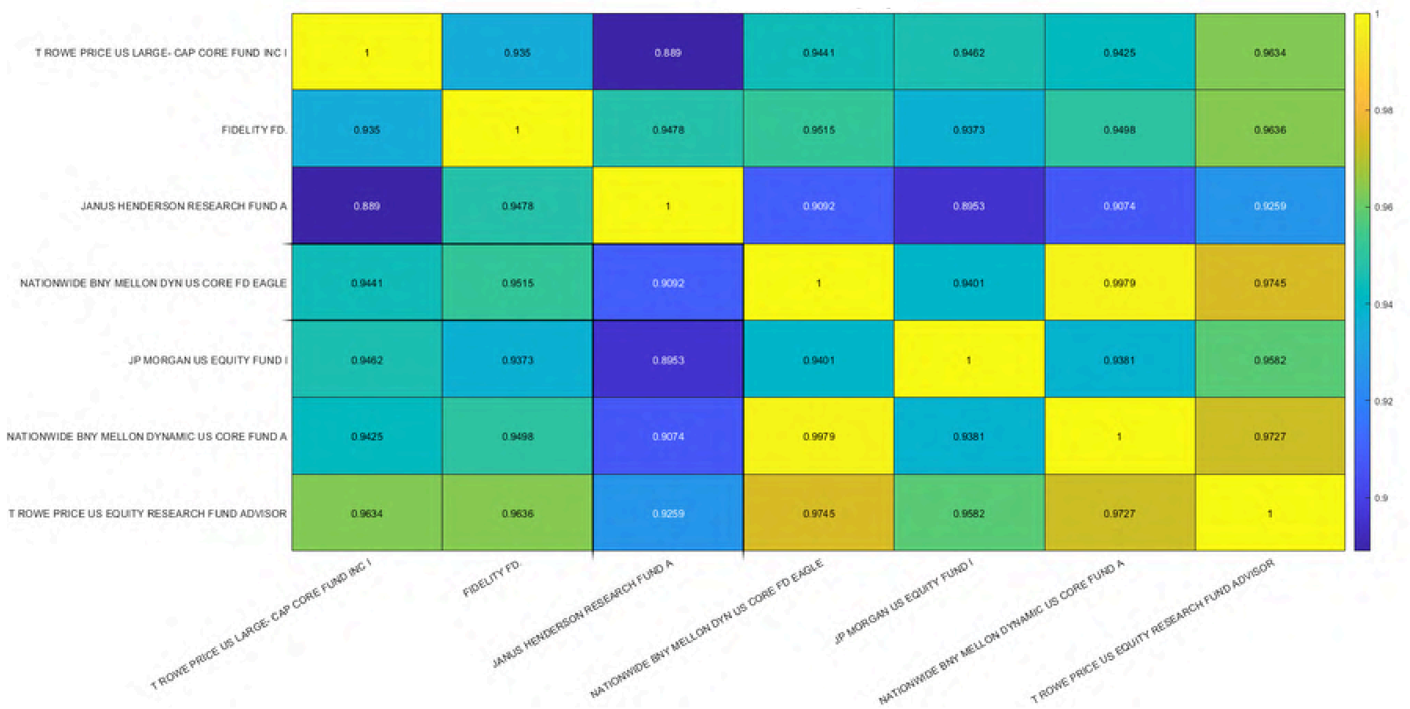




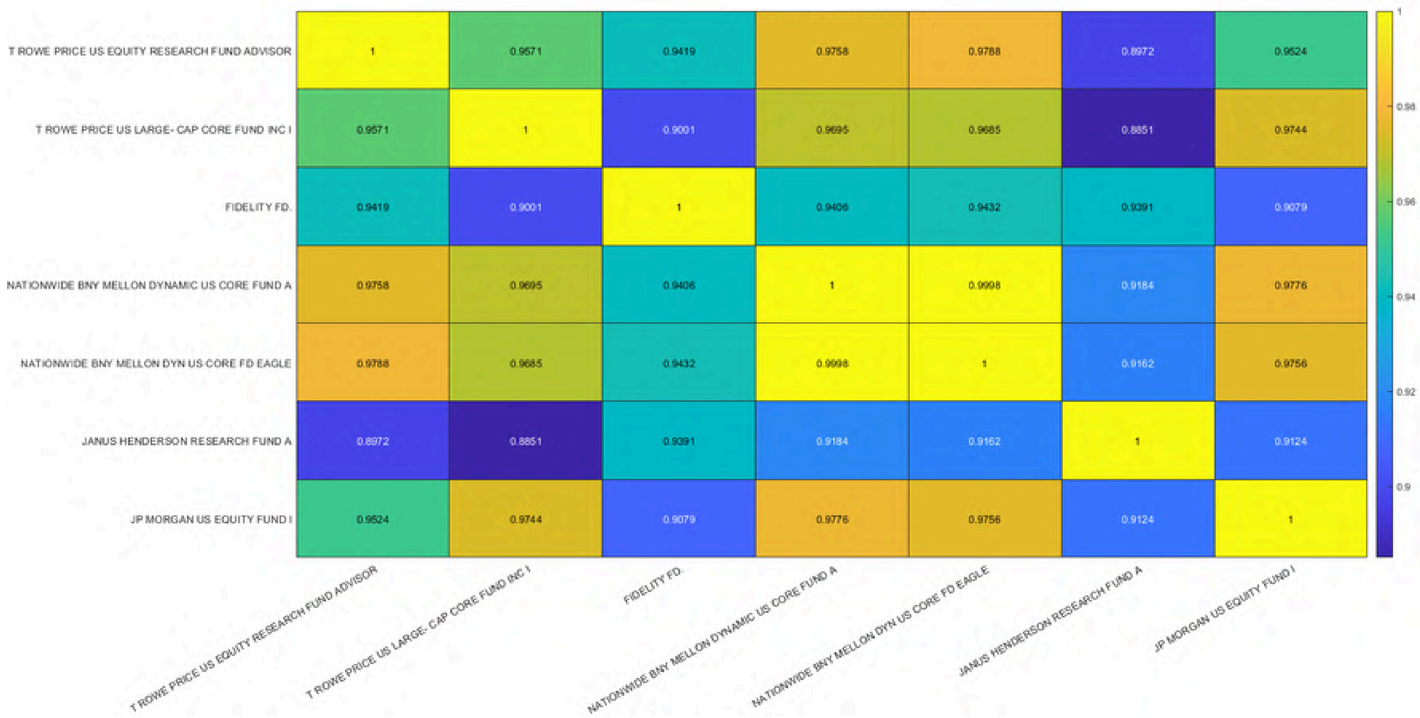
QUESTION 5: PLOT THE BEHAVIOR OF SELECTED FUND PRICES

The correlation matrices confirm the previous hypothesis, showing a high average degree of correlation.

CORRELATION HEATMAP - FUNDS DAILY



CORRELATION HEATMAP - FUNDS MONTHLY

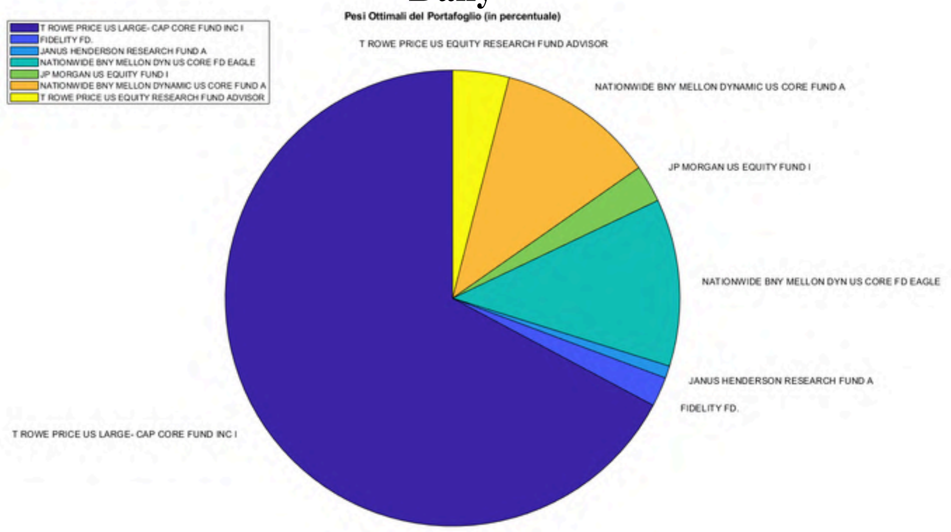


QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

The Mean-Variance Optimal Portfolio Allocation is a foundational concept in modern portfolio theory. It refers to the process of selecting the proportions of various assets in a portfolio in such a way that the portfolio's expected return is maximized for a given level of risk (variance), or equivalently, the risk is minimized for a given level of expected return.

Portfolio 1: Min risk

Daily



The optimal portfolio weights are the following:

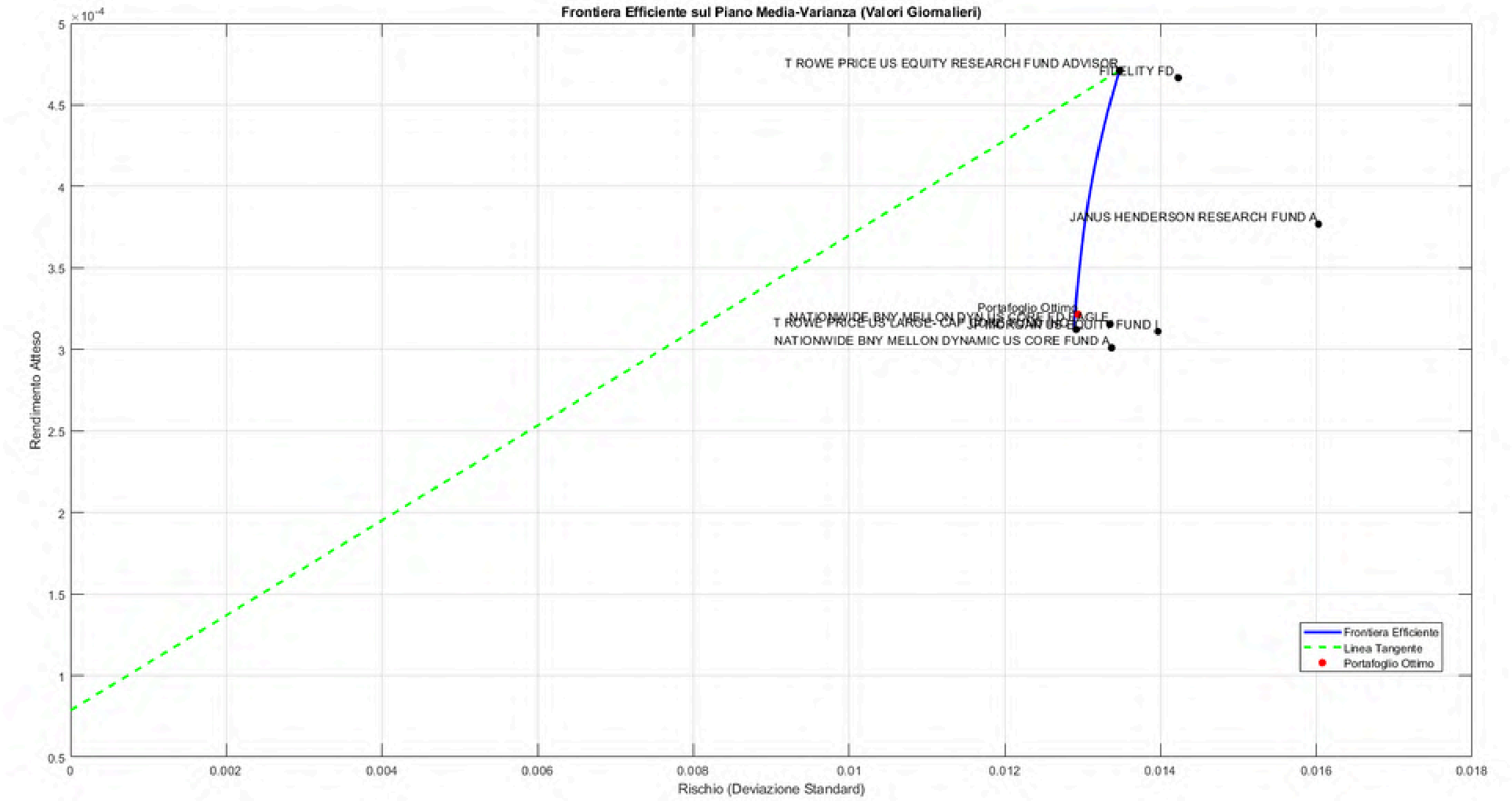
```
Pesi ottimali del portafoglio:
T ROWE PRICE US LARGE- CAP CORE FUND INC I: 0.67212
FIDELITY FD.: 0.020932
JANUS HENDERSON RESEARCH FUND A: 0.0087528
NATIONWIDE BNY MELLON DYN US CORE FD EAGLE: 0.11876
JP MORGAN US EQUITY FUND I: 0.026517
NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A: 0.11282
T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR: 0.0401
Rendimento del portafoglio: 0.00032146
Rendimento annualizzato: 0.084365
Rischio del portafoglio: 0.01294
Rischio annualizzato: 0.20542
Skewness del portafoglio: -0.97602
Curtosi del portafoglio: 17.8114
Beta del portafoglio: 0.95696
Rapporto di Sharpe: 0.018769
Rapporto di Sortino: 0.025294
Alpha di Jensen: -0.00010661
```

The portfolio's performance exhibits several notable characteristics. The portfolio's return is quite low at **0.00032146**, with an annualized return of **8.44%**, indicating modest growth over time. The risk associated with the portfolio is relatively low at 0.01294, with an annualized **risk** of **20.54%**, suggesting moderate volatility. The negative skewness of -0.97602 indicates that returns tend to be more frequently negative compared to a normal distribution. The high kurtosis of 17.8114 suggests that the returns have heavy tails, meaning extreme events, both positive and negative, have occurred more frequently than in a normal distribution.
The portfolio's beta of 0.95696 shows that it is almost in line with the market, with a slight tendency to be less volatile. However, the Sharpe ratio is very low at 0.018769, indicating that the return is not particularly good relative to the risk taken. Similarly, the Sortino ratio is also low at 0.025294, suggesting that the return is not especially favorable compared to the downside risk. The negative Jensen's alpha of -0.00010661 indicates that the portfolio has underperformed relative to the expected return given its risk.
In summary, the portfolio demonstrates modest performance with moderate risk, but with a tendency towards extreme events and underperformance relative to market expectations. It may be beneficial to consider strategies to enhance returns or further reduce risk.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 1: Min risk

Daily



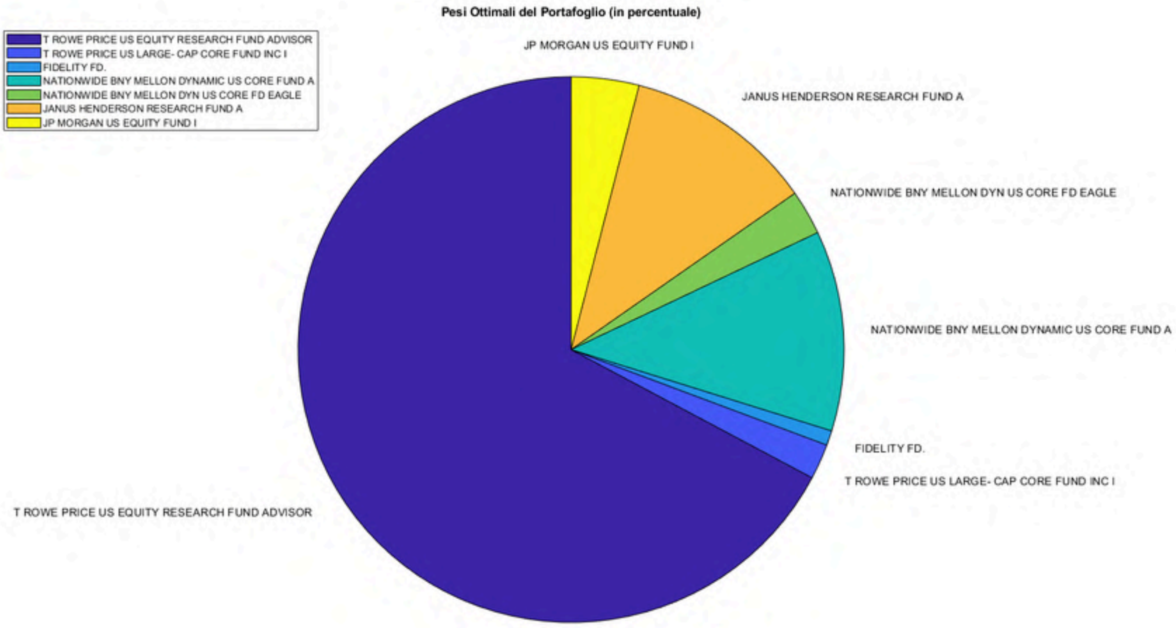

```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.00016744
Exit flag: 1
Output:
         iterations: 40
          funcCount: 328
    constrviolation: 2.2204e-16
           stepsize: 0.0138
          algorithm: 'interior-point'
      firstorderopt: 5.1429e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
       bestfeasible: [1×1 struct]
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 40 iterations, violating the constraints by a value close to zero. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 1: Min risk

Monthly



The optimal portfolio weights are the following:

```
Pesi ottimali del portafoglio:
T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR: 0.48675
T ROWE PRICE US LARGE- CAP CORE FUND INC I: 0.28445
FIDELITY FD.: 0.2038
NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A: 0.0082566
NATIONWIDE BNY MELLON DYN US CORE FD EAGLE: 0.014558
JANUS HENDERSON RESEARCH FUND A: 0.00041827
JP MORGAN US EQUITY FUND I: 0.0017604
Rendimento del portafoglio: 0.0091567
Rendimento annualizzato: 0.11559
Rischio del portafoglio: 0.047402
Rischio annualizzato: 0.1642
Skewness del portafoglio: -1.183
Curtosi del portafoglio: 4.6059
Beta del portafoglio: 1.008
Rapporto di Sharpe: 0.17567
Rapporto di Sortino: 0.24239
Alpha di Jensen: -0.00056583
```

The portfolio's performance has some strengths but also areas that need attention. It has a decent annualized **return** of **11.56%**, which is pretty good, and the risk level, with an annualized **volatility** of **16.42%**, is moderate. This means it's not too wild in terms of ups and downs, but it's still exposed to market movements, especially since its beta is almost exactly 1, showing it moves closely with the market.

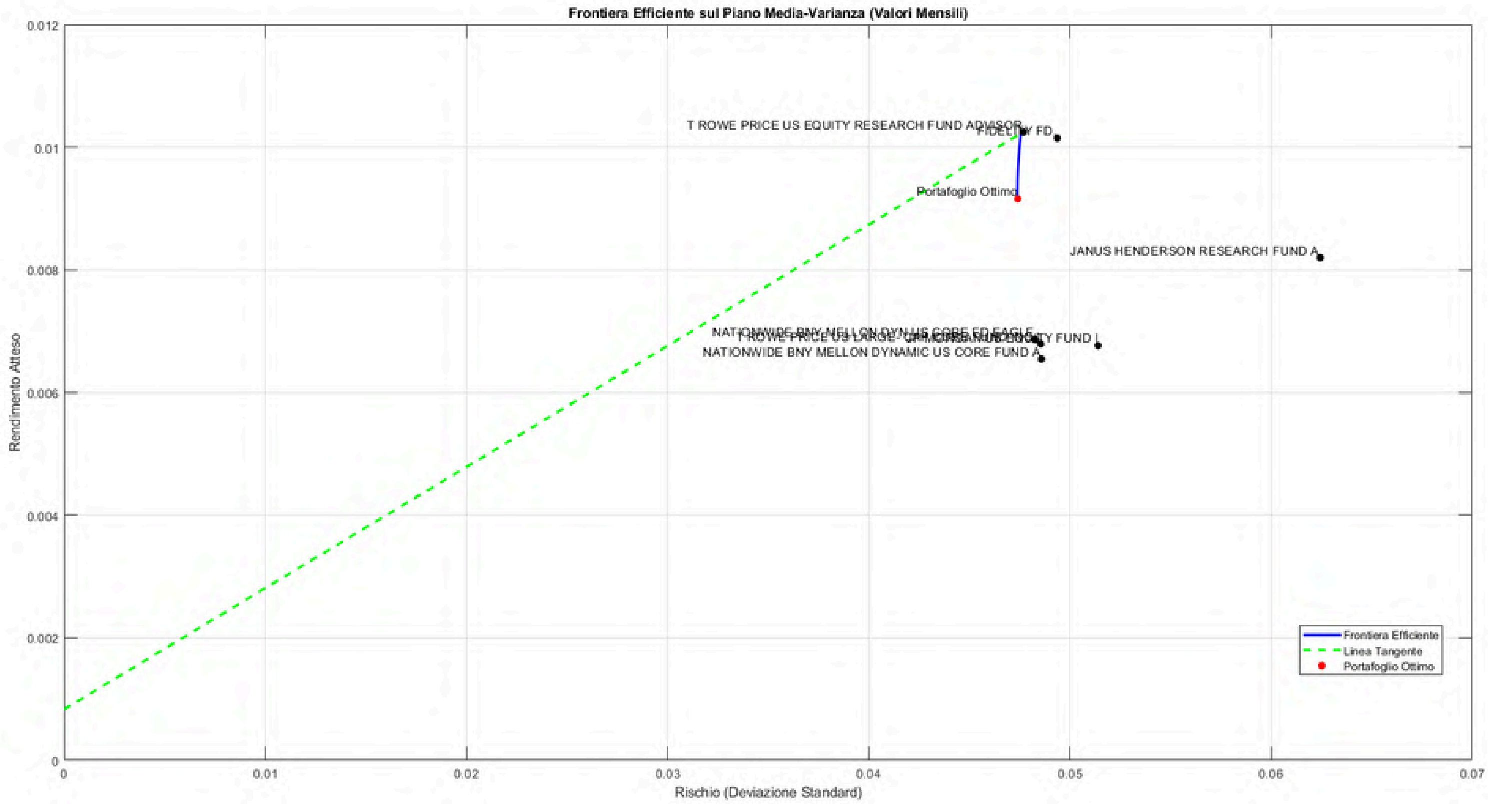
However, there are some red flags. The negative skewness of -1.183 tells us that the portfolio tends to have more negative returns than positive ones, which isn't great if you're trying to avoid losses. The kurtosis of 4.6059 suggests that while extreme returns aren't off the charts, they do happen more often than in a normal distribution, which could lead to some unexpected surprises.

The Sharpe ratio of 0.17567 and the Sortino ratio of 0.24239 are okay, but they could be better. They show that the portfolio is doing alright in terms of risk-adjusted returns, but there's room for improvement, especially when it comes to handling downside risk. The negative Jensen's alpha of -0.00056583 is a bit of a letdown, as it indicates the portfolio isn't performing as well as it should be given its market risk.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 1: Min risk

Monthly



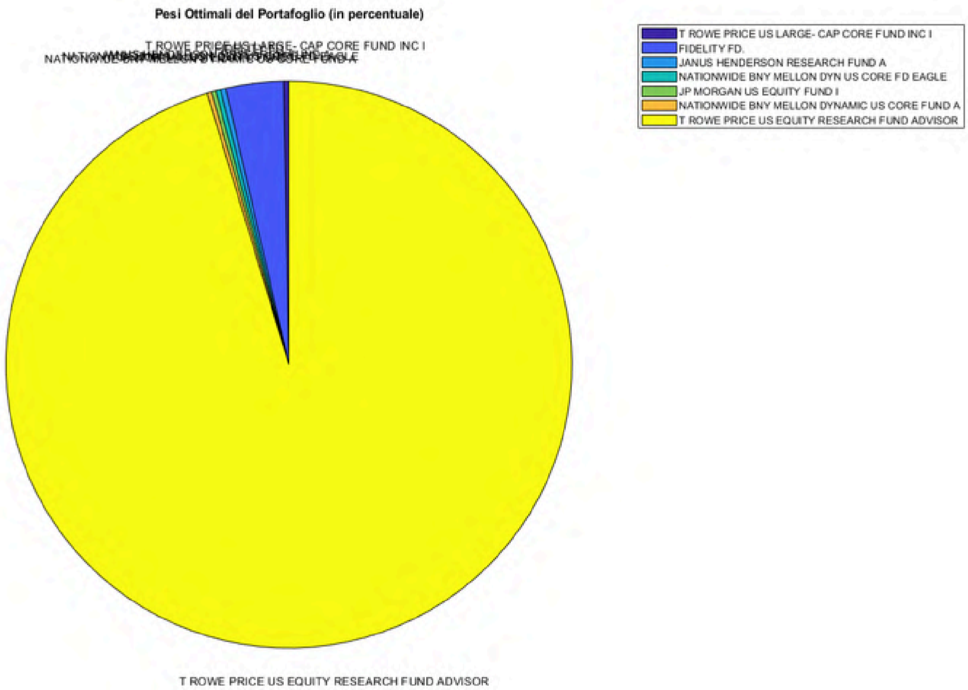

```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: 0.0022469
Exit flag: 1
Output:
         iterations: 43
          funcCount: 354
    constrviolation: 2.2204e-16
           stepsize: 0.0191
          algorithm: 'interior-point'
      firstorderopt: 4.0479e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
       bestfeasible: [1×1 struct]
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 43 iterations, violating the constraints by a value close to zero. The algorithm used is 'Interior Point.' The value of the objective function corresponds exactly to the portfolio variance.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 2: Min Risk, Max Ret

Daily



The optimal portfolio weights are the following:

```
Pesi ottimali del portafoglio:
T ROWE PRICE US LARGE- CAP CORE FUND INC I: 0.0030142
FIDELITY FD.: 0.03275
JANUS HENDERSON RESEARCH FUND A: 0.0030177
NATIONWIDE BNY MELLON DYN US CORE FD EAGLE: 0.0027846
JP MORGAN US EQUITY FUND I: 0.0025234
NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A: 0.0025231
T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR: 0.95339
Rendimento del portafoglio: 0.00046894
Rendimento annualizzato: 0.12541
Rischio del portafoglio: 0.013481
Rischio annualizzato: 0.21401
Skewness del portafoglio: -0.87828
Curtosi del portafoglio: 17.8598
Beta del portafoglio: 1.0113
Rapporto di Sharpe: 0.029955
Rapporto di Sortino: 0.039589
Alpha di Jensen: 2.1012e-05
```

This portfolio has some interesting aspects, but there are also areas that need attention. The annualized **return** of **12.54%** is quite strong, indicating that the portfolio has grown significantly over time. However, the risk is relatively high, with an annualized **volatility of 21.40%**, suggesting there have been significant ups and downs. This is further confirmed by the beta of 1.0113, which shows that the portfolio moves almost in line with the market, making it sensitive to market fluctuations.

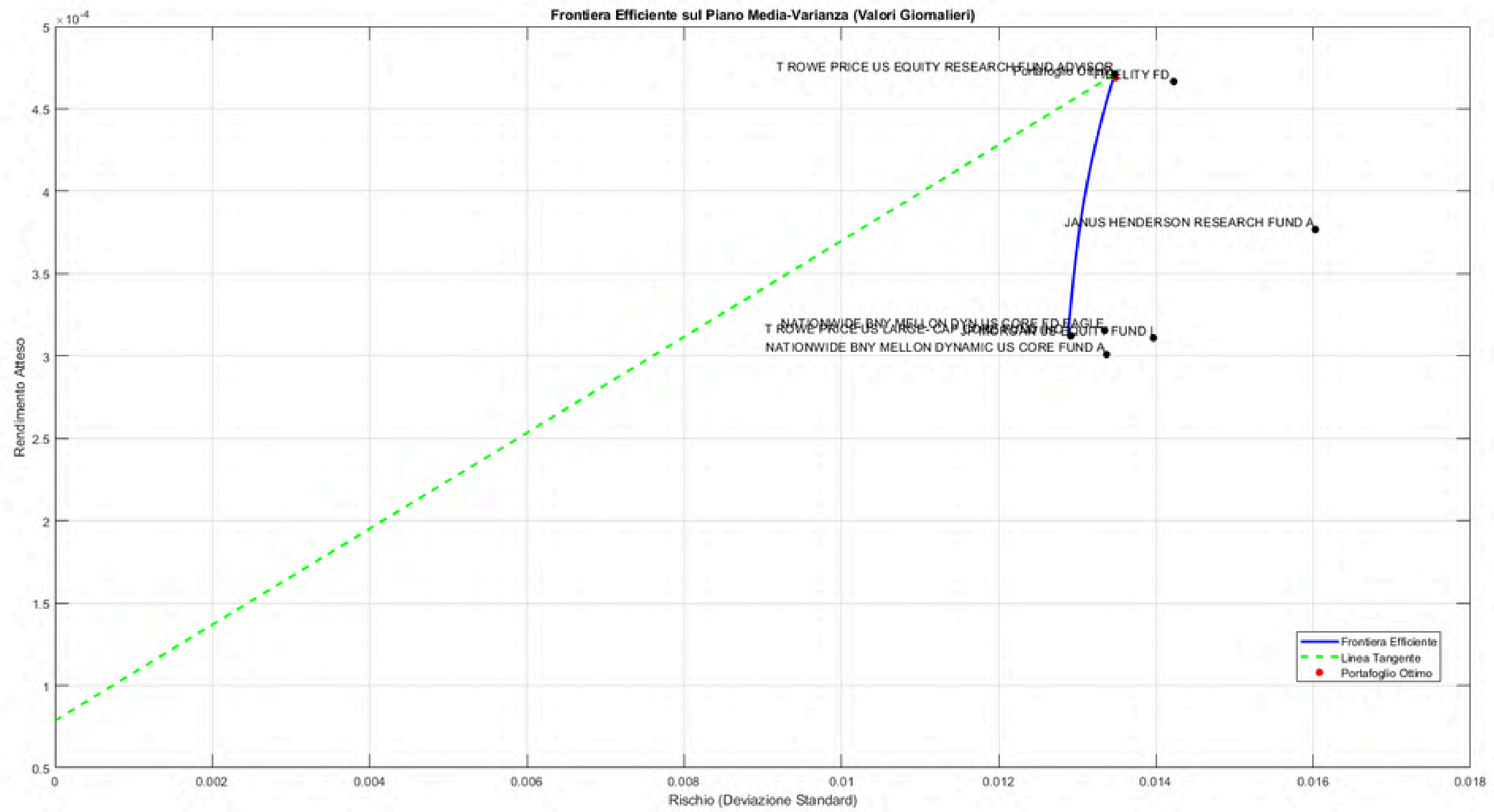
The negative skewness of -0.87828 suggests that the portfolio tends to experience more negative returns than positive ones, which could be a concern if the goal is to minimize losses. The very high kurtosis of 17.8598 is a red flag, as it indicates that there have been many extreme returns, both positive and negative. This means the portfolio could be prone to sudden, unexpected spikes or drops.

On the positive side, the Sharpe ratio of 0.029955 and the Sortino ratio of 0.039589 show that the portfolio is managing risk-adjusted returns reasonably well, though there is definitely room for improvement. The slightly positive Jensen’s alpha (2.1012e-05) is a good sign, indicating that the portfolio is performing a bit better than expected given its market risk.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 2: Min Risk, Max Ret

Daily



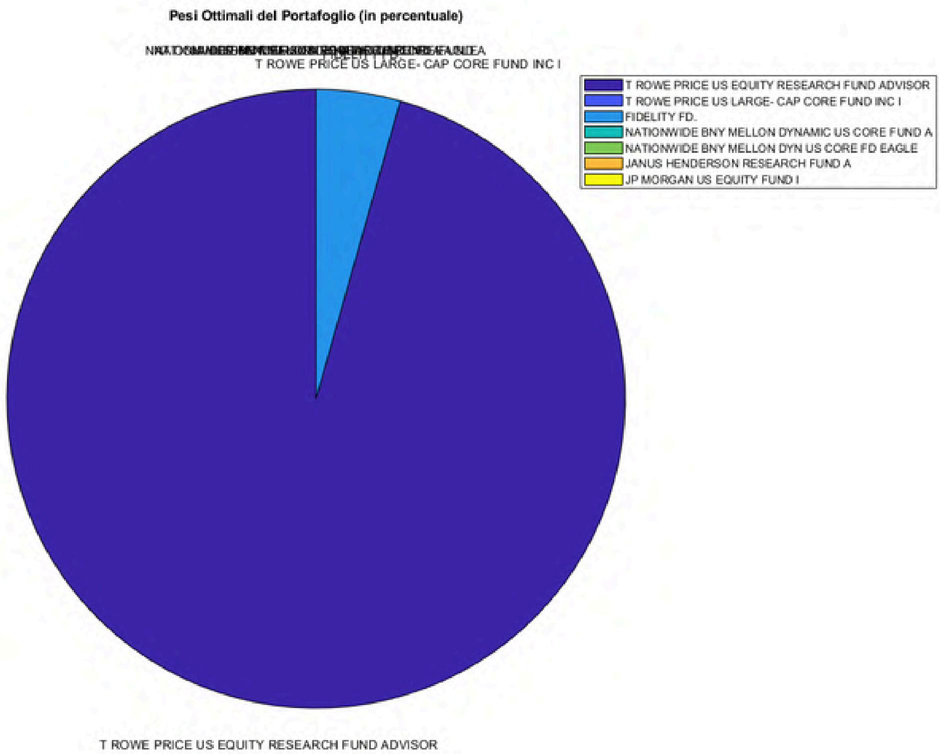

```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.0002872
Exit flag: 1
Output:
         iterations: 40
          funcCount: 328
    constrviolation: 0
           stepsize: 0.0331
          algorithm: 'interior-point'
      firstorderopt: 7.6763e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
       bestfeasible: [1×1 struct]
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 40 iterations, violating the constraints by a value close to zero. The algorithm used is 'Interior Point.' In this case, he value of the objective function does not provide any information on portofolio's parameters.

QUESTION 6,7,8 : MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 2: Min Risk, Max Ret

Monthly



The optimal portfolio weights are the following:

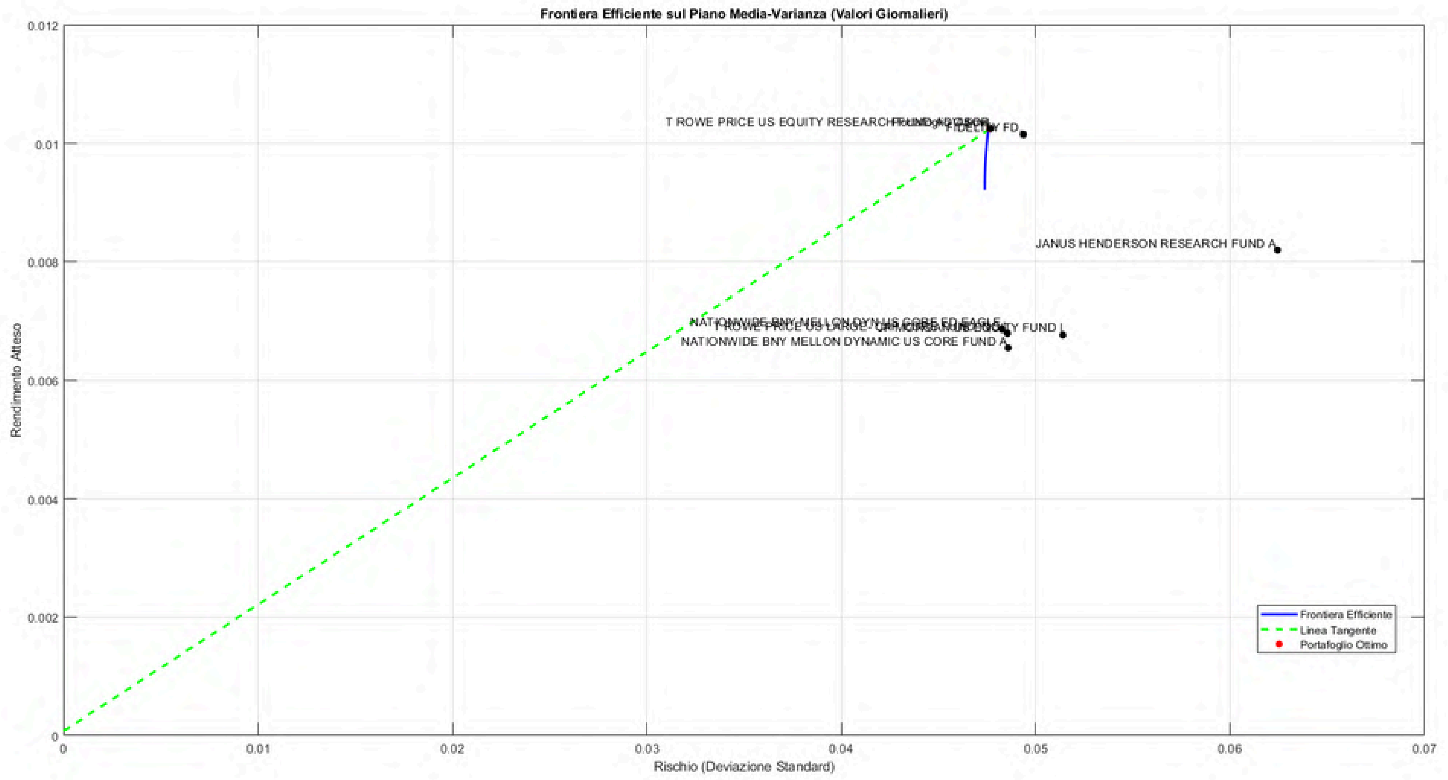
```
Pesi ottimali del portafoglio:
T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR: 0.95605
T ROWE PRICE US LARGE- CAP CORE FUND INC I: 5.0364e-06
FIDELITY FD.: 0.043918
NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A: 5.1818e-06
NATIONWIDE BNY MELLON DYN US CORE FD EAGLE: 5.6398e-06
JANUS HENDERSON RESEARCH FUND A: 8.934e-06
JP MORGAN US EQUITY FUND I: 4.9356e-06
Rendimento del portafoglio: 0.010242
Rendimento annualizzato: 12.039
Rischio del portafoglio: 0.047642
Rischio annualizzato: 0.75629
Skewness del portafoglio: -1.234
Curtosi del portafoglio: 5.0406
Beta del portafoglio: 1.0234
Rapporto di Sharpe: 0.21334
Rapporto di Sortino: 0.29841
Alpha di Jensen: 0.00036564
```

This portfolio shows a mix of strengths and areas that could use some improvement. The annualized return of **12.04%** is quite solid, indicating that the portfolio has been performing well over time. However, the risk is relatively high, with an annualized **volatility of 75.63%**, which suggests significant fluctuations in returns. This is further highlighted by the beta of 1.0234, meaning the portfolio moves almost in sync with the market, making it sensitive to market movements.
The negative skewness of -1.234 indicates that the portfolio tends to have more negative returns than positive ones, which could be a concern if you're aiming to minimize losses. The kurtosis of 5.0406 suggests that the portfolio experiences more extreme returns than a normal distribution, which could lead to unexpected volatility.
On the positive side, the Sharpe ratio of 0.21334 and the Sortino ratio of 0.29841 indicate that the portfolio is managing risk-adjusted returns reasonably well, though there is room for improvement. The positive Jensen's alpha of 0.00036564 is a good sign, showing that the portfolio is outperforming its expected return based on its market risk.

QUESTION 6,7,8: MEAN VARIANCE OPTIMAL PORTFOLIO ALLOCATION

Portfolio 2: Min Risk, Max Ret

Monthly




```
Risultati dell'ottimizzazione:
Valore della funzione obiettivo: -0.0079726
Exit flag: 1
Output:
         iterations: 31
          funcCount: 256
    constrviolation: 2.2204e-16
           stepsize: 0.0368
          algorithm: 'interior-point'
      firstorderopt: 6.1024e-07
       cgiterations: 0
            message: 'Local minimum found that satisfies the constraints.↵↵Optimization completed
        bestfeasible: [1×1 struct]
```

As seen from the results of the exit flag, the optimization performed correctly. The algorithm took 31 iterations, violating the constraints by a value close to zero. The algorithm used is 'Interior Point.' In this case, he value of the objective function does not provide any information on portofolio’s parameters.

QUESTION 9, 10: FUNDS PERFORMANCE RANKING

Presented below is the code to answer this questions.

```matlab
% Carica i dati dal file Excel con la regola di denominazione delle variabili impostata su 'preserve'
opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet', 'funds
daily');
opts.VariableNamingRule = 'preserve';
funds_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

opts = detectImportOptions('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', 'Sheet',
'SP500indexD');
opts.VariableNamingRule = 'preserve';
benchmark_data = readtable('C:\Users\Tomma\MATLAB Drive\EFM EXAM 2025\DBEXAM.xlsx', opts);

% Converti le date in formato datetime
funds_data.DATE = datetime(funds_data.DATE, 'InputFormat', 'dd/MM/yyyy');
benchmark_data.DATE = datetime(benchmark_data.DATE, 'InputFormat', 'dd/MM/yyyy');

% Allinea i dati delle date
start_date = datetime('10/01/2020', 'InputFormat', 'dd/MM/yyyy');
end_date = datetime('10/01/2025', 'InputFormat', 'dd/MM/yyyy');
funds_data = funds_data(funds_data.DATE >= start_date & funds_data.DATE <= end_date, :);
benchmark_data = benchmark_data(benchmark_data.DATE >= start_date & benchmark_data.DATE <= end_date, :);

% Trova le date comuni
common_dates = intersect(funds_data.DATE, benchmark_data.DATE);

% Filtra i dati per le date comuni
funds_data = funds_data(ismember(funds_data.DATE, common_dates), :);
benchmark_data = benchmark_data(ismember(benchmark_data.DATE, common_dates), :);

% Calcola i rendimenti giornalieri normali
funds_returns = diff(funds_data{:, 2:end}) ./ funds_data{1:end-1, 2:end};
benchmark_returns = diff(benchmark_data{:, 2}) ./ benchmark_data{1:end-1, 2};

% Assicurati che le dimensioni delle matrici siano compatibili
if size(funds_returns, 1) ~= size(benchmark_returns, 1)
    error('Le dimensioni delle matrici dei rendimenti non corrispondono.');
end

% Calcola i beta dei titoli
num_stocks = size(funds_returns, 2);
beta = zeros(num_stocks, 1);
mean_returns = zeros(num_stocks, 1);
std_returns = zeros(num_stocks, 1);
sharpe_ratio = zeros(num_stocks, 1);
information_ratio = zeros(num_stocks, 1);
average_drawdown = zeros(num_stocks, 1);
pain_index = zeros(num_stocks, 1);
sterling_ratio = zeros(num_stocks, 1);
burke_ratio = zeros(num_stocks, 1);
jensen_alpha = zeros(num_stocks, 1);
treynor_index = zeros(num_stocks, 1);
treynor_black_ratio = zeros(num_stocks, 1);
stock_names = funds_data.Properties.VariableNames(2:end);

% Tasso privo di rischio giornaliero
risk_free_rate_daily = 0.02 / 252;

for i = 1:num_stocks
    X = [ones(size(benchmark_returns)), benchmark_returns];
    y = funds_returns(:, i);
    b = X \ y;
    beta(i) = b(2);
    mean_returns(i) = mean(funds_returns(:, i));
    std_returns(i) = std(funds_returns(:, i));
    sharpe_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / std_returns(i);
    information_ratio(i) = (mean_returns(i) - mean(benchmark_returns)) / std_returns(i);

    % Calcola l'Average Drawdown
    cumulative_returns = cumprod(1 + funds_returns(:, i)) - 1;
    drawdowns = cumulative_returns - cummax(cumulative_returns);
    average_drawdown(i) = mean(drawdowns(drawdowns < 0));

    % Calcola il Pain Index
    pain_index(i) = mean(abs(drawdowns(drawdowns < 0)));

    % Calcola lo Sterling Ratio
    sterling_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / abs(average_drawdown(i));

    % Calcola il Burke Ratio
    burke_ratio(i) = (mean_returns(i) - risk_free_rate_daily) / sqrt(mean(drawdowns(drawdowns < 0).^2));

    % Calcola il Jensen Alpha
    jensen_alpha(i) = mean_returns(i) - (risk_free_rate_daily + beta(i) * (mean(benchmark_returns) -
risk_free_rate_daily));

    % Calcola il Treynor Index
    treynor_index(i) = (mean_returns(i) - risk_free_rate_daily) / beta(i);

    % Calcola il Treynor-Black Ratio
    treynor_black_ratio(i) = jensen_alpha(i) / beta(i);
end

% Calcola i rendimenti annualizzati e le deviazioni standard annualizzate
annualized_mean_returns = mean_returns * 252;
annualized_std_returns = std_returns * sqrt(252);
annualized_sharpe_ratio = sharpe_ratio * sqrt(252);
annualized_information_ratio = information_ratio * sqrt(252);
annualized_jensen_alpha = jensen_alpha * 252;
annualized_treynor_index = treynor_index * 252;
annualized_treynor_black_ratio = treynor_black_ratio * 252;

% Seleziona i 5 indicatori di performance per il ranking
performance_indicators = [annualized_information_ratio, annualized_sharpe_ratio, annualized_jensen_alpha,
pain_index, annualized_treynor_index];

% Assegna pesi a ciascun indicatore (puoi modificare questi pesi in base alle tue preferenze)
weights = [0.3, 0.25, 0.2, 0.15, 0.1]; % La somma dei pesi deve essere 1

% Inizializza una matrice per memorizzare i ranking
rankings = zeros(num_stocks, 5);

% Calcola i ranking per ciascun indicatore
for i = 1:5
    [~, sorted_indices] = sort(performance_indicators(:, i), 'descend');
    [~, rankings(:, i)] = sort(sorted_indices);
end

% Calcola il punteggio complessivo per ciascun fondo
overall_scores = zeros(num_stocks, 1);
for i = 1:num_stocks
    overall_scores(i) = sum(rankings(i, :) .* weights);
end

% Aggiungi i punteggi complessivi alla tabella dei risultati
results_table = table(stock_names', beta, annualized_mean_returns, annualized_std_returns,
annualized_sharpe_ratio, annualized_information_ratio, ...
    pain_index, sterling_ratio, burke_ratio, annualized_jensen_alpha, annualized_treynor_index,
annualized_treynor_black_ratio, overall_scores, ...
    'VariableNames', {'Stock', 'Beta', 'Annualized_Mean_Return', 'Annualized_Std_Dev',
'Annualized_Sharpe_Ratio', 'Annualized_Information_Ratio', ...
    'Pain_Index', 'Sterling_Ratio', 'Burke_Ratio', 'Annualized_Jensen_Alpha', 'Annualized_Treynor_Index',
'Annualized_Treynor_Black_Ratio', 'Overall_Score'});

% Ordina i fondi in base al punteggio complessivo
sorted_funds = sortrows(results_table, 'Overall_Score', 'ascend'); % 'ascend' perché un punteggio più
basso è migliore

% Visualizza i risultati
disp('Ranking dei fondi basato su 5 indicatori di performance:');
disp(sorted_funds(:, {'Stock', 'Overall_Score', 'Annualized_Information_Ratio',
'Annualized_Sharpe_Ratio', 'Annualized_Jensen_Alpha', 'Pain_Index', 'Annualized_Treynor_Index'}));

% Seleziona il miglior fondo
top_fund = sorted_funds(1, :);
disp('Il miglior fondo selezionato è:');
```

QUESTION 9, 10: FUNDS PERFORMANCE RANKING

The results from the Command Window are the following:

Stock	Annualized_Information_Ratio	Annualized_Sharpe_Ratio	Annualized_Jensen_Alpha	Pain_Index	Annualized_Treynor_Index
{'JANUS HENDERSON RESEARCH FUND A' }	-0.026827	0.42441	-0.015724	0.24938	0.096225
{'FIDELITY FD.' }	0.04042	0.54664	0.0050763	0.15317	0.11884
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	0.035688	0.57081	0.0064455	0.11559	0.12032
{'COLUMBIA LARGE CAP GROWTH FUND I' }	-0.037992	0.42213	-0.018885	0.22576	0.096501
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	-0.11699	0.39938	-0.027779	0.16821	0.086627
{'JP MORGAN US EQUITY FUND I' }	-0.14131	0.37621	-0.03201	0.17152	0.082176
{'JANUS HENDERSON FORTY FUND I' }	-0.14121	0.30817	-0.046867	0.29356	0.071217
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE' }	-0.15203	0.38818	-0.030631	0.16424	0.082915
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I' }	-0.16851	0.3907	-0.027091	0.13955	0.085006
{'FIDELITY MAGELLAN' }	-0.15844	0.31993	-0.04428	0.2365	0.072061
{'BLACKROCK FD.MID CAP' }	-0.16362	0.26668	0.072981	0.24873	-3.3957
{'FIDELITY MAGELLAN_1' }	-0.15844	0.31993	-0.04428	0.2365	0.072061
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	-0.16878	0.3706	-0.033941	0.16904	0.079477
{'MORGAN STANLEY INSIGHT FUND A' }	-0.14462	0.1222	-0.092081	1.1057	0.041212
{'GOLDMAN SACHS LARGE CAP CORE FUND A' }	-0.23996	0.2597	-0.057146	0.204	0.057984
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R' }	-0.49273	-0.018668	-0.0032846	0.1749	0.42527
{'CAPITAL GROUP US EQUITY FUND' }	-0.30987	0.2885	-0.043786	0.11046	0.0634
{'VANGUARD EXPLORER FD.' }	-0.31612	0.11715	-0.09395	0.3269	0.028135
{'VANGUARD PRIMECAP FD.' }	-0.34448	0.14781	-0.079946	0.17335	0.034144
{'NEUBERGER BERMAN GENESIS FUND' }	-0.36539	0.10005	-0.092486	0.27706	0.023854
{'PIMCO RAE US FUND A' }	-0.38177	0.1227	-0.080219	0.12453	0.029254
{'JANUS HENDERSON ENTERPRISE FUND A' }	-0.48682	-0.0086415	-0.11349	0.25214	-0.0021054
{'FRANKLIN TEMPLETON SMACS: SERIES E' }	-0.5356	0.08976	-0.073692	0.090977	0.020692

The funds ranking is the following:

Ranking dei fondi in ordine di punteggio (dal migliore al peggiore):

Stock	Overall_Score
{'JANUS HENDERSON RESEARCH FUND A' }	4.25
{'FIDELITY FD.' }	4.4
{'T ROWE PRICE US EQUITY RESEARCH FUND ADVISOR'}	4.6
{'COLUMBIA LARGE CAP GROWTH FUND I' }	5.1
{'JP MORGAN US RESEARCH ENHANCED EQUITY FUND A'}	7.35
{'JP MORGAN US EQUITY FUND I' }	9.1
{'JANUS HENDERSON FORTY FUND I' }	9.55
{'NATIONWIDE BNY MELLON DYN US CORE FD EAGLE' }	9.6
{'T ROWE PRICE US LARGE- CAP CORE FUND INC I' }	10.35
{'FIDELITY MAGELLAN' }	10.4
{'BLACKROCK FD.MID CAP' }	10.65
{'FIDELITY MAGELLAN_1' }	11.4
{'NATIONWIDE BNY MELLON DYNAMIC US CORE FUND A'}	11.9
{'MORGAN STANLEY INSIGHT FUND A' }	12.65
{'GOLDMAN SACHS LARGE CAP CORE FUND A' }	14.6
{'BLACKROCK ADVANTAGE LARGE CAP CORE FUND R' }	15.05
{'CAPITAL GROUP US EQUITY FUND' }	15.15
{'VANGUARD EXPLORER FD.' }	16.45
{'VANGUARD PRIMECAP FD.' }	16.65
{'NEUBERGER BERMAN GENESIS FUND' }	17.5
{'PIMCO RAE US FUND A' }	18.85
{'JANUS HENDERSON ENTERPRISE FUND A' }	19.35
{'FRANKLIN TEMPLETON SMACS: SERIES E' }	21.1

QUESTION 9, 10: FUNDS PERFORMANCE RANKING

The best selected fund is the following:

```
Il miglior fondo selezionato è:

{'JANUS HENDERSON RESEARCH FUND A'}
```

The ranking algorithm used in this script is designed to evaluate and rank funds based on a combination of five performance indicators. The goal is to assign an overall score to each fund that reflects its overall performance relative to the selected indicators. The five chosen indicators are the Annualized Information Ratio, the Annualized Sharpe Ratio, the Annualized Jensen's Alpha, the Pain Index, and the Annualized Treynor Index. These indicators cover both return and risk, providing a comprehensive view of the fund's performance.

Each indicator is assigned a weight that reflects its relative importance in the calculation of the overall score. The weights are 0.3 for the Information Ratio, 0.25 for the Sharpe Ratio, 0.2 for the Jensen's Alpha, 0.15 for the Pain Index, and 0.1 for the Treynor Index. The sum of the weights is 1, ensuring that the overall score is a balanced combination of the indicators.

For each indicator, the funds are ranked from best to worst, and a ranking is assigned to each fund. The fund with the best performance receives a ranking of 1, while the fund with the worst performance receives a ranking of N, where N is the total number of funds. For example, if there are 10 funds, the fund with the highest Information Ratio receives a ranking of 1 for that indicator, while the fund with the lowest Information Ratio receives a ranking of 10.

The overall score for each fund is calculated as a weighted linear combination of the rankings. This means that the ranking for each indicator is multiplied by the weight assigned to that indicator, and the results are summed to obtain the overall score. For example, if a fund has a ranking of 1 for the Information Ratio, 2 for the Sharpe Ratio, 3 for the Jensen's Alpha, 4 for the Pain Index, and 5 for the Treynor Index, its overall score will be calculated as $(1 \times 0.3) + (2 \times 0.25) + (3 \times 0.2) + (4 \times 0.15) + (5 \times 0.1) = 2.3$.

The funds are then sorted based on the overall score, with a lower score indicating better performance and a higher score indicating worse performance. This is because the rankings are assigned such that 1 is the best and N is the worst. Finally, the funds are displayed in ascending order of overall score, from best to worst, and the top-performing fund, which is the one with the lowest overall score, is identified and displayed.

The algorithm is flexible and can be customized by adjusting the weights of the indicators or adding and removing indicators based on specific needs. This approach combines rankings and weights to provide an objective and customizable evaluation of fund performance, making it a useful tool for investors seeking a comprehensive and balanced assessment.

References

- *Pocci, C., Rotundo, G. and De Kok, R. (2016) Matlab per le Applicazioni Economiche e Finanziarie. Santarcangelo di Romagna: Maggioli Editore.*
- *Professor Marzo's lectures*