The Importance of Portfolio Diversification

Business and Financial Modeling Capstone

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Agenda

- Project Overview
- Data & Summary Statistics
- Portfolio Optimization
- CAPM Analysis
- Alpha and Beta
- Regression Analysis
- Portfolio Diversification with Mixed Assets
- Portfolio Performance
- Portfolio Comparison to AAPL

Project Overview

- In this project, I explored the concepts of portfolio management, risk assessment, and diversification to construct optimal investment strategies.
- Project Steps:
  - Import historical data on 10 stocks and the DJI.
  - Calculate daily returns and summary statistics.
  - Create optimized portfolios by determining the minimum variance and max Sharpe ratio first for a 2 stock portfolio and then for 10.
  - Use Capital Asset Pricing Model (CAPM) analysis and calculated Alpha and Beta for all the securities.
  - Create a mixed asset portfolio and calculate its returns.
- **Note: I completed this project using Python, not Excel.**

Data & Summary Statistics

Data:

- Retrieved historical daily prices for AAPL, MSFT, WFC, DIS, COP, XOM, GOOG, BIDU, TSLA, TTM and the DJI.
- Sample window: June 30th, 2010, to June 30th, 2016.

Summary Statistics:

- Calculated daily returns for the securities using ***adjusted close*** price, as any corporate actions are accounted for in this price.
- Calculated some summary stats on all the stocks, including mean, standard deviation, and Sharpe ratio

As we move forward, we will leverage this knowledge to optimize our portfolio and construct efficient frontiers.

Summary Statistics for Adj Daily Returns

	AAPL	MSFT	WFC	DIS	COP
count	1511.000000	1511.000000	1511.000000	1511.000000	1511.000000
mean	0.000839	0.000747	0.000626	0.000898	0.000403
std	0.016516	0.014818	0.015646	0.013734	0.016763
min	-0.123558	-0.113995	-0.090440	-0.091708	-0.092116
25%	-0.007660	-0.007404	-0.007497	-0.006015	-0.008121
50%	0.000635	0.000181	0.000296	0.001244	0.000447
75%	0.010368	0.008479	0.008585	0.008263	0.009051
max	0.088741	0.104522	0.080680	0.076302	0.066390
Sharpe Ratio	0.050817	0.050408	0.039981	0.065366	0.024030

	XOM	GOOG	BIDU	TSLA	TTM
count	1511.000000	1511.000000	1511.000000	1511.000000	1511.000000
mean	0.000511	0.000878	0.000897	0.002028	0.000815
std	0.011976	0.015998	0.024940	0.034218	0.024833
min	-0.061882	-0.083775	-0.149990	-0.193274	-0.105373
25%	-0.005697	-0.007191	-0.013654	-0.015353	-0.013381
50%	0.000227	0.000437	-0.000347	0.000901	0.000831
75%	0.007046	0.008823	0.015338	0.018938	0.014027
max	0.055159	0.160524	0.110082	0.243951	0.123826
Sharpe Ratio	0.042695	0.054897	0.035974	0.059271	0.032813

	DJI
count	1511.000000
mean	0.000443
std	0.009110
min	-0.055464
25%	-0.003900
50%	0.000535
75%	0.005229
max	0.042408
Sharpe Ratio	0.048645

Portfolio Optimization: 2 Stocks

- Constructed portfolios with the best risk-return trade-offs through asset allocation and diversification. With only MSFT and WFC available for investment in this scenario, I allocated weights for the minimum variance portfolio and the portfolio with the highest Sharpe ratio.
- The graphs show the efficient frontier, which guides asset allocation for optimal returns and risk management.

```
Optimal Portfolio Allocation:
Weight_MSFT     0.553384
Weight_WFC      0.446616
Return          0.000693
Std_Dev         0.013130
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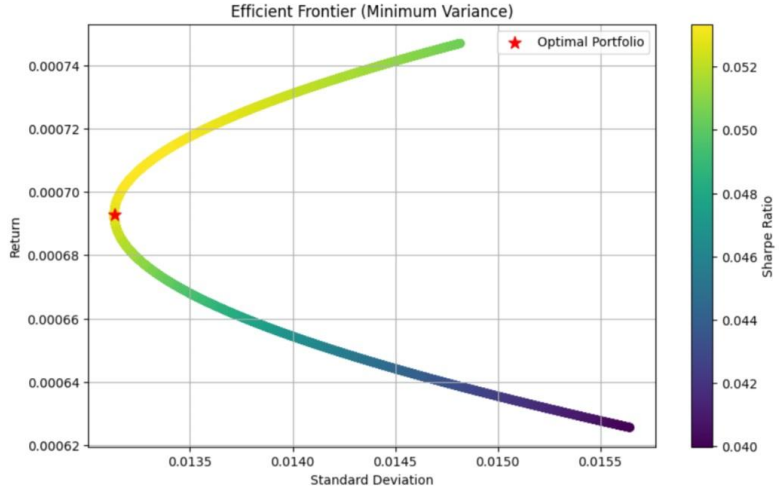


```
Optimal Portfolio Allocation (Tangency Portfolio):
MSFT weight: 0.6810947366661741
WFC weight: 0.3189052633338259
Return: 0.0007082242381175002
Std_Dev: 0.013276401288922407
Sharpe Ratio: 0.05334459411892212
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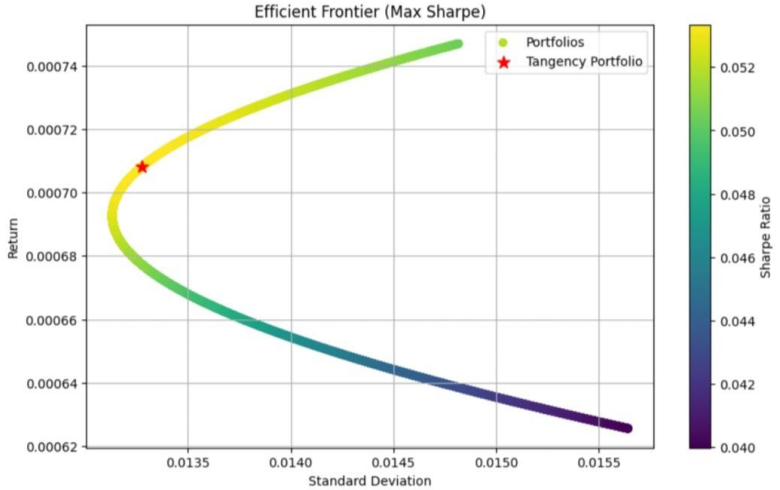


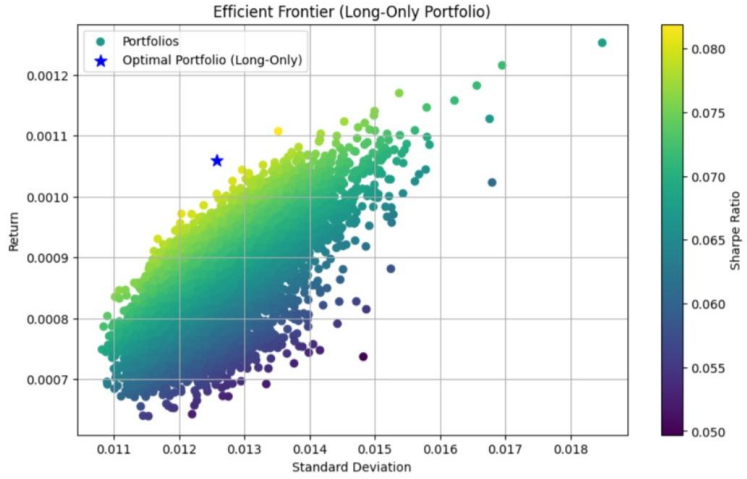
Portfolio Optimization: 10 Stocks

- Constructed the “optimal risky portfolio” on the efficient frontier with 10 stocks.
- Leveraging the same techniques from the 2-stock portfolio, I identified the optimal mix of stocks by weight.
- Two scenarios: “long-only” or “short-selling allowed”. For each scenario, I calculated portfolio weights and characteristics.
    - Exploring both unconstrained and constrained regimes provides insights into different risk management approaches.
    - Understanding the impact of short selling on portfolio composition helps tailor strategies to specific mandates.

Portfolio Optimization: 10 Stocks

- The unconstrained or “short-selling” portfolio yielded higher returns and a higher Sharpe Ratio.

```
Optimal Portfolio Allocation (Long-Only Portfolio):
AAPL weight: 0.16891
MSFT weight: 0.10018
WFC weight: 0.00000
DIS weight: 0.38830
COP weight: 0.00000
XOM weight: 0.00000
GOOG weight: 0.17498
BIDU weight: 0.00000
TSLA weight: 0.16763
TTM weight: 0.00000
Return: 0.00106
Std_Dev: 0.01258
Sharpe Ratio: 0.08416
```




```
Optimal Portfolio Allocation (Unconstrained Portfolio):
AAPL weight: 0.20913
MSFT weight: 0.15263
WFC weight: -0.17892
DIS weight: 0.49947
COP weight: -0.24405
XOM weight: 0.21612
GOOG weight: 0.20241
BIDU weight: -0.01497
TSLA weight: 0.17990
TTM weight: -0.02173
Return: 0.00115
Std_Dev: 0.01307
Sharpe Ratio: 0.08796
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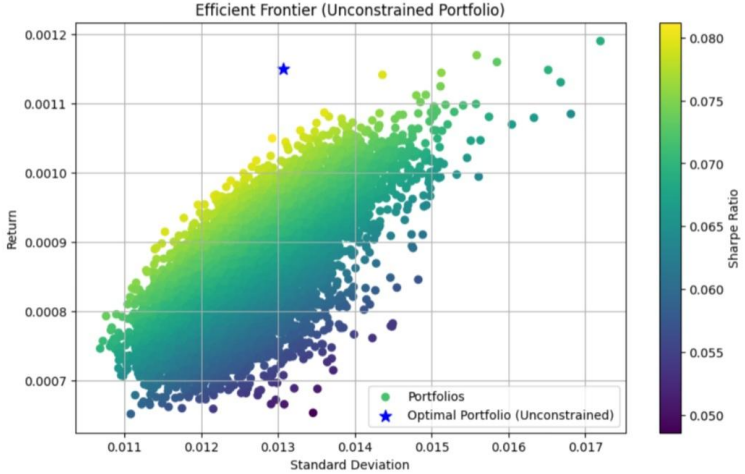
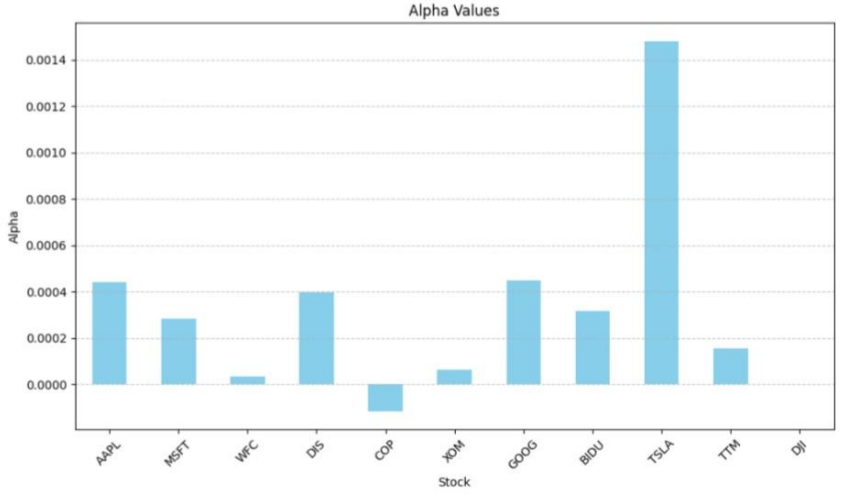


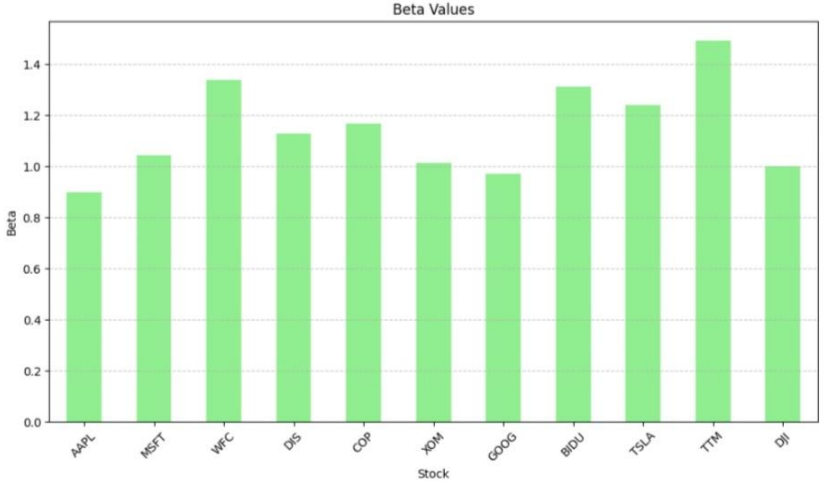
CAPM Analysis

- Used the Capital Asset Pricing Model (CAPM) for assessing individual securities' risk and return.
  - CAPM provides valuable insights for informed investment decisions.
- Through regression analysis, I calculated Alpha and Beta for each security against the market index, DJI.
  - Alpha and Beta help identify riskiest and least risky investment.

Alpha and Beta

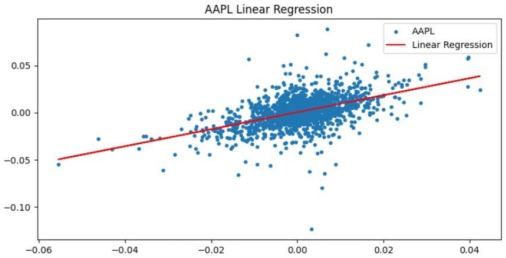
- Alpha measures a security's performance relative to its risk level. Positive alpha indicates outperformance.
- Beta indicates a security's sensitivity to market movements. A Beta of 1 means it moves with the market
- TSLA has the highest Alpha. TTM has the highest Beta.

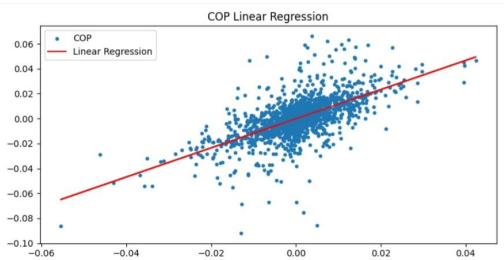


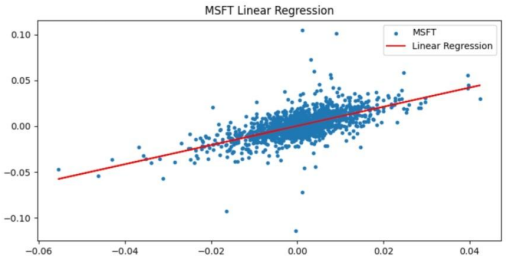


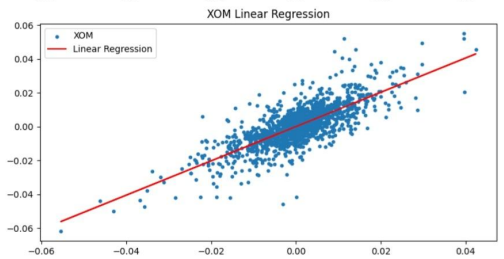
Regression Analysis

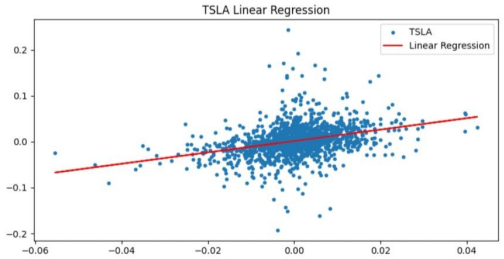
- Linear regression plots: Displays the relationship between the returns of the stocks and the returns of the S&P 500.
- This visualization demonstrates the beta of the stocks, which can be understood as the slope of the regression line.

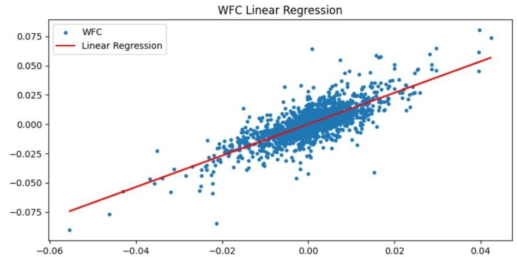


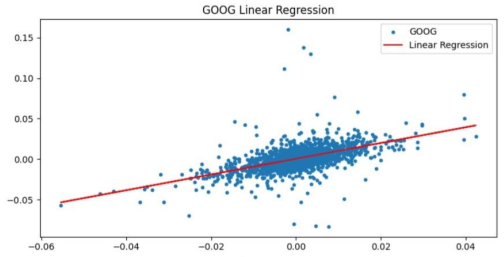


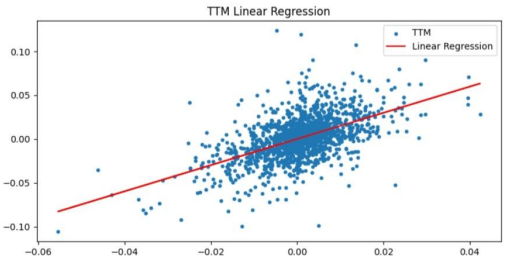


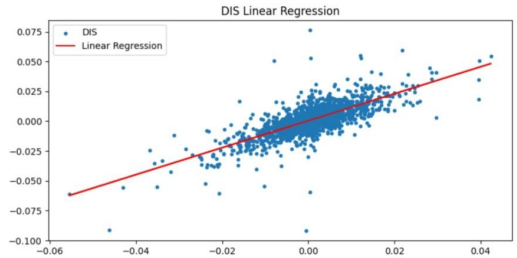


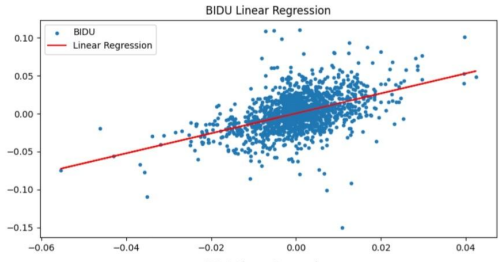






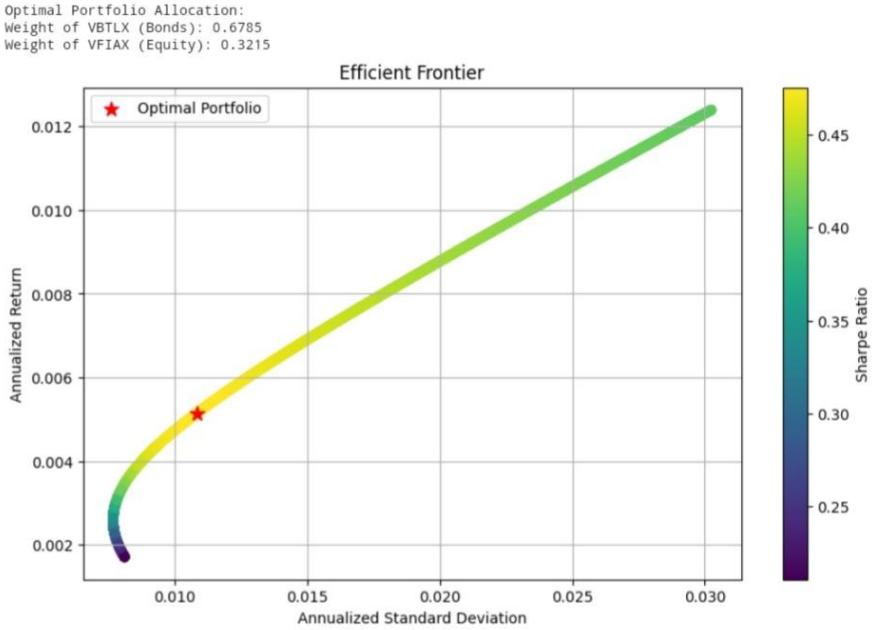






Portfolio Diversification with Mixed Assets

- Constructed an “optimal risky portfolio” on the efficient frontier using a mix of assets, including fixed income and equity funds.
- Allocated $5M across 2 funds: VBTLX (bonds) and VFIAX (stocks)
- Calculated the optimal weight for each asset.
- The goal of this portfolio diversification was to achieve enhanced risk-adjusted returns by combining different asset classes.



Portfolio Returns

- Invested $5M in both funds for 6 months (Jan 2016 - July 2016)
  - Used the optimal weights we determined previously
- Calculated monthly and overall returns for the portfolio

```
Portfolio Monthly Returns for 2016:
Date
2016-01-31   -0.006202
2016-02-29    0.004091
2016-03-31    0.028276
2016-04-30    0.003870
2016-05-31    0.005940
2016-06-30    0.014033
2016-07-31    0.016248
dtype: float64

Final Portfolio Value at the End of July 2016: $5338908.73
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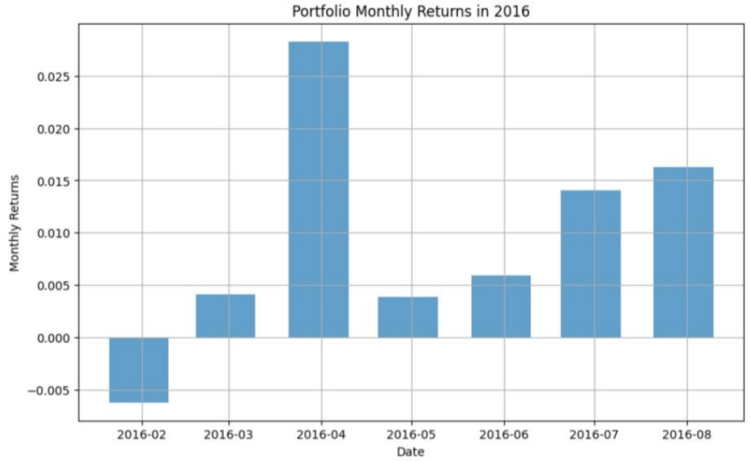
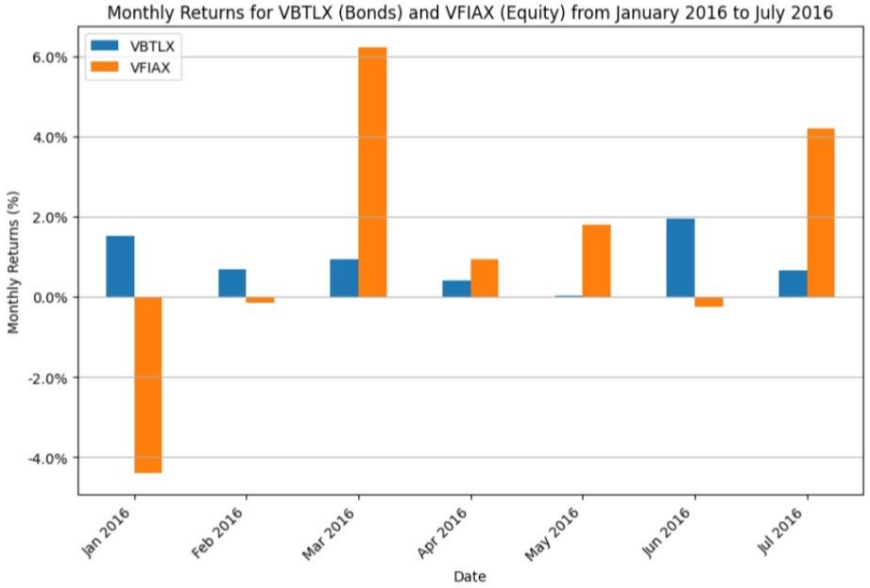
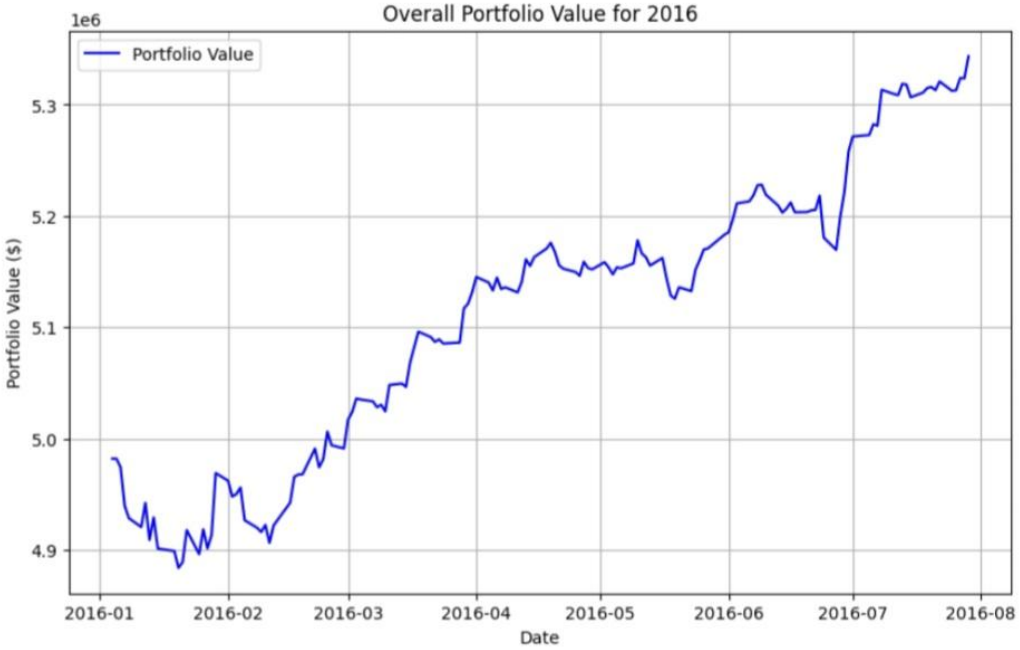




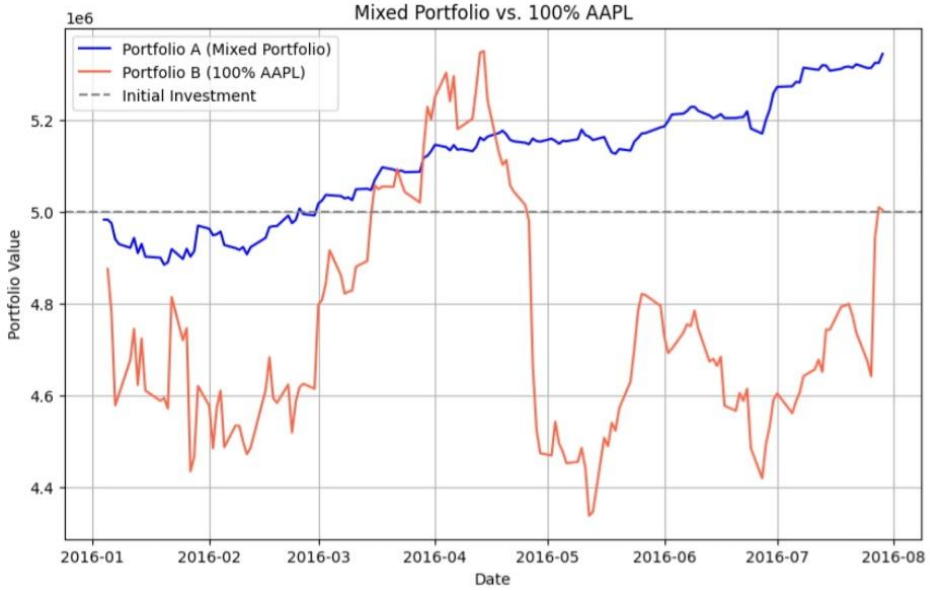
Portfolio Performance

- Final Portfolio Value: $5,388,909.28
- Our diversified portfolio is up 7.78% overall over the span of 6 months



Portfolio Performance and Comparison to AAPL

- Our mixed portfolio outperformed the 100% AAPL allocated portfolio.
- AAPL is nearly back at its January price by the end of the 6 months.
- Comparing our portfolio returns to AAPL helps evaluate the effectiveness of diversification as an investment strategy.



Key Takeaways

- Understanding the efficient frontier and portfolio optimization helps in constructing diversified and risk-efficient portfolios.
- Assessing risk and return characteristics of different assets enables us to make informed investment decisions.
- Portfolio diversification plays a crucial role in managing risk and maximizing returns in real-life investment scenarios.