Intro to Financial Engineering

Capital Asset Pricing Model

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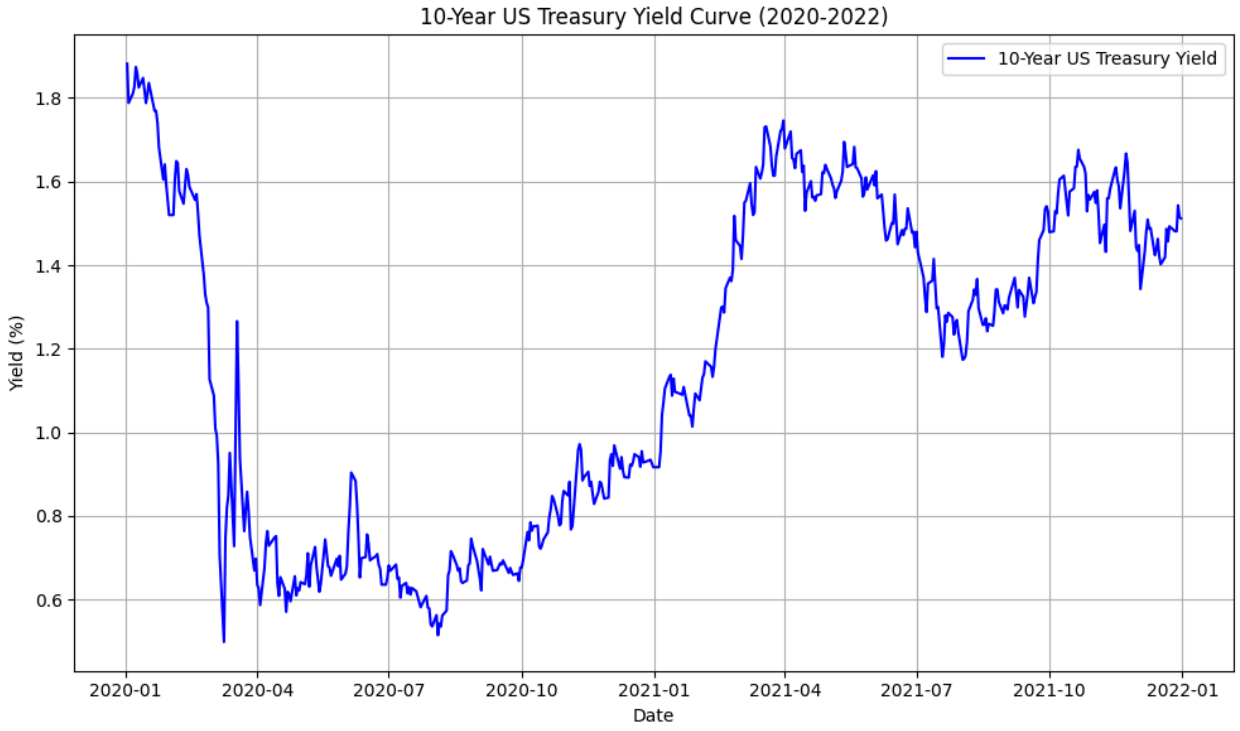
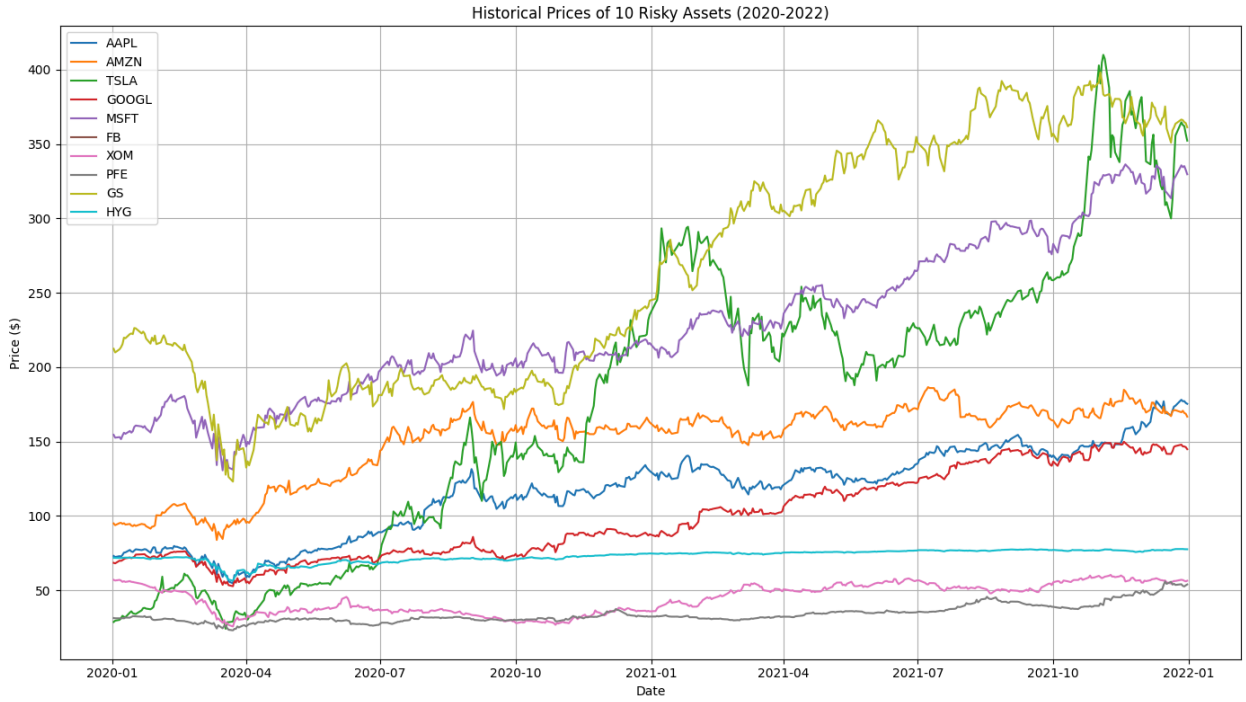
10 year US Treasury Yield Curve (2020 - 2022)





Capital Asset Pricing Model (CAPM):

The Capital Asset Pricing Model is a financial model that establishes a linear relationship between the expected return of an asset and its systematic risk (beta). It was developed by William Sharpe, John Lintner, and Jan Mossin.

The formula for CAPM is as follows:

$$\text{Expected Return} = \text{Risk-Free Rate} + \beta \times (\text{Market Return} - \text{Risk-Free Rate})$$

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AAPL: 8.90%
AMZN: 6.35%
TSLA: 7.99%
GOOGL: 9.42%
MSFT: 4.31%
XOM: 8.77%
PFE: 5.58%
GS: 9.91%
HYG: 8.48%
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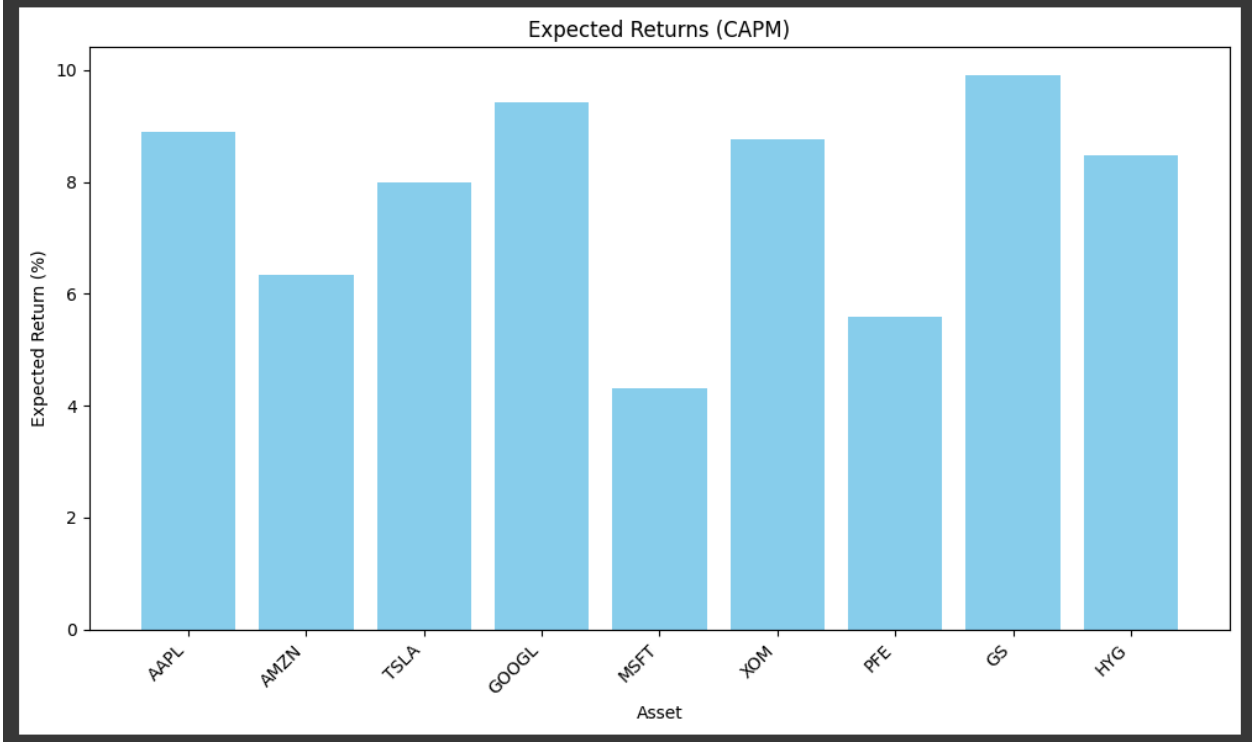
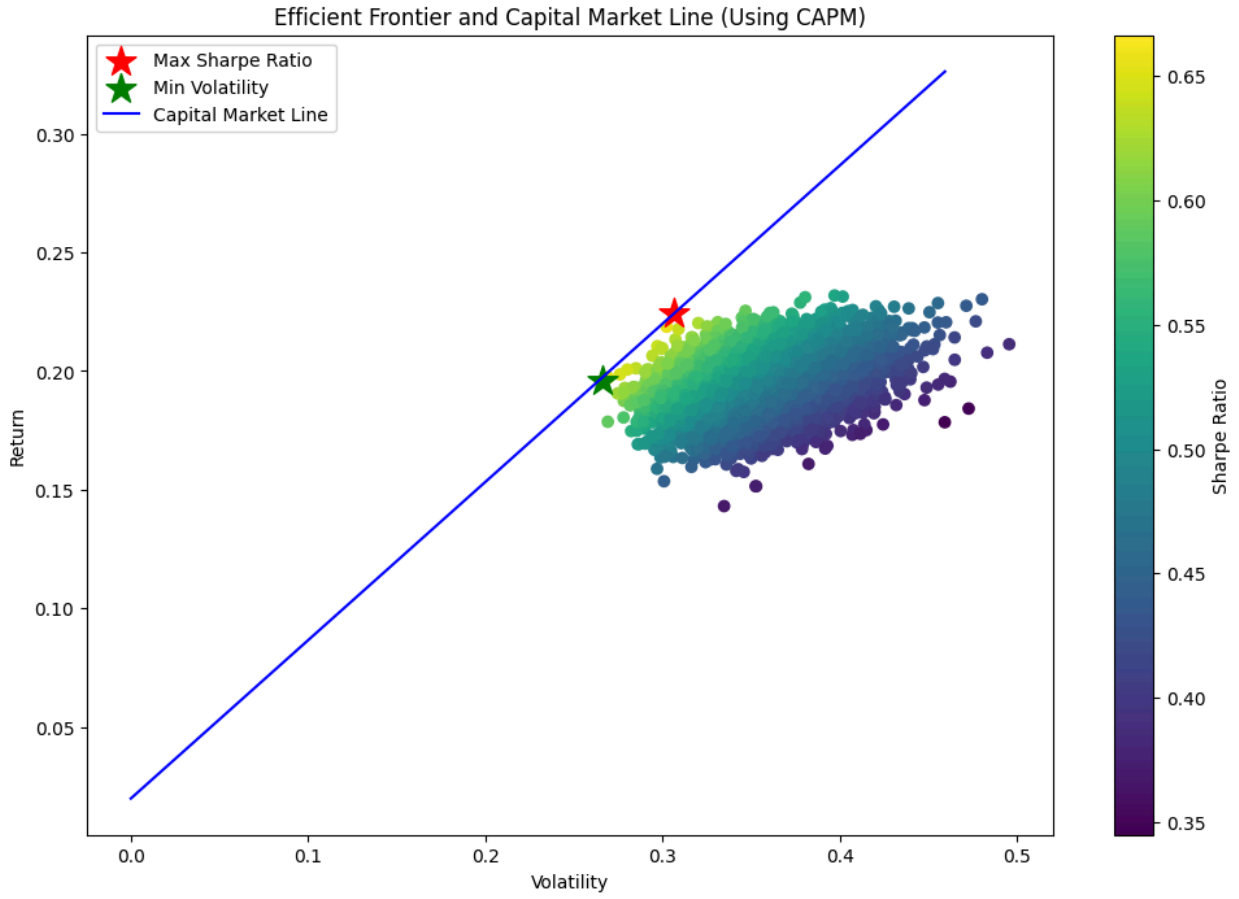


Efficient Frontier:

The Efficient Frontier is a set of optimal portfolios that offer the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. Portfolios on the efficient frontier are considered "efficient" because they provide the maximum possible return for a given level of risk or the minimum possible risk for a given level of return.The efficient frontier is graphically represented as a curve on a risk-return graph, with risk typically plotted on the x-axis and return on the y-axis.



$$R_p = r_f + \frac{R_T - r_f}{\sigma_T}\sigma_p$$

where:

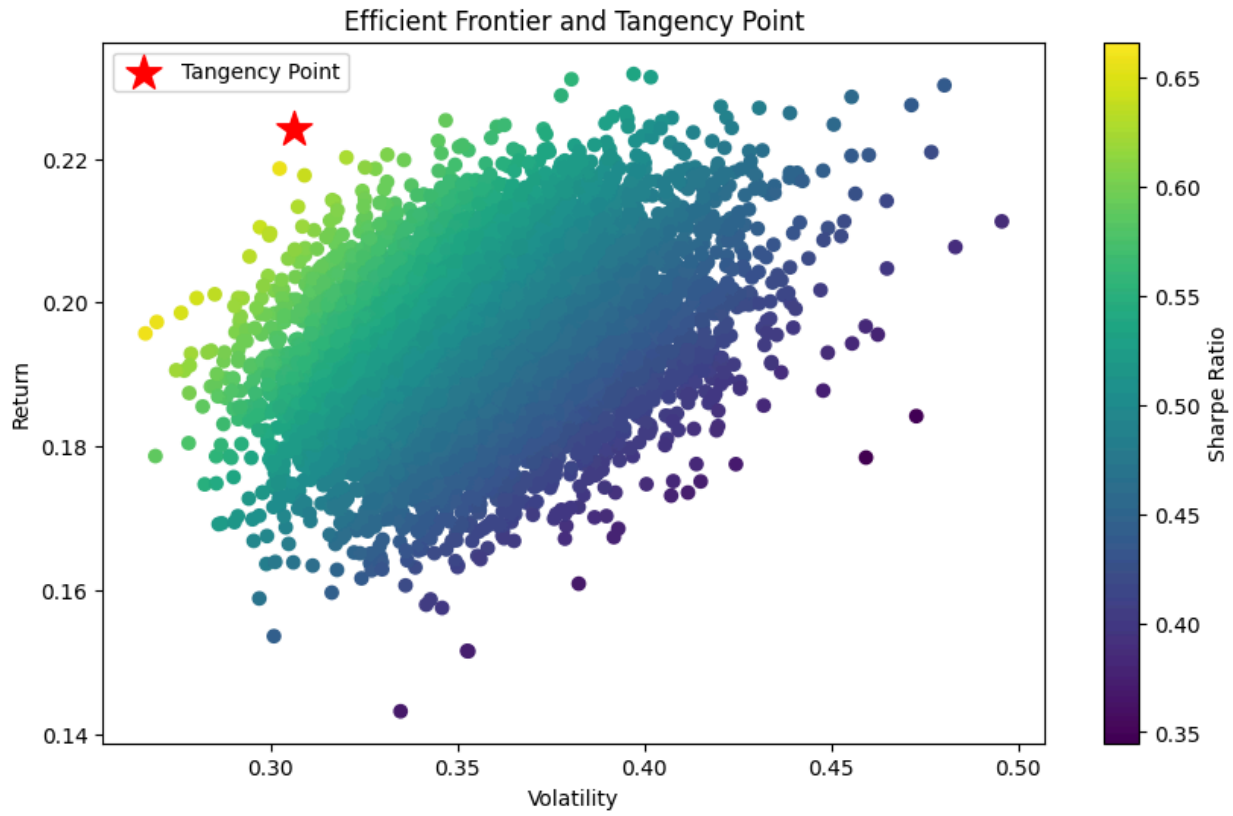
R_p = portfolio return

r_f = risk free rate

R_T = market return

σ_T = standard deviation of market returns

σ_p = standard deviation of portfolio returns



Tangency Point:
Return: 0.22408346698616474
Volatility: 0.30626100969130265
Sharpe Ratio: 0.6663710381934407
Weights: 0.11111111111111113

Maximum Sharpe Ratio: The tangency point corresponds to the portfolio with the maximum Sharpe ratio. The Sharpe ratio measures the excess return of a portfolio per unit of risk (volatility) taken. Therefore, the tangency portfolio achieves the highest risk-adjusted return among all possible portfolios on the efficient frontier.

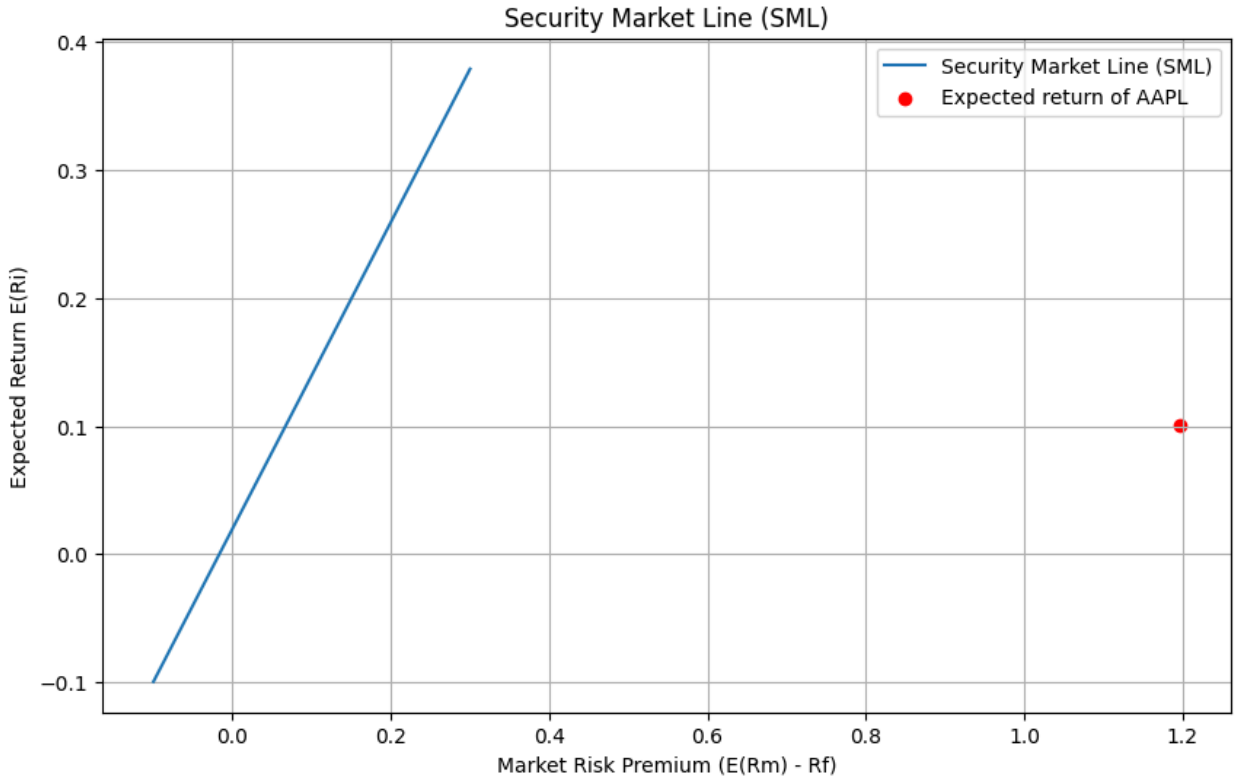
Optimal Risk-Return Tradeoff: The tangency portfolio provides the best tradeoff between risk and return. It balances the desire for higher returns with the aversion to risk. By investing in the tangency portfolio, an investor maximizes their expected return for a given level of risk or minimizes their risk for a given level of return.

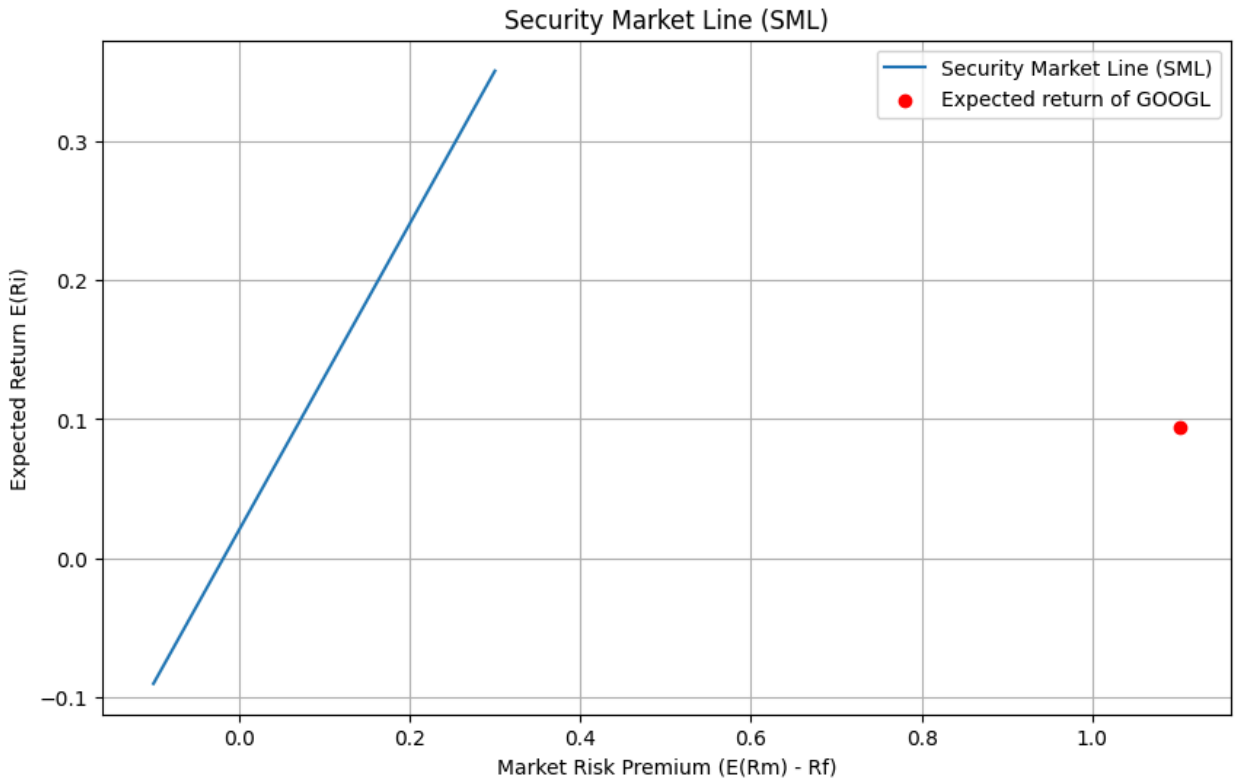
Efficient Diversification: The tangency portfolio represents the most efficient level of diversification achievable within the available set of assets. It combines assets in such a

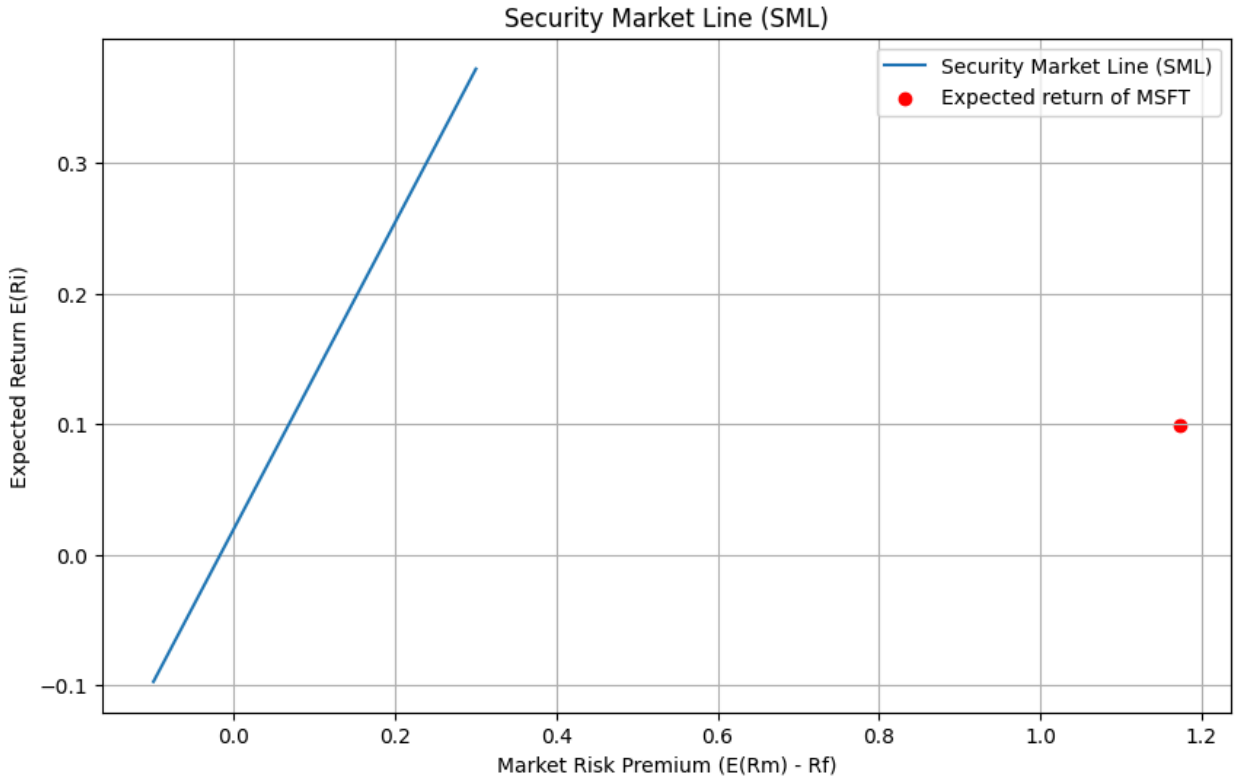
way that it minimizes portfolio risk while maximizing expected return. This optimal diversification helps to reduce portfolio volatility without sacrificing returns.

Foundation of Modern Portfolio Theory: The concept of the tangency portfolio is fundamental to Harry Markowitz's Modern Portfolio Theory. MPT suggests that investors can construct efficient portfolios by combining assets in proportions that maximize the Sharpe ratio. The tangency portfolio exemplifies this principle and serves as a cornerstone for portfolio construction and asset allocation decisions.

Benchmark for Investment Strategy: The tangency portfolio provides a benchmark for evaluating investment strategies. Investors can compare their portfolio allocations and performance against the tangency portfolio to assess whether they are achieving optimal risk-adjusted returns. Deviations from the tangency portfolio may indicate potential inefficiencies in portfolio construction.




Security Market Line (SML)
Security Market Line (SML)
Expected return of GOOGL
Expected Return E(Ri)
0.3
0.2
0.1
0.0
−0.1
0.0
0.2
0.4
0.6
0.8
1.0
Market Risk Premium (E(Rm) - Rf)


Security Market Line (SML)
Security Market Line (SML)
Expected return of MSFT
Expected Return E(Ri)
0.3
0.2
0.1
0.0
−0.1
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Market Risk Premium (E(Rm) - Rf)