Portfolio Optimization with Risk Management to Support Strategic Business Decision-Making

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Motivation

In today's dynamic financial markets, businesses need robust strategies to manage investments and mitigate risks. This project focuses on portfolio optimization by leveraging advanced data analysis and visualization techniques to support strategic business decision-making. By bridging the gap in the traditional optimization model like that of Markowitz we have a more solid optimized portfolios, businesses can as well achieve higher returns while managing risk effectively.

Portfolio Optimization: Portfolio optimization is a crucial process that helps in balancing risk and return. It involves selecting the best mix of assets to maximize returns for a given level of risk or to minimize risk for a given level of expected return.

Figure 1: Balance between Risk and Reward

Limitations of Traditional Models: Traditional models like Markowitz's Portfolio Theory, developed in the 1950s, assume static risk-return relationships. While foundational, these models have limitations in dynamic markets where conditions change rapidly. They often fail to account for the complexities and interdependencies of modern financial markets, making them less effective in today's environment.

Figure 2: Limitations and Criticisms of Markowitz Efficient Set

Enhanced Performance: This research integrates advanced risk management tools to enhance portfolio performance like Value-at-risk (VaR) which measures worst-case losses and Conditional VaR which focuses on extreme tail risks. By incorporating other factors such as volatility and asset correlation, the model provides a more comprehensive approach to portfolio optimization.

This integration ensures that the portfolios are not only optimized for returns but also resilient to market volatility and uncertainties. The goal is to align investment strategies for the best business objectives, whether it be capital preservation, income generation, or growth.

Methodology

Data Collection: Historical stock data of five months period from May – October 2024 was collected from Yahoo Finance for selected companies, including Amazon (AMZN), McDonald's (MCD), Microsoft Corp (MSFT), Walmart (WMT), and Intel Corp (INTC))

Date	AMZN	MCD	MSFT	WMT	INTC
2024-05-01	179	269.4614	392.7335	58.4803	30.0565
2024-05-02	184.72	268.3322	395.6173	59.3349	30.195
2024-05-03	186.21	265.4258	404.388	59.4442	30.581
2024-05-06	188.7	264.4243	411.2296	59.4939	30.7748
2024-05-07	188.76	262.6569	407.0531	60.2392	30.4866
2024-05-08	188	263.6289	408.2464	59.9212	29.8109
2024-05-09	189.5	263.0987	410.0164	60.2682	29.9003
2024-05-10	187.48	270.021	412.4229	60.3081	29.6618

Figure 3: Historical Stock Data of the five (5) selected companies

Data Analysis:

- Calculated mean returns and covariance matrix of stock prices.
- Assessed correlation between the assets to determine optimal diversification strategies.
- Visualized stock prices over time and correlation matrices using advanced plotting techniques like Plotly and Seaborn

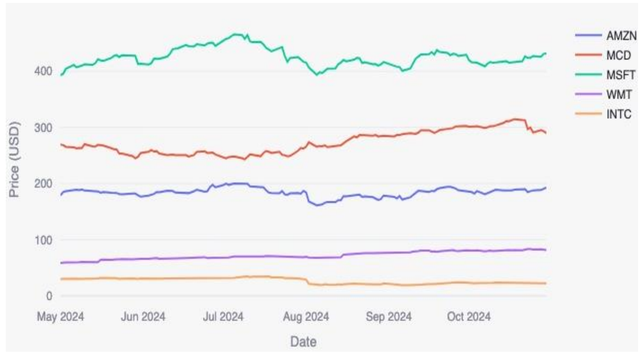

Figure 4: Stock Prices Trend Over Time

Portfolio Optimization:

- Generated multiple portfolios with random weights.
- Calculated returns, volatility, and Sharpe ratios for each portfolio.
- Identified optimal portfolios based on the highest Sharpe ratio.

Visualization:

- Plotted stock prices, portfolio optimization results, and correlation heatmaps to provide clear insights. Used Matplotlib and Plotly to visualize the efficient frontier, risk-return profiles, and correlations.

Result And Discussion

Optimal Portfolios: Identified portfolios with higher returns and manageable risk.

	Returns	Volatility	Sharpe Ratio	VaR	CVaR
0	0.0012	0.0088	0.1394	0.0012	0.0012
1	0.0016	0.0096	0.1627	0.0016	0.0016
2	0.0011	0.0116	0.0908	0.0011	0.0011
3	0	0.0184	-0.0027	0	0
4	0.0013	0.0099	0.1356	0.0013	0.0013
5	0.0011	0.0097	0.1094	0.0011	0.0011
6	0.0002	0.0154	0.0145	0.0002	0.0002
7	0.0003	0.0138	0.0199	0.0003	0.0003
8	0.0002	0.0134	0.0151	0.0002	0.0002
9	0.0006	0.0144	0.0417	0.0006	0.0006
10	0.0008	0.011	0.0774	0.0008	0.0008

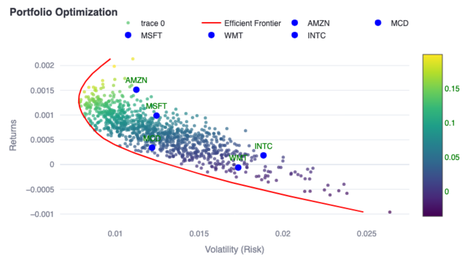

Figure 5: Portfolio Optimization Table and Graph

- The optimized portfolios had a Sharpe ratio of 0.2, which lies closer to the efficient frontier offering a better compensation of risk
- Analysis revealed that certain assets contributed to a more stable returns while others added growth potentials.
- Portfolio risk was effectively reduced through strategic selection of assets with low correlation
- Risk management strategies integrated into the portfolio construction minimized potential losses during market volatility

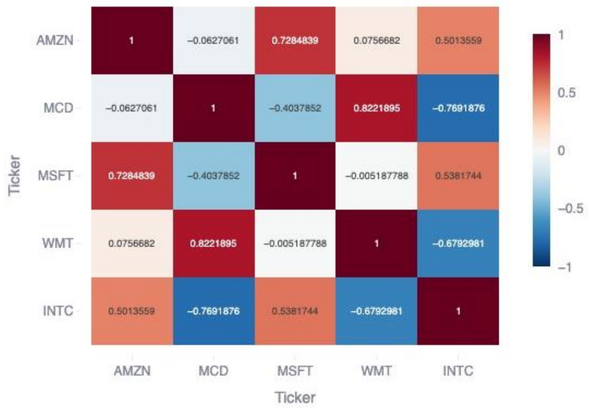

Figure 6: Correlation Matrix Heatmap

Conclusion:
This project showcases how portfolio optimization enhances strategic business decision-making. The model integrated risk management tools like VaR and CVaR enhancing portfolio stability and returns. This Portfolio Optimization model not only benefit investors but can also provide valuable insights for broader financial strategy development.