International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Optimizing Portfolio Allocation in the Indian Defense Sector: A Python-Based Approach

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ABSTRACT

This paper presents a detailed analysis of portfolio construction strategies aimed at maximizing risk-adjusted returns for investors, utilizing Python-based methodologies. By leveraging historical data on stock returns and risks, a meticulous selection process identified 5 stocks with superior risk-return profiles, outperforming the dataset's average measures with higher returns and lower risks. The selected stocks from the defense industry formed the foundation of an optimal portfolio designed to minimize sector-specific risks while maximizing growth potential.

Through rigorous portfolio optimization techniques, including Markowitz's mean-variance optimization, an optimal portfolio allocation was identified with a return of 62.40% and volatility of 27.74%. Insights from the study provide valuable perspectives for investors seeking realistic and sustainable wealth accumulation strategies. The research also highlights future avenues for exploration, such as integrating alternative asset classes, incorporating behavioral finance insights, and leveraging advancements in risk management technologies. This study contributes to advancing portfolio theory and offers practical guidance for investment decision-making.This study demonstrates the effectiveness of Python in financial analysis and portfolio optimization while furthering the theory of portfolios and providing valuable guidance for making investment decisions.

Keywords*: Returns, Risk, Volatility, Optimal Portfolio Construction, Defense Sector, Markowitz Portfolio Theory,*

Introduction:

The Indian defense sector is undergoing a significant transformation, driven by a number of initiatives aimed at promoting indigenous defense and reducing reliance on imports.

The Department of Defense has been actively driving the Make in India initiative, resulting in notable accomplishments and ambitious goals. On February 1, 2024, the Finance Minister presented the Interim Budget, allocating INR621,540 crores to the Ministry of Defense, the highest among all ministries and accounting for approximately 13% of total budget. India's defense exports in 2021-22 totaled a record INR 14,000 crores as of December 2022.

Furthermore, the defense budget for 2022-2023 stated that 68% of the defense capital procurement budget would be allocated to domestic industry. The Indian government has set a USD 25 billion defense production target for 2025 (including USD 5 billion in exports by 2025).The Ministry of Defense has set a target of INR 1.75 lakh crore for aerospace and defense by 2025, including INR 35,000 crore in exports.

The Indian defense sector, as the country's second largest armed force, has long been identified as a priority for the 'Aatmanirbhar Bharat' or Self-Reliant India initiative, with a strong emphasis on the establishment of indigenous defense infrastructure supported by a necessary research and development ecosystem. The recent budget allocation is a significant step toward achieving the government's goal of a self-sufficient defense sector.

A key component of investment management is portfolio creation, in which investors try to put together a group of stocks that together accomplish their intended financial objectives while skillfully controlling risk. In order to improve portfolio performance, the process entails strategically allocating assets, taking the risk-return trade-off into account, and applying diversification principles. Harry Markowitz developed modern portfolio theory (MPT), which serves as the theoretical foundation for portfolio creation and highlights the significance of diversification in maximizing returns for a particular degree of risk. Python is a great tool for creating and managing investment portfolios because of its extensive libraries for data analysis and optimization.

Statement of the Research Problem:

Limited Knowledge and Expertise: A lot of investors are not well-versed in assessing defense industry equities and comprehending how they affect portfolio management.

Difficulties in Risk Management and Volatility: For investors in the military industry, market instability, geopolitical unrest, and regulatory changes present serious obstacles. Therefore, effective risk management and portfolio diversification measures are required.

Adoption of Data-Driven Approaches: It's possible that traditional investing approaches fall short in capturing the special dynamics of defense stocks or in revealing new trends and opportunities

Complexity of Defense Sector Dynamics: There are several different industries within the Indian military sector, such as land-based, naval, and aerospace defense systems, each with unique complexities and market dynamics. Investors must comprehend these industries' nuances

Review of Literature:

A study by Krishnaprabha and Vijayakumar (2015) examined the risk and return analysis of a few Indian stocks, particularly those in the banking and automotive industries. They stressed how crucial risk and return analysis is in directing people's personal decision-making processes.

Dr. Laxman Kumar Behera's book "Indian Defence Industry: An Agenda for Making in India" provides a comprehensive analysis of the country's defense sector and policy. It includes subjects like the role of the Defense Research and Development Organization (DRDO), public sector initiatives, defense industrialization, and private sector participation. The author's observations influence policy choices and promote independence in the defense industrial sector. The authors examine the correlation between equity share risk and return, emphasizing the necessity of conducting regular portfolio assessments grounded in investor risk-return standards.

Ten pharmaceutical businesses listed on the NSE were chosen, and their risk-return characteristics were examined by Dr. M. Muthu Gopalakrishnan and Amal Vijay A K (2017). They looked at data from 2012 to 2015 using methods including mean, beta, standard deviation, alpha, correlation, and covariance. Their findings emphasized how crucial it is for investors looking for high returns to take risk and return considerations into account.

Wang and Aste present a unique use of the Inverse Covariance Clustering (ICC) technique for dynamic portfolio optimization. They outperform conventional approaches by incorporating market conditions found through ICC into the portfolio optimization procedure.

Zhang uses Python to carry out an extensive empirical investigation of financial data analysis and portfolio optimization. Zhang uses Python-based approaches to select six equities from the Chinese stock market that make up the FTSE A50, and then creates optimal portfolios with the maximum Sharpe ratio and the shortest variance. The performance of various portfolios is compared and examined in the study, offering valuable insights into efficient portfolio creation techniques.

Wing Commander Swaim Prakash Singh's research paper "Exploring Multi-dimensional Trends for the Indian Air Force" explores important multi-dimensional trends in air power. It looks at how these developments affect the capabilities and defense strategy of the Indian Air Force.

Research Objectives:

1. To Analyze Historical Risk and Return Profiles and To Construct Efficient Portfolios.
2. To Identify Optimal Portfolio Allocations using Python.

Data Analysis:

Historical Returns Analysis: To comprehend the performance dynamics over a certain time period, historical returns of defense sector companies from the Nifty India Defense Index were examined. Calculating the daily, monthly, and annual returns of individual companies as well as the index itself was part of this investigation.

Risk Measures Calculation: To assess the degree of risk connected to specific stocks and the portfolio as a whole, risk measures like beta, Sharpe ratio, and standard deviation (volatility) were computed. The risk-adjusted returns of stocks and portfolios were assessed with the use of the Sharpe ratio.

Correlation Analysis: The degree of a linear relationship between the returns of the various defense sector companies that are part of the index was investigated using correlation analysis. This study aided in portfolio diversification and risk management by pointing out equities that move in unison and those that show diverging price fluctuations.

Efficient Frontier Construction: To determine the best portfolios that deliver the highest projected returns for a given level of risk or the lowest risk for a specified level of return, the efficient frontier was built using the principles of Modern Portfolio Theory (MPT). This involved calculating the expected returns and standard deviations of each portfolio and simulating alternative combinations of portfolios by assigning weights to individual stocks. The most efficient allocations were represented by portfolios that lay on the efficient frontier, which visually represented the trade-off between risk and return.

Hypotheses Testing and Methods:

- Null Hypothesis (H0): There is no significant difference in the mean returns of the selected defense sector stocks over the past five years.
- Alternative Hypothesis (H1): There is a significant difference in the mean returns of the selected defense sector stocks over the past five years.

This study applies Analysis of Variance (ANOVA) to investigate potential differences in the mean returns of selected defense sector stocks over a five-year period.

Five defense sector stocks were included in the analysis: ASTRAMICRO.NS, BDL.NS, BEL.NS, COCHINSHIP.NS, and HAL.NS. Returns data for each stock over the specified time frame were collected and subjected to ANOVA, a statistical method used to compare means across multiple groups simultaneously

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
ASTRAMICRO.NS	48	2.726731385	0.056806904	0.030976848
BDL.NS	48	2.331543457	0.048573822	0.02095357
BEL.NS	48	2.035797922	0.042412457	0.009034248
COCHINSHIP.NS	48	1.755952437	0.036582342	0.016019821
HAL.NS	48	2.529313517	0.052694032	0.01345446

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.012469959	4	0.00311749	0.172353272	0.952394247	2.410057813
Within Groups	4.250630469	235	0.018087789			
Total	4.263100427	239				

Fig: 1 Anova

Source: Excel output.

The associated p-value (0.952394247) is much higher than the typical significance level of 0.05. Therefore, we fail to reject the null hypothesis. This suggests that there is no significant difference in the mean returns of the selected defense sector stocks over the past five years based on the F-test.

Research Outcome and Findings:

Combined table showing the Returns and Risk of the stocks.

Based on their returns, the stocks are sorted in descending order, with the stocks that give the highest returns mentioned first.

Stocks	**Returns**	**Risk**
DCXINDIA.NS	inf	NaN
ZENTEC.NS	136.659947	16.508749
MAZDOCK.NS	129.869732	19.490645
COCHINSHIP.NS	95.721814	15.570864
HAL.NS	81.433831	9.737294
ASTRAMICRO.NS	68.702761	11.749513
GRSE.NS	68.171001	12.523331
BDL.NS	59.108624	12.270154

MIDHANI.NS	57.625006	11.802586
BEL.NS	56.199511	7.585551
SOLARINDS.NS	54.681222	8.880314
DATAPATTNS.NS	33.456825	12.908227
MTARTECH.NS	31.922384	7.156476
PARAS.NS	13.136772	10.032078

Source: python output.

- The average return for the dataset is roughly 63.31% • The average risk is roughly 11.15%.
- The largest gains are seen in stocks like DCXINDIA.NS, ZENTEC.NS, and MAZDOCK.NS, but they also carry a high risk.
- The least risky stock is BEL.NS, which is followed by SOLARINDS.NS, MTARTECH.NS, PARAS.NS, and SOLARINDS.NS, respectively, with risks of 8.88%, 7.16%, and 10.03%

Risk & Return profiles of portfolio stocks:

Stocks	Returns	Risk
BEL.NS	56.199511	7.585551
BDL.NS	59.108624	12.270154
ASTRAMICRO.NS	68.702761	11.749513
COCHINSHIP.NS	95.721814	15.570864
HAL.NS	81.433831	9.737294

Source: Self compiled.

- COCHINSHIP.NS has the highest historical returns (95.72) among the listed stocks. And COCHINSHIP.NS also has the highest risk (15.57) compared to the other stocks.
- BDL.NS has relatively high returns (59.11) with moderate risk (12.27).
- HAL.NS and ASTRAMICRO.NS show good returns with lower associated risks compared to COCHINSHIP.NS.
- BEL.NS exhibits moderate returns (56.20) with relatively lower risk (7.59) compared to other stocks in the list.

Cumulative returns:

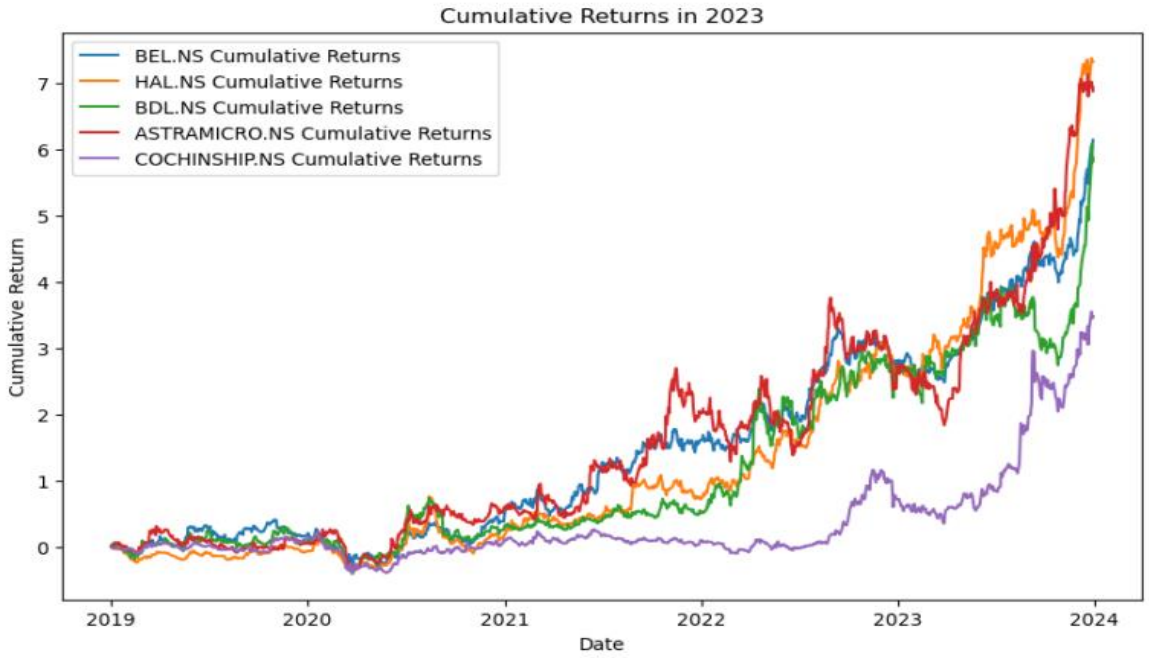

Fig: 2 Cumulative Returns

Source: python output.

This chart shows the growth of the prices of the selected five stocks for the observed period of five years. The stocks faced a dip during the pandemic, but gradually the prices went high. Astra microwave products' price has shot up during the year 2023, along with Hindustan Aeronautics Limited.

Overall all the 5 stocks have performed well giving a good percentage of returns with minimized risk level.

Correlation Matrix:

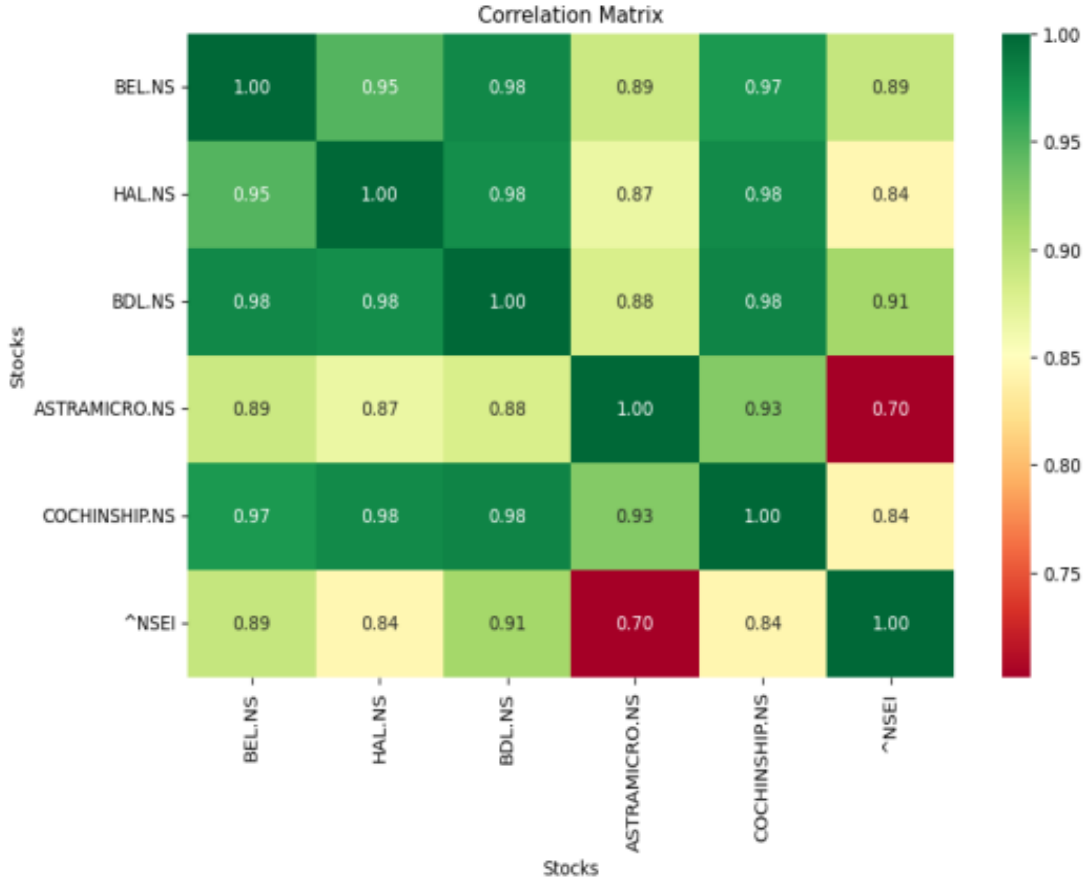

Fig: 3 Correlation Matrix

Source: python output.

- There are significant positive relationships between BEL.NS, HAL.NS, and BDL.NS as well as with COCHINSHIP.NS. This suggests that there is a tendency for these stocks to move in tandem with one another.
- The extremely high correlation of 0.981 between BDL.NS and COCHINSHIP.NS suggests a very good link between these two equities.
- There is a rather weak positive connection of 0.702 between ASTRAMICRO.NS and NSEI.

Optimal Portfolio Allocation:

Stocks	Allocation %
BEL.NS	30.3
HAL.NS	39.18
BDL.NS	0.08
ASTRAMICRO.NS	19.67
COCHINSHIP.NS	10.76

Source: python output.

Based on past performance and risk characteristics and the Markowitz Portfolio suggestion , this allocation shows the suggested distribution of money across these particular stocks within the portfolio with the goal of optimizing risk-adjusted returns. Greater trust in the performance and future returns of BEL.NS and HAL.NS stocks is reflected in the allocation of higher percentages. In contrast, BDL.NS has a low allocation %, most likely as a result of its lower weighting in the strategy for the entire portfolio. A well-proportioned distribution across the chosen stocks aids in risk diversification and seizes expansion prospects in the Indian defense industry.

Efficient Frontier:

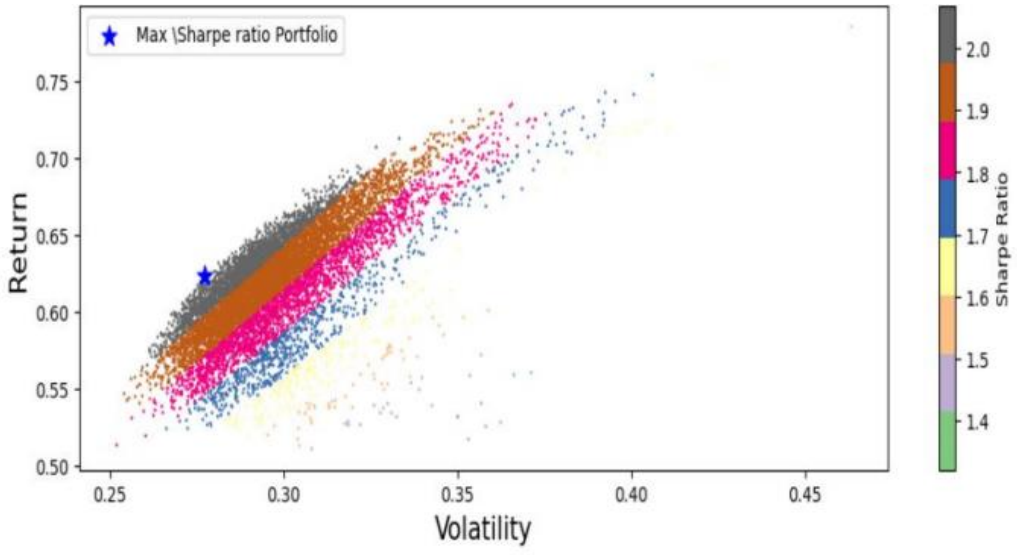

Fig: 4 Efficient Frontier

Source: python output.

- The Markowitz model has determined the ideal portfolio allocation, which is anticipated to yield a 62.4% return. The portfolio's assets are carefully chosen and distributed to produce this return.

- The portfolio's volatility (27.74%) indicates that there is still a substantial amount of risk involved, even with the comparatively high return. Nevertheless, considering the anticipated return, this degree of risk is deemed tolerable. Achieving equilibrium between risk management and return maximization is the goal of the Markowitz model.
- The blue star indicates the optimal portfolio combination that gives the highest return with minimum risk, also where Sharpe ratio is maximum.

Decision:

- 30.3 % of BEL.NS should be bought.
- 39.18 % of HAL.NS should be bought.
- 0.08 % of BDL.NS should be bought.
- 19.67 % of ASTRAMICRO.NS should be bought.
- 10.76 % of COCHINSHIP.NS should be bought.

Markowitz optimal portfolio return is: 62.4% with volatility 27.74 %

Scope for Future Research:

- Examine the effects of implementing alternative asset classes into portfolio allocation techniques, such as commodities, cryptocurrencies, or REITs.
- To learn how psychological biases affect investing decisions, investigate the behavioral facets of portfolio decision-making and investor preferences.
- Examine how technology, including blockchain and artificial intelligence, can transform the way that portfolio management is done.

Conclusion:

This study focused on building a portfolio of five carefully chosen stocks with strong risk-return profiles in order to minimize volatility and enhance growth potential. The research promotes portfolio optimization techniques, especially Modern Portfolio Theory (MPT), highlighting the significance of customized diversification in line with investors' financial objectives and risk tolerance. Building a well-balanced portfolio required careful consideration of stock correlations using a correlation matrix analysis.

The study promotes portfolio optimization techniques by highlighting customized diversification in line with investors' financial objectives and risk tolerance. Building a balanced portfolio required careful examination of stock correlations using a correlation matrix.

The research provides useful information to financial advisors and portfolio managers, enabling improved portfolio performance and well-informed investment choices.

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I am Avetha Angeline A., and I completed my bachelor's degree at Stella Maris College in Chennai. I am currently pursuing my MBA in Finance at CMS Business School in Bengaluru. My deep interest in finance, especially in learning about the nuances of financial markets and investing methods, is what motivates me to pursue this academic path. I have a strong desire to learn about the workings of the stock market and how they affect the ability to make wise financial decisions. I hope to improve my knowledge of this dynamic discipline and offer insightful contributions to the field of finance through my studies and research.