Enterprise for Society

Assignment 1

Portfolio Allocation based on Financial Performance

Sustainable and Entrepreneurial Finance

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1 Introduction

1.1 Dataset

The subset used for this analysis consists of assets in the Pacific region, with E-Scores available for the period 2013-2024. All the other Pacific assets are not considered for the sake of comparability in the following reports. The final sample consisted of 409 assets from Australia (64), Hong Kong (50), Japan (270), New Zealand (5), Singapore (20).

1.2 Missing values

Two types of missing values were identified in the dataset, based on the listing status of the firms:

- **Newly listed firms**: These companies were not yet traded at the beginning of the sample period, resulting in missing return data for the initial months. These missing values were left unchanged, as they accurately reflect the absence of market data prior to listing.

- **Delisted firms**: For firms that were delisted, a return of -100% was recorded in the month of delisting to reflect a total loss in value for investors. For all subsequent months, the return was set as missing, indicating the firm was no longer part of the investable universe.

2 Exercise 1

Purpose of the analysis: The objective of this exercise is to assess the financial performance of individual assets over the period 2014–2024 using key risk and return indicators. By computing the annualized average return and annualized volatility based on monthly data, we aim to evaluate the profitability and risk levels associated with each asset. Understanding these metrics is essential for making informed investment decisions and optimizing portfolio allocation.
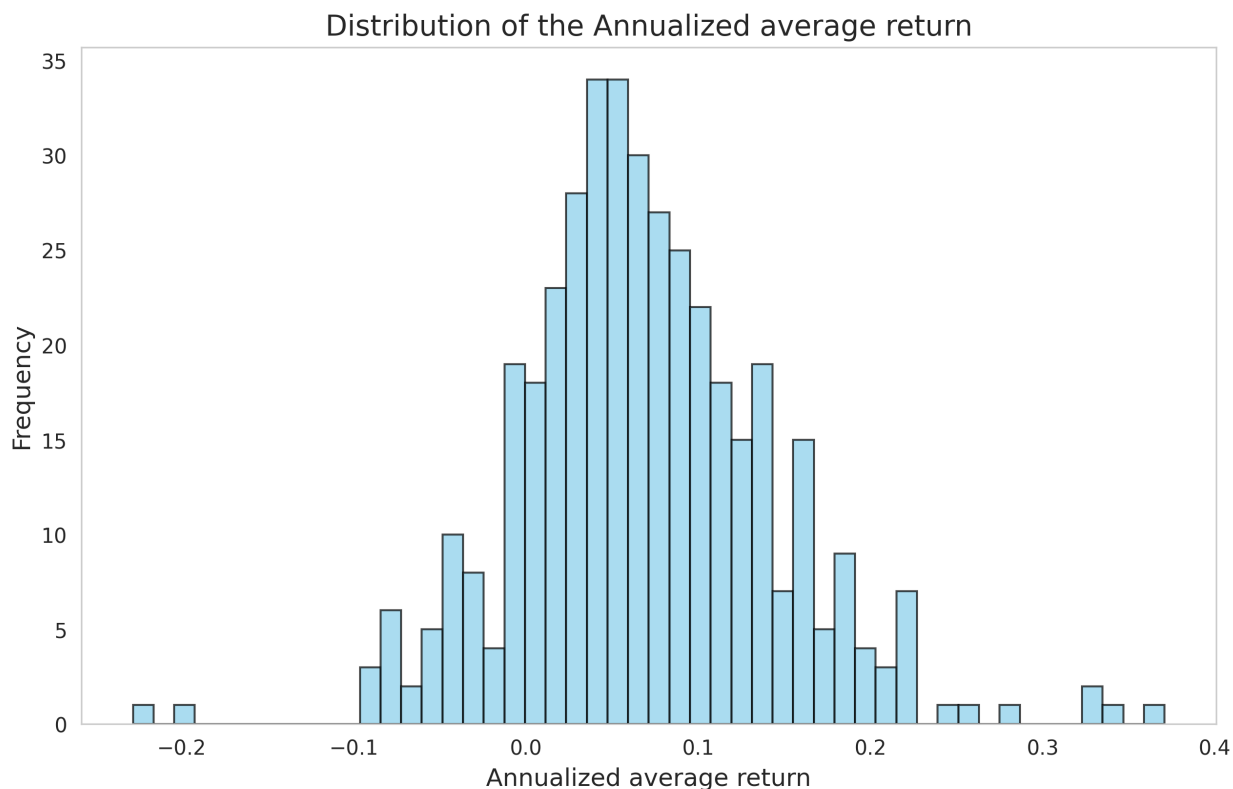
2.1 Annualized average return

Figure 1: Annualized return histogram during 2014 - 2024

Statistic	Value
Mean	6.90%
Median	6.3%
Mode	6.3%
Max value	37.1%
Min value	-22.8%

Table 1: Annualized Return Statistics (2014–2024)

Interpretation: As we can see in the histogram, the distribution of the Pacific companies' annualized returns between 2014 and 2024 appears approximately normal, with most returns con-

centrated around 6% and a slight positive skew. The Median is at 6.3% and the Mean at 6.9%. This suggests that a majority of firms in the dataset delivered moderate positive returns over the period, reflecting overall market stability and growth in the region. Additionally, we observe that a few firms achieved exceptionally high annualized returns, exceeding 30% per year, while a minority experienced very low returns, falling below -20% per year. The maximum return in our sample is 37.1%, while the minimum return is -22.8%, indicating high volatility between the two extreme return values in our dataset.
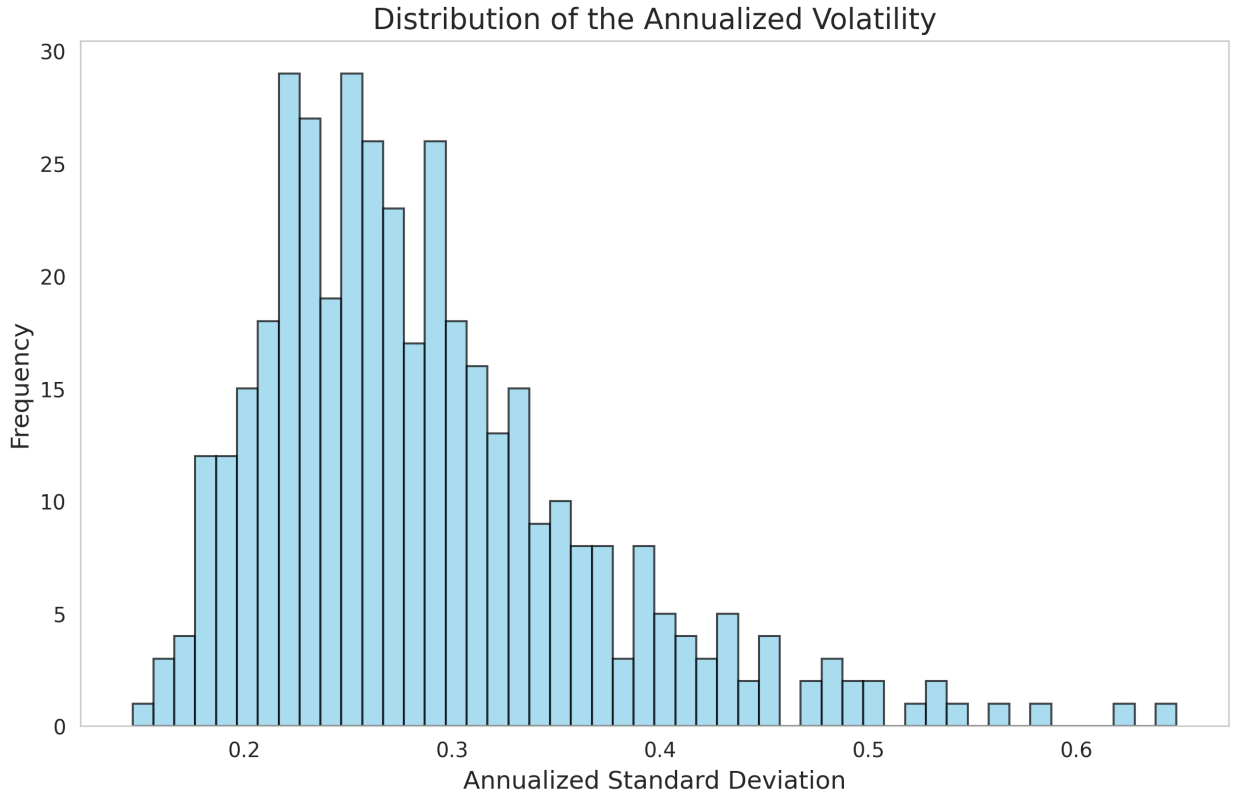
2.2 Annualized volatility

Figure 2: Annualized volatility histogram for during the period 2014-2024

Statistic	Value
Mean	28.8%
Median	27%
Mode	25.7%
Max value	64.8%
Min value	14.6%

Table 2: Annualized volatility Statistics (2014–2024)

The distribution appears to be right-skewed, with most assets exhibiting volatility between 25% and 30%. The peak of the distribution occurs around 25.7%, suggesting that the majority of assets

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have moderate volatility. The median volatility is 27%, indicating that half of the assets have volatility below this level, while the mean of 28.8% suggests that a few assets with higher volatility pull the average upward. There are fewer assets with extremely low or high volatility, as seen in the tails of the distribution. The right tail extends beyond 40%, indicating that some assets experienced significant price fluctuations, likely reflecting riskier or more speculative investments. Conversely, the left tail, with assets below 20%, suggests a small number of low-volatility assets, which could correspond to stable or defensive investments. This distribution provides insights into the risk profile of assets over the observed period. Investors might prefer assets clustered around the peak of 25.7% for a balanced risk-return tradeoff, while those with a higher risk appetite may explore the right tail for more volatile opportunities.

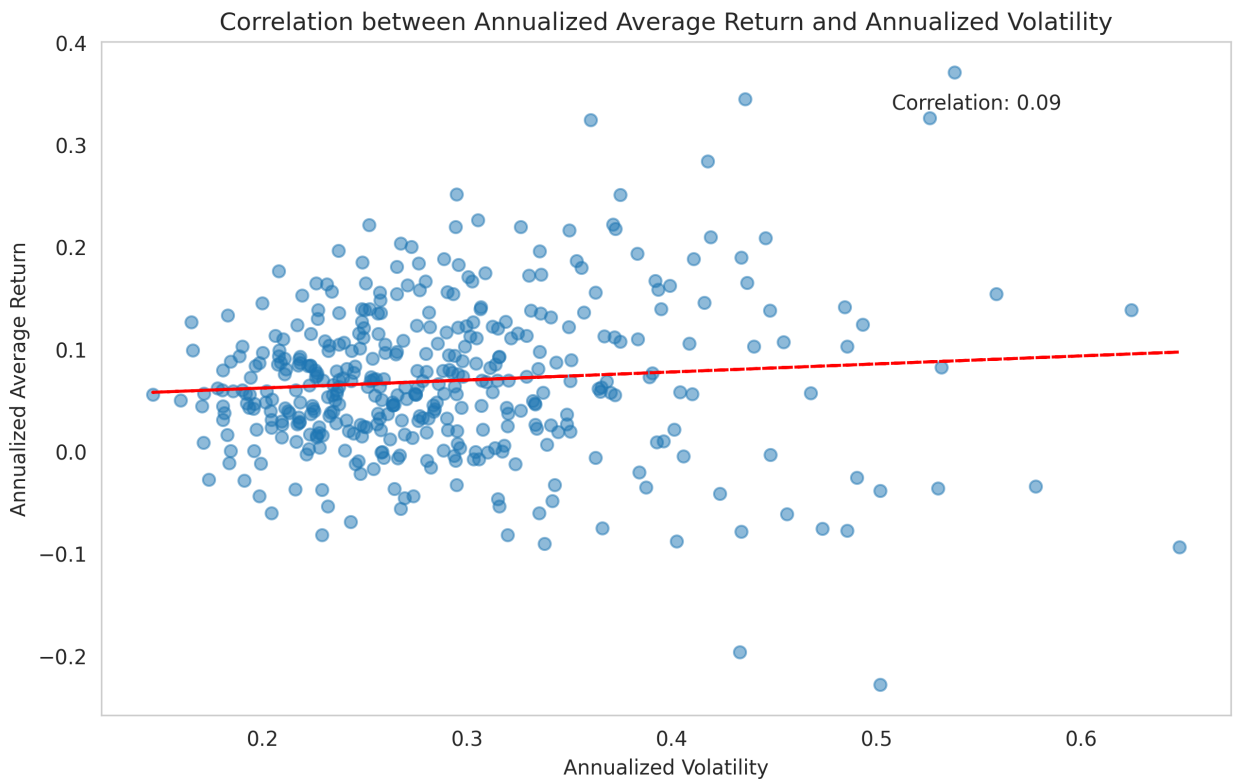## 2.3 Correlation between individual average returns and volatility

Figure 3: Correlation scatter plot

The scatter plot shows the relationship between Annualized Average Return and Annualized Volatility for our subset of individual assets. The correlation coefficient is 0.09, indicating a very weak positive relationship between the two variables. The spread of the data points suggests that assets with both high and low volatilities can exhibit a wide range of average returns, implying that volatility is not a strong predictor of return in this sample. This suggests that taking on higher risk in our dataset would not necessarily lead to higher returns.

3 Exercise 2

Purpose of the Analysis: The goal of this analysis is to evaluate and compare the performance of two types of investment portfolios constructed using monthly stock return data from January 2014 to December 2024. The first one is the equally-weighted (EW) portfolio, where each stock in the portfolio receives the same weight every month. The second one is the value-weighted (VW), where each stock is weighted in proportion to its market capitalization. By analyzing these two portfolios, we aim to understand how the weighting strategy impacts performance, risk, and return characteristics over time.

3.1 Portfolio Statistics and Interpretation

The following are the results of our analysis:

Metric	Equally Weighted EWP	Market Value Weighted MVWP
Annualized Return	6.90%	6.16%
Annualized Volatility	14.94%	14.03%
Sharpe Ratio	0.384	0.356
Min Return	-13.69%	-11.54%
Max Return	13.24%	13.52%

Table 3: Portfolio Performance Comparison: EWP vs. MVWP (2014–2024)

Annualized Return

The annualized return represents the compounded return a portfolio would achieve if its performance remained consistent over the year. The EWP outperformed the MVWP, yielding 6.90 % versus 6.16%, respectively. This suggests that the smaller-cap stocks in the EWP performed better than the larger-cap stocks in the MVWP over the 2014–2024 period.

Annualized Volatility

The annualized volatility captures the fluctuations in returns over a year, and it's a critical measure of risk. The EWP exhibits slightly higher volatility (14.94%) compared to the MVWP (14.03%), reflecting its exposure to more volatile smaller-cap stocks. Since the EWP allocates equal weight to all stocks regardless of size, it is more susceptible to large price swings of smaller, potentially more speculative companies. This higher volatility could be seen as a disadvantage for risk-averse investors, but it could also present opportunities for higher returns under favorable conditions.

Sharpe Ratio

The Sharpe ratio measures the risk-adjusted return of a portfolio, indicating how much excess return an investor can expect for each unit of risk. Although both portfolios have similar ratios, with the EWP at 0.384 and the MVWP at 0.356, the EWP offers a slightly better return per unit of risk. On a risk-adjusted basis, the EWP might be more attractive to investors willing to accept slightly more volatility in exchange for better performance.

Minimum and Maximum Return

The minimum and maximum return highlights respectively the worst and best performance over the period. The EWP experienced a deeper drawdown of -13.69%, compared to the MVWP's -11.54%. This illustrates that the EWP is more exposed to the risks of smaller-cap stocks, which

can be more volatile, especially during market downturns. Similarly, the MVWP achieved a slightly better maximum return of 13.52% compared to the EWP's 13.24%. This can be attributed to the dominance of larger-cap stocks in the MVWP, which might experience stronger price increases during market rallies driven by large, well-established companies. However, the maximum return is not necessarily indicative of long-term performance, and it may reflect short-term market fluctuations rather than sustainable growth.
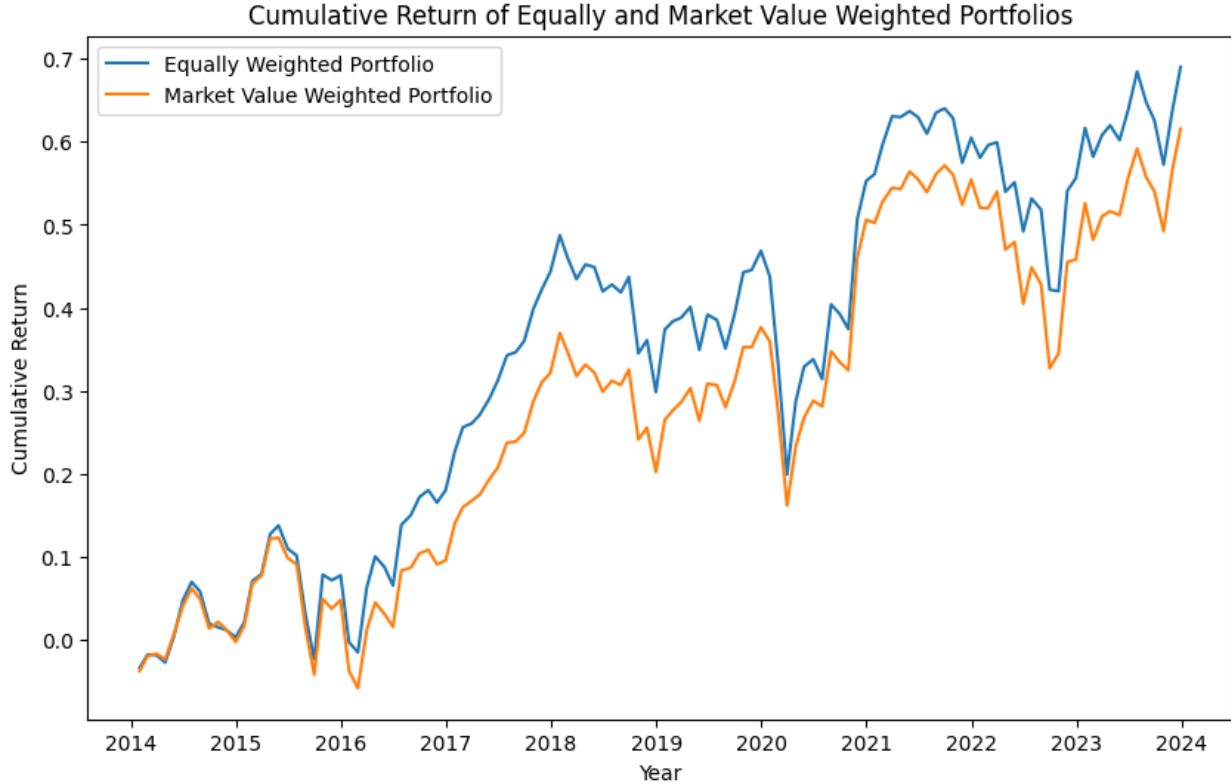
3.2 Cumulative Return Chart

Figure 4: Cumulative Return plot

The cumulative return graph highlights the performance gap between the Equally Weighted Portfolio (EWP) and the Market Value Weighted Portfolio (MVWP) from 2014 to 2024. Initially similar, the EWP began to outperform from 2017 onward.

Both portfolios incurred notable losses during market stress events, especially during the COVID-19 outbreak in early 2020. Yet the MVWP looked comparatively steadier during these downturns, exhibiting less severe negative fluctuations. This is supported by statistical data indicating the MVWP's lower minimum return (-11.54). This illustrates the trade-off between the two strategies: the EWP offers higher potential returns with increased volatility, while the MVWP provides consistent stability at the cost of lower gains.

3.3 Risk return Chart

The risk-return scatter plot visualizes the investment universe by mapping individual assets and portfolio strategies based on their risk-return profiles. The horizontal axis represents annualized

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Risk-Return Profile of the Portfolios
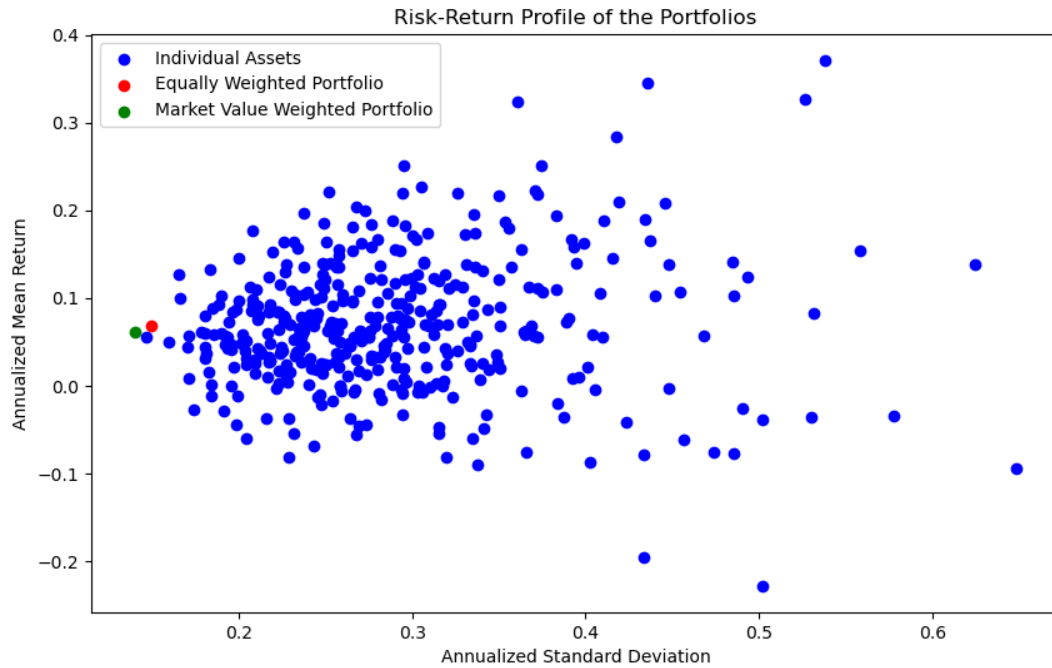
standard deviation (risk) from 0.1 to 0.6, while the vertical axis shows annualized mean returns from -20% to 40%. Individual assets form a dispersed cloud, indicating varied performance and volatility, with no perfect linear relationship between risk and return, though a positive association is noted.

Both the Equally Weighted Portfolio (red dot) and the Market Value Weighted Portfolio (green dot) are positioned in the upper-left quadrant, showcasing the benefits of diversification. The EWP is slightly to the right and higher than the MVWP, indicating its superior returns (6.90% vs. 6.16%) with marginally higher risk (14.94% vs. 14.03%). The MVWP reflects market behavior, weighted by market capitalization, resulting in more moderate risk-return characteristics.

4 Exercise 3

Purpose of the analysis: The purpose of this exercise is to construct the efficient frontier over the period 2014–2024, using firms with Environmental, Social, and Governance (E/S/G) scores or carbon emissions data. The efficient frontier helps investors identify optimal portfolios that achieve the highest expected return for a given level of risk, incorporating sustainability factors into portfolio selection. This analysis is essential for understanding how risk and return interact in a portfolio and how optimization techniques can improve investment decisions. It allows investors to determine whether sustainable assets align with traditional risk-return tradeoffs and how they perform compared to standard allocation strategies.

4.1 Modern Portfolio main components

The graph below articulates several fundamental components of Modern Portfolio Theory:

- **The Efficient Frontier** delineates the set of optimal portfolios that provide the highest expected return for a specified level of risk. Any portfolio positioned below this line is deemed inefficient.

- **The Tangency Portfolio** denotes the optimal portfolio when combined with the risk-free asset; it is the point at which the Capital Allocation Line touches the efficient frontier.

- **The Minimum and Maximum Variance Portfolio** respectively exhibit the lowest and higher possible risk on the efficient frontier.

- **The Risk-Free Asset** represents the theoretical risk-free return.

- **The Individual Assets** represent the individual stock associated to their respective risk-return profiles.

4.2 Ex–ante vs Ex-post Sharpe Ratio Portfolios

After computing the ex post performance of each portfolio along the efficient frontier, we came to the following results: The portfolio with the highest ex-ante Sharpe ratio had an ex-ante Sharpe of 1.5251, but its realized ex-post Sharpe ratio was lower at 1.4002. In contrast, the portfolio that achieved the highest ex-post Sharpe ratio had an ex-post Sharpe of 1.4805, despite having a slightly lower ex-ante Sharpe ratio of 1.5217. In modern portfolio theory, the portfolios expected to maximize risk-adjusted returns, are computed relying on historical estimates, which may differ from future market conditions.

4.3 Efficient frontier plot

From the plot, it is clear that neither the Equally Weighted Portfolio nor the Market Value Weighted Portfolio is situated on the efficient frontier, indicating that they are not optimized portfolios from a purely mathematical standpoint. The Equally Weighted Portfolio appears to have a higher return and greater risk compared to the Market Value Weighted Portfolio, consistent with prior data. The tangency portfolio offers superior risk-adjusted returns relative to both portfolios. The maximum return portfolio indicates significantly greater potential returns than either the Equally Weighted

Efficient Frontier with Capital Allocation Line, Tangency and Special Portfolios
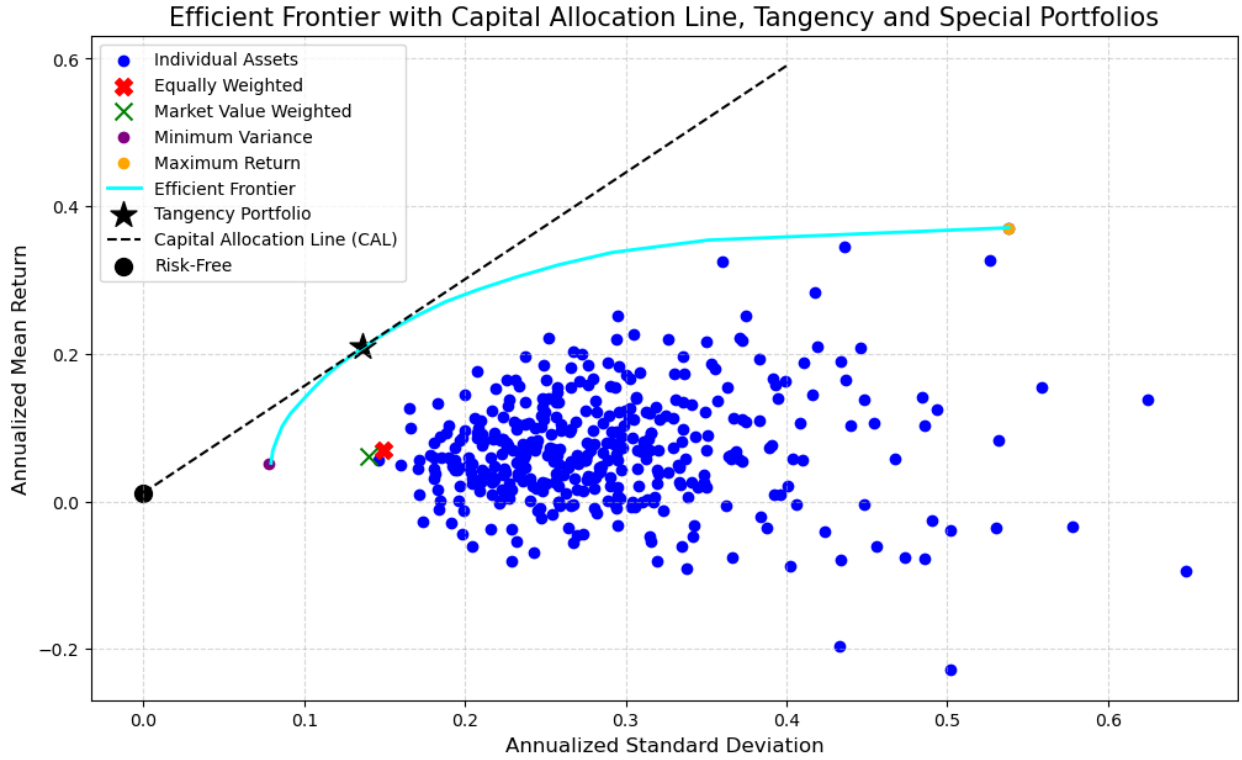
Portfolio or the Market Value Weighted Portfolio. The minimum-variance portfolio presents lower risk than either of the aforementioned portfolios, suggesting a potential for enhanced diversification.

The following are the results of our analysis for minimum variance and maximum return portfolios.

Metric	Minimum Variance Portfolio	Maximum Return Portfolio
Annualized Return	5.20%	37.09%
Annualized Volatility	10.47%	52.76%
Sharpe Ratio	0.506	0.681

Table 4: Portfolio Performance Comparison: Minimum Variance Portfolio vs. Maximum Return Portfolio (2014–2024)

5 Exercise 4

Purpose of the analysis: The purpose of this task is to evaluate the performance of a minimum variance portfolio constructed using historical data, while ensuring that only past information is used to make forward-looking decisions. This out-of-sample, dynamically rebalanced strategy aims to minimize risk under realistic constraints and compare its risk-adjusted performance—measured by metrics like annualized returns, volatility, and the Sharpe ratio—to a benchmark value-weighted portfolio.

Metric	MVWP	YRP
Annualized Return	6.16%	4.94%
Annualized Std Dev	14.03%	11.08%
Sharpe Ratio	0.356	0.341
Min Return	-11.55%	-9.58%
Max Return	13.52%	10.21%

Table 5:
Performance comparison of different portfolios - Value Market Weighted Portfolio (MVWP) and Yearly Rebalanced Portfolio (YRP)

5.1 Returns and Volatility

Examining the two portfolios (Market Value Weighted and Yearly Rebalanced), it's possible to see that the annualized return of the MVWP is higher than the YRP. On the other hand, the volatility of the MVWP is also higher, reflecting the fact that greater profits come with greater risks.

The approach of the Yearly Rebalanced portfolio appears more defensive: volatility drops to about 11% , but its average return is lower than that of the Market Value Weighted. This suggests a conservative investment strategy aimed to mitigate significant market fluctuations. Furthermore, the main disadvantage of the YRP, compared to the MVWP, is that it does take into account only prior data and not all the sample. This lack of information leads to worse performance.

5.2 Sharpe Ratios

Looking at the Sharpe ratios, all the portfolios present positive values with small variations: Market Value Weighted: 0.36; Yearly Rebalanced: 0.34.

A 0.02 difference in Sharpe ratio is not large, but it indicates that the "market-based" approach (MVWP) offered a slightly better balance between risk and return than the out-of-sample Markowitz optimization (YRP). The YRP's lower risk did not translate into a high enough return to surpass MVWP's Sharpe ratio.

5.3 Monthly Return Extremes

Analyzing monthly extremes further distinguishes the portfolios:

1. The MVW portfolio experienced substantial monthly swings, with minimum returns around -14.15% and maximum returns approaching +13.15%. This aligns with its 14% volatility and its tendency to reflect stock market swings quite directly.

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2. The YR portfolio, however, shows notably narrower monthly return variations, with a minimum of about -5.08% and a maximum of +10.21%. This confirms the more "cautious" nature of the YR portfolio, which mitigates extreme fluctuations but also misses out on the market's highest upswings, reflecting its lower overall volatility.

5.4 Observations

From a theoretical standpoint, the Yearly Rebalanced (YR) portfolio employs Markowitz's mean-variance framework by recalculating the optimal weights at the end of each year based solely on the data available up to that point. This approach, which enforces a long-only constraint (i.e., no short selling), is fundamentally different from the Equally Weighted Portfolio or the Market Value Weighted Portfolio, which are constructed and evaluated retrospectively on the full sample after the observation period.

Because the YR portfolio is updated yearly, it "reacts" to newly added data, meaning that at each rebalancing the optimization is performed on a limited set of historical observations. This has two key implications:

1. **Limited Data Horizon:** The YR portfolio's decisions are based only on past information up to each rebalancing date, rather than on the entire data sample. In contrast, the MVWP is computed using the full sample after the fact, which allows it to capture the overall market dynamics more completely. As a result, the YR portfolio may not be able to "catch up" with the performance that could have been achieved if one had hindsight.

2. **Reactionary Nature:** Since the YR portfolio is re-optimized every year, it inherently reflects a reactive strategy. It adjusts its allocations in response to the most recent data, which may lead to more conservative or even more concentrated allocations. This reactionary process can cause the portfolio to miss some of the stronger upward market movements, ultimately yielding a lower average return.

The empirical outcomes support this reasoning are:

1. The YR portfolio has a lower annualized return compared to the MVWP.

2. While it benefits from a lower volatility, the Sharpe ratio is slightly lower.

3. The monthly return extremes for YR are more contained, reflecting its defensive and reactionary nature, but this also means it does not capture as many of the strong market rallies.