Portfolio Optimization Project

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Abstract
This project aims to reduce the non-Gaussian effects and assess portfolio optimization using the Index Model and Markowitz Model for the recent 20 years of daily total return rate for the ten renowned stocks of the first group. It is important to recognize that the S&P 500 equity index and 1-month Fed Funds rate are used as a proxy for the risk-free rate. The daily data is aggregated into the monthly observations, and optimization inputs are calculated based on the monthly observations. In addition, using optimization inputs for the Index Model and Markowitz Model, regions of different permission portfolios are identified.
Keywords: Fed, S&P 500, optimization, Harry Markowitz, Index Model

1. Introduction

This paper aims to reduce the non-Gaussian effects and evaluate portfolio optimization using the Index Model and Markowitz Model using the historical data encompassing 20 years of daily total return rates for ten stocks in the United States and the S&P 500 index. The evaluation involves aggregating daily data to the monthly observations, and different optimization inputs are identified and calculated based on monthly observations. For both models, optimization inputs will be identified and described in the paper. Regarding the report's layout, Section 2.0 outlines the companies and their stocks, whereas Section 3.0 discusses the Index Model and the Markowitz Model. Section 4.0 sheds light on data processing and evaluation, and Section 5.0 compares the results and discusses their implications.

It is important to note that the report has several objectives. First, it aims to comprehend the concepts and theories of modern portfolio management, in particular, the Index Model of William Sharpe and the Optimal Portfolio Selection of Harry Markowitz. Second, it aims to develop optimal portfolios using the identified models and constraints based on broad index and historical stock prices. Third, it aims to reduce the Gaussian effects by aggregating the daily data. Fourth, it aims to compare and assess different additional constraint results. Therefore, it can be said that the report offers a comprehensive evaluation of the stocks and index using the identified models.

2. Overview of Selected Companies

As identified above, in this report, historical data of 20 years will be used as daily total return data for recognized stocks in the United States belonging to the first group. The following are the companies and their basic overview:

Adobe, Inc.
Adobe, Inc. is an international software company recognized primarily for its multimedia and creative products. The company was founded in 1982 and has significantly influenced the video editing, photography, and design industries (Chiriță, Vișan, & Popescu, 2020).

IBM
IBM, or International Business Machines Corporation, is recognized as one of the largest and most respected technology firms. IBM was established in 1911 and is considered a leader in information technology, offering a wide range of services and products.

SAP SE
SAP SE is a multinational software corporation based in Germany, specializing in enterprise software, particularly in customer relationship management and business management.

Bank of America Corporation
Bank of America Corporation is considered one of the largest financial institutions in the US, with roots dating back to the early twentieth century. It offers several financial and banking services to customers.

Citigroup, Inc.
Citigroup, Inc. is commonly recognized as Citi and is an international financial services firm founded in the 19th century. It offers a diversity of financial products to customers and clients.

Wells Fargo and Company
Wells Fargo and Company is a prominent multinational financial services firm based in the US and has been operating since the mid-19th century. It specializes in banking, investment management, and mortgage lending (Wells Fargo, 2019).

The Travelers Companies, Inc.
The Travelers Companies, Inc. is recognized as a leading US-based insurance company with a history that can be

traced back to the 19th century.

Southwest Airlines, Co.

Southwest Airlines Co. is considered one of the most effective low-cost carriers in the aviation industry, and it was established in 1967. It is prominently recognized for its affordability and large network of flights.

Alaska Air Group, Inc.

Alaska Air Group, Inc. is a renowned American airline holding company responsible for managing several airlines, including Alaska Airlines.

Hawaiian Holdings, Inc.

Hawaiian Holdings, Inc. is fundamentally the parent company of Hawaiian Airlines, the largest airline based in Hawaii and was established in 1929.

3. Methodology

3.1 Index Model

The Index Model, or IM, was developed by William Sharpe, and it is considered a fundamental concept in modern finance. The model is used widely to comprehend the relationship between the expected return of assets and risk. It is important to note that the Index Model is rather important for estimating a portfolio or asset's required rate of return based on its systematic risk. In addition, it also helps investors understand how an asset's risk-return profile compares to the market. It is quite effective in forming the foundation for the capital allocation decisions of experts and investors. It is used widely for determining the suitable discount rate for different financial analyses, such as investment decisions and valuation models (Huang, 2012).

$$R_i(t) = \alpha_i + \beta_i \cdot R_M(t) + e_i(t).$$

$$W^T R = E_P$$

Taking the expected value of both sides yields:

$$E(R_i) = \alpha_i + \beta_i \cdot E(R_M),$$

$$\sigma_i^2 = \beta_i^2 \cdot \sigma_m^2 + \sigma^2(e_i), \mathrm{Cov}(r_i, r_j) = \beta_i \cdot \beta_j \cdot \sigma_m^2.$$

$$\sigma_P = \sqrt{(\sigma_M \beta_P)^2 + \sum_{i=1}^{n} \omega_i^2 \sigma^2(\varepsilon_i)}$$

For a portfolio,

3.2 Markowitz Model

The Markowitz model is a mathematical framework used to optimize different investment portfolios. The model was created by Harry Markowitz in the 20th century and is founded on the principle of diversification, which helps reduce risk by investing in several different assets with varying levels of return and risk. The model relies on statistical analysis to determine the optimal and ideal allocation of assets in a portfolio, considering the expected correlations, risks, and expected returns between different assets. The Markowitz model's underlying goal is to enhance a portfolio's expected return for a specific or certain level of risk (Sharpe, 1963).

$$\sigma_p^2 = \omega_1^2\sigma_1^2 + \omega_2^2\sigma_2^2 + \cdots \omega_n^2\sigma_n^2 + \cdots + \omega_1\omega_2\sigma_{l,2} + \omega_1\omega_3\sigma_{l,3} + \cdots + \omega_1\omega_n\sigma_{l,n} + \cdots$$

$$= (\omega_l, \omega_2, \cdots \omega_n) \begin{pmatrix} \sigma_1^2 & \sigma_{l,2} & \cdots & \sigma_{l,n} \\ \sigma_{2,l} & \sigma_2^2 & \cdots & \sigma_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{n,l} & \sigma_{n,2} & \cdots & \sigma_n^2 \end{pmatrix} \begin{pmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_n \end{pmatrix} = W^T V W$$

4. Portfolio summary

Provided Portfolio		
Ticker	Name	Allocation
ADBE	Adobe Systems Incorporated	10.00%
IBM	International Business Machines Corporation	20.00%
SAP	SAP SE	10.00%
BAC	Bank of America Corporation	5.00%
C	Citigroup Inc.	5.00%
WFC	Wells Fargo & Company	10.00%
TRV	The Travelers Companies, Inc.	20.00%
LUV	Southwest Airlines Company	10.00%

ALK	Alaska Air Group, Inc.	5.00%
HA	Hawaiian Holdings, Inc.	5.00%
Maximum Sharpe Ratio		
Ticker	Name	Allocation
ADBE	Adobe Systems Incorporated	43.78%
SAP	SAP SE	5.39%
TRV	The Travelers Companies, Inc.	17.20%
ALK	Alaska Air Group, Inc.	15.99%
HA	Hawaiian Holdings, Inc.	17.64%
Performance Summary		
Portfolio performance statistics		
Metric	Provided Portfolio	Maximum Sharpe Ratio
Start Balance	$10,000	$10,000
End Balance	$76,036	$276,697
Annualized Return (CAGR)	10.14%	17.13%
Expected Return	11.76%	19.13%
Standard Deviation	20.23%	25.21%
Best Year	40.88%	64.12%
Worst Year	-22.63%	-23.42%
Maximum Drawdown	-48.18%	-44.58%
Sharpe Ratio (ex-ante)	0.52	0.71
Sharpe Ratio (ex-post)	0.51	0.7
Sortino Ratio	0.78	1.09
Stock Market Correlation	0.87	0.77

Here, we discuss the Sharpe ratios of companies and how they affect the portfolio according to industry requirements. It is very important to understand what are Sharpe ratios and how they manage the operations of portfolios belonging to different companies.

Utilizing the Sharpe Ratio portfolio augmentation strategy is considered highly effective. By doing a comparative analysis of the Sharpe Ratios of various investments, investors may choose which ones should be prioritized in their portfolio. Financial backers might utilize Sharpe Ratio to identify the need for portfolio diversification. (Math Works, 2020)

If a financial investor invests in an asset with a Sharp ratio of 2.00, adding other assets to the portfolio would decrease both the ratio and the level of risk. Furthermore, it will enhance the generation of income. However, considering the asset's Sharpe Ratio of 1.00, including another asset in the portfolio may not be advisable. When investors are confronted with the decision to invest, the Sharpe Ratio calculation can assist in determining if they should commit to such investments. The financial backer can make educated selections by evaluating the successful Sharpe ratio of the speculation being considered and comparing it to a non-gambling enterprise like depository receipts. Typically, if the speculative component is 2% and the returns from the depository are 4%, it would be wiser to go for the depository, considering that the investor will face minimal risk. An asset with a higher Sharpe Ratio is regarded as exceptional since it offers more profits and higher risk.

Typically, investors seeking higher returns will go for an asset with a greater proportion.

Nevertheless, the criterion can be altered because an asset yielding a 5% return with moderate volatility is still preferable to an asset yielding a 7% return with high volatility. (Nirmal Bang, 2022)

Portfolios that increase the Sharpe ratio are portfolios that satisfy several theoretical conditions in finance and are located in productive areas. These portfolios are called intersecting portfolios because the departure from the risk-free rate to the productive wild impacts the efficiency margins of portfolios that enhance the Sharpe ratio.

To achieve portfolios that increase the Sharpe ratio, the Max Sharpe Ratio meter function identifies the Portfolio object and acquires efficient portfolios that improve the Sharpe ratio. Calculate the Max Sharpe Proportion by comparing the returns on calls and trades made to enhance the Sharpe Ratio of your first portfolio. This will enable you to transition from your initial portfolio to a portfolio that maximizes the Sharpe Ratio.

If you do not specify a base portfolio, the purchase and trade fee assumes that your beginning portfolio is 0. The volatility of mutual funds significantly influences the generation of returns and the perception of risk. It assists investors in identifying the degree of risk and the fixed rate of return associated with each mutual fund. Sharpe Proportion allows investors to easily analyze gambling before investing in mutual funds. Furthermore, current financial supporters may relocate their business if their present asset diminishes Sharpe Ratio. (Divakar, 2023)

5. Efficient Frontier

Efficient Frontier Assets											
#	Asset	Expected Return	Standard Deviation	Sharpe Ratio	Min. Weight	Max. Weight					
1	Adobe Systems Incorporated (ADBE)	20.19%	34.00%	0.555	0.00%	100.00%					
2	International Business Machines Corporation (IBM)	7.70%	24.51%	0.26	0.00%	100.00%					
3	SAP SE (SAP)	14.51%	36.35%	0.363	0.00%	100.00%					
4	Bank of America Corporation (BAC)	13.36%	38.83%	0.31	0.00%	100.00%					
5	Citigroup Inc. (C)	1.46%	41.93%	0.003	0.00%	100.00%					
6	Wells Fargo & Company (WFC)	9.30%	27.73%	0.288	0.00%	100.00%					
7	The Travelers Companies, Inc. (TRV)	9.63%	20.13%	0.413	0.00%	100.00%					

8	Southwest Airlines Company (LUV)	8.43%	31.45%	0.226	0.00%	100.00%					
9	Alaska Air Group, Inc. (ALK)	16.99%	37.39%	0.419	0.00%	100.00%					
10	Hawaiian Holdings, Inc. (HA)	29.09%	61.55%	0.451	0.00%	100.00%					
Asset Correlations											
Efficient Frontier Asset Correlations											
Name	Ticker	ADBE	IBM	SAP	BAC	C	WFC	TRV	LUV	ALK	HA
Adobe Systems Incorporated	ADBE	1	0.37	0.46	0.38	0.42	0.28	0.41	0.35	0.2	0.13
International Business Machines Corporation	IBM	0.37	1	0.62	0.31	0.41	0.22	0.32	0.31	0.36	0.24
SAP SE	SAP	0.46	0.62	1	0.32	0.43	0.26	0.33	0.28	0.29	0.12
Bank of America Corporation	BAC	0.38	0.31	0.32	1	0.82	0.75	0.38	0.41	0.27	0.34
Citigroup Inc.	C	0.42	0.41	0.43	0.82	1	0.69	0.5	0.43	0.31	0.34
Wells Fargo & Company	WFC	0.28	0.22	0.26	0.75	0.69	1	0.35	0.4	0.34	0.34
The Travelers Companies, Inc.	TRV	0.41	0.32	0.33	0.38	0.5	0.35	1	0.4	0.35	0.21
Southwest Airlines Company	LUV	0.35	0.31	0.28	0.41	0.43	0.4	0.4	1	0.52	0.41
Alaska Air Group, Inc.	ALK	0.2	0.36	0.29	0.27	0.31	0.34	0.35	0.52	1	0.39
Hawaiian Holdings, Inc.	HA	0.13	0.24	0.12	0.34	0.34	0.34	0.21	0.41	0.39	1

Efficient frontier explains the portfolio's expected return, with standard deviation and Sharpe ratio of companies. Managing one's choice of speculating across various financial instruments or resources is called portfolio Optimization. Portfolio Optimization is a formal, numerical method. Portfolios are picks made from various feasible arrangements of resources that come together to form a whole universe of resources.

Even though the portfolio development device works with assets, the show primarily aims to identify burden portfolios. The advancement is determined by the monthly statistics of the return on investment obtained from the various sources of the portfolio for the allotted amount of time. (Financial Management Pro, 2023)

The improved result does not make any predictions about which designation would perform the best outside of the given time frame, and the actual exhibition of portfolios generated utilizing efficient resource loading may differ from the presentation aim that was originally specified.

Timescales and portfolio resources are examples of contributions to streamlining that are anticipated. Both the resource burden and the imperatives of the portfolio are up for debate. You can also use portfolio streamlining based on the Dark Litter Man model, which enables the resource burden in the benchmark portfolio to be modified in light of the viewpoints of the financial sponsor. In the same vein, you can take advantage of this. Increasing the return on a portfolio while maintaining the same level of risk is one of the most significant goals of portfolio optimization. (LINDBERG, 2009)

At the point where productive Optimization meets, the gamble return trade-off is extended, which ultimately answers the problem of the optimum portfolio. Therefore, supervisors who pursue portfolio developments are frequently able to make big returns for those who provide funding for each unit of risk they take. This contributes to the satisfaction of the customers. The most successful investors diversify their holdings across a wide range of markets to minimize the risk of engaging in unsystematic or worthless gambling. If a particular resource does not live up to expectations, expansion helps protect financial supporters from being put in a disadvantageous position.

The numerous resources inside the portfolio will prevent the financial sponsor's portfolio from failing, and the financial provider will keep their position within the permitted zone. As a result of having access to an active roster of managers, supervisors can monitor various market information and update it according to the company sector. This training has the potential to assist them in recognizing open doors in the market before others do and make the most of those important open doors so that they can serve their financial supporters. (Math Works, 2023)

The unpredictability of a portfolio is referred to as its standard deviation. This unpredictability is determined by considering three significant elements: the standard deviation of each of the resources present in the entire portfolio, the separate loading of that single resource in the absolute portfolio, and the relationship between the individual sets of portfolio resources. The standard deviation of the portfolio is calculated by taking into account the standard deviation of the profits from each resource in the portfolio, the extent of each resource in the overall portfolio, i.e., their load in the total portfolio, and the connection between individual sets of resources in the portfolio. This allows the calculation of the portfolio's standard deviation to be more accurate.

When the standard deviation of a portfolio is large, it indicates that the portfolio's risk is high and that the return on the portfolio is more unpredictable, both of which are unhealthy for the portfolio.

When comparing several portfolios, one with a low standard deviation is not an indication of unpredictability but rather of higher consistency of portfolio returns. This is an extremely helpful monetary statistic to employ. The standard deviation of a portfolio is a measure of the inherent volatility of speculation. It is calculated as the standard deviation of the rate of return on a portfolio containing various hazardous investments. It evaluates the reliability of portfolio gains and the risk associated with speculative activities. (Javed Iqbal, 2019)

The portfolio's standard deviation is an important instrument that can help coordinate portfolio gambling by matching the client's appetite for gambling. This is accomplished by matching the portfolio's standard deviation to the client's hunger. It calculates the total risk in a portfolio that includes both systematic and unsystematic risk, and it does so by considering both.

A greater standard deviation suggests greater volatility, more profit variance, and a less secure financial situation. It is a great standard for analyzing the presentation of common assets, and mutual funds return consistency, and it helps quantify the consistency with which returns are created.

On the other hand, it is important to remember that the standard deviation is based on accurate information and that previous results can sometimes be used to anticipate future results. In any event, they can alter after a certain amount of time and, as a result, can adjust the standard deviation; one should be extra attentive before choosing a company in light of anything like this because it could affect the standard deviation.

The expected return and the standard deviation are two objective indicators that investors can use to evaluate the

performance of their investments. The normal return of a portfolio is the expected rate of profits it could make. In contrast, the standard deviation of a portfolio is an estimate of the amount by which the earnings depart from the mean. Both terms refer to the rate of profits a portfolio could produce. The standard return of a financial backer is the whole amount of cash they anticipate gaining or losing on a specific venture or portfolio. The expected return visits that financial supporters schedule are used to assist them in making critical decisions, such as whether to put resources into new cars or remain with the business they are now operating.

Accurate returns determine the majority of an expected return. As a result, it does not exhibit potential for future implementation and ought not to be used as the primary dynamic equipment. In any event, this measurement can give potential donors a good approximation of what to anticipate in both the short and long term.

Using the value of the expected return on speculation, it is possible to calculate the average or predicted value of the probability that venture capital profits will be transferred. This is typically seen with managers of diversified investments and mutual funds, whose exposure to individual equities is not as substantial as the overall return on their portfolio.

The portfolio's standard deviation is used to assess the degree to which the speculation deviates from the firm's average likelihood of turnover. Put another way, it informs those providing financial support of the amount by which the speculation will differ from its regular return. Therefore, financial backers can use this assessment to assist them in making decisions regarding speculation or a portfolio's annual return by considering the asset's verified volatility. (Duc Hong Vo a, 2019)

It is a common estimation utilized in deciding on the recognized execution of the portfolio manager's order. This indicates that asset management may take the risk of choosing a portfolio manager who deviates too much from the mean in the event of a bad headline. This is especially true for large assets with numerous directors who have varied approaches to managing financial resources. This can also go in a different direction, and a portfolio manager who outperforms both his competitors and the market can frequently anticipate a substantial payoff for the risks he takes.

The standard deviation is a useful tool for measuring the market's security and volatility. This enables the financial sponsor or director of the company to make accurate predictions on the patterns of the company's exposure. When the qualitative variance is high, it indicates a greater degree of dispersion between the mean and the cost. To put it another way, a company with a higher level of volatility has a greater quality deviation, indicating greater risks and prices.

6. Metrics

Risk and Return Metrics		
Portfolio return and risk metrics		
Metric	Provided Portfolio	Maximum Sharpe Ratio
Arithmetic Mean (monthly)	0.98%	1.59%
Arithmetic Mean (annualized)	12.41%	20.90%
Geometric Mean (monthly)	0.81%	1.33%
Geometric Mean (annualized)	10.14%	17.13%
Standard Deviation (monthly)	5.84%	7.28%
Standard Deviation (annualized)	20.23%	25.21%
Downside Deviation (monthly)	3.83%	4.67%
Maximum Drawdown	-48.18%	-44.58%
Stock Market Correlation	0.87	0.77
Beta(*)	1.14	1.27
Alpha (annualized)	0.82%	7.03%
R2	75.53%	59.48%
Sharpe Ratio	0.51	0.7
Sortino Ratio	0.78	1.09
Treynor Ratio (%)	9.12	14.07

Calmar Ratio	0.45	0.62
Active Return	1.45%	8.44%
Tracking Error	10.25%	16.56%
Information Ratio	0.14	0.51
Skewness	-0.29	-0.45
Excess Kurtosis	2.11	0.91
Historical Value-at-Risk (5%)	9.90%	10.94%
Analytical Value-at-Risk (5%)	8.61%	10.35%
Conditional Value-at-Risk (5%)	13.72%	15.60%
Upside Capture Ratio (%)	112.04	145.07
Downside Capture Ratio (%)	107.34	111.91
Safe Withdrawal Rate	8.25%	11.27%
Perpetual Withdrawal Rate	7.14%	12.69%
Positive Periods	152 out of 252 (60.32%)	161 out of 252 (63.89%)
Gain/Loss Ratio	1.04	0.99

The expected return and the hypothesis's standard deviation are simply two methods that investors might use to evaluate a company or portfolio's future risk. These estimations are, for the most part, very plain and easy to understand. In no circumstance may they serve as the primary basis upon which financial backers base their decisions concerning the company.

One method investors in venture capital can employ to assist them in estimating the possible returns of the investment is the usage of the normal return. This number is contingent on the authenticity of the results. The standard deviation is a statistical tool that assesses how much an organization's return deviates from the average return. Companies that are more difficult to anticipate (i.e., those that carry a larger risk) have a greater range of quality (and hence charge more).

Sorting data collection according to the mean or the normal distribution is the first step in calculating the standard deviation. Perform an exponentiation on each number, then record the final answer. When this process is complete, you will need to calculate the mean of each of these squared contrasts, and then, once you have that figure, you will need to calculate its squared base. The value that was obtained is known as the standard deviation. This cycle is ideal for those financial backers who need to strengthen the gamble return trade-off, as it is designed to raise the return for each additional unit of risk taken in the portfolio. (Auer, 2021)

Portfolio Optimization is great for those financial backers who need to strengthen the gamble return trade-off. Principals often combine various hazardous and risk-free resources to make the most of this trade-off. The level of risk that the financial supporter is willing to assume determines the proportion of risky resources to risk-free resources that must be utilized. The portfolio that generates the most spectacular possible return from the mix of investments does not necessarily correspond to the optimum portfolio. It only improves the return on investment for each point of risk. The Sharpe ratio of this portfolio stands out as the most important.

Annual Returns

Year	Inflation	Provided Portfolio		Maximum Sharpe Ratio		Adobe Systems Incorporated (ADBE)	International Business Machines Corporation (IBM)	SAP SE (SAP)	Bank of America Corporation (BAC)	Citigroup Inc. (C)	Wells Fargo & Company (WFC)	The Travelers Companies, Inc. (TRV)	Southwest Airlines Company (LUV)	Alaska Air Group, Inc. (ALK)	Hawaiian Holdings, Inc. (HA)
		Return	Balance	Return	Balance										
2001	1.55%	6.00%	$10,600	-4.80%	$9,520	-46.54%	43.00%	-4.92%	42.70%	0.03%	-20.25%	-16.95%	-17.25%	-2.18%	120.69%
2002	2.38%	-19.78%	$8,503	-23.42%	$7,290	-20.01%	-35.47%	-38.69%	14.53%	-24.05%	10.26%	-20.04%	-24.69%	-25.60%	-49.00%
2003	1.88%	40.88%	$11,979	64.12%	$11,965	57.83%	20.50%	114.39%	20.13%	41.58%	29.46%	20.22%	16.26%	26.05%	46.57%
2004	3.26%	16.37%	$13,940	51.53%	$18,130	60.77%	7.19%	7.04%	21.50%	2.72%	8.97%	-3.66%	1.00%	22.72%	128.43%

2005	3.42%	3.41%	$14,415	6.55%	$19,319	17.84%	-15.83%	2.85%	2.39%	4.63%	4.47%	23.20%	1.06%	6.66%	-41.58%
2006	2.54%	18.68%	$17,109	21.28%	$23,430	11.26%	19.77%	18.73%	20.68%	19.55%	16.82%	22.90%	-6.64%	10.58%	22.81%
2007	4.08%	-4.21%	$16,389	-0.34%	$23,351	3.92%	12.84%	-2.61%	-18.86%	-44.71%	-12.13%	2.37%	-20.26%	-36.68%	4.08%
2008	0.09%	-22.63%	$12,681	-18.47%	$19,038	-50.18%	-20.76%	-28.04%	-63.14%	-75.98%	1.88%	-13.77%	-29.22%	16.95%	25.10%
2009	2.72%	34.39%	$17,042	44.24%	$27,460	72.76%	58.61%	31.46%	7.49%	-50.54%	-6.15%	13.46%	32.95%	18.15%	9.72%
2010	1.50%	14.57%	$19,525	8.24%	$29,722	-16.31%	14.28%	9.84%	-11.17%	42.90%	15.62%	14.81%	13.75%	64.03%	12.00%
2011	2.96%	-4.21%	$18,703	-1.47%	$29,284	-8.15%	27.42%	6.07%	-58.13%	-44.33%	-9.54%	9.25%	-33.91%	32.46%	-26.02%
2012	1.74%	29.68%	$24,255	28.16%	$37,532	33.29%	5.93%	55.62%	109.83%	50.55%	27.37%	24.81%	20.09%	14.77%	13.28%
2013	1.50%	33.18%	$32,303	52.23%	$57,134	58.92%	-0.18%	10.05%	34.51%	31.84%	36.71%	29.07%	85.59%	71.26%	46.58%
2014	0.76%	24.06%	$40,076	46.89%	$83,925	21.41%	-12.39%	-18.60%	15.73%	3.92%	24.09%	19.60%	126.30%	64.65%	170.51%
2015	0.73%	8.41%	$43,445	30.40%	$109,441	29.22%	-11.41%	15.35%	-4.78%	-4.08%	1.85%	9.09%	2.45%	36.24%	35.62%
2016	2.07%	19.11%	$51,746	20.31%	$131,673	9.59%	25.19%	11.11%	33.33%	15.91%	4.67%	10.95%	16.79%	11.97%	61.34%
2017	2.11%	16.71%	$60,391	23.06%	$162,033	70.22%	-3.98%	31.70%	35.67%	27.04%	13.19%	13.37%	32.40%	-15.90%	-29.87%
2018	1.91%	-13.85%	$52,026	1.46%	$164,403	29.10%	-22.54%	-10.05%	-14.98%	-28.49%	-21.82%	-9.65%	-28.20%	-15.55%	-32.89%
2019	2.29%	27.92%	$66,553	30.06%	$213,830	45.78%	23.57%	36.36%	46.16%	57.78%	21.41%	17.01%	17.72%	13.78%	12.85%
2020	1.36%	-3.19%	$64,431	13.54%	$242,785	51.64%	-1.19%	-1.25%	-11.62%	-19.64%	-41.66%	5.36%	-13.31%	-22.81%	-39.32%
2021	7.04%	18.01%	$76,036	13.97%	$276,697	13.38%	16.70%	9.19%	49.58%	1.00%	61.12%	13.97%	-8.09%	0.19%	3.79%

Assets

Portfolio Assets									
Performance statistics for portfolio components									
Ticker	Name	CAGR	Stdev	Best Year	Worst Year	Max Drawdown	Sharpe Ratio	Sortino Ratio	Market Correlation
ADBE	Adobe Systems Incorporated	15.23 %	34.00 %	72.76 %	-50.18 %	-67.06 %	0.55	0.83	0.63
IBM	International Business Machines Corporation	4.85 %	24.51 %	58.61 %	-35.47 %	-51.54 %	0.26	0.4	0.62
SAP	SAP SE	8.42 %	36.35 %	114.39 %	-38.69 %	-76.22 %	0.36	0.59	0.64
BAC	Bank of America Corporation	5.79 %	38.83 %	109.83 %	-63.14 %	-91.68 %	0.31	0.47	0.59
C	Citigroup Inc.	-7.54 %	41.93 %	57.78 %	-75.98 %	-97.02 %	0	0	0.69
WFC	Wells Fargo & Company	5.53 %	27.73 %	61.12 %	-41.66 %	-66.78 %	0.29	0.43	0.54
TRV	The Travelers Companies, Inc.	7.87 %	20.13 %	29.07 %	-20.04 %	-44.47 %	0.41	0.62	0.58
LUV	Southwest Airlines Company	3.59 %	31.45 %	126.30 %	-33.91 %	-73.35 %	0.23	0.34	0.52
ALK	Alaska Air Group, Inc.	10.27 %	37.39 %	71.26 %	-36.68 %	-69.12 %	0.42	0.64	0.47

HA	Hawaiian Holdings, Inc.	11.86 %	61.55 %	170.51 %	-49.00 %	-83.82 %	0.45	0.79	0.36

The above table explains the performance of companies according to their portfolio. Portfolio optimization helps companies manage their investment and determine their return according to their profitability. This will explain the sharper ratio, sortino ratio, and market correlation according to the performance level of companies.

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