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Risk-Adjusted Portfolio Optimization Using NSE Blue-Chip Stocks

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ABSTRACT

In today's volatile financial markets, investors are increasingly concerned not only about maximizing returns but also about managing the risks associated with their portfolios. This study examines strategic portfolio construction and risk-adjusted performance evaluation using selected blue-chip stocks listed on the National Stock Exchange (NSE) of India. Ten large-cap stocks from banking, information technology, FMCG, telecom and infrastructure sectors were selected to build a diversified equity portfolio. Daily closing price data from 2014 to 2026 were collected from Yahoo Finance and analysed using Python for return calculation, risk measurement and portfolio simulation.

The study adopts Modern Portfolio Theory (MPT) as its theoretical base and applies Monte Carlo simulation to generate a large number of portfolio combinations with different weight allocations. For each simulated portfolio, expected return, volatility, Sharpe Ratio, Sortino Ratio, Beta and Maximum Drawdown were computed to assess performance from a risk-adjusted perspective. The results show that a well-diversified portfolio combining banking and IT stocks achieves an attractive balance between return and risk, with an annual expected return of around 18.9 per cent, volatility of 15.7 per cent and a Sharpe Ratio of 0.885. The optimal portfolio identified has a Beta slightly below one, indicating marginally lower volatility than the overall market, while still delivering competitive returns.

The findings highlight the importance of diversification, systematic asset allocation and the use of quantitative tools in constructing efficient portfolios. The study also demonstrates how integration of Python for analytics and Power BI for visualization can make portfolio analysis more practical and decision-oriented for investors, analysts and students.

INDEX TERMS — Portfolio construction, risk-adjusted performance, Modern Portfolio Theory, Monte Carlo simulation, Sharpe Ratio, NSE blue-chip stock

I. INTRODUCTION

Rapid globalization, technological change and frequent macroeconomic shocks have made equity markets more dynamic and uncertain than ever before. In such an environment, investors who focus only on returns without understanding risk exposure are likely to face unstable and sometimes severe losses. This has shifted attention from individual stock picking to portfolio construction, where the central idea is to combine assets in a way that balances risk and return.

Portfolio construction refers to the process of selecting and allocating funds across a set of

financial assets to achieve an optimal risk–return trade-off based on the investor's objectives and risk tolerance. Rather than holding a single stock, investors are encouraged to diversify across sectors and companies so that poor performance of one security does not severely damage overall wealth. Modern Portfolio Theory (MPT), introduced by Harry Markowitz, formalizes this idea by showing that the risk of a portfolio depends not just on the risk of each asset, but also on how their returns move together.

At the same time, simply constructing a portfolio is not sufficient; its performance must be evaluated relative to the risk taken. Risk-adjusted performance measures such as the Sharpe Ratio, Sortino Ratio and Beta provide deeper insight than absolute return, because they indicate whether higher returns are the result of smart allocation or simply higher risk. In practice, investors now expect analytical, data-driven methods that combine theory with real market data, rather than relying on intuition alone.

This study focuses on constructing an optimal portfolio of NSE-listed blue-chip stocks and evaluating its performance using multiple risk-adjusted measures. By using Python for data analysis, Monte Carlo simulation for optimization and Power BI for visualization, the study aims to bridge the gap between theoretical concepts and practical implementation in the Indian stock market context.

II. REVIEW OF LITERATURE

The foundation for this study goes back to **Markowitz (1952)**, who first explained how investors should look at a portfolio instead of individual shares. He showed that when we combine different assets whose prices do not move exactly together, the overall risk of the portfolio can come down without sacrificing return. This idea led to the concept of the **efficient frontier**, which is the set of portfolios that give the highest possible return for each level of risk. Even today, most portfolio models start from this Modern Portfolio Theory framework.

Later, researchers focused on how to judge whether a portfolio's return is "good" for the amount of risk taken. **Sharpe (1966)** analysed US mutual funds and introduced what is now called the **Sharpe ratio**, which compares the extra return earned over the risk-free rate with the volatility of that return. A higher Sharpe ratio means the investor is getting more return for each unit of total risk, so this measure is still widely used by fund managers and researchers. **Jensen (1968)** added another view by proposing **Jensen's alpha**, which checks whether a portfolio earns more or less than what the Capital Asset Pricing Model (CAPM) predicts for its level of market risk. In his famous study, he found that most mutual funds did not generate positive alpha, which means they did not consistently beat the market after adjusting for risk.

Because investors are usually more worried about losses than about total ups and downs, **Sortino and Price (1994)** suggested focusing only on downside movements. They developed the **Sortino ratio**, which divides excess return by downside deviation, so good volatility (returns above the target) is not treated as a penalty. CFA Institute and other authors later pointed out that Sharpe, Jensen's alpha and Sortino each look at performance from a slightly different angle, and using them together can give a more complete picture of how efficiently a portfolio is performing.

Several studies have applied these concepts in the Indian equity market. **Saha (2022)** used Sharpe's single-index model to build an optimal portfolio from Nifty 50 stocks. He calculated the excess-return-to-beta ratio for each stock, set a cut-off point, and kept only those shares that crossed this level. The study reported that only a few blue-chip companies, such as Hindustan Unilever, TCS and HDFC Bank, qualified for inclusion and that the resulting portfolio gave better risk-adjusted returns than a simple index-based approach.

In a similar line, **Malayappan (2025)** examined all Nifty 50 companies using the single-index model over different historical periods. He formed portfolios based on 1-, 3-, 5- and 10-year data and then checked how they performed in the next year. The results showed that portfolios based on the most recent 1- and 3-year data did better than the Nifty 50 index, while longer-period optimisations did not always beat the benchmark, suggesting that frequent re-optimisation with fresh data works better in the Indian context.

Another study, **"Application of Single Sharpe Index on the Optimal Portfolio – Evidence from Indian Blue-Chip Companies"**, applied the same approach directly to a selected group of large-cap Indian stocks. The authors found that only three out of fourteen blue-chip companies met the selection criteria, and that Hero MotoCorp received the highest portfolio weight

because of its strong excess-return-to-beta value. This shows that even within well-known blue-chip names, only a small subset may actually be efficient from a risk-adjusted point of view, and quantitative screening is necessary to pick them.

More recently, researchers have started combining Modern Portfolio Theory with artificial intelligence. A paper in Expert Systems with Applications proposed a **sector-based, AI-driven portfolio model for the NSE** using Dempster–Shafer evidence theory, Granger causal networks and deep recurrent neural networks. The study first identified strong sectors and then used a neural network to decide stock weights, finally comparing its results with traditional Markowitz portfolios. The AI-based model achieved better risk-adjusted performance, suggesting that integrating machine learning with classical theories can further improve portfolio outcomes for Indian investors.

Taken together, these studies show that:

- Modern Portfolio Theory gives a strong base for understanding the risk–return trade-off.
- Risk-adjusted measures such as Sharpe ratio, Jensen's alpha and Sortino ratio are essential tools to judge how efficiently a portfolio is performing.
- In the Indian market, especially with Nifty 50 and blue-chip stocks, portfolios built using systematic models like the single-index approach and newer AI-based methods have been able to deliver better risk-adjusted returns than simple, un-optimised holdings.

This evidence supports the focus of the present study on **risk-adjusted portfolio optimization using NSE blue-chip stocks**, and on evaluating results with multiple performance measures rather than return alone

III. OBJECTIVES OF THE STUDY

The overall aim of this research is to construct an optimal equity portfolio using NSE-listed blue-chip stocks and to evaluate its performance using risk-adjusted measures.

PRIMARY OBJECTIVE

- To construct an optimal portfolio of selected NSE blue-chip stocks and evaluate its performance based on risk and return.

SECONDARY OBJECTIVES

- To analyse historical price movements and return patterns of the selected stocks.
- To study the relationship between risk and return in equity investments.
- To apply Modern Portfolio Theory and Monte Carlo simulation for efficient portfolio construction.
- To evaluate portfolio performance using Sharpe Ratio, Sortino Ratio, Beta, volatility and Maximum Drawdown.
- To compare the portfolio's performance with a benchmark index (Nifty 50).
- To examine the role of diversification in reducing portfolio risk.
- To demonstrate the use of Python and Power BI as practical tools in portfolio management.

IV. RESEARCH METHODOLOGY

This study follows an analytical research design, relying on existing market data to examine the behaviour of selected stocks and portfolios rather than collecting primary responses from investors. The focus is on discovering patterns in returns and risk using quantitative techniques.

A. Data and Sample Selection

The research is based entirely on secondary data obtained from Yahoo Finance, a widely used financial information platform. Daily closing prices from 2014 to 2026 were collected for ten NSE-listed blue-chip stocks: Reliance Industries, Tata Consultancy Services, Infosys, HDFC Bank, ICICI Bank, ITC, Larsen & Toubro, State Bank of India, Hindustan Unilever and Bharti Airtel. These companies represent key sectors such as banking, IT, FMCG, telecom and infrastructure, providing sectoral diversification within the portfolio.

B. Tools and Techniques

Python served as the primary analytical tool for data extraction, cleaning, return computation and portfolio simulation. Libraries such as yfinance were used to download historical prices, pandas to manage time-series data, numpy for numerical operations, and matplotlib for plotting graphs such as stock performance and the efficient

frontier. Power BI was used to transform the analytical outputs into interactive dashboards that visually display stock trends, portfolio allocation and key performance metrics.

Daily returns were calculated using percentage change in closing prices, and risk was measured by the standard deviation of returns. A Monte Carlo simulation was implemented to generate 10,000 portfolio combinations with randomly assigned weights that sum to one across the ten stocks. For each portfolio, expected annual return, annualized volatility, Sharpe Ratio, Sortino Ratio, Maximum Drawdown and Beta (relative to Nifty 50) were calculated. The portfolio with the highest Sharpe Ratio was identified as the optimal portfolio.

V. DATA ANALYSIS AND DISCUSSION

A. STOCK RETURN AND RISK BEHAVIOUR

The historical analysis shows that the selected stocks exhibit distinct price and return patterns over the 2014–2026 period. Companies such as Reliance, TCS and Infosys display strong long-term upward trends, while banking stocks like SBIN and ICICI Bank show higher short-term volatility but also provide attractive return potential. FMCG stocks such as Hindustan Unilever and ITC appear more stable with moderate returns, reflecting their defensive nature. This diversity in behaviour supports the case for diversification across sectors.

Standard deviation of daily returns confirms that stocks like SBIN and ICICI Bank carry higher risk compared to relatively stable stocks such as HDFC Bank and Hindustan Unilever. The distribution of daily returns for most stocks is concentrated around zero, with occasional extreme values, indicating typical market fluctuations with periods of both gains and losses.

B. EFFICIENT FRONTIER AND OPTIMAL PORTFOLIO

Using Monte Carlo simulation, 10,000 portfolios were generated by randomly assigning weights to the ten stocks and computing expected return and risk for each combination. Plotting these portfolios produced an efficient frontier curve, where the upper boundary represents portfolios that deliver the maximum possible return for each level of volatility. Portfolios lying below this frontier are considered inefficient because they offer lower returns for the same risk.

Among all simulated portfolios, the one with the highest Sharpe Ratio was selected as the optimal portfolio. In this allocation, State Bank of India, TCS and Infosys receive relatively higher weights, while some stable but lower-return stocks receive smaller allocations to maintain diversification. The approximate weights reported in the analysis are 0.145 for Reliance, 0.172 for TCS, 0.167 for Infosys, 0.079 for HDFC Bank, 0.134 for ICICI Bank, 0.041 for ITC, 0.059 for L&T, 0.180 for SBIN, 0.002 for Hindustan Unilever and 0.017 for Bharti Airtel.

C. RISK-ADJUSTED PERFORMANCE

The optimal portfolio delivers an expected annual return of about 18.9 per cent with annualized volatility of 15.7 per cent, resulting in a Sharpe Ratio of 0.885 when compared against a 5 per cent risk-free rate. The Sortino Ratio, which focuses only on downside volatility, is even higher at around 1.20, indicating that negative return fluctuations are relatively well controlled. The Maximum Drawdown of approximately −33.4 per cent reflects the worst peak-to-trough decline over the study period, highlighting the potential loss during extreme market conditions.

The Beta of the optimal portfolio is about 0.909, which means the portfolio is slightly less volatile than the market index (Nifty 50) while still generating competitive returns. This suggests that the portfolio is suitable for investors who seek growth but prefer not to take on full market risk. Power BI dashboards designed in the study visually summarize these metrics, making it easier to interpret complex numerical results at a glance.

VI. FINDINGS AND SUGGESTIONS

The analysis confirms that diversification across sectors significantly reduces portfolio risk compared to investing in individual stocks. Stocks with higher returns generally exhibit higher volatility, reinforcing the classical risk–

return trade-off in equity markets. The efficient frontier demonstrates that only a subset of all possible portfolios truly offer attractive combinations of risk and return, emphasizing the value of systematic optimization.

The optimal portfolio identified in this study provides a well-balanced allocation that achieves a reasonable Sharpe Ratio with a Beta slightly below one, indicating efficient risk-adjusted performance. The use of multiple measures—Sharpe Ratio, Sortino Ratio, Beta and Maximum Drawdown—offers a more complete picture of portfolio behaviour than reliance on any single metric.

Based on these findings, the study suggests that investors should:

- Diversify across sectors and avoid concentrating funds in a single stock or industry.
- Evaluate investments using risk-adjusted measures rather than focusing only on absolute returns.
- Periodically monitor and rebalance their portfolios to maintain desired risk–return characteristics as market conditions change.
- Make use of analytical tools such as Python and visualization platforms like Power BI to support data-driven decision-making.
- Adopt a long-term investment horizon to smooth out short-term volatility and benefit from compounding.

B. LIMITATIONS OF THE STUDY

- The study considers only ten NSE-listed blue-chip stocks; including more securities could change the optimal allocation.
- The analysis is based on historical data from 2014 to 2026 and does not capture structural breaks or future market shocks.
- Transaction costs, taxes, liquidity constraints and short-selling restrictions are not explicitly modelled.
- The risk-free rate is assumed to be constant for the Sharpe and Sortino calculations, which may not fully reflect changing interest rate conditions.

C. SUGGESTIONS FOR INVESTORS

- Diversify across sectors and avoid concentrating funds in a single stock or industry, even within a blue-chip universe.
- Evaluate investments using risk-adjusted measures rather than focusing only on absolute returns.
- Periodically monitor and rebalance portfolios to maintain desired risk–return characteristics as market conditions change.
- Make use of analytical tools such as Python and visualization platforms like Power BI to support data-driven decision-making.
- Adopt a long-term investment horizon to smooth out short-term volatility and benefit from compounding.

D. IMPLICATIONS FOR INVESTORS

The findings of this study suggest that retail investors should avoid concentrating their savings in a single sector or stock, even when it is a blue-chip company. By combining banking and IT stocks along with defensive FMCG counters, investors can achieve more stable returns for a similar level of risk. The results also show that simple tools like Sharpe and Sortino ratios can be used to compare different portfolios and avoid strategies that offer only marginally higher returns at the cost of significantly higher volatility. Finally, the study indicates that low-cost data tools such as Python and Power BI can help even individual investors to analyse market data more systematically and make evidence-based decisions rather than relying only on tips or sentiment.

VII. CONCLUSION

This study set out to construct an optimal portfolio of NSE-listed blue-chip stocks and to evaluate its performance through a risk-adjusted lens. Using more than ten years of daily price data, Modern Portfolio Theory, Monte Carlo simulation and multiple performance metrics, it demonstrates that carefully designed diversified portfolios can achieve attractive returns with controlled levels of risk.

By integrating real Indian market data with Python-based analytics and Power BI dashboards, the research moves beyond theory and shows how portfolio optimization can be implemented in a practical, transparent and replicable way. The results reinforce the importance of diversification, systematic asset allocation and the use of risk-adjusted performance measures for informed investment decisions.

For students, analysts and individual investors, the study offers a clear framework for applying quantitative portfolio management techniques to real-world data. Future research can extend this work by including additional asset classes, incorporating transaction costs and exploring advanced models such as factor-based or machine learning-driven portfolio strategies.

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