IME611A: Group Project
Equity Portfolio Management

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Objective:

Consider any 10 stocks from NIFTY50 companies. You can collect the data on stock prices and other useful indicators from NSE (or other trading portals). You must construct a portfolio where you invest a total amount of money of INR 5,00,000. Consider a risk-free annual rate of 6%.

- You need to construct a risky portfolio comprising the 10 companies as guided by their correlation. You may use historical data of a minimum of 150 trading days to estimate the expected return, standard deviation, correlation, and other relevant parameters.
- You are required to provide the allocation of the money in each of the 10 stocks. How many shares would be bought of each company if all the purchases are made on a single date (any date's (12 October to 5 November) prices may be used.)?
- What would be the Sharpe ratio?
- Draw and report the portfolio frontier, CAL.
- What considerations may you have to make for the COVID-induced situation to your correlation matrix?
- Any tool (Excel/R/Python) may be used.
- Trade in the same stocks on MoneyBhai and show your end portfolio positions.

Overview:

The goal of our portfolio optimization project is to retrieve the expected return for a given risk tolerance. The return is associated with a portfolio of weightages (asset-allocation) to help decide investment strategies. The optimization strategy that will be used in this analysis is Modern Portfolio Theory (by Harry Markowitz), commonly known as Mean Variance Optimization (MVO). The MVO model only takes into consideration historical results and thus is limited to that. It will not be able to account for other factors that could affect a model such as insight into future market forecasts.

Data Collection:

We collected the historical data for the 150 trading days for 10 stocks from Nifty50.

Start Date: 05/03/2022
End Date: 12/10/2022

To pull the data into the excel sheet, we used the formula:
=STOCKHISTORY(stock, start_date, [end_date]) for daily frequency.

Company Name	Ticker
Bharti Airtel Limited (XNSE:BHARTIARTL)	BHARTIARTL
ITC LIMITED (XNSE:ITC)	ITC
Hero MotoCorp Limited (XNSE:HEROMOTOCO)	HEROMOTOCO
HCL TECHNOLOGIES LIMITED (XNSE:HCLTECH)	HCLTECH
COAL INDIA LTD (XNSE:COALINDIA)	COALINDIA
State Bank of India (XNSE:SBIN)	SBIN
LARSEN AND TOUBRO LIMITED (XNSE:LT)	LT
DR.REDDY'S LABORATORIES LTD (XNSE:DRREDDY)	DRREDDY
BAJAJ FINANCE LIMITED (XNSE:BAJFINANCE)	BAJFINANCE
ADANI ENTERPRISES LIMITED (XNSE:ADANIENT)	ADANIENT

We then calculated the daily returns for these stocks in %:
$\mathbf{R_i = \{(Closing\ Price)_i - (Closing\ Price)_{i-1} / (Closing\ Price)_{i-1}\}^* 100}$

<u>Portfolio Optimization</u>:

Based on the daily returns, we then calculated the **Average Daily Return**, **Variance**, **Annual Return** and **Annual Variance** (by considering 252 trading days in a financial year):

	BHARTIARTL	ITC	HEROMOTOCO	HCLTECH	COALINDIA	SBIN	LT	DRREDDY	BAJFINANCE	ADANIENT
Avg. Daily Return	0.10	0.27	0.12	-0.12	0.16	0.14	0.12	0.09	0.13	0.51
Variance	2.23	1.87	3.28	2.38	4.75	2.38	2.56	2.36	4.65	5.35
Annual Return	26.20	67.28	29.19	-29.56	41.00	35.56	29.67	22.88	33.76	129.34
Annual Variance	562.86	470.56	827.43	600.85	1,196.67	598.61	646.16	594.98	1,172.27	1,349.38

We then also calculated the Excess Returns as:
$\mathbf{R_{i,\ excess} = R_i - R_{avg}}$

<u>Covariance Matrix</u>:

A covariance matrix was created using the excess returns (multiplied by its transpose) to compare each asset with all the other respective assets. This matrix is essential in understanding the risk of each asset and how it relates to the others.

	BHARTIARTL	ITC	HEROMOTOCO	HCLTECH	COALINDIA	SBIN	LT	DRREDDY	BAJFINANCE	ADANIENT
BHARTIARTL	562.86	80.46	173.37	214.82	134.63	217.64	239.47	61.13	246.95	311.43
ITC	80.46	470.56	147.81	114.95	291.05	156.88	195.10	97.17	241.85	330.79
HEROMOTOCO	173.37	147.81	827.43	194.73	204.46	253.00	287.60	155.70	284.51	368.69
HCLTECH	214.82	114.95	194.73	600.85	183.89	248.48	347.77	176.07	354.83	288.45
COALINDIA	134.63	291.05	204.46	183.89	1,196.67	279.32	313.52	103.63	270.08	443.44
SBIN	217.64	156.88	253.00	248.48	279.32	598.61	334.64	102.00	471.81	411.47
LT	239.47	195.10	287.60	347.77	313.52	334.64	646.16	220.20	409.82	510.27
DRREDDY	61.13	97.17	155.70	176.07	103.63	102.00	220.20	594.98	135.18	203.86
BAJFINANCE	246.95	241.85	284.51	354.83	270.08	471.81	409.82	135.18	1,172.27	552.70
ADANIENT	311.43	330.79	368.69	288.45	443.44	411.47	510.27	203.86	552.70	1,349.38

Now using the above covariance matrix and portfolio weights we calculate portfolio variance. Initially we gave equal weights to all 10 stocks and calculated the expected return, associated risk and corresponding sharpe ratio.

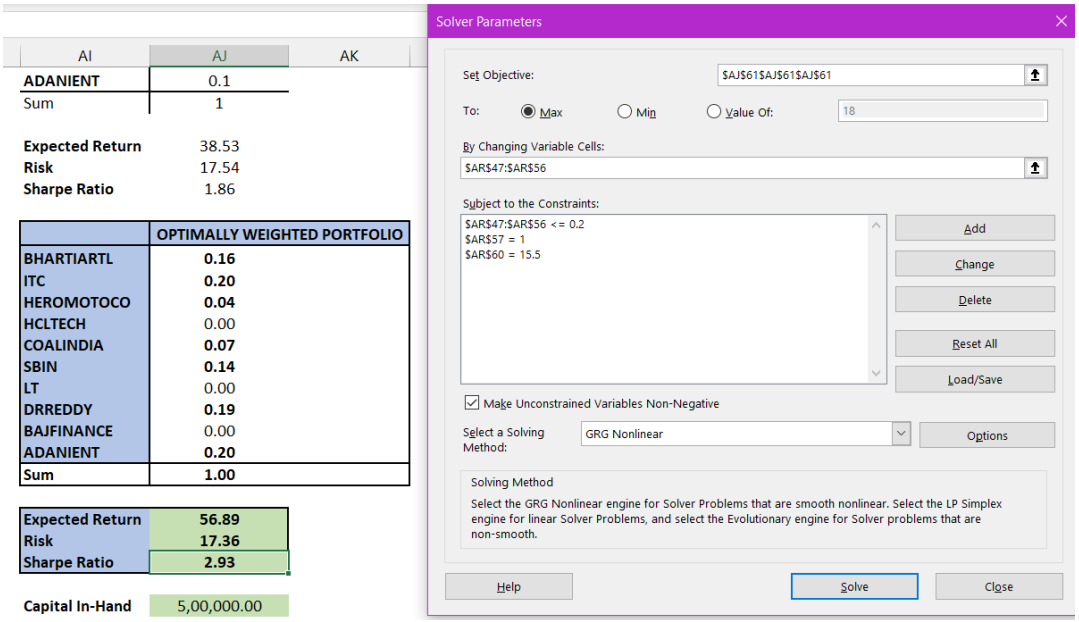
$$\mathrm{E}(R_p) = \sum_i w_i \, \mathrm{E}(R_i)$$

$$\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij}$$

In order to create an efficient frontier, the expected return $E(R_p)$ was maximised while constraining the standard deviation σ_p to specific values. The weights of each asset i, is w_i. The correlation coefficient ρ_{ij} is the correlation between assets i and j.

<u>Optimal-Weight Calculation</u>:

Since we know that the **Sharpe Ratio = (Expected Returns - Risk free rate) / Risk**
So, we used **Excel's SOLVER plug-in** to maximise the Sharpe Ratio, by changing the weights of different stocks. The **constraint** while maximising was that the **sum of all the weights should be equal to 1**, since we cannot spend more than we have.



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	ADANIENT	0.1	
	Sum	1	
	Expected Return	38.53	
	Risk	17.54	
	Sharpe Ratio	1.86	

	OPTIMALLY WEIGHTED PORTFOLIO
BHARTIARTL	**0.16**
ITC	**0.20**
HEROMOTOCO	**0.04**
HCLTECH	0.00
COALINDIA	**0.07**
SBIN	**0.14**
LT	0.00
DRREDDY	**0.19**
BAJFINANCE	0.00
ADANIENT	**0.20**
Sum	**1.00**

Expected Return	**56.89**
Risk	**17.36**
Sharpe Ratio	**2.93**

Capital In-Hand	5,00,000.00

The optimal point with minimal risk is an annual Expected Return of 96.70% and a portfolio consisting of the following assets:

	OPTIMALLY WEIGHTED PORTFOLIO
BHARTIARTL	**0.16**
ITC	**0.20**
HEROMOTOCO	**0.04**
HCLTECH	0.00
COALINDIA	**0.07**
SBIN	**0.14**
LT	0.00
DRREDDY	**0.19**
BAJFINANCE	0.00
ADANIENT	**0.20**
Sum	**1.00**

Expected Return	56.89
Risk	17.36
Sharpe Ratio	2.93

<u>Efficient Frontier and CAL</u>:

To find the efficient frontier, we first found out the values of Minimum and Maximum Risk:

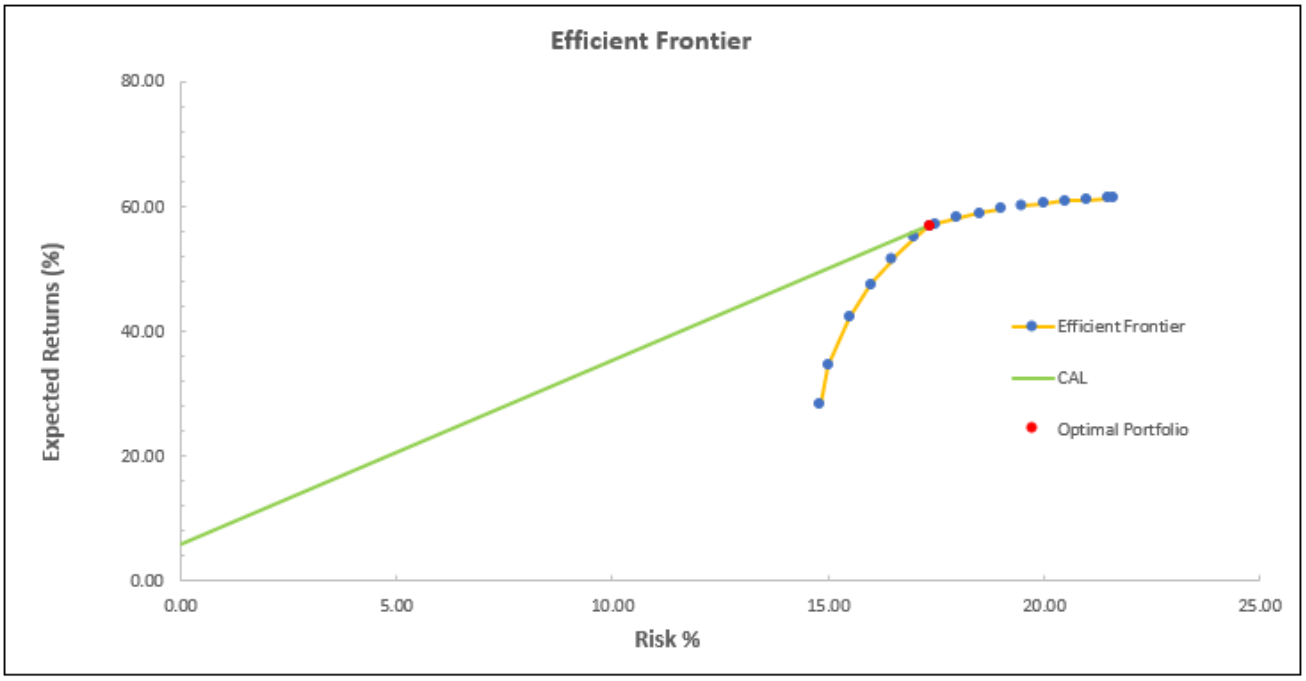
Minimum Risk: In SOLVER, we set the objective to minimise the Risk
(R_{min} = 14.82%)

Maximum Risk: In SOLVER, we set the objective to maximise the Expectations
(R_{max} = 21.62%)

Then, we used solver to generate data points in between these values of Risk by:

Objective: Maximise E(r)
Variables: Weights of the portfolio
Constraints: i) Sum of the weights = 1
ii) Risk = R_o (where R_o is the value for which we want to generate the data point)

Finally, we plotted the data points on the **efficient frontier**.
To get the **CAL**, we plotted a line which passes from the points:
(0, 6) - for entirely risk free allocation
(17.36, 56.89) - for the optimally weighed portfolio



The weightage of each asset was constrained to positive values to avoid short selling and with an **upper bound of 20% to ensure diversification**. The solver was run for multiple different iterations of risk for the portfolio to get different points for the efficient frontier. After about 10 scenarios, the Expected Return of the Portfolio was graphed against the risk to get the efficient frontier.

Real Time Stock Market Analysis

Using Rs. 5,00,000.00 as capital, based on our above analysis and real time trading on NSE between dates 13th October and 9th November, we'll generate the following profit:

Stock	Amount	13/10/2022	# Shares	09/11/2022	Profit
BHARTIAIRTEL	₹ 80,467.78	₹ 768.90	105	₹ 819.05	₹ 5,248.35
ITC	₹ 1,00,000.00	₹ 328.65	304	₹ 360.70	₹ 9,752.02
HEROMOTOCO	₹ 21,623.15	₹ 2,546.45	8	₹ 2,651.50	₹ 892.03
COALINDIA	₹ 32,934.38	₹ 234.55	140	₹ 255.80	₹ 2,983.82
SBIN	₹ 72,421.17	₹ 521.45	139	₹ 615.55	₹ 13,069.00
DRREDDY	₹ 92,553.53	₹ 4,254.65	22	₹ 4,534.90	₹ 6,096.42
ADANIENT	₹ 1,00,000.00	₹ 3,233.65	31	₹ 3,997.20	₹ 23,612.64
Net Profit					₹ 61,654.28