

Portfolio Optimization and Efficient Frontier Analysis

Using Indian Stock Market Data

June 12, 2025

Contents

1	Objective	2
2	Stock Selection	2
3	Data Description	2
4	Key Metrics Calculation	2
4.1	Expected Monthly Returns and Volatility	2
4.2	Covariance Matrix	2
5	Portfolio Construction	2
6	Portfolio Performance	3
7	Efficient Frontier Simulation	3
8	Identification of Optimal Portfolios	3
8.1	Tangency Portfolio (Maximum Sharpe Ratio)	3
8.2	Minimum Variance Portfolio	3
9	Visualizations	4
9.1	Efficient Frontier Plot	4
9.2	Efficient Frontier with Capital Market Line	5
9.3	Portfolio Weights Visualization	5
10	Conclusion	6

1 Objective

The objective of this assignment is to build and evaluate portfolios using historical monthly data from the Indian stock market. We compute expected returns, standard deviations, covariance matrices, and Sharpe ratios from scratch, and visualize the Efficient Frontier to identify optimal portfolios.

2 Stock Selection

We selected three actively traded Indian stocks from different sectors:

- **Reliance Industries (RELIANCE.NS)** – Energy / Conglomerate
- **Infosys (INFY.NS)** – Information Technology
- **ICICI Bank (ICICIBANK.NS)** – Financials

3 Data Description

Historical data for the selected stocks was downloaded from Yahoo Finance using the `yfinance` Python package. The data spans from January 2020 to May 2023 at a monthly frequency.

4 Key Metrics Calculation

4.1 Expected Monthly Returns and Volatility

The expected monthly returns and standard deviations (volatility) for individual stocks were computed using historical monthly returns.

Stock	Expected Return (Monthly)	Volatility (Monthly)
Reliance Industries	1.8301%	9.1002%
Infosys	1.8649%	8.8355%
ICICI Bank	2.0418%	10.0426%

Table 1: Expected Returns and Volatility

4.2 Covariance Matrix

The covariance matrix was calculated to evaluate portfolio risk based on the joint variability of stock returns.

5 Portfolio Construction

We created five custom portfolios with different weight combinations for the three selected stocks.

Portfolio	Reliance	Infosys	ICICI Bank
Portfolio 1	15.99%	43.55%	40.46%
Portfolio 2	3.63%	25.94%	70.43%
Portfolio 3	25.43%	29.24%	45.33%
Portfolio 4	37.72%	25.09%	37.19%
Portfolio 5	46.39%	49.09%	4.52%

Table 2: Portfolio Weight Allocations

The risk-free rate is assumed to be 0.5% per month (6% annualized).

6 Portfolio Performance

For each portfolio, we calculated expected return, volatility, and annualized Sharpe ratio.

Portfolio	Return (Monthly)	Volatility (Monthly)	Sharpe Ratio
Portfolio 1	1.8791%	7.1662%	0.6666
Portfolio 2	1.8468%	7.8856%	0.5916
Portfolio 3	1.8941%	7.1468%	0.6757
Portfolio 4	1.9187%	7.1575%	0.6866
Portfolio 5	1.9454%	7.2879%	0.6870

Table 3: Portfolio Performance Metrics

7 Efficient Frontier Simulation

We simulated 100,000 random portfolios by assigning random weights to the three stocks (sum of weights equals 1). For each portfolio, expected return, volatility, and Sharpe ratio were computed.

8 Identification of Optimal Portfolios

8.1 Tangency Portfolio (Maximum Sharpe Ratio)

- Maximum Sharpe Ratio: 0.7006
- Portfolio Weights:
 - Reliance Industries: 37.43%
 - Infosys: 40.42%
 - ICICI Bank: 22.14%

8.2 Minimum Variance Portfolio

- Minimum Volatility: 7.0029%

- Portfolio Weights:
 - Reliance Industries: 30.67%
 - Infosys: 41.58%
 - ICICI Bank: 21.75%

9 Visualizations

9.1 Efficient Frontier Plot

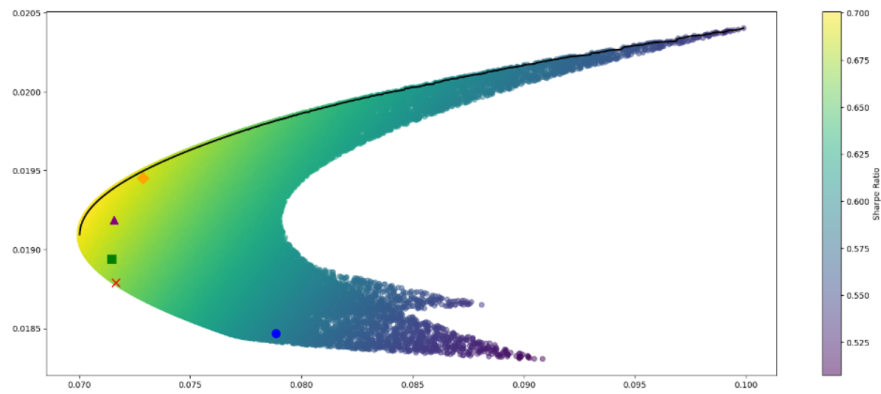


Figure 1: Efficient Frontier with Custom Portfolios

9.2 Efficient Frontier with Capital Market Line

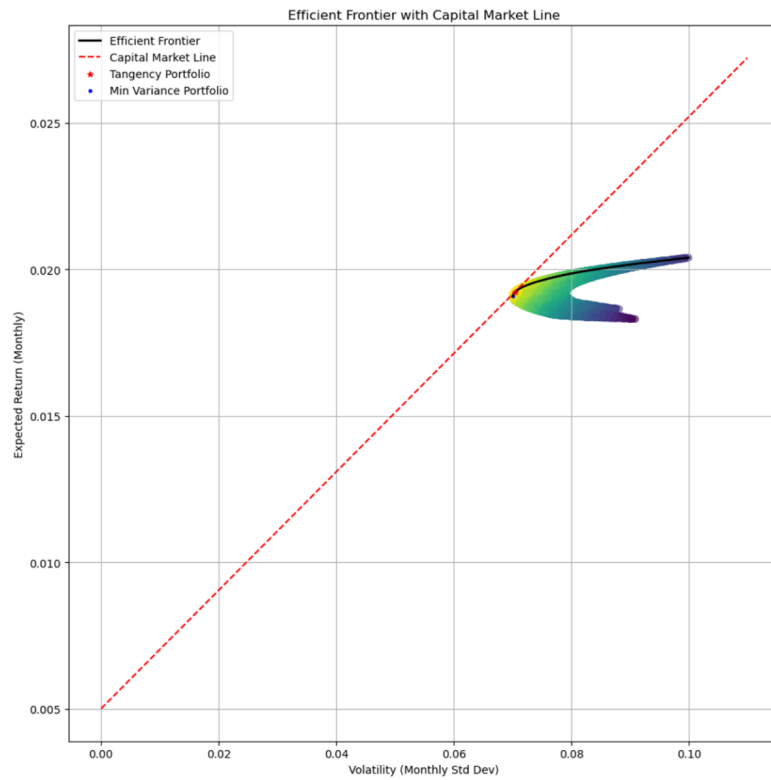


Figure 2: Efficient Frontier with Capital Market Line, Tangency Portfolio and Minimum Variance Portfolio

9.3 Portfolio Weights Visualization

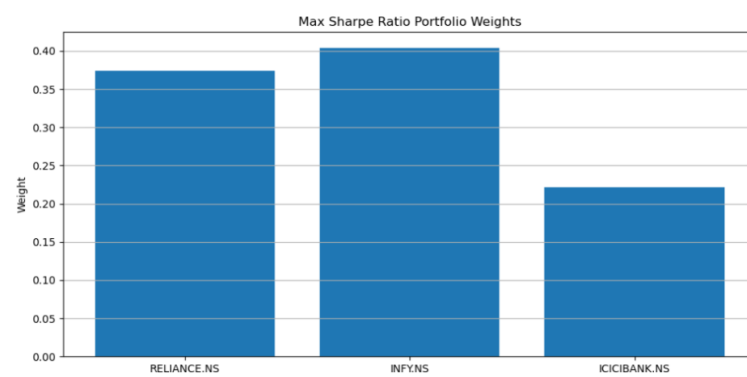


Figure 3: Max Sharpe Ratio Portfolio Weights

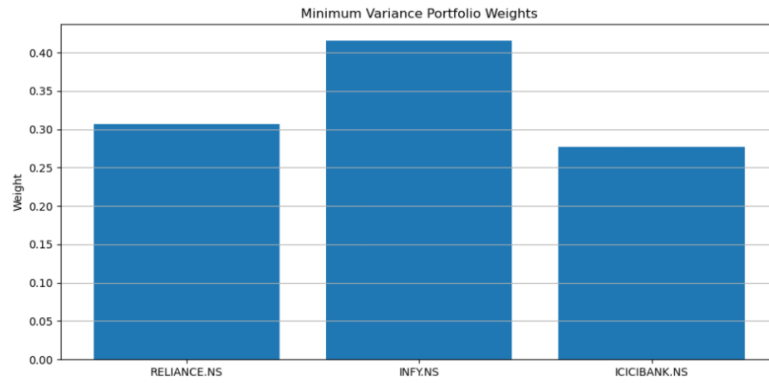


Figure 4: Minimum Variance Portfolio Weights

10 Conclusion

In this assignment, we successfully constructed multiple portfolios using Indian stock market data, calculated their performance metrics, and visualized the efficient frontier. The maximum Sharpe ratio and minimum variance portfolios were identified and analyzed.