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Construction of Optimal Portfolio Using Sharpe Single Index Model on Nifty Fifty Stocks

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Abstract: The main goal of this comprehensive project is to construct an effective portfolio using stocks from the esteemed Nifty 50 index, which includes the top 50 companies on the National Stock Exchange (NSE) of India. By applying the Sharpe Single Index Model, the project thoroughly evaluates the performance of each Nifty 50 stock. The project conducts a thorough analysis to calculate key metrics, including the Treynor ratio, Sharpe ratio, Jensen's ratio, and C value, for all the selected stocks. These metrics provide crucial insights into each stock's risk-return profile, helping investors make informed decisions when diversifying their investments. Using this study, investors can refine their strategies to lower risk and boost returns. This allows them to build portfolios that fit their financial goals and risk tolerance, thus improving their investment effectiveness. Additionally, the project serves as a practical guide to portfolio managers, offering actionable insights for navigating the complexities of the stock market. By gaining a deep understanding of portfolio construction and risk management, investors can refine their portfolios to achieve long-term financial success. Ultimately, the project seeks to provide investors with the knowledge and tools needed to effectively navigate the dynamic Indian stock market. Through in-depth analysis of Nifty 50 stocks and the application of advanced statistical methods, investors can better achieve their financial goals and succeed in the ever-changing market landscape.

Key Words: Optimal portfolio, Sharpe Single Index Model, Risk-return profiles, Treynor ratio, Sharpe ratio, Portfolio construction

1. Introduction

Efficient portfolio construction is a systematic process that integrates modern financial theories and advanced statistical techniques to manage risk and optimize returns. A fundamental approach to portfolio management is the simple index model, which assesses stocks relative to a broader market index, such as the S&P 500 or Nifty 50. This model aims to balance risk and return by analyzing each stock's performance, considering its correlation with the market index and unique risk attributes (Reilly & Brown, 2021). To build an efficient portfolio using the simple index model, historical data on stock performance and the overall market index is gathered. Statistical analysis is conducted to calculate key metrics like beta, which measures a stock's sensitivity to market movements, as well as other risk indicators such as standard deviation or volatility (Bodie, Kane, & Marcus, 2020). These metrics help investors assess the risk levels of individual stocks compared to the broader market, facilitating informed investment decisions. Furthermore, the analysis of correlations between stocks and the market index is crucial, as selecting stocks with low correlations can enhance diversification, thereby reducing overall portfolio risk while still aiming for returns (Fabozzi, Gupta, & Markowitz, 2021).

The portfolio construction process involves selecting a mix of stocks with varying risk profiles to achieve a desired balance of risk and return. By adhering to this structured approach, investors can make data-driven decisions regarding portfolio allocation, effectively managing market risks (Ang, 2014). Diversification across a range of financial assets—such as stocks, bonds, and mutual funds—is a key component of portfolio management, as it helps in optimizing returns while managing risks effectively (Pástor & Stambaugh, 2020). Diversified portfolios can mitigate the effects of market volatility, promoting long-term wealth accumulation. Moreover, they enable investors to align their strategies with specific financial goals, risk tolerance, and investment horizons (Pedersen, 2022). In essence, constructing an efficient portfolio using the simple index model involves combining financial theories with statistical techniques. By assessing the risk-return profiles of individual stocks and their correlations with the broader market, investors can create portfolios that optimize returns while managing risk. This approach relies heavily on quantitative analysis and risk management strategies to meet long-term financial objectives (Bali, Engle, & Murray, 2016). However, investors often face challenges when selecting and allocating funds across various securities, especially when lacking adequate market performance information. Many mistakenly focus solely on returns as a measure of success, overlooking the crucial aspect of risks involved, which can lead to flawed investment decisions (Damodaran, 2022).

This study evaluates the risk and return of Nifty stocks to construct an optimum portfolio using the Sharpe Index Model. Portfolio performance is analyzed using Sharpe, Treynor, and Jensen's indices to provide a comprehensive assessment of efficiency. The key findings will highlight the portfolio's effectiveness, top-performing stocks, and areas for improvement. Based on these insights, recommendations will be made to refine future portfolio management strategies, aiming for improved risk-adjusted returns for investors. The study relies on secondary data over a five-year period and employs technical analysis techniques for evaluating Nifty stocks and constructing an optimal portfolio.

2. Literature review

Chintan A. Shah's study (2015) in the International Journal of Research and Analytical Reviews compared Sharpe Index Model and CAPM for BSE Top 15 securities, favouring Sharpe's accuracy in portfolio construction. Frida Pacho's (2014) study in the Research Journal of Finance and Accounting affirmed CAPM's enduring utility for investment management, evaluating project profitability based on Standard Deviation, Expected Return, and Residual Variance. Dr. N Krishnamoorthy and Mahabub Basha S (2022) used the Sharpe single index model to construct an optimal portfolio with BSE Sensex 30 stocks, identifying nine stocks, with Dr. Reddy's Labs having the highest allocation.

Tanuj Nandan and Nivedita Srivastava (2017) the Sharpe Single Index Model construct an optimal portfolio comprising Nifty stocks, with a focus on 24 selections primarily from the banking sector, aiming to maximize risk-adjusted returns. Nenavath Sreenu (2018) examined CAPM and the three-factor model of Fama in the Indian stock exchange, noting a positive relationship between beta and average yearly returns, as well as a size-to-returns relationship. Variables considered were Standard Deviation, Expected Return, and Residual Variance. M. Sathyapriya's (2016) study, the Sharpe Index Model was employed to construct optimal portfolios comparing the performance of 20 companies from infrastructure and pharmaceutical sectors. Results showed the pharmaceutical sector outperformed infrastructure by 80%. Dr. S. Poornima and Aruna P. Remesh employed Sharpe's Single Index Model to construct optimal portfolios with selected NSE stocks. They categorized sectors based on risk and return and analyzed various metrics.

Imroz Mahmud's (2019) study, Sharpe's Single Index Model was used on the Dhaka Stock Exchange to create an optimal portfolio. The model surpassed individual stocks and market indices, providing efficient risk-return combinations. Bal Krishna Khadka and Dr. Umesh Rajopadhyaya (2023) conducted an empirical study on optimal portfolio construction using the Single Index Model at the Nepal Stock Exchange. Their analysis emphasized optimal sector allocation, assessing risk with Sharpe Ratio, return, and standard deviation. Dr. B.G. Satyaprasad and Prof. Anusha P.H. (2018) employed Sharpe's Single Index Model to construct optimal portfolios of FMCG and pharmaceutical sector stocks, selecting five companies from a sample of twenty-four. They emphasized continuous portfolio monitoring and updating.

Verma and Hirpara (2016) evaluated portfolio performance employing Sharpe, Jensen, and Treynor methods. Their analysis unveiled that securities surpassed market returns, with positive Treynor measure results. This suggests that the selected securities not only yielded higher returns but also exhibited positive risk-adjusted performance relative to the market benchmark. Ramanathan and Jahnavi (2014) explored optimal equity portfolio construction in India's banking and IT sectors (2009-2013) using the Sharpe Index Model. PVR showed high risk and returns, contrasting with Dish TV's lower returns. They emphasized the media and entertainment industry's growth potential. Rout and Panda (2020) examined Sharpe Single Index Model for constructing optimal portfolios, focusing on top 25 Sensex stocks by market cap from Jan 2009 to Dec 2019. Emphasized securities with excess return to beta ratio exceeding set threshold for robust investment strategy. Natarajan (2012) explore optimal portfolio construction with Nifty stocks using Sharpe's Single Index Model, analyzing April 2006 - December 2011 data. They identify four stocks for an optimal portfolio.

Sandhar, Jain, and Kushwah (2018) explore optimal portfolio construction via the Sharpe Single Index Model, analyzing NSE-listed companies and Nifty index data. They recommend revising portfolios excluding certain stocks. Bhatt's (2016) study, published in an International Multidisciplinary Peer-Reviewed E-Journal, focuses on optimal portfolio construction using the Sharpe Single Index Model with Nifty50, emphasizing risk, return, and beta analysis. Debabrata Chattopadhyay, Sibnath Banerjee, and Sanjeev Kumar Srivastaw (2022) The Asia-Pacific Journal of Management and Technology compared Nifty 50 portfolio methods, favoring beta diversification for risk minimization with fewer stocks. Sarvamangala K J and G Sudarsana Reddy's (2022) research on optimal portfolio construction using Sharpe's Single Index Model, published in IRJEdT, identifies six company stocks for an optimal portfolio of 15, with varied proportions of investment allocated each. The study focuses on mean, beta, variance, and return. Dong (2021) examines portfolio construction of ten stocks using Markowitz and Index models with constraints, at International Conference World Economy and Project Management, emphasizing superior portfolios under specific constraints analyzing returns, standard deviation, and Sharpe ratio.

3. Research methodology

This thorough descriptive study carefully analyses available data to create a well-balanced investment portfolio, employing precise calculations and statistical evaluation. By quantifying projected returns and taking into account past performance, market patterns, and economic signals, it offers valuable information that assists investors in making knowledgeable investment choices that are in line with their financial goals. The sample size of the study is 50 companies listed in the NSE. The data taken for the research is secondary in nature. The data has been collected from the official website of National Stock Exchange (NSE). The period of the study is for 5 years from January 2019 to December 2023.

3.1 Tools used

When determining the best portfolio and evaluating its performance, several analytical tools are essential. Risk and Return analysis is fundamental, as it examines the trade-off between the potential reward of an investment and its associated risk. Beta is used to measure a portfolio's volatility relative to the market, indicating its sensitivity to market movements. Variance and Standard Deviation quantify the dispersion of returns, providing a measure of the portfolio's overall risk. The Single Sharpe Index Model is utilized to evaluate the risk-adjusted return, while the Sharpe Performance Ratio refines this assessment by considering the excess return per unit of total risk. The Treynor Performance Ratio focuses on the excess return per unit of market risk, using beta as the risk measure. Lastly, Jensen's Performance Ratio assesses the portfolio's actual return compared to its expected return based on the Capital Asset Pricing Model identifying any abnormal performance. By employing these tools, investors can comprehensively assess which portfolio offers the best balance of risk and return, thereby identifying the optimal investment choice.

4. Analysis and interpretation

In an effort to construct an efficient portfolio using stocks from India's Nifty 50 index, I analysed all 50 companies and created an optimized portfolio. This analysis involved calculating the mean

return and beta values for each stock, which are essential metrics for evaluating performance and risk.

4.1 Mean return

The average mean return, denoted as R_i, for a stock is calculated using the formula:

$$Ri = \frac{Pt-Po}{Po} * 100 \quad (1)$$

Where P_t is the closing price at time and P_o is the opening price.

From the analysis of the 50 companies, Adani Enterprises had the highest mean return at 0.294319%. The average return across all 50 companies was 0.091181%.

4.2 Beta

Calculated the beta values for these stocks, which measure a stock's volatility relative to the market. The beta value is determined using the SLOPE function in excel analysis:

$$\text{Beta} = SLOPE(Known\ y's, Known\ x's) \quad (2)$$

Analyse the 50 companies Adani Enterprises had a beta of 0.76643, indicating high volatility. Bharat Petroleum Corporation Ltd stock is less risky and the return is also less. The average beta for these companies was 0.3822, indicating that, collectively, they are less risky than the market.

4.3 Excess return to beta

To evaluate the stocks based on their risk-return profile, calculated the excess return to beta ratio. This ratio is calculated as:

$$\text{Excess Return to Beta Ratio} = \frac{Ri-Rf}{\beta} \quad (3)$$

Where R_i is the mean return, R_f is the risk-free rate (assumed constant), and β is the market risk.

Analyse the 50 companies Adani Enterprises had the highest return to beta ratio at 0.2897. Adani Enterprises exhibited the highest return to beta ratio, indicating a favorable risk-return balance. Bharat Petroleum Corporation's stock had the lowest ratio, indicating a less favourable balance of risk and return. Stock selection for the optimal portfolio hinges on including stocks with the highest ratios while excluding those with the lowest, ensuring a balanced and efficient portfolio.

4.4 Cut – off point and proportion of the investment

The cut-off point in investment refers to a threshold or benchmark that determines whether a particular investment is acceptable or not. It can be based on various financial metrics, such as the minimum required rate of return, a specific net present value (NPV), or a payback period. Investors use this criterion to filter out projects or opportunities that do not meet their financial objectives.

$$Ci = \frac{\sigma^2 m * \frac{\varepsilon(Ri - Rf)\beta}{\sigma^2 ei}}{1 + \sigma^2 m * \varepsilon\beta^2 / \sigma^2 ei} \quad (4)$$

Table 1: Calculation of the C value

Securities Name	**Ci**
Adani Enterprises Ltd	0.0206
Apollo Hospitals Enterprise Ltd	0.0260
Tata Consumer Products Ltd	0.0348
LTIMindtree Ltd	0.0385
Titan Company Ltd	0.0450
Tata Motors Ltd	0.0512
Bharti Airtel Ltd	0.0546
HCL Technologies Ltd	0.0564
Sun Pharmaceuticals Industries Ltd	0.0578
Tata Steel Ltd	0.0590
Hindalco Industries Ltd	0.0602
Divis Laboratories Ltd	0.0607
Cipla Ltd	0.0609
JSW Steel Ltd	0.0618
Bajaj Finance Ltd	0.0622
UltraTech Cement Ltd	0.0624
Grasim Industries Ltd	0.06251
Bajaj Auto Ltd	0.06254
ICICI Bank Ltd	0.06253
Asian Paints Ltd	0.06251
NTPC Ltd	0.06249
Bajaj Finserv Ltd	0.0623
Adani Parts & Special Economic Zone Ltd	0.0595
SBI Life Insurance Company Ltd	0.0592
Shriram Finance Ltd	0.0590
Dr Reddys Laboratories Ltd	0.0590
Larsen & Toubro Ltd	0.0584
Infosys Ltd	0.0579
Mahindra & Mahindra Ltd	0.0574
Power Grid Corporation of India Ltd	0.0574
State Bank of India	0.0550
Reliance Industries Ltd	0.0312
Nestle India Ltd	0.0308
Axis Bank Ltd	0.0307
Eicher Motors Ltd	0.0305
Wipro Ltd	0.0304
Tech Mahindra Ltd	0.0302
Tata Consultancy Services Ltd	0.0301

Securities Name	Ci
HDFC Life Insurance Company Ltd	0.0298
Indusind Bank Ltd.	0.0294
HDFC Bank Ltd	0.0286
Kotak Mahindra Bank Ltd	0.0280
Coal India Ltd	0.0279
Britannia Industries Ltd	0.0277
Maruti Suzuki India Ltd	0.0274
Oil & Natural Gas Corpn Ltd	0.0273
Hero MotoCorp Ltd	0.0270
ITC Ltd	0.0269
Hindustan Unilever Ltd	0.0265
Bharat Petroleum Corporation Ltd	0.0265

In Table 1, the Bajaj Auto stock stands out with the highest C value of 0.062539, setting the cut-off rate for portfolio inclusion. Securities listed before this threshold will be considered for the optimal portfolio, including Adani Enterprises, Apollo Hospitals Enterprise, Tata Consumer Products, LTI Mindtree, Titan Company, Tata Motors, Bharti Airtel, HCL Technologies, Sun Pharmaceuticals Industries, Tata Steel, Hindalco Industries, Divis Laboratories, Cipla, JSW Steel, Bajaj Finance, UltraTech Cement, Grasim Industries, and Bajaj Auto. Determining the proportion of optimal investment for each stock is necessary.

4.5 Proportion of the investment

The study identified eighteen stocks for an optimal portfolio form Table 2, assigning specific investment proportions using the formula 5.

$$Xi = \frac{Zi}{\varepsilon Zi} \qquad Zi = \frac{\beta i}{\sigma ei2}\ [Ri\ - \frac{Rf}{\beta i} - C] \qquad (5)$$

Table 2 Proportion of investment on selected stocks

Securities Name	Zi	Xi
Adani Enterprises	19.478	15.40%
Tata Motors	15.707	12.42%
Tata Consumer Products	19.690	15.57%
Apollo Hospitals Enterprise	10.505	8.31%
LTIMindtree	13.319	10.53%
Titan Company	8.681	6.86%
Bharti Airtel	10.303	8.15%
Hindalco Industries	7.245	5.73%
JSW Steel	5.668	4.48%
Tata Steel	4.179	3.30%
Bajaj Finance	2.885	2.28%
HCL Technologies	2.764	2.19%

Securities Name	Zi	Xi
Sun Pharmaceuticals Industries	1.444	1.14%
Grasim Industries	2.329	1.84%
Divis Laboratories	0.919	0.73%
UltraTech Cement	0.818	0.65%
Bajaj Auto	0.529	0.42%
Total return on portfolio	126.463	1

Adani Enterprises receives the highest allocation at 15.38%, reflecting its strong potential for returns. Other significant investments include Apollo Hospitals Enterprise (12.40%), Tata Consumer Products (15.55%), LTI Mindtree (8.29%), Titan Company (10.52%), Tata Motors (6.85%), Bharti Airtel (8.13%), HCL Technologies (5.72%), Sun Pharmaceuticals Industries (4.47%), Tata Steel (3.30%), Hindalco Industries (2.28%), Divis Laboratories (2.18%), Cipla (1.14%), JSW Steel (1.84%), Bajaj Finance (0.73%), UltraTech Cement (0.65%), Grasim Industries (0.42%), and Bajaj Auto (0.16%).

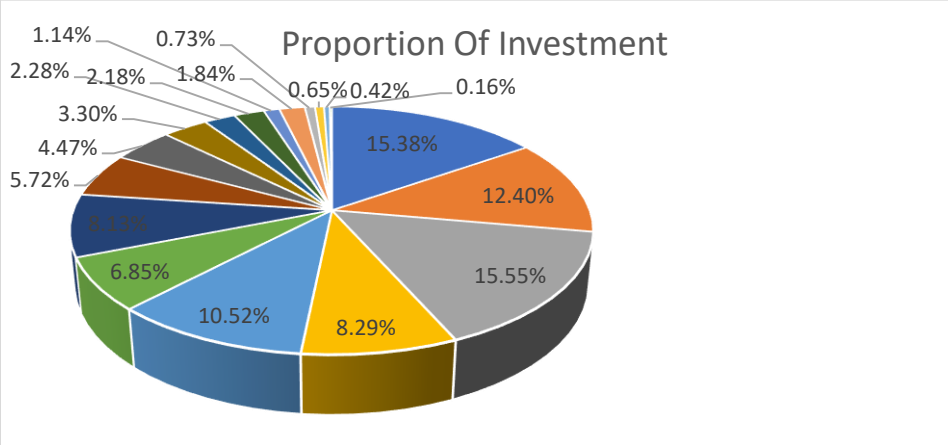

Figure 1Proportion of investment on selected stocks

Table 3 Return on portfolio

Securities	Stock return in %	Proportion	Return on portfolio %
Adani Enterprises	0.29432	15.38%	4.53%
Apollo Hospitals Enterprise	0.14631	12.40%	1.81%
Tata Consumer Products	0.14769	15.55%	2.30%
LTIMindtree	0.12899	8.29%	1.07%
Titan Company	0.12910	10.52%	1.36%
Tata Motors	0.16649	6.85%	1.14%
Bharti Airtel	0.12052	8.13%	0.98%
HCL Technologies	0.10539	5.72%	0.60%
Sun Pharmaceuticals Industries	0.10185	4.47%	0.46%
Tata Steel	0.11093	3.30%	0.37%
Hindalco Industries	0.11519	2.28%	0.26%
Divis Laboratories	0.09614	2.18%	0.21%

Securities	Stock return in %	Proportion	Return on portfolio %
Cipla	0.08478	1.14%	0.10%
JSW Steel	0.11388	1.84%	0.21%
Bajaj Finance	0.11284	0.73%	0.08%
UltraTech Cement	0.09429	0.65%	0.06%
Grasim Industries	0.09679	0.42%	0.04%
Bajaj Auto	0.08800	0.16%	0.01%
Total return on portfolio	2.25349	100.00%	

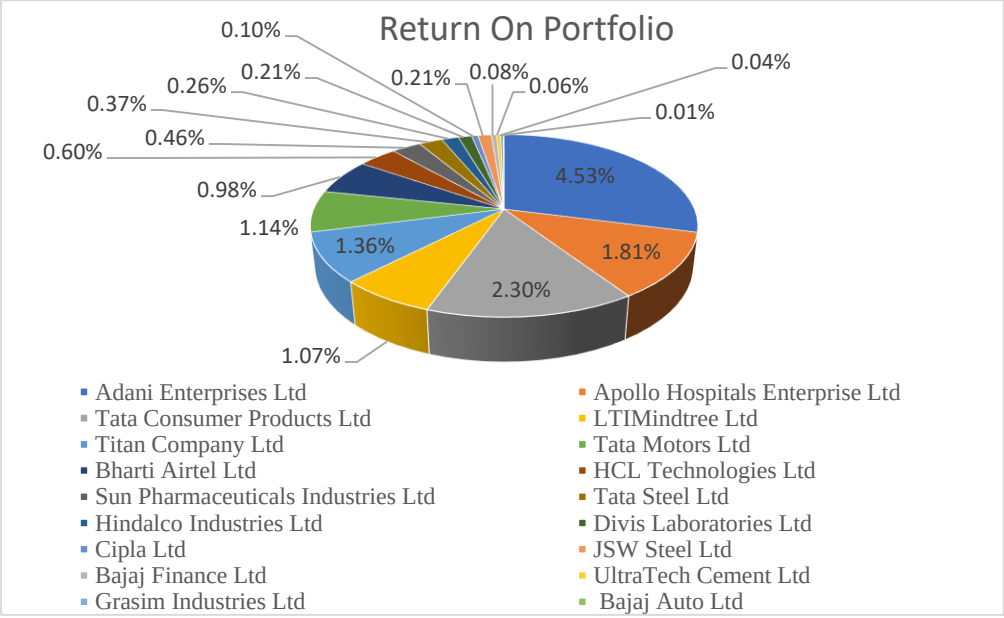

Figure 2 Return on portfolio

Table 3 summarizes portfolio and individual security returns, calculated based on investment proportions. The highest portfolio return, at 0.0453%, is attributed to Adani Enterprises Ltd, while the lowest, at 0.00014%, is from Bajaj Auto Ltd. Sharpe's Single Index Model aids investors and fund managers in selecting securities for optimal diversification benefits.

Table 4 Treynor Ratio, Jenson's Ratio, Sharpe Ratio

Company	TR	Rank	JR	Rank	SR	Rank
Adani Enterprises	0.290	1	0.215	1	1.922	1
Apollo Hospitals Enterprise	0.274	2	0.088	2	1.637	2
Tata Consumer Products	0.213	3	0.072	3	1.619	3
LTIMindtree	0.191	4	0.072	4	1.419	4
Titan Company	0.141	5	0.054	5	1.294	5
Tata Motors	0.140	6	0.053	6	1.086	6
Bharti Airtel	0.139	7	0.045	7	1.053	7
HCL Technologies	0.120	8	0.039	8	1.034	8
Sun Pharmaceuticals Industries	0.110	9	0.037	9	0.913	9
Tata Steel	0.110	10	0.035	10	0.724	10

Company	TR	Rank	JR	Rank	SR	Rank
Hindalco Industries	0.091	11	0.035	11	0.666	11
Divis Laboratories	0.089	12	0.031	12	0.659	12
Cipla	0.086	13	0.027	13	0.651	13
JSW Steel	0.080	14	0.021	15	0.649	14
Bajaj Finance	0.069	15	0.021	14	0.627	15
UltraTech Cement	0.069	16	0.019	16	0.593	16
Grasim Industries	0.067	17	0.013	17	0.544	17
Bajaj Auto	0.064	18	0.011	18	0.380	18

From the table 4, Adani Enterprises Ltd notably leads among 18 analyzed stocks with the highest ratio at 0.290%, indicating potentially superior returns relative to market risk. Bajaj Auto has the lowest ratio at 0.064%, suggesting lower returns compared to market risk. Jensen's ratio, reflecting a stock's performance relative to the market, signifies excess returns after considering risk. Adani Enterprises Ltd boasts a Jensen's Ratio of 0.215, outperforming 18 other stocks, suggesting potential for superior returns. Cipla Ltd exhibits the lowest ratio at 0.011, indicating weaker returns against market risk. Stocks with higher Sharpe ratios generally offer better risk-adjusted performance. Among 18 examined stocks, Tata Consumer Products Ltd notably stands out with a Sharpe ratio of 1.922, surpassing competitors in returns relative to risk. Cipla has the lowest Sharpe ratio at 0.380.

5. Findings & suggestions

Among the 50 different stocks Adani Enterprises Ltd stock has the highest monthly return of 0.294319% and the Hero MotoCorp Ltd stock has the lowest return of 0.042015%. Reliance Industries Ltd has the highest beta value of 1.0867755 indicating the stock is highly volatile. It is found that out of 50 stocks considered for the study, only 18 stocks are occupied in the optimal portfolio. Only 18 stocks have a ratio of excess return to beta with Ci greater than a C = 0.0625. The top 18 stocks, ranked from 1 to 18, are chosen for the best portfolio. The higher return on Portfolio is from the Adani Enterprises Ltd ie. 0.0453% and the lowest is Bajaj Auto Ltd ie. 0.00014%. If an investor invest in the 18 stocks portfolio, his/her total daily expected portfolio return is 0.1558%. Among the 18 stocks, Adani Enterprises Ltd stands out with the highest Treynor Ratio which is 0.290%, it indicating it potentially offers better returns. Adani Enterprises Ltd has a Jensen's Ratio of 0.215, which is higher than the other 18 stocks. So, the company can able to generate better returns. Tata Consumer Products Ltd stands out due to its exceptional performance at 1.922. It shows that the higher Sharpe ratio is a sign of superior risk-adjusted returns.

Investors often face challenges in creating optimal portfolios. This study aimed to construct an efficient portfolio using Sharpe's single index model, evaluating performance with the Sharpe, Treynor, and Jensen ratios. From the Nifty 50, only 18 securities were suitable for the final portfolio, highlighting the importance of thorough analysis. Broader economic and macroeconomic conditions significantly influence these securities' market behavior, making comprehensive understanding essential for building robust portfolios. This approach ensures informed, strategic investment decisions and better alignment with financial objectives and market dynamics.

6. Conclusion

Investors, whether individuals or institutions, often face challenges in creating optimal portfolios. This study aimed to construct an efficient portfolio using Sharpe's single index model. Performance of selected securities was evaluated using the Sharpe ratio, Treynor ratio, and Jensen's ratio. Out of the wide range of Nifty 50 options, only 18 securities were suitable for the final portfolio, underscoring the importance of thorough analysis in investment decisions. Broader economic and macroeconomic conditions significantly influence these securities' market behaviour, making comprehensive understanding of these factors essential for building a robust investment portfolio and achieving informed, strategic investment outcomes.

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