Project-3 (Capital Asset Pricing Model)

Group 29
Nakkina Vinay

Overview

- Choosing the assets
- Exploratory Data Analysis (Correlation Matrix)
- Calculated Beta Values for risky assets
- Expected Return for risky assets using CAPM formula
- Calculating the CML equation using CAPM model and plotting the Efficient Frontier and CML
- Tangency Point obtained and its significance
- Security Market Line (SML) for 3 chosen assets
- Sharpe Ratio and Treynor Ratio (Relevant Performance Measures) for each optimized portfolios and comparing to individual assets
- (Bonus) Comparing the portfolios constructed using Markowitz and CAPM approaches

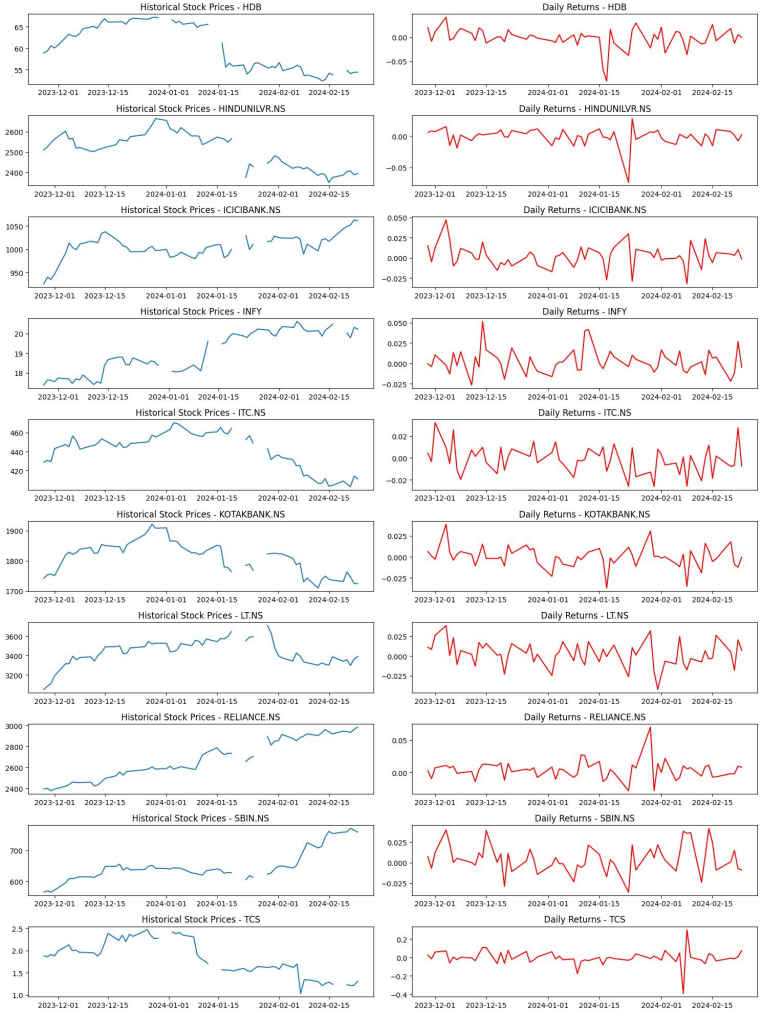
Chosen Assets

Risky Assets

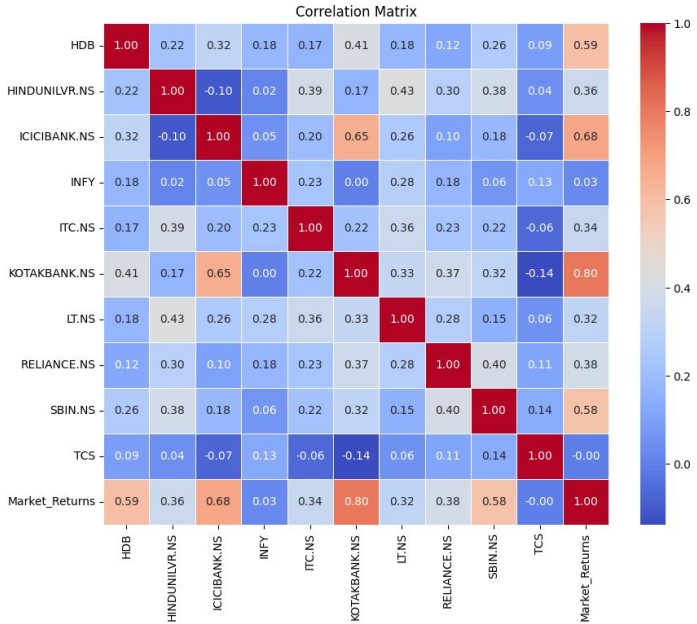
- RELIANCE.NS
- TCS
- INFY
- HDB
- HINDUNILVR.NS
- ICICIBANK.NS
- SBIN.NS
- ITC.NS
- KOTAKBANK.NS
- LT.NS

Risk-Free Assets

- Public Provident Fund (risk-free rate = 7.1 % p.a.)


Historical Stock Prices - HDB
Daily Returns - HDB
Historical Stock Prices - HINDUNILVR.NS
Daily Returns - HINDUNILVR.NS
Historical Stock Prices - ICICIBANK.NS
Daily Returns - ICICIBANK.NS
Historical Stock Prices - INFY
Daily Returns - INFY
Historical Stock Prices - ITC.NS
Daily Returns - ITC.NS
Historical Stock Prices - KOTAKBANK.NS
Daily Returns - KOTAKBANK.NS
Historical Stock Prices - LT.NS
Daily Returns - LT.NS
Historical Stock Prices - RELIANCE.NS
Daily Returns - RELIANCE.NS
Historical Stock Prices - SBIN.NS
Daily Returns - SBIN.NS
Historical Stock Prices - TCS
Daily Returns - TCS
2023-12-01
2023-12-15
2024-01-01
2024-01-15
2024-02-01
2024-02-15

Exploratory Data Analysis (Correlation Matrix)



Beta Values for Risky Assets

$$\beta = \frac{\text{Covariance of Asset Returns with Market Returns}}{\text{Variance of Market Returns}}$$

These beta values can be used to calculate the returns of the risky assets using the CAPM formula

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Beta for RELIANCE.NS: 1.14
Beta for TCS: 0.44
Beta for INFY: 0.83
Beta for HDB: 0.04
Beta for HINDUNILVR.NS: 0.39
Beta for ICICIBANK.NS: 0.91
Beta for SBIN.NS: 0.45
Beta for ITC.NS: 0.49
Beta for KOTAKBANK.NS: 0.89
Beta for LT.NS: -0.00
```

Expected return for risky assets Using CAPM

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

Where:

- $E(R_i)$ = Expected return of the asset or portfolio i
- R_f = Risk-free rate
- β_i = Beta of the asset or portfolio i
- $E(R_m)$ = Expected return of the market portfolio

```
Expected Returns using CAPM formula:
RELIANCE.NS: 0.42%
TCS: -0.14%
INFY: 0.21%
HDB: 0.01%
HINDUNILVR.NS: -0.02%
ICICIBANK.NS: 0.19%
SBIN.NS: 0.24%
ITC.NS: -0.04%
KOTAKBANK.NS: -0.00%
LT.NS: 0.02%
```

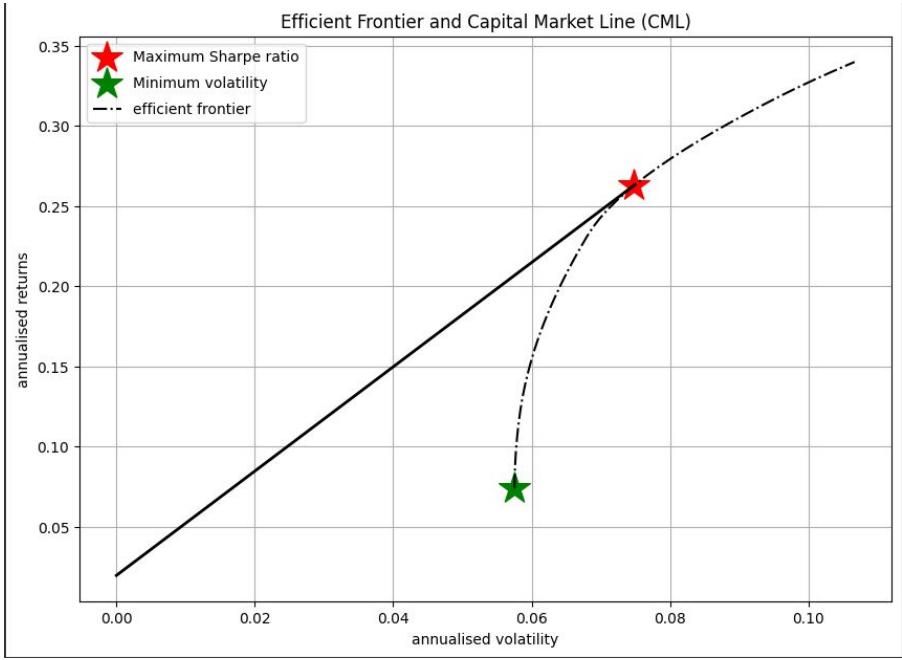
Efficient frontier and CML

CML Equation:

$$E(R_p) = R_f + \frac{E(R_m) - R_f}{\sigma_m} \times \sigma_p$$

Where:

- $E(R_p)$ = Expected return of the portfolio
- R_f = Risk-free rate
- $E(R_m)$ = Expected return of the market portfolio
- σ_m = Standard deviation (volatility) of the market portfolio
- σ_p = Standard deviation (volatility) of the portfolio



Tangency Point

- Tangency point on efficient frontier where CML touches it is (0.26, 0.07)
- The tangency point on the efficient frontier indicates the portfolio with the highest Sharpe ratio, maximizing return per unit of risk.
- It represents the optimal allocation of assets, providing investors with the best risk-adjusted return achievable within the given set of investment options.

Significance of Tangency Point

Optimal Portfolio Composition: The tangency point signifies the best portfolio for maximizing risk-adjusted return.

Efficiency: It indicates the most efficient mix of risk-free asset with a risky portfolio.

Portfolio Allocation: Helps investors choose their ideal asset allocation based on risk tolerance and return goals.

The CML's tangency point determines the optimal combination of risky assets and risk-free asset in a portfolio.

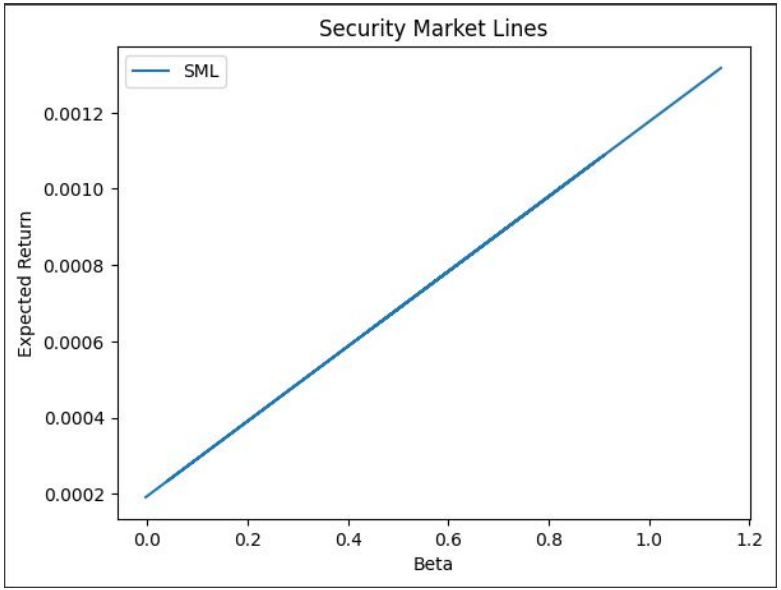
Security Market Lines

Chosen three assets → **RELIANCE.NS, TCS, INFY**

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

Where:

- $E(R_i)$ is the expected return of the asset or portfolio i.
- R_f is the risk-free rate.
- β_i is the beta of the asset or portfolio i.
- $E(R_m)$ is the expected return of the market portfolio.



Sharpe Ratio and Treynor Ratio

Sharpe Ratio Formula:

$$S = \frac{R_p - R_f}{\sigma_p}$$

where:

- S represents the Sharpe Ratio,
- R_p is the portfolio return,
- R_f is the risk-free rate,
- σ_p is the standard deviation of the portfolio's returns.

Treynor Ratio Formula:

$$T = \frac{R_p - R_f}{\beta_p}$$

$$\beta_p = \sum_{i=1}^{n} w_i \times \beta_i$$

Where:

- β_p is the portfolio beta,
- w_i is the weight of asset i in the portfolio,
- β_i is the beta of asset i,
- n is the number of assets in the portfolio.

Sharpe Ratio, Treynor Ratio

```
Portfolio Sharpe Ratios:
max_sharpe_ratio portfolio: 0.3473005740751381
min_volatility portfolio: 0.1052317697407258

Portfolio Treynor Ratios:
max_sharpe_ratio portfolio: 0.005734574920040447
min_volatility portfolio: 0.001619179304703188
```

Optimized portfolios Ratios

Sharpe Ratio indicates how well a portfolio's return compensates for its risk, while Treynor Ratio measures how efficiently a portfolio utilizes systematic risk to generate returns.

```
Asset Sharpe Ratios:
RELIANCE.NS: 0.2827510927660742
TCS: -0.020409732934092328
INFY: 0.12492269095801321
HDB: -0.002991574844438204
HINDUNILVR.NS: -0.027946683370393178
ICICIBANK.NS: 0.1252238206958829
SBIN.NS: 0.13202290494671146
ITC.NS: -0.04880078205972612
KOTAKBANK.NS: -0.01902775313967368
LT.NS: 9.435364629122385e-05

Asset Treynor Ratios:
RELIANCE.NS: 0.003531580410074106
TCS: -0.0038295159785722904
INFY: 0.0022379200047535964
HDB: -0.001568170689197713
HINDUNILVR.NS: -0.000949596548292983
ICICIBANK.NS: 0.001868109082702987
SBIN.NS: 0.004981331371494623
ITC.NS: -0.0012532768200315088
KOTAKBANK.NS: -0.00026905454929599434
LT.NS: 0.001984283849199401
```

Each Asset Ratios

(BONUS) Comparing the portfolios constructed using Markowitz and CAPM approaches.

Markowitz Approach (MPT):

Diversification: Emphasizes spreading investments across assets to reduce risk.
Efficient Frontier: Identifies portfolios offering optimal risk-return tradeoffs.
Risk-Return Tradeoff: Highlights the balance between risk and return in portfolio construction.

CAPM Approach:

Systematic Risk Assessment: Evaluates assets based on their sensitivity to market movements (beta).
Expected Return Estimation: Estimates expected returns using the risk-free rate, market risk premium, and beta.
Pricing Implications: Suggests assets are priced according to systematic risk, with higher returns demanded for higher beta assets.

Difference between Markowitz and CAPM Approaches

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Maximum Sharpe Ratio Portfolio Allocation

Annualised Return: 0.33
Annualised Volatility: 0.09


Ticker      HDB  HINDUNILVR.NS  ICICIBANK.NS   INFY  ITC.NS  KOTAKBANK.NS  \
allocation  0.0            0.0         18.59  19.41     0.0           0.0

Ticker      LT.NS  RELIANCE.NS  SBIN.NS  TCS
allocation    0.0        21.51    40.49  0.0
--------------------------------------------------------------------------------
Minimum Volatility Portfolio Allocation

Annualised Return: 0.09
Annualised Volatility: 0.07


Ticker      HDB  HINDUNILVR.NS  ICICIBANK.NS   INFY  ITC.NS  KOTAKBANK.NS  \
allocation  0.0          24.17         23.66  21.46    12.7          7.69

Ticker      LT.NS  RELIANCE.NS  SBIN.NS   TCS
allocation    0.0         9.77      0.0  0.55
```

Markowitz Results

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Maximum Sharpe Ratio Portfolio Allocation

Annualised Return: 0.26
Annualised Volatility: 0.07


            HDB  HINDUNILVR.NS  ICICIBANK.NS   INFY  ITC.NS  KOTAKBANK.NS  \
allocation  0.0            0.0         13.65  16.56     0.0           0.0

            LT.NS  RELIANCE.NS  SBIN.NS  TCS
allocation   1.21        20.76    27.83  0.0
--------------------------------------------------------------------------------
Minimum Volatility Portfolio Allocation

Annualised Return: 0.07
Annualised Volatility: 0.06


            HDB  HINDUNILVR.NS  ICICIBANK.NS   INFY  ITC.NS  KOTAKBANK.NS  \
allocation  0.0          20.99         19.84  16.24    8.06          6.56

            LT.NS  RELIANCE.NS  SBIN.NS   TCS
allocation    0.0         7.87      0.0  0.44
```

CAPM Results

Key Insights

- Markowitz focuses on **diversification** and **risk optimization.**
- CAPM provides a **systematic framework** for **assessing risk** and **estimating expected returns**.
- Integrating both approaches enhances portfolio management and investment decisions.

Thank You