Introduction to Financial Engineering

Assignment - 2

Group 5

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Asset Chosen

- Stocks chosen for the purpose of this assignment are :- HCLTech , TCS , INFOSYS , SBI , HDFC bank , ICICI bank , Hindustan unilever , Bajaj Finance , Adani Enterprises , Larsen & Toubro .

- Data was collected for the three months starting from 3/7/2023 to 29/9/2023. Therefore Data consists of 63 entries of closing price for each day

Date	Price	Change %	Price	Change %	Price	Change %	Price	Change %	Price	Change %
7/3/2023	2,385.50	NaN	7,333.00	NaN	1,719.80	NaN	1,333.70	NaN	585.45	NaN
7/4/2023	2,387.70	0.09%	7,860.45	7.19%	1,728.20	0.49%	1,345.15	0.86%	589.25	0.65%
7/5/2023	2,399.15	0.48%	7,838.75	-0.28%	1,673.30	-3.18%	1,347.30	0.16%	590.6	0.23%
7/6/2023	2,402.90	0.16%	7,766.25	-0.92%	1,675.00	0.10%	1,343.90	-0.25%	592.5	0.32%
7/7/2023	2,379.60	-0.97%	7,622.35	-1.85%	1,660.40	-0.87%	1,330.20	-1.02%	593.6	0.19%
7/10/2023	2,410.25	1.29%	7,533.25	-1.17%	1,656.45	-0.24%	1,329.15	-0.08%	592.6	-0.17%
7/11/2023	2,422.90	0.52%	7,444.00	-1.18%	1,648.40	-0.49%	1,348.60	1.46%	588.55	-0.68%
7/12/2023	2,387.90	-1.44%	7,431.95	-0.16%	1,632.95	-0.94%	1,333.30	-1.13%	589.25	0.12%
7/13/2023	2,362.05	-1.08%	7,474.60	0.57%	1,641.10	0.50%	1,365.10	2.39%	585.65	-0.61%
7/14/2023	2,376.10	0.59%	7,482.35	0.10%	1,644.50	0.21%	1,425.95	4.46%	584.4	-0.21%
7/17/2023	2,408.55	1.37%	7,510.95	0.38%	1,678.90	2.09%	1,422.95	-0.21%	601.1	2.86%
7/18/2023	2,416.90	0.35%	7,420.00	-1.21%	1,677.50	-0.08%	1,475.20	3.67%	592.35	-1.46%
7/19/2023	2,423.75	0.28%	7,584.70	2.22%	1,685.10	0.45%	1,474.95	-0.02%	601.45	1.54%
7/20/2023	2,419.75	-0.17%	7,596.60	0.16%	1,688.75	0.22%	1,449.50	-1.73%	610.05	1.43%
7/21/2023	2,416.30	-0.14%	7,581.75	-0.20%	1,675.75	-0.77%	1,331.60	-8.13%	615.1	0.83%
7/24/2023	2,418.20	0.08%	7,581.60	0.00%	1,678.40	0.16%	1,336.60	0.38%	617.65	0.41%
7/25/2023	2,466.65	2.00%	7,606.45	0.33%	1,696.60	1.08%	1,334.60	-0.15%	609.6	-1.30%
7/26/2023	2,470.75	0.17%	7,433.15	-2.28%	1,690.70	-0.35%	1,348.85	1.07%	615.15	0.91%
7/27/2023	2,428.40	-1.71%	7,284.10	-2.01%	1,673.15	-1.04%	1,353.15	0.32%	616.55	0.23%
7/28/2023	2,463.20	1.43%	7,381.60	1.34%	1,643.50	-1.77%	1,340.50	-0.93%	616.05	-0.08%

Methodology

Return for each day is calculated using :

Closing price (Present_day) - Closing price (Previous_day)/ Closing price (Previous_day)

For example :- 7/4/2023 2,387.70

7/3/2023 2,385.50

Return = 2,387.70 - 2,385.50 / 2,385.50
= 0.0009

Return % = 0.09 %

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100\%$$

Where:

- R_t = Daily return for day t
- P_t = Price on day t
- P_{t-1} = Price on the previous day

Methodology

Expected Return is calculated :

$$\bar{R} = \frac{\sum R_i}{N}$$

Where:

- $\bar{R}$ = Mean return
- R_i = Individual return
- N = Number of returns

	Asset_1	Asset_2	Asset_3	Asset_4	Asset_5	Asset_6	Asset_7	Asset_8	Asset_9	Asset_10
Mean_Return	0.000345	0.001121	-0.00187	0.001311	0.000418	0.000794	0.001287	0.003445	0.000198	-0.00143

Methodology

Portfolio Variance is calculated :

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i \times w_j \times \sigma_{ij}$$

Where:

- σ_p^2 = Portfolio variance
- w_i = Weight of asset i in the portfolio
- w_j = Weight of asset j in the portfolio
- σ_{ij} = Covariance between assets i and j
- N = Number of assets in the portfolio

Covariance Matrix

	Return_1	Return_2	Return_3	Return_4	Return_5	Return_6	Return_7	Return_8	Return_9	Return_10
Return_1	0.000293	0.000007	0.000022	0.000002	0.000003	0.000029	-0.000020	-0.000019	-0.000027	0.000014
Return_2	0.000007	0.000215	0.000030	-0.000003	0.000023	0.000006	0.000021	-0.000012	0.000036	0.000014
Return_3	0.000022	0.000030	0.000102	0.000028	0.000019	0.000040	0.000027	0.000026	0.000020	-0.000008
Return_4	0.000002	-0.000003	0.000028	0.000247	-0.000046	0.000115	0.000123	-0.000021	0.000010	0.000066
Return_5	0.000003	0.000023	0.000019	-0.000046	0.000124	0.000005	-0.000008	0.000031	0.000029	-0.000002
Return_6	0.000029	0.000006	0.000040	0.000115	0.000005	0.000171	0.000099	0.000014	0.000010	0.000031
Return_7	-0.000020	0.000021	0.000027	0.000123	-0.000008	0.000099	0.000134	0.000011	0.000025	0.000022
Return_8	-0.000019	-0.000012	0.000026	-0.000021	0.000031	0.000014	0.000011	0.000149	0.000021	-0.000009
Return_9	-0.000027	0.000036	0.000020	0.000010	0.000029	0.000010	0.000025	0.000021	0.000073	0.000015
Return_10	0.000014	0.000014	-0.000008	0.000066	-0.000002	0.000031	0.000022	-0.000009	0.000015	0.000085

Markowitz's mean-variance optimization

It is a optimization problem where we have to minimize the risk subjected/constraint given that sum of the weights = 1

Markowitz's mean-variance optimization problem can be formulated as follows:

$$\text{minimize} \quad w^T \Sigma w$$

$$\text{subject to} \quad w^T \mu = \text{target return}$$

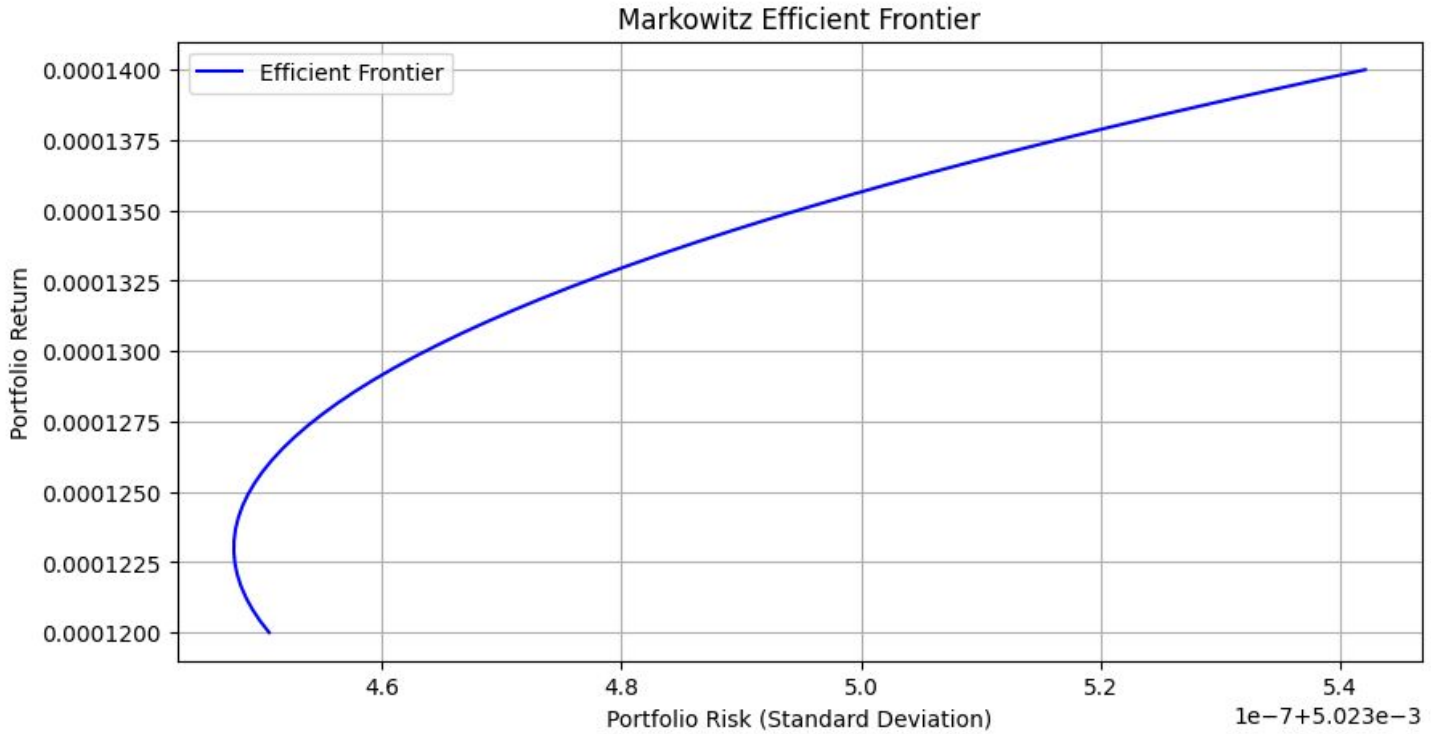
$$\sum_{i=1}^{n} w_i = 1$$

Results

Optimal weights for the problem when subjected to constraints $OW^T = 1$

```
Optimal Weights:
[0.09521674 0.0439849  0.11505803 0.01426402 0.11790629 0.
 0.07855369 0.11885617 0.17216998 0.24399019]
```

Results :- Markowitz Curve



Results :- Weights corresponding to two different risks

For `target_risk_1 = 0.000100`

```
Weights =  [0.09184713 0.03194988 0.12213474 0.01578118 0.1268991  0.
 0.07301513 0.12982633 0.16630377 0.24224274]
```

For `target_risk_2 = 0.000200`

Weights = `[9.17032927e-02 3.86595115e-02 1.25232403e-01 8.86625894e-18`
`1.16555372e-01 1.66182934e-12 9.64174223e-02 1.23048160e-01`
`1.59342009e-01 2.49041830e-01]`