Portfolio Optimization / Risk Forecasting

Stock Market Analysis Report: AAPL, MSFT, GOOGL (2022–2024)

Objective: - To analyze and compare the performance, volatility, and risk metrics of three major tech stocks—Apple (AAPL), Microsoft (MSFT), and Alphabet (GOOGL)—over the period from January 2022 to December 2024. The analysis aimed to:

- Assess historical returns and volatility.
- Optimize a portfolio allocation.
- Evaluate risk using Value at Risk (VaR) and Sharpe Ratio.
- Extract key insights on stock behavior and trading volumes.

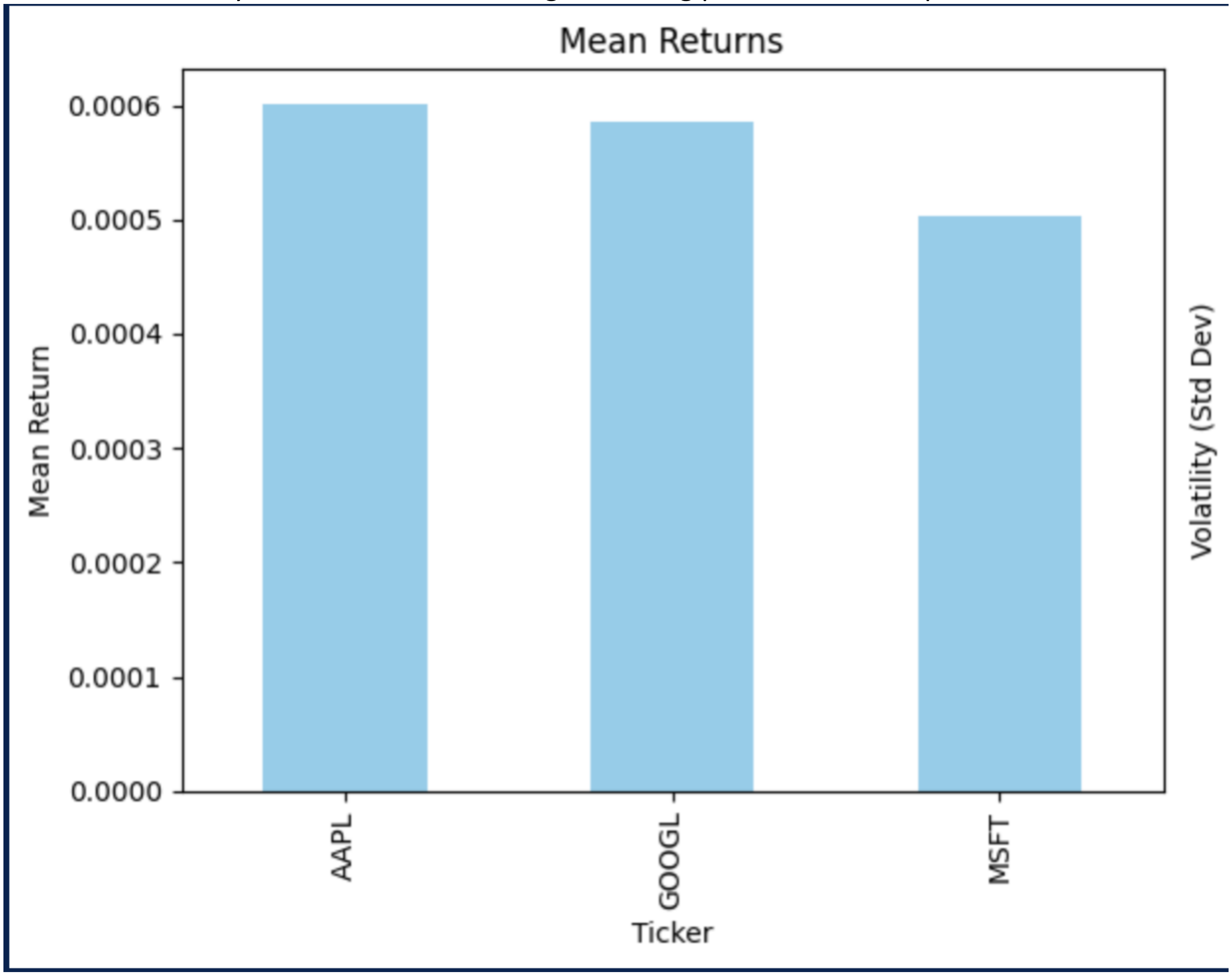
Data Collection: -

- **Source**: Yahoo Finance via the yfinance API.
- **Timeframe**: January 1, 2022 – December 31, 2024.
- **Tickers**: AAPL, MSFT, GOOGL.
- **Metrics Fetched**: Open, High, Low, Close, Volume.

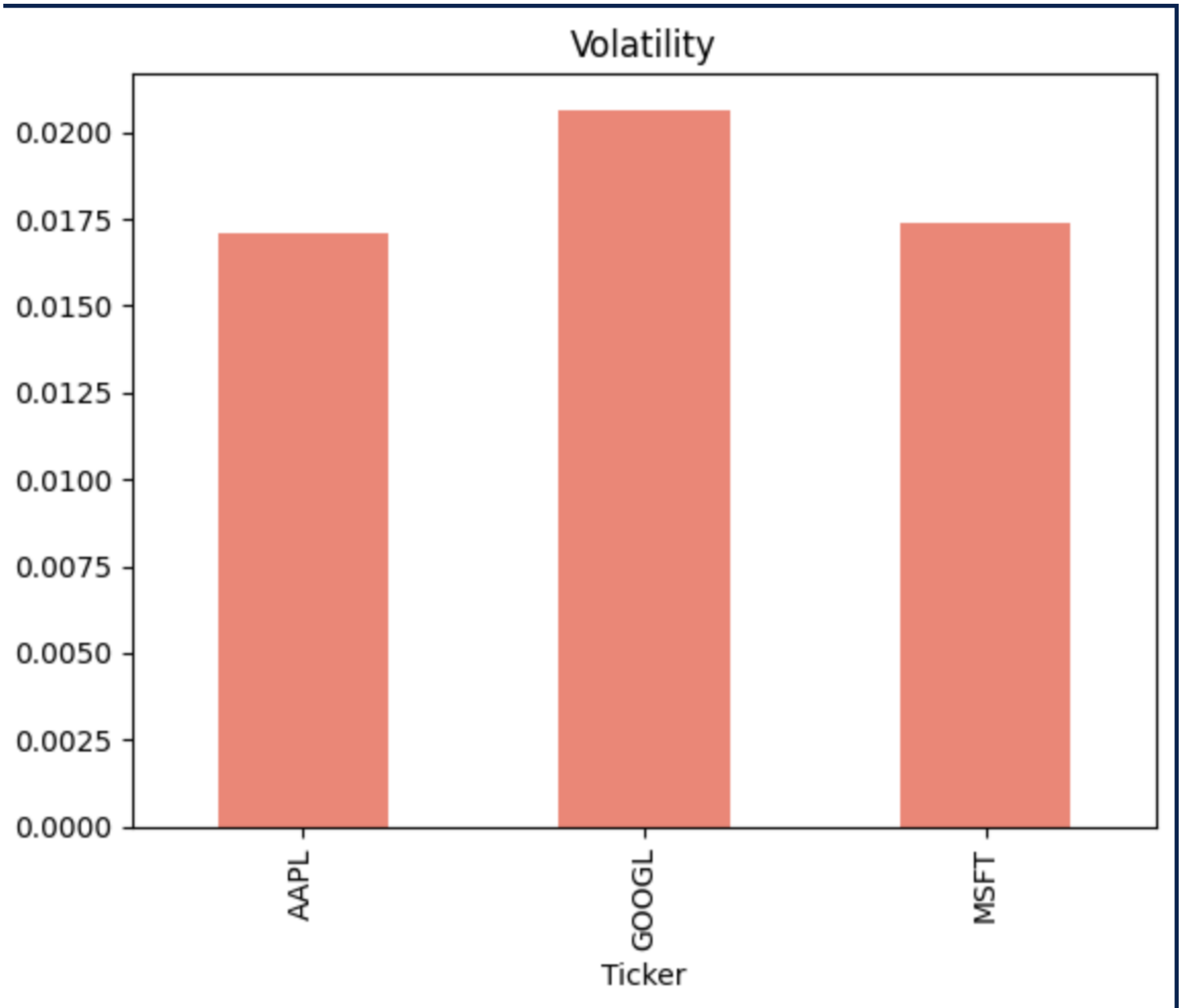
Return & Volatility Analysis: -

```
...  Mean Returns:
      Ticker
     AAPL     0.000601
     GOOGL    0.000586
     MSFT     0.000502
     dtype: float64
     Volatility:
      Ticker
     AAPL     0.017076
     GOOGL    0.020637
     MSFT     0.017381
     dtype: float64
     Correlation matrix:
      Ticker       AAPL      GOOGL      MSFT
     Ticker
     AAPL    1.000000  0.622300  0.684721
     GOOGL   0.622300  1.000000  0.694132
     MSFT    0.684721  0.694132  1.000000
```

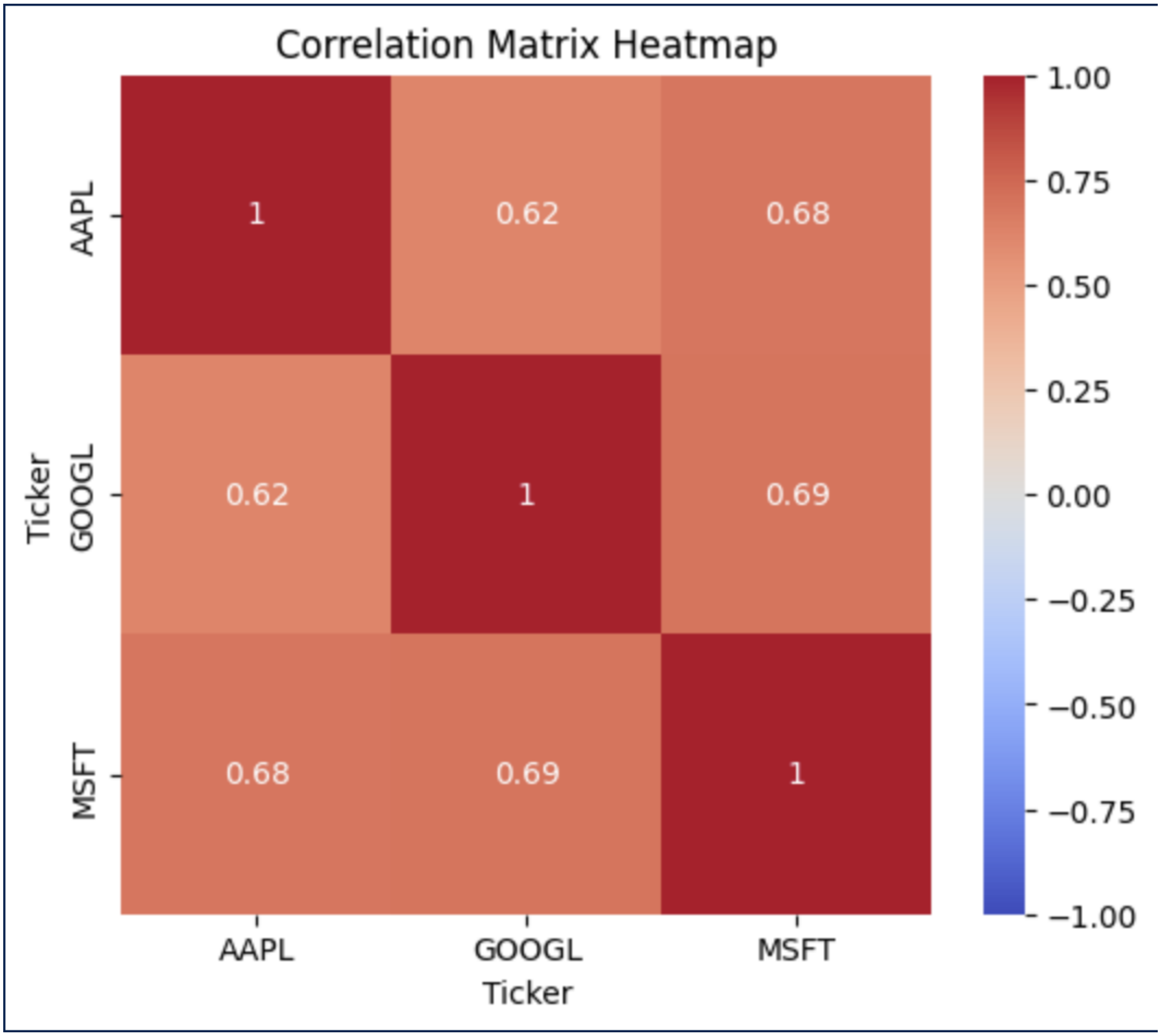
Explanation: - All stocks had positive average returns, with **AAPL** showing slightly higher returns and lower volatility than the others, making it a strong performer in this period.



Explanation: The mean return represents the average daily return of a stock over the selected period. It indicates the overall performance trend—whether the stock typically gains or loses value each day. Based on the analysis above AAPL most of the gains much better than GOOGL and MSFT.



Explanation: - Volatility measures how much a stock's returns fluctuate over time. Higher volatility means greater risk, as the price can swing dramatically in either direction. Based on the analysis GOOGL is riskiest stock.



Insights: All three stocks are **positively correlated**, especially MSFT and GOOGL, which suggests moderate diversification benefits when combining them.

- **AAPL & GOOGL** = **0.62** → moderately move together.
- **AAPL & MSFT** = **0.68** → slightly stronger connection.
- **GOOGL & MSFT** = **0.69** → strongest correlation among the three

All three stocks move in the same general direction. Since GOOGL and MSFT are more closely tied (0.69), combining them may not add many varieties to your portfolio. However, the slightly lower correlation with AAPL means adding AAPL could help spread the risk a bit giving **some** diversification benefit.

Things to notice: - These stocks are majorly for the company who are related big tech, adding other stocks like real estate, Oil & Gas companies would in diversifying the portfolio which will decrease the risk.

Portfolio Optimization (Mean-Variance): -

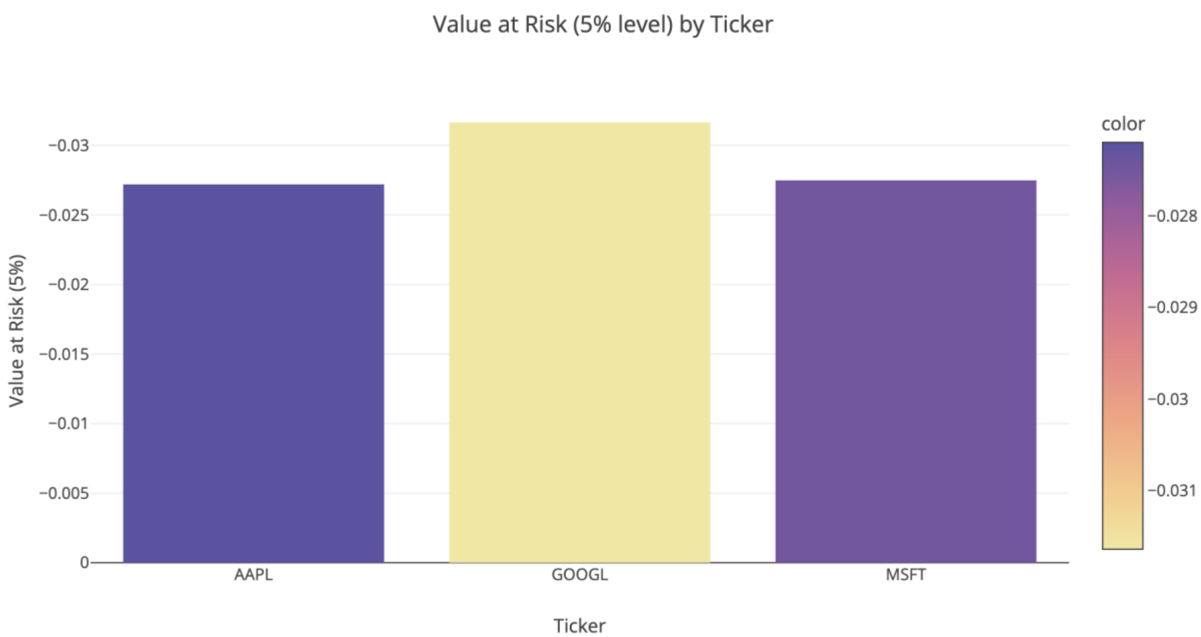
Goal: Maximize expected return with minimal risk using a risk aversion factor ($\gamma = 0.1$).

```
Optimal portfolio weights:
AAPL: 1.0000
GOOGL: 0.0000
MSFT: 0.0000
```

Interpretation: AAPL provided the best return-to-risk ratio in the given period, making it the sole optimal choice under this model. However, this is a result of the specific historical data and might not hold in future conditions.

Risk Metrics: -

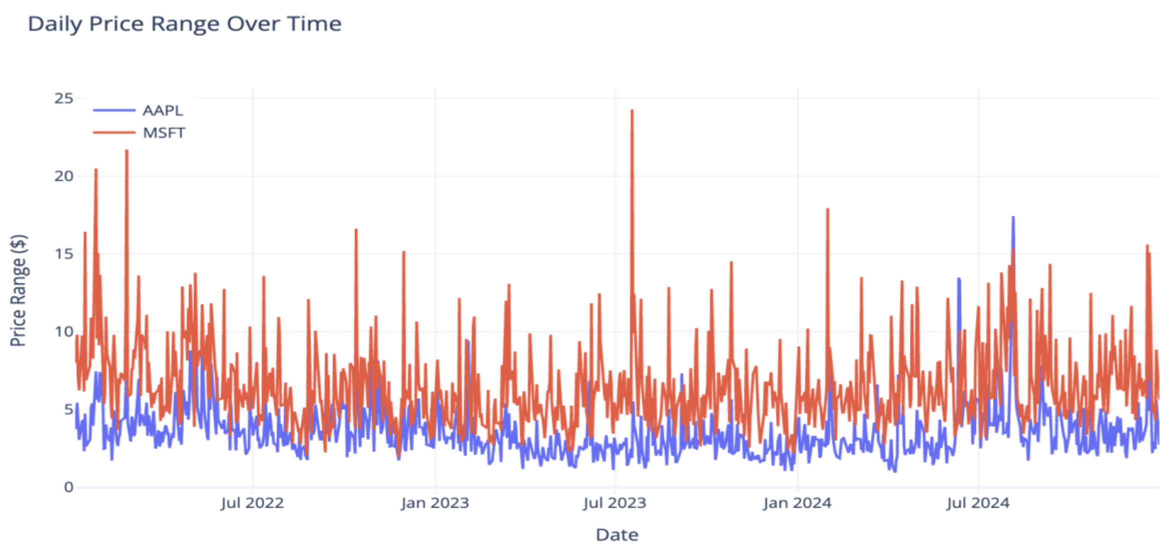
```
Value at Risk (5% level):
Ticker
AAPL    -0.027196
GOOGL   -0.031642
MSFT    -0.027486
Name: 0.05, dtype: float64
```



- Sharpe Ratio: AAPL had the highest risk-adjusted return.
- VaR (5%): On any given day, there's a 5% chance AAPL could lose more than 2.72%, etc.

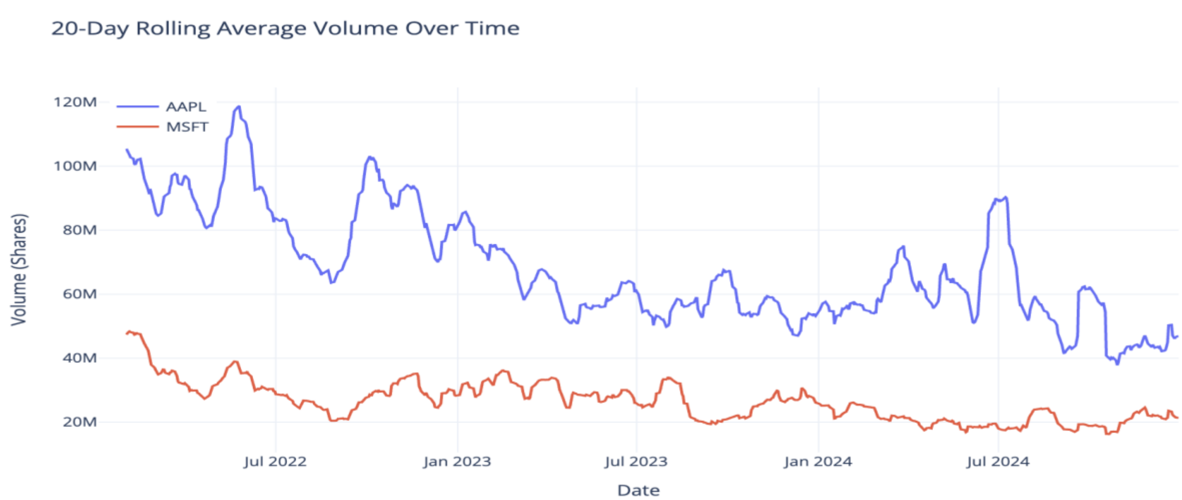
Additional Metrics: -

Price Range:



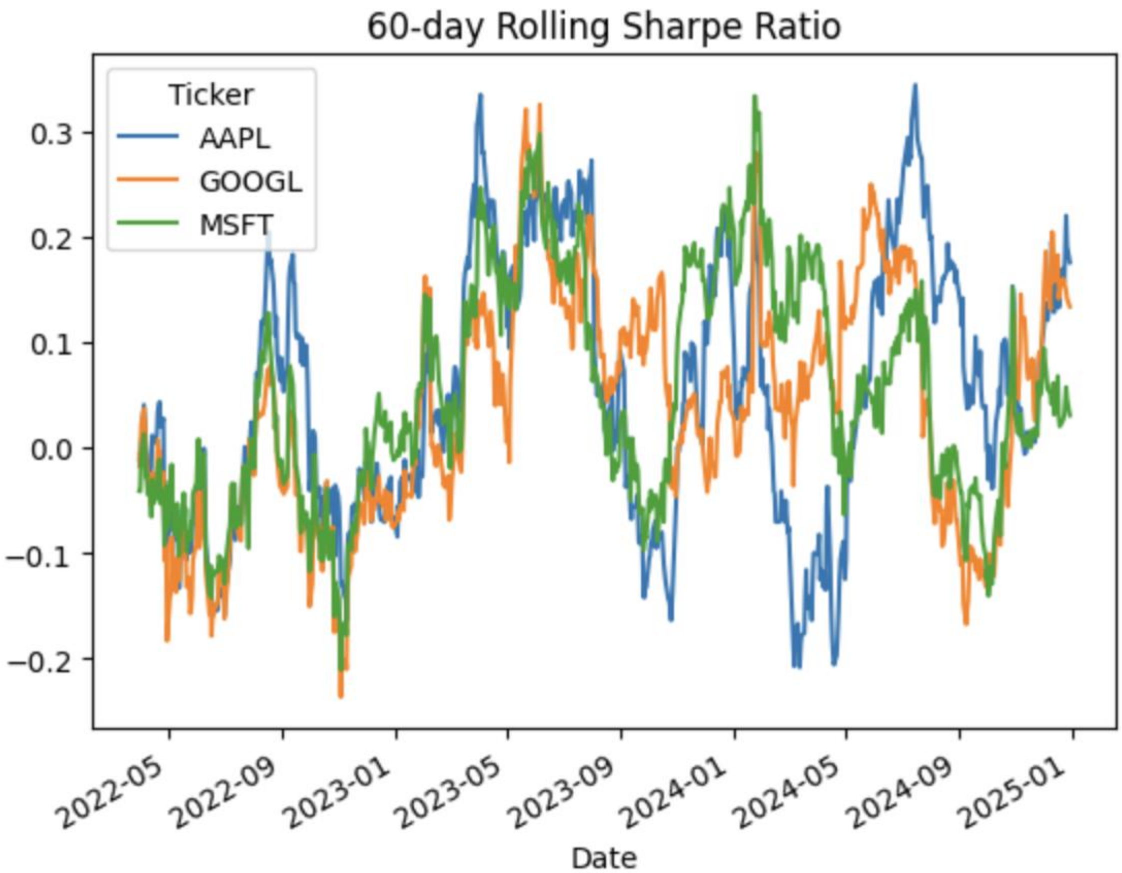
Explanation: - MSFT tends to have a **larger daily price range** than AAPL, especially in early January 2022. MSFT showed greater intraday price fluctuations compared to AAPL. This suggests that MSFT might be more responsive to news or investor sentiment within the trading day during that period.

Volume MA:



Explanation: - A 20-day rolling average smooths out volume data to show longer-term investor interest or activity. MSFT's trading activity was slightly declining, possibly indicating lower market interest or fewer transactions over time.
Based on early January 2022 data, MSFT exhibited higher intraday volatility than AAPL, as seen in its larger daily price range. Additionally, MSFT's trading volume showed a slight downward trend, whereas AAPL's rolling average is not yet meaningful due to insufficient data for a 20-day window.

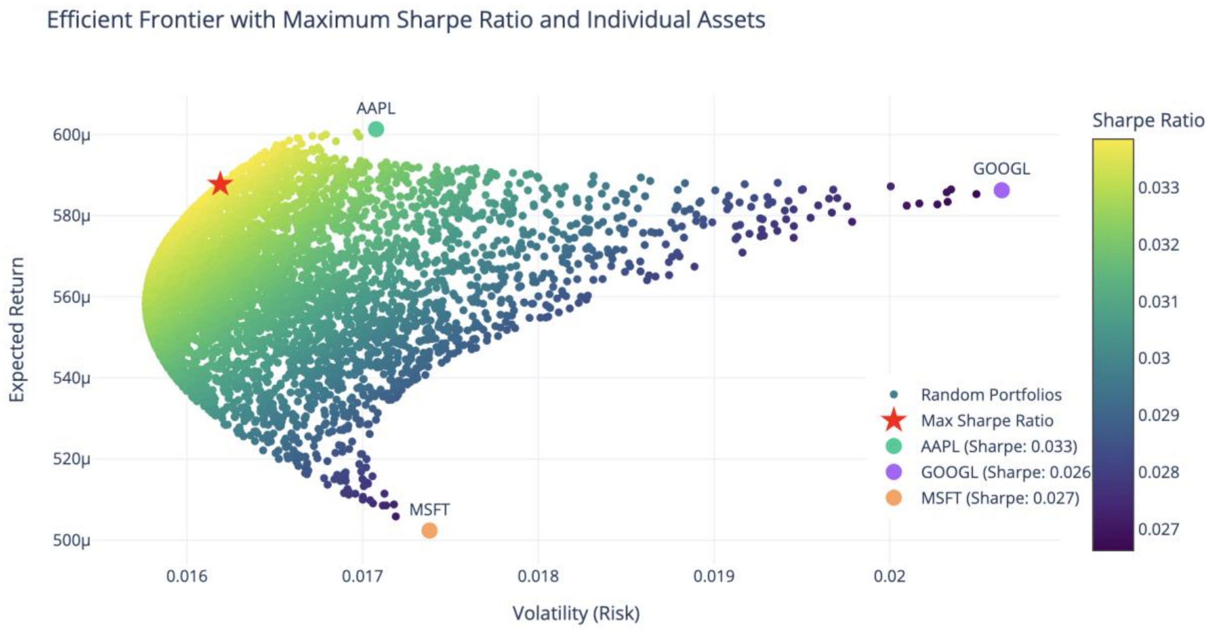
60- day Rolling Sharpe Ratio: -



Explanation: - Over the observed period, **MSFT displayed more stable risk-adjusted performance**, while **AAPL exhibited higher peaks but also more volatility** in its Sharpe Ratio. Investors preferring **steady risk-adjusted returns** might lean toward MSFT, while those willing to accept volatility for potentially higher reward might prefer AAPL.

Efficient Frontier with Maximum Sharpe Ratio and Individual Assets: -

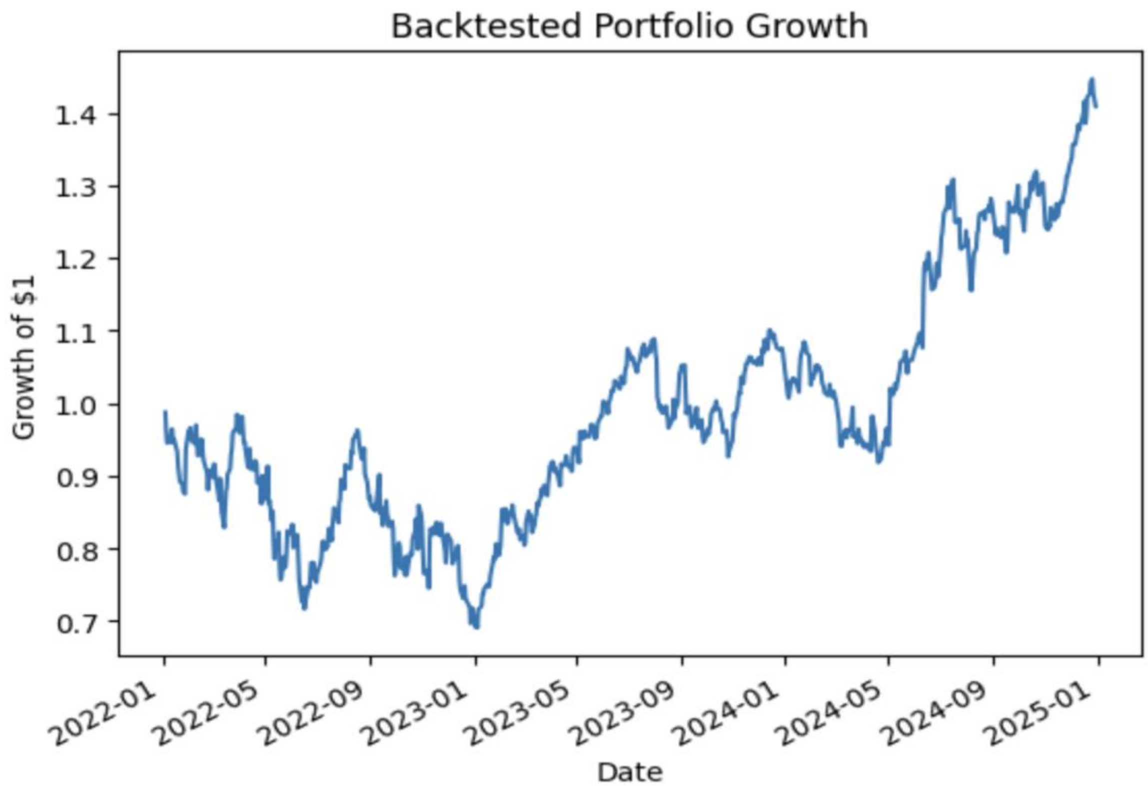
We generate **5,000 random portfolios** with different weights. For each portfolio, we calculate **expected return**, **risk (volatility)**, and **Sharpe ratio**. We find the portfolio with the **highest Sharpe ratio** (best risk-adjusted return).



- All random portfolios colored by their Sharpe ratio.
- The **best Sharpe ratio portfolio** as a red star.
- Each individual stock with its own risk and return.

Back-tested Portfolio Growth: -

Y-axis: "Growth of $1" — This shows how $1 invested in the portfolio would have grown over time.**X-axis**: Date, ranging from early 2022 to early 2025.The chart represents **cumulative returns**, reflecting **compounded growth** from simulated back testing.



CONCLUSION: -

Despite early underperformance, it **recovered and outperformed significantly** over the long term. The final return (over 40% cumulative) highlights the **importance of staying invested** and suggests the strategy may be robust when held through full market cycles.