

Application of Modern Portfolio Theory to NIFTY 50 Stocks

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Aim

The purpose of this project was to establish how the NIFTY 50 is composed, analyze its returns, create an efficient portfolio from the top 10 companies listed in the NIFTY 50 by implementing modern portfolio theory, quantify risk and reward by calculating Sortino's Ratio, Treynor's Ratio and plot the efficient frontier graph.

Introduction

One of the primary pursuits of many economic subjects is investing in financial markets. The present financial markets' characteristic liberalization, globalization, and information technology development were the main drivers of this activity. Even small retail investors, who typically lack the necessary expertise and experience, are now able to benefit from the direct purchase or sale of securities on the capital market thanks to the growth of information technology. Investors allocate their available cash to assets based on a variety of objectives and employ chosen investing techniques in an effort to maximize returns while minimizing the risk of losses. The Modern Portfolio Theory is one of the most commonly used methods for creating strategies and building portfolios.

Theory

Modern Portfolio Theory

It is a realistic strategy for choosing investments that will maximize the investors overall returns while maintaining a reasonable degree of risk. Using this mathematical framework, a portfolio of assets is created that maximizes expected return for the total amount of assumed risk. In the Journal of Finance(1952) in the paper titled "Portfolio Selection," American economist Harry Markowitz laid the groundwork for this idea. Later, he received the Nobel Prize for his contributions to contemporary portfolio theory.

NIFTY 50

The NIFTY 50 is a benchmark Indian stock market index that represents the weighted average of 50 of the largest Indian companies listed on the National Stock Exchange. It is one of the two main stock indices used in India, the other being the BSE SENSEX. The Indian economy's 13 sectors are covered by the NIFTY 50 index, which gives investment managers access to the Indian market through a single portfolio. Due to the growth of sectoral indices, including NIFTY Bank, NIFTY IT, NIFTY Pharma, NIFTY SERV SECTOR, NIFTY Next 50, etc., between 2008 and 2012, the NIFTY 50 index's market capitalization share of the NSE decreased from 65% to 29%. The NIFTY 50 Index assigns financial services a weightage of 39.47%, followed by energy 15.31%, 13.01% to IT, 12.38% to consumer goods, 6.11% to automobiles and 0% to the agricultural sector.

CAGR (Compounded annual growth rate)

It depicts the cumulative performance of a parameter over a significant period of time and is used to measure the relative profitability of businesses.

$$\text{CAGR} = \left[\frac{\text{End value}}{\text{Beginning value}} \right]^{[1/\text{years}]} - 1$$

Volatility

Volatility represents how large an asset's prices swing around the mean price - it is a statistical measure of its dispersion of returns.

$$\sigma_T = \sigma \sqrt{T}$$

σ_T = volatility over a time period

σ = standard deviation of returns

T = number of trading days

Volatility used as a proxy for risk assessment, volatile assets are often considered riskier than less volatile assets because the price is expected to be less predictable. For example, when the stock

market rises and falls more than one percent over a sustained period of time, it is called a "volatile" market.

Sharpe Ratio

It is used to help investors understand the return of an investment compared to its risk. Modern Portfolio Theory states that adding assets to a diversified portfolio that has low correlations can decrease portfolio risk without sacrificing return. A high Sharpe ratio is good when compared to similar portfolios or funds with lower returns. Adding diversification should increase the Sharpe ratio compared to similar portfolios with a lower level of diversification. The Sharpe ratio can also help explain whether a portfolio's excess returns are due to smart investment decisions or a result of too much risk.

$$\text{Sharpe Ratio} = \frac{(R_x - R_f)}{\text{StdDev}(R_x)}$$

Where :

R_x = Expected portfolio return

R_f = Risk free rate of return

StdDev R_x = Standard deviation on portfolio return / volatility

Sharpe Ratio Grading Thresholds:

- Less than 1: Bad
- 1 - 1.99: Adequate/good
- 2-2.99: Very good
- Greater than 3: Excellent

Data

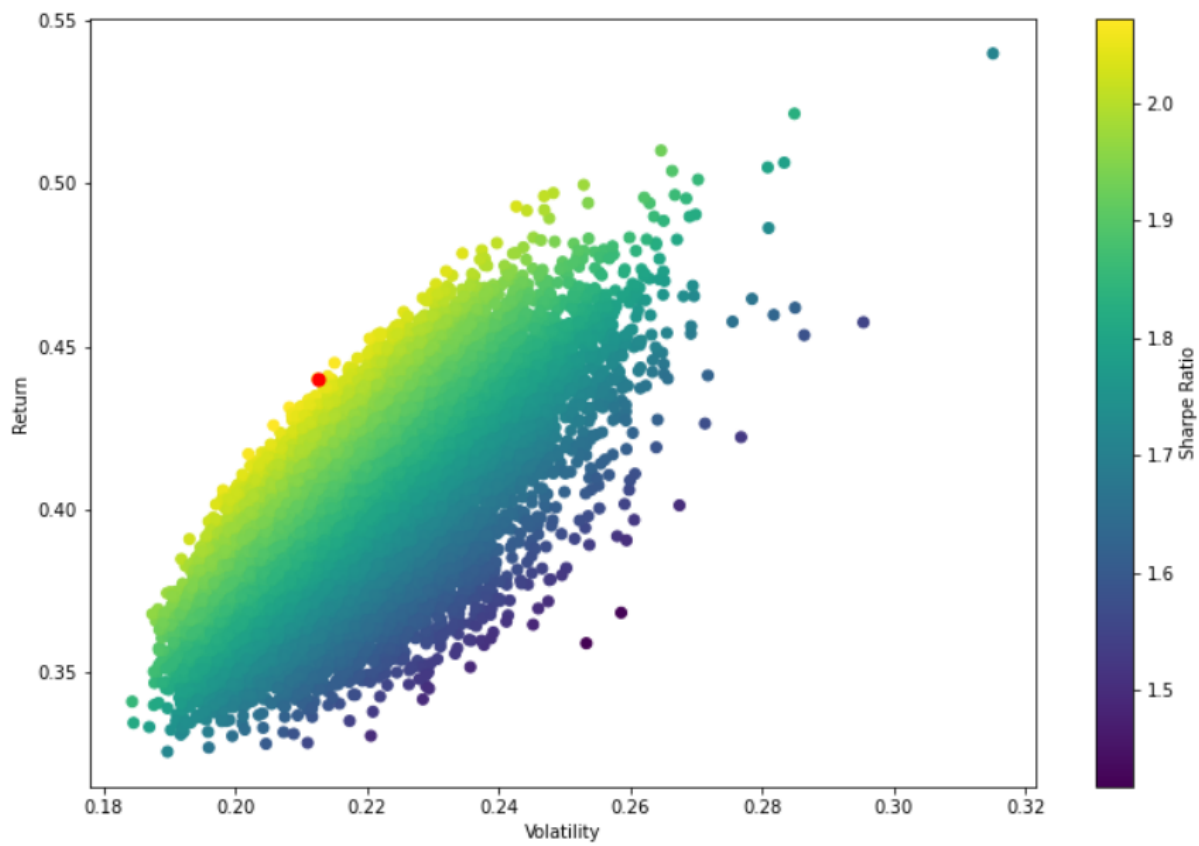
The data is taken from Yahoo! Finance, a media entity that is a part of the Yahoo! network. In addition to stock quotes, news articles, financial reports, and unique material, it offers financial news, data, and opinion. Additionally, it provides a few online tools for managing personal finances. A CSV file containing historical share price data is easily accessible. Stock Prices of all the NIFTY 50 stocks from 1st January, 2017 to 31st December, 2021 are combined into a dataframe. NIFTY 50 Index values for the same period are also obtained.

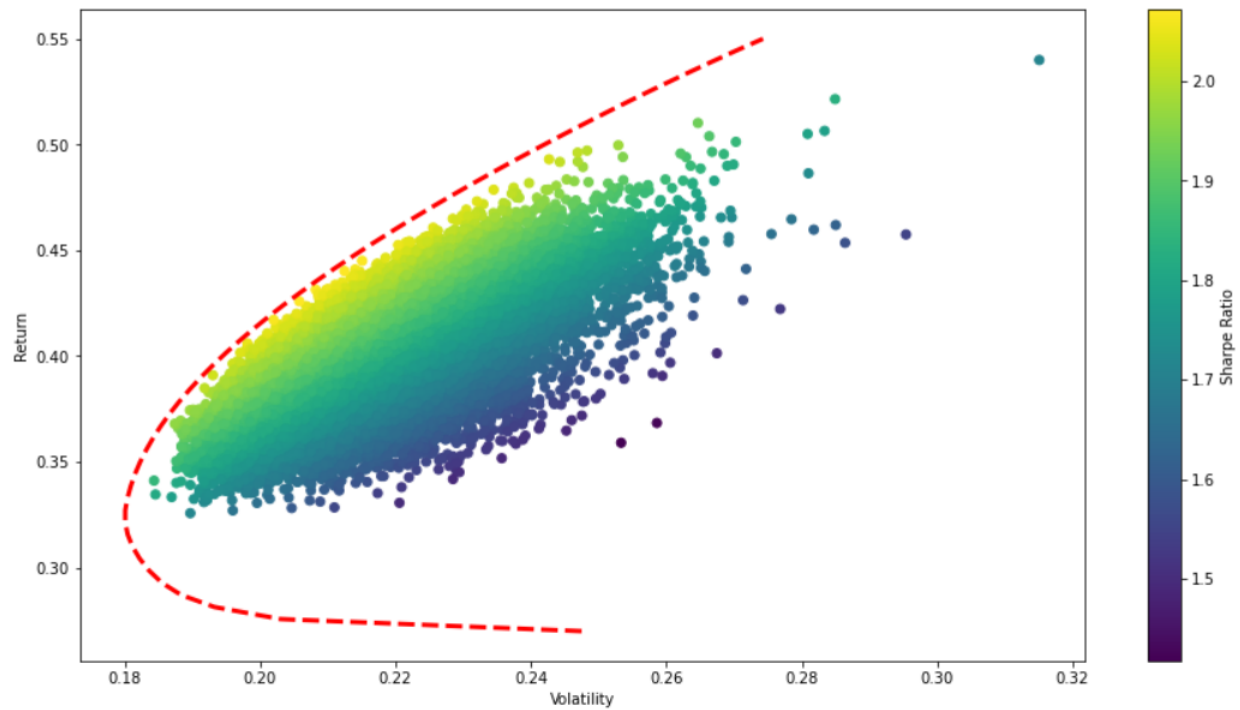
Method

The first step is to identify the top ten stocks among the NIFTY 50 companies. For this, the Sharpe ratio is calculated, and the stocks with the top 10 Sharpe ratios are listed. The risk free rate is taken to be 6%.

| Company | Sharpe Ratio |
|---------------|--------------|
| ADANIENT.NS | 1.971886 |
| LTI.NS | 1.554727 |
| TITAN.NS | 1.294358 |
| BAJFINANCE.NS | 1.128166 |
| TATACONSUM.NS | 1.092854 |
| DIVISLAB.NS | 1.076358 |
| WIPRO.NS | 0.964229 |
| BAJAJFINSV.NS | 0.947865 |
| ASIANPAINT.NS | 0.935453 |
| RELIANCE.NS | 0.908411 |

The next step is to find the log returns of these 10 stocks and then do a randomized simulation. The objective of the simulation is to determine the appropriate weights of the stocks to be held using historical data and to appropriately diversify our portfolio. Through randomized selection of weights and calculation of returns, volatility and the sharpe ratio a total of 600,000 scenarios are tried out. A scatter plot for Volatility vs Return is plotted, the best sharpe ratio of the optimal portfolio is obtained as 1.78(red point).





An efficient frontier can also be plotted.

Next, taking a total investment capital of Rs. 10,000,000 (ten million), the portfolio is calculated with the optimum weights obtained from the simulation. For calculation of number of shares, the closing prices on the last day the market was open in 2021 has been utilized.

| Name | No. of shares |
|---------------|----------------------|
| ADANIENT.NS | 993.368324 |
| LTI.NS | 256.951678 |
| TITAN.NS | 561.658687 |
| BAJFINANCE.NS | 78.065948 |
| TATACONSUM.NS | 53.679846 |
| DIVISLAB.NS | 340.717366 |
| WIPRO.NS | 2599.827129 |
| BAJAJFINSV.NS | 20.538367 |
| ASIANPAINT.NS | 226.084420 |
| RELIANCE.NS | 69.392980 |

The number of shares of each company to be purchased are obtained. Here short selling has not been considered. Now we compare the portfolio with the Nifty 50 index in terms of volatility, CAGR, Sharpe Ratio, etc. for the time period from 1st May, 2022 to 30th October, 2022.

Result

| Parameter | PORTFOLIO | NIFTY 50 |
|---|----------------------|----------------------|
| Volatility(in %) | 15.554003129514848 % | 11.448813910606127 % |
| Return Percentage | 5.431491542902385% | 4.2046809046729745 % |
| Sharpe Ratio | 0.1617764887134183 | 0.11262838085842854 |
| Alpha It depicts the absolute value at which the performance of a stock deviates from a benchmark index value. | 1.0698587935368877 % | — |
| Beta It is the measure of the risk calculation in comparison to benchmark , if the value >1 then portfolio is riskier than benchmark and vice versa. | 1.121718919168848 | — |
| Treynor Its a risk/return measure that allows investors to adjust a portfolio's returns for systematic risk.A higher Treynor ratio result means a portfolio is a more suitable investment. | 2.2432286455459765 | — |
| Sortino Ratio It is used to evaluate an investment's return for a given level of bad risk | 0.33601826933676493 | 0.1687629966634262 |

Conclusion

From the different parameters it can be observed that the optimal portfolio that we obtained is much more volatile and riskier($\beta > 1$) than the benchmark(Nifty 50 index). This is expected since the optimal portfolio that we had obtained by implementing Modern Portfolio Theory was backtested for the time period from 1st May, 2022 to 30th October, 2022. This time period has been a really volatile period for the financial markets and the markets have been moving sideways. The results that we had obtained are in accordance with the theory.

References

<https://openresearch-repository.anu.edu.au/bitstream/1885/203403/2/Customizing%20Modern%20Portfolio.pdf>

<https://digitalcommons.murraystate.edu/cgi/viewcontent.cgi?article=1101&context=honorstheses>

<https://academicjournals.org/journal/JAT/article-full-text-pdf/2EDF5C31124>

<https://core.ac.uk/download/pdf/39667232.pdf>

<https://www.investopedia.com/terms/m/modernportfoliotheory.asp>

https://en.wikipedia.org/wiki/NIFTY_50