Project

Markowitz Portfolio Optimization

What is Markowitz Portfolio Optimization?

- Markowitz portfolio optimization is a strategy for constructing investment portfolios.
- It aims to maximize returns while minimizing risk.
- Steps include selecting assets, estimating their returns and risks.
- Correlations between assets are analyzed.
- An efficient portfolio is constructed to balance risk and return.
- Diversification across assets with different risk-return profiles is key.

Historical Data

The data is taken from investing.com.Using their three months data from 1st oct 2023 to 31st Dec 2023.

https://docs.google.com/spreadsheets/d/1LIPiEVjliexOOMZtTHuEtLW-3m6zU0Y6nBsViBK949I/edit#gid=0.

Assets

The assets chosen are

- Infosys Pvt Ltd.
- Tata Motors
- Sun Pharma
- HDFC Bank
- Reliance Industries
- Bharti Airtel
- Hindustan Unilever
- Tata Steel
- Bajaj Finance
- NTPC

Markowitz Mean-Variance Optimization Formula

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Minimize:

$$\sigma^2 = WCW^T$$

Subject to:

$$OW^T = 1$$

Now,

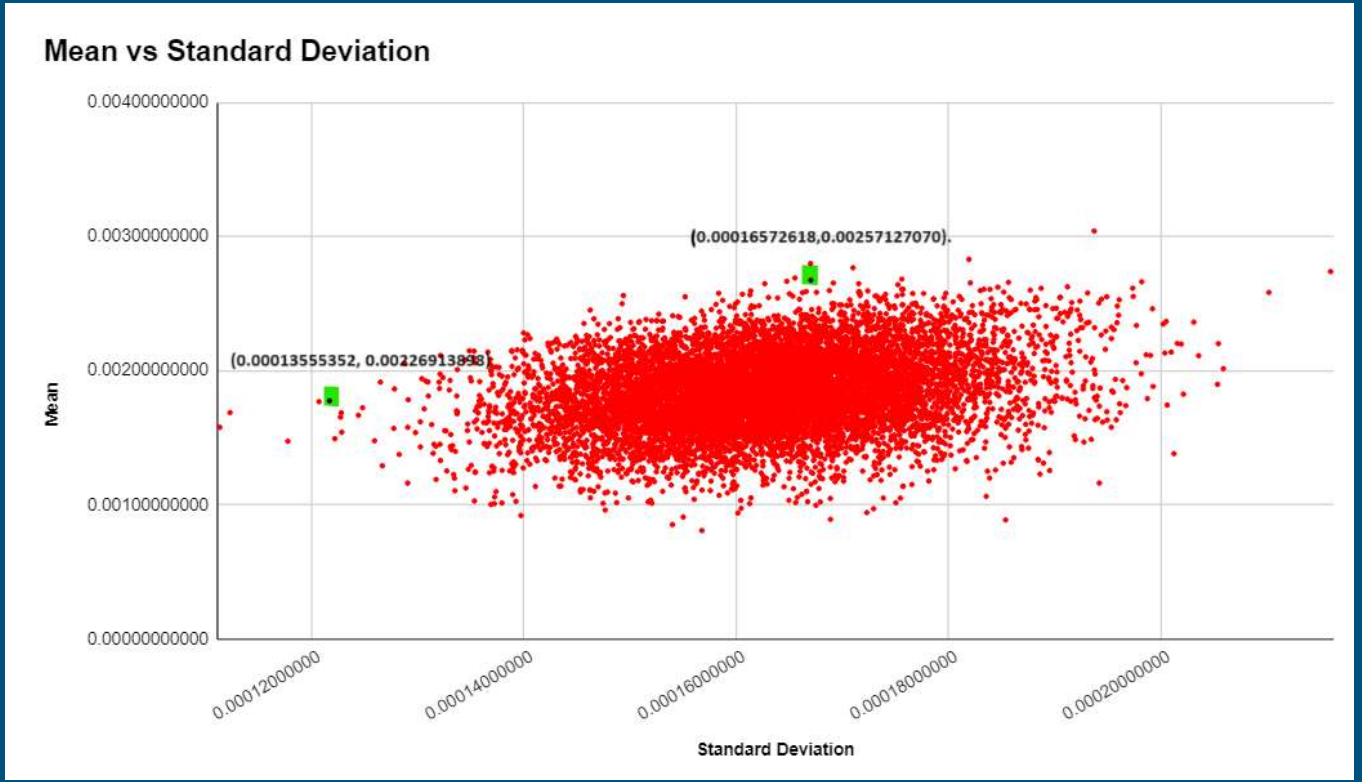
$$W_{\min} = \frac{OC^{-1}}{OC^{-1}O^T}$$

Risk and Return For Each Assets

Infosys Pvt Ltd.	TATA Motors	Sun Pharma	HDFC Bank	Reliance Industries	Bharti Airtel	Hindustan Unilever	Tata Steel	Bajaj Finance	NTPC
Return (Mean μ = E(R))									
0.00155378	0.00341353	0.00174823	0.00212513	0.00201997	0.00197941	0.00112592	0.00137406	-0.00148609	0.00458761

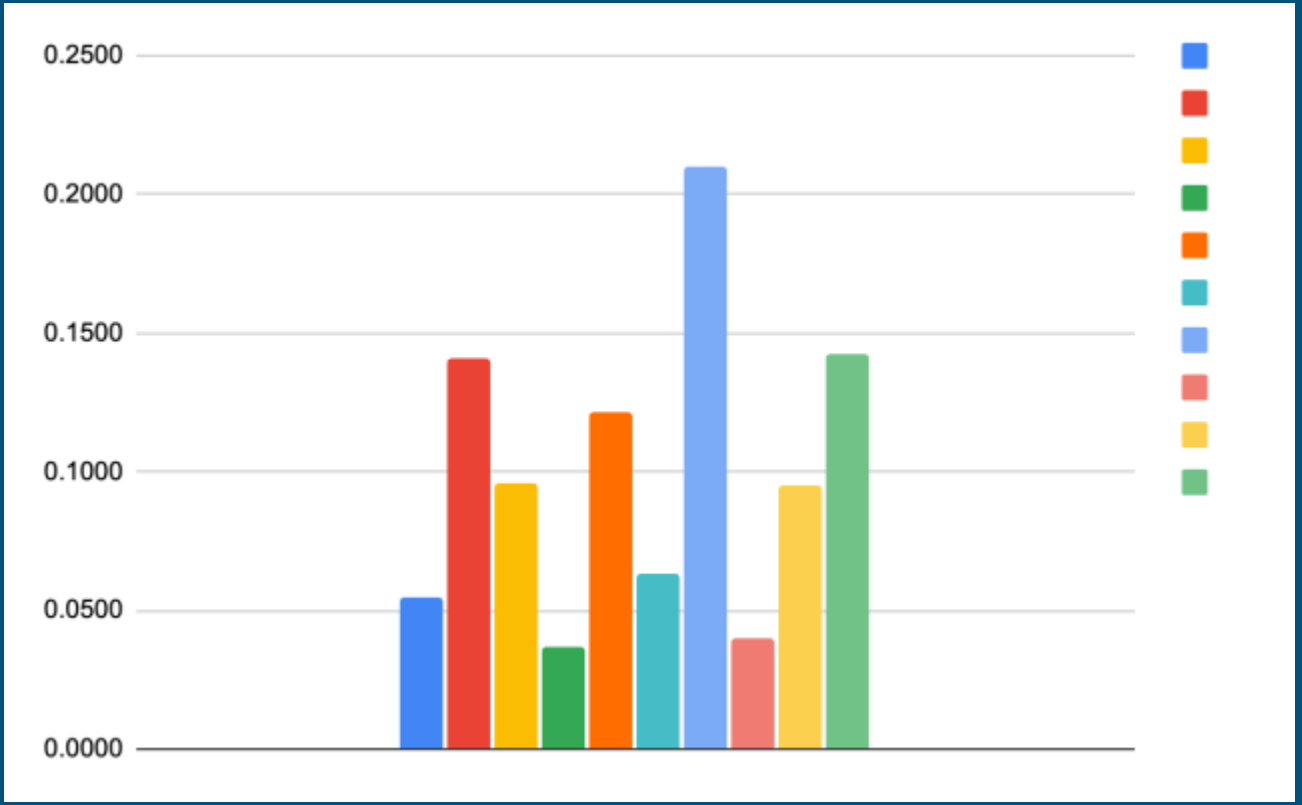
Infosys Pvt Ltd.	TATA Motors	Sun Pharma	HDFC Bank	Reliance Industries	Bharti Airtel	Hindustan Unilever	Tata Steel	Bajaj Finance	NTPC
Risk (Varience σ^2)									
0.00019820	0.00021744	0.00008766	0.00008180	0.00007556	0.00010340	0.00005984	0.00016177	0.00018778	0.00022940

Efficient Frontier



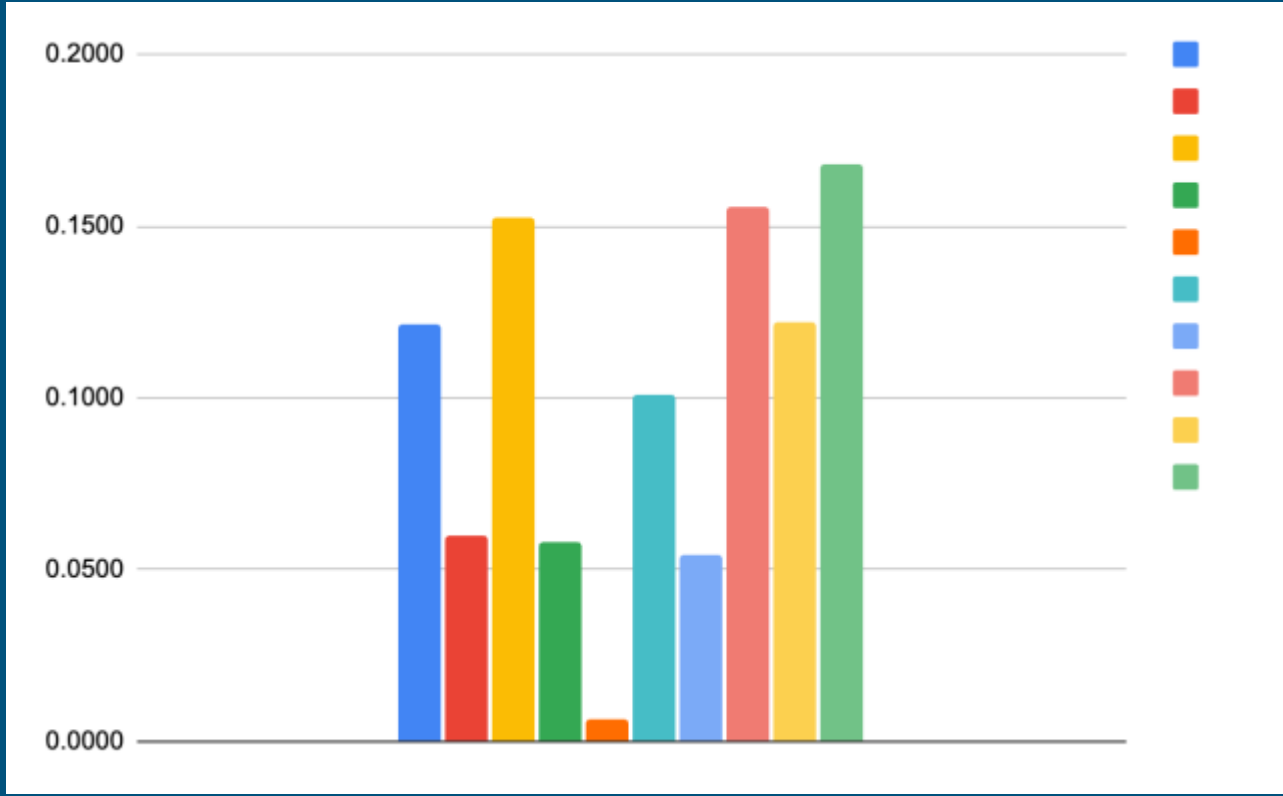
Weights For First Point

The Point chosen on efficient frontier is **(0.00016572618,0.00257127070)**.



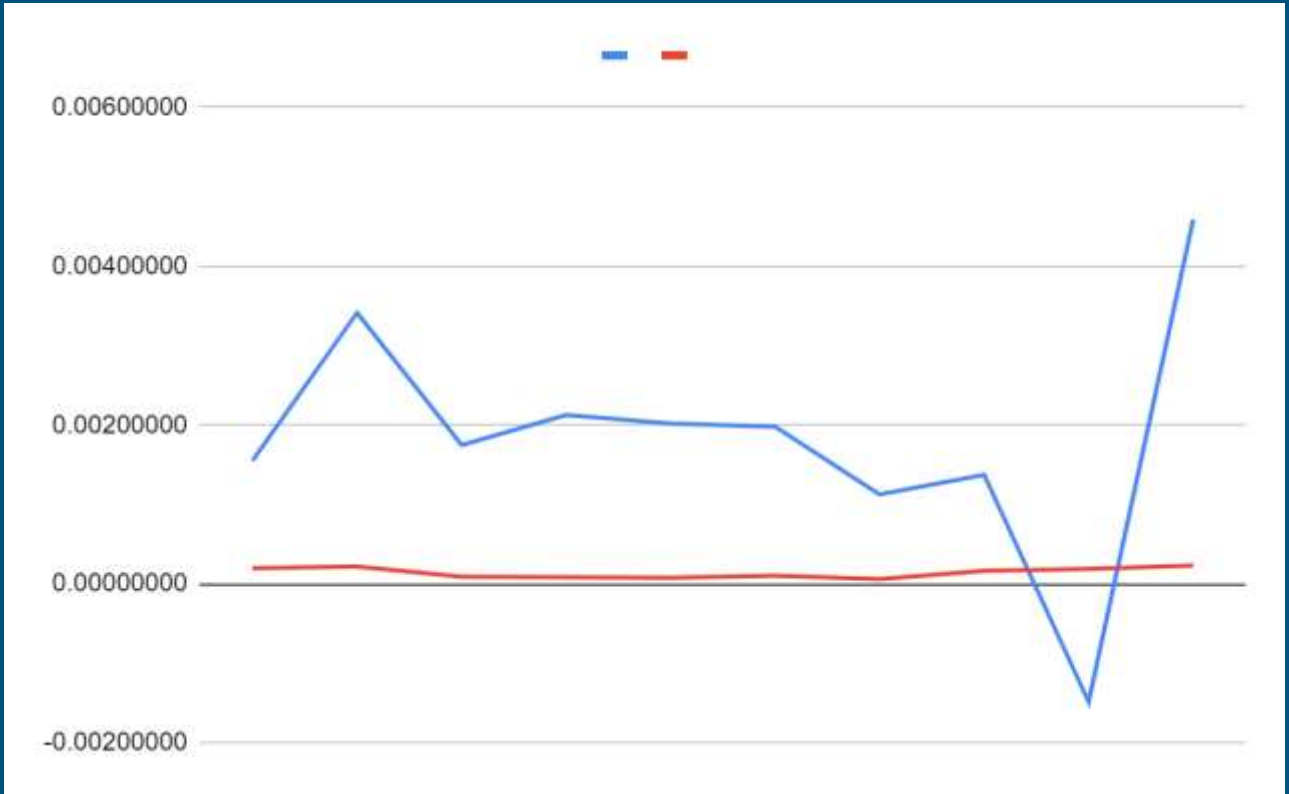
Weights For the Second Point

The Point chosen on efficient frontier is **(0.00013555352, 0.00226913898)**



Trade-off: Risk Vs Return

Return
Risk



Limitations of Markowitz Optimization

- Markowitz optimization assumes that asset returns are normally distributed, which may not hold true in real-world scenarios.
- The optimization is highly sensitive to input parameters such as expected returns, covariance matrix, and risk tolerance, which can lead to unstable and unreliable results.
- Estimating expected returns and covariance matrix accurately is challenging, especially with limited historical data, leading to potential errors in portfolio construction.
- Markowitz optimization may lead to highly concentrated portfolios, especially when dealing with a large number of assets, which can result in poor diversification and increased risk.

Application of Markowitz Portfolio

- Portfolio Management: Maximizes returns for a given risk level.
- Asset Allocation: Determines optimal asset mix based on historical returns and correlations.
- Risk Management: Balances assets to reduce overall portfolio risk.
- Wealth Management: Tailors investment strategies to individual risk tolerance and return objectives.
- Mutual Funds: Constructs diversified portfolios for competitive returns.