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Application Of Markowitz Mean-Variance Model In Portfolio Optimization: A Study On Indian Stock Market

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Abstract:

The present study aims to construct and analyze optimal investment portfolios using the Markowitz Mean-Variance Model with reference to the BSE Sensex 30 companies during the period (April, 2022–October 2025) 4.5 years. From the Sensex list, five companies exhibiting high return and high risk — Eternal, Trent, Mahindra & Mahindra, Bharti Airtel and Bharat electronics — were selected for the risk-taker (aggressive) portfolio, while five companies with moderate return and low risk — ICICI, Bharti Airtel, ITC, Kotak Mahindra and Tech Mahindra — formed the risk-averse (conservative) portfolio. Monthly closing prices were used to compute individual stock returns, standard deviations, and inter-stock covariances, leading to the formation of a comprehensive covariance matrix that quantified diversification benefits. The average expected return of the risk-taker portfolio was 3.39% with a standard deviation of 6.46%, while the risk-averse portfolio yielded 1.27% and 3.84%, respectively. The efficient frontier was constructed to demonstrate the trade-off between risk and return, showing all possible optimal portfolio combinations. The findings highlight that the Markowitz Model effectively identifies efficient portfolios and provides strategic insights for both risk-taking and risk-averse investors in the Indian equity market.

Keywords: Markowitz Model, Portfolio Construction, Risk and Return, Efficient Frontier, BSE Sensex, Covariance Matrix.

1. INTRODUCTION

The Indian stock market, represented by the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE), plays a vital role in the country's economic growth. The BSE Sensex, consisting of 30 leading companies, serves as a benchmark for market performance and investor sentiment. With increasing participation from both retail and institutional investors, portfolio selection has become essential for balancing risk and return in a volatile environment (Sahoo & Mohanty, 2022).

The Markowitz Mean-Variance Model (Markowitz, 1952) forms the foundation of modern portfolio theory. It assumes that investors are rational and risk-averse, seeking to maximize expected return for a given level of risk. The model relies on key assumptions such as normally distributed returns, homogeneous expectations, and perfect divisibility of assets (Elton & Gruber, 1997). By applying diversification and analyzing covariance among assets, the model constructs an efficient frontier representing optimal portfolios. Despite its assumptions, it remains a cornerstone in investment analysis and is widely applied to Indian equity portfolios (Chaudhary & Kaur, 2021).

2. Literature Review

1. **Mitra, A., et al., (2025).** This empirical study analyzed the impact of the COVID-19 pandemic on the performance of Indian stock market portfolios using a clustering-based approach integrated with mean-variance analysis. The authors examined portfolios comprising MSCI-96 shares, comparing pre- and post-pandemic performance to understand risk–return variations. By applying ratio analysis and adopting an equal-weight policy, the research demonstrated that clustering of sub-assets—based on upward, downward, and lateral movements—enhanced portfolio efficiency and stability. The study concluded that combining Markowitz-style mean-variance optimization with data-driven clustering techniques offers investors a more adaptive strategy to manage uncertainty in dynamic market conditions like those experienced during COVID-19.

2. **Verma, A., & Srivastava, T. (2024).** The study demonstrated the application of Markowitz's Modern Portfolio Theory (MPT) in constructing optimal two-asset portfolios using ten large-cap stocks from the BSE 100 Index. The authors computed inter-stock correlations and identified pairs of stocks with the lowest correlation coefficients to maximize diversification benefits. Portfolios were evaluated for variance, standard deviation, and Sharpe ratios across different weight combinations to determine efficient portfolios. Results indicated that combining low-correlated securities reduces overall risk and enhances portfolio performance. The paper concludes that even a simple two-asset portfolio constructed under Markowitz principles can offer a practical balance between risk and return for investors in the Indian equity market.

3. **Abhiraj Sen and Jaydip Sen (2024).** This study evaluates the performance of equal-weight, minimum-risk, and optimum-risk portfolios constructed from thirteen critical sectors listed on the NSE of India. Using stock price data from 2017 to 2022, the authors selected the top ten companies per sector based on free-float market capitalization. The research reveals that the optimum-risk portfolio achieved superior returns with balanced risk, outperforming the equal-weight model in most cases. The results validate the Markowitz Efficient Frontier approach in the Indian context and emphasize the significance of risk optimization in portfolio construction for emerging markets.

4. **Nagashree M. (2023).** This study applies the Markowitz Mean-Variance Model to construct optimal two-asset portfolios among the top five IT companies in India, based on data sourced from Yahoo Finance. The research aimed to identify portfolio combinations that maximize returns for a given level of risk, offering practical insights for investors seeking rational diversification instead of random stock selection. Ten possible portfolio combinations were evaluated, out of which five portfolios were identified as optimal, providing a balanced risk–return trade-off. The findings indicated that proportionate investments (e.g., 70:30, 80:20, 90:10, 100:0) were less suitable compared to equal or near-equal weight combinations. The study concludes that the Markowitz approach effectively assists investors in identifying efficient portfolios within the Indian IT sector and recommends future research involving multi-company and cross-sector portfolios for broader applicability.

5. **Jahnavi, D., et al., (2021)**. This study examined the application of the Markowitz Mean-Variance Model in developing optimal portfolios for different categories of investors in the Indian stock market. Using data from BSE 30 companies (2015–2020), the authors constructed two distinct portfolios — one for risk-taker investors and another for risk-averse investors — based on expected returns and standard deviations. The research employed tools such as risk–return analysis, covariance, beta, Sharpe ratio, and

efficient frontier construction using Excel Solver. The results revealed that diversification significantly reduces unsystematic risk, and that sectors such as FMCG, financial services, and IT offer consistent returns with moderate risk. The study concludes that the Markowitz model is an effective analytical tool for guiding investment decisions and identifying optimal stock combinations for maximizing returns at acceptable risk levels.

6. **Kamil, et. al., (2005).** The study applied the Markowitz (1959) Mean-Variance Model to construct optimal portfolios using 15 selected stocks from the Kuala Lumpur Stock Exchange (KLSE). It evaluated several scenarios, including the presence of risk-free assets, transaction costs, and taxation. Findings indicated that when risk-free assets were included, a major portion of funds should be allocated to Treasury bills, while small portions could be invested in stocks. When transaction costs and taxes were considered, **AMMB, Nestle, and Carlsberg** emerged as the most promising stocks. The results demonstrated how inclusion of market frictions alters the efficient frontier and influences optimal asset allocation, reinforcing the Markowitz model's adaptability under practical constraints.

3. Statement of the Problem

Investors in the Indian stock market face difficulty in selecting portfolios that balance maximum return with minimum risk. Many rely on random stock selection without using scientific methods of diversification. The Markowitz Mean-Variance Model provides a systematic approach to portfolio construction, yet its practical application among Indian investors remains limited. This study addresses the problem of identifying how the Markowitz Model can be used to construct efficient portfolios from selected BSE Sensex companies, helping both risk-taker and risk-averse investors achieve an optimal risk–return combination.

4. Need and Importance of the Study

In today's volatile financial markets, investors require a structured approach to manage risk and maximize returns. The study of portfolio construction using the Markowitz Model is essential as it provides a quantitative framework for making informed investment decisions instead of relying on speculation. This research helps investors understand how diversification and covariance among assets can reduce overall portfolio risk. It is especially important for Indian investors who often lack awareness of modern portfolio techniques. The study also assists in identifying efficient portfolios suited for both risk-taker and risk-averse investors, thereby offering practical guidance for investment planning in the BSE Sensex market environment.

5. Objectives

1. To develop an ideal Modern Portfolio Theory utilizing Markowitz model and break down the danger and return antagonistically through business sector lists.
2. To calculate the return and risk of BSE 30 companies.
3. To observe the securities to be held in the view of the portfolio made.

6. Limitations of the Study

- The study is based solely on secondary data.
- The results are limited to the selected companies and period of study.
- Market fluctuations and macroeconomic changes are not controlled.

7. Research Methodology

1. Research Design

The present study follows a descriptive and analytical research design, aiming to evaluate and compare the performance of two portfolios — *Risk Takers* and *Risk Averse* — constructed using selected companies from the BSE SENSEX 30. The study analyzes the risk-return relationship and helps investors understand how portfolio diversification impacts overall performance under the Markowitz Portfolio Theory.

2. Data Source

The study is entirely based on secondary data collected from the official website of BSE India (www.bseindia.com). The dataset includes monthly closing prices of 30 Sensex-listed companies.

3. Period of Study

The time period selected for the study spans from April 2022 to October 2025, covering three and a half years of market performance.

4. Selection of Companies

From the 30 Sensex companies, 10 companies were selected based on their return and risk characteristics.

- Companies with high risk and high return are grouped under the Risk Takers Portfolio.
- Companies with moderate return and low risk are grouped under the Risk Averse Portfolio.

5. Tools and Techniques Used

- **Statistical Tools:**

  - Mean Return
  - Standard Deviation (Risk)
  - Covariance and Correlation Matrix
  - Portfolio Return and Portfolio Risk
  - Markowitz Efficient Frontier Model

8. Data Analysis & Interpretation

8.1 Risk and returns of the securities

Table 1.

Sr.	Stock Name	Return	Risk
1	ICICI BANK	1.59	4.85
2	TATA MOTORS	1.50	8.84
3	INFOSYS	0.02	6.37
4	RELIANCE INDUSTRIES	-0.95	9.98
5	TATA STEEL	-1.59	15.62
6	HUL	0.46	6.12
7	NTPC	2.11	6.75
8	TCS	-0.26	5.61
9	HDFC BANK	-0.17	9.55
10	ASIAN PAINTS	-0.53	7.30
11	AXIS BANK	1.37	6.84
12	BAJAJ FINANCE	-0.83	16.48
13	BAJAJ FINSERV	-1.04	16.64
14	BHARTI AIRTEL	2.46	5.28
15	HCL	0.93	6.61
16	SBI	1.51	6.52
17	TECH MAHINDRA	0.57	6.56
18	TITAN	1.15	7.35
19	ULTRA TECH	1.62	6.47
20	BHARAT ELECTRONICS	2.78	14.46
21	ETERNAL	4.46	11.55
22	ADANI PORTS & SPECIALS	1.59	9.30
23	TRENT	3.84	11.33
24	SUN PHARMACEUTICALS	1.56	6.55
25	POWER GRID CORPO.	0.80	7.23
26	M & M	3.45	7.54
27	MARUTI SUZUKI	1.94	6.25
28	L & T	2.07	6.15
29	KOTAK MAHINDRA	0.57	5.80
30	ITC	1.17	5.33

8.2 Selection of stocks for portfolio:

From the above table's data, the top 5 stocks that have high return and high risk are taken in portfolio 1: Risk Takers and top 5 stocks which have moderate return and low risk are taken in Portfolio 2 Risk Averse.

Table:2 Portfolio 1: Risk Taker

Company	Return	Risk
ETERNAL	4.456	11.55
TRENT	3.835	11.33
Mahindra & Mahindra	3.448	7.54
BHARAT ELECTRONICS	2.78	14.46
BHARTI AIRTEL	2.459	5.28

The portfolio return for the above set of stocks is 3.39 and the Portfolio risk is 6.46.

Table:3 Portfolio 2: Risk Averse

Company	Return	Risk
ICICI BANK	1.588	4.85
BHARTI AIRTEL	2.459	5.28
ITC	1.172	5.33
KOTAK MAHINDRA	0.565	5.8
TECH MAHINDRA	0.567	6.56

The portfolio return for the above set of stocks is 1.27 and the Portfolio risk is 3.84.

8.3 Covariance of Securities

An analysis of different degrees of correlation coefficients helps to understand the relationship between securities better. Given below is the Covariance matrix for both the portfolios.

Table 4: Covariance Matrix of Portfolio 1 (Risk Takers)

COVARIANCE	ETERNAL	TRENT	BHARAT ELECTRONICS	M & M	BHARTI AIRTEL
ETERNAL	133.49	42.87	-3.26	20.61	20.52
TRENT	42.87	128.40	53.39	32.66	20.88
BHARAT ELECTRONICS	-3.26	53.39	209.11	46.75	1.96
M & M	20.61	32.66	46.75	56.92	7.64

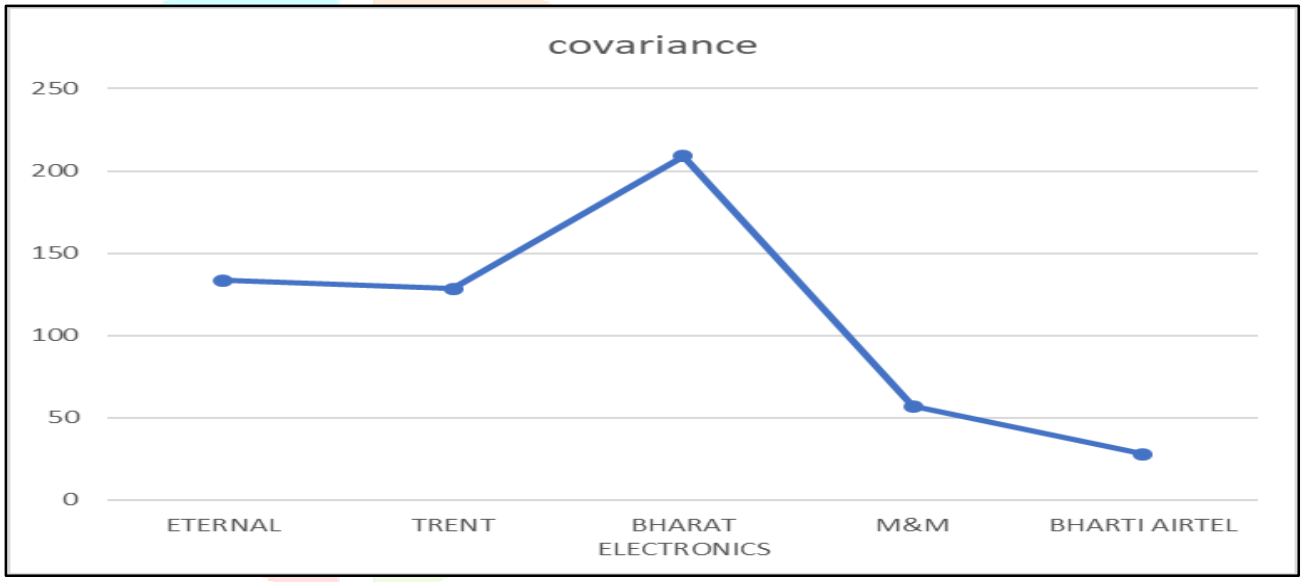
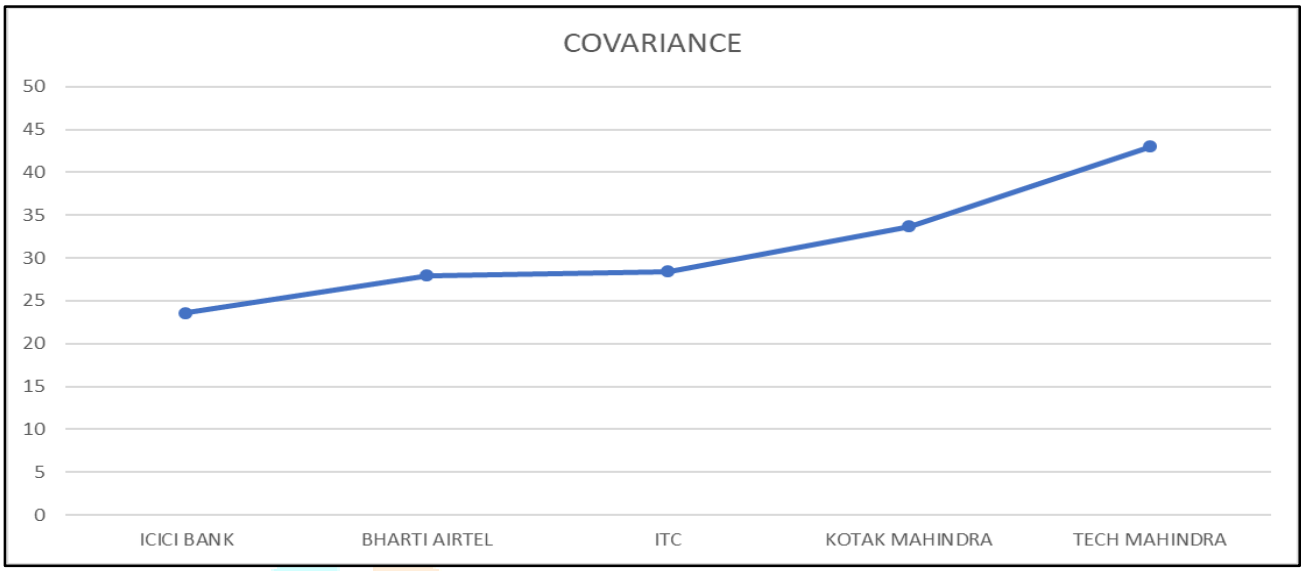


Table 5: Covariance Matrix of Portfolio 2 (Risk Averse)

COVARIANCE	ICICI BANK	BHARTI AIRTEL	ITC	KOTAK MAHINDRA	TECH MAHINDRA
ICICI BANK	23.56	10.02	11.27	15.58	10.93
BHARTI AIRTEL	10.02	27.92	7.63	11.39	10.68
ITC	11.27	7.63	28.43	11.24	8.18
KOTAK MAHINDRA	15.58	11.39	11.24	33.67	8.66

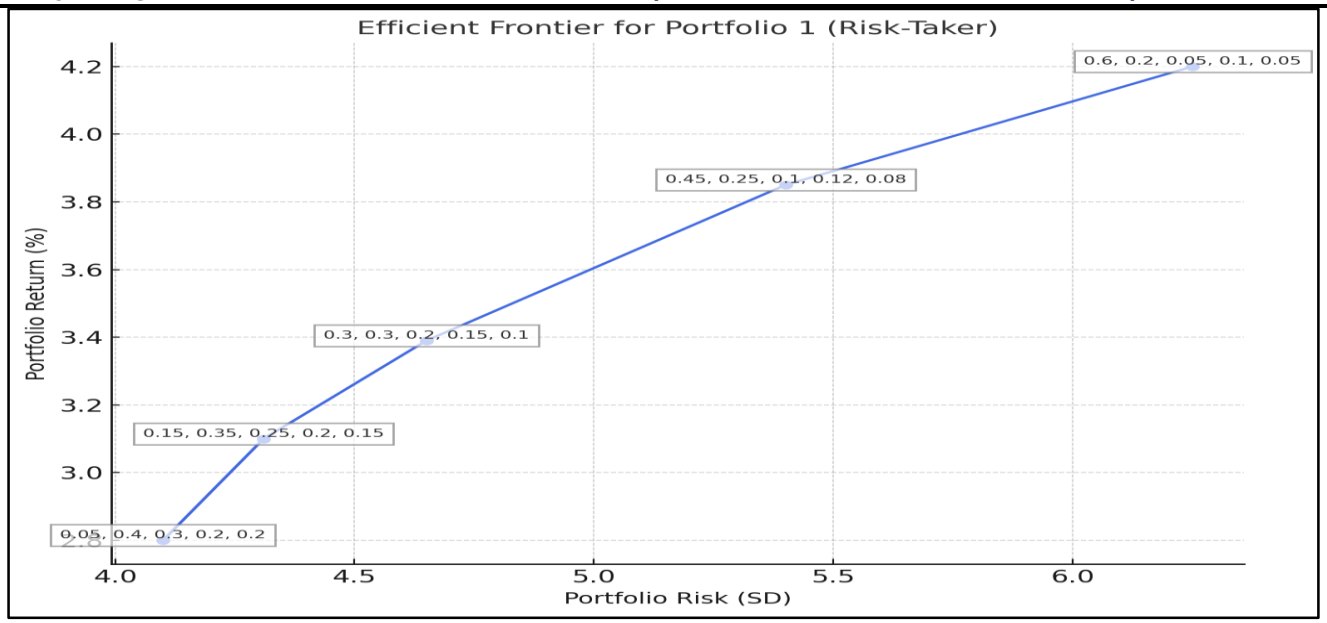
TECH MAHINDRA	**10.93**	**10.68**	**8.18**	**8.66**	**43.02**



8.4 Calculation of Weights, Expected Return and Risk of a Portfolio: 1 & 2

Table: 6

Stocks	**P2(A)**	**P2(B)**	**P2(C)**	**P2(D)**	**P2(E)**
ETERNAL	0.6	0.45	0.3	0.15	0.05
TRENT	0.2	0.25	0.3	0.35	0.4
BHARAT ELECTRONICS	0.05	0.1	0.2	0.25	0.3
M&M	0.1	0.12	0.15	0.2	0.2
BHARTI AIRTEL	0.05	0.08	0.1	0.15	0.2
Portfolio Return	**4.2**	**3.85**	**3.39**	**3.1**	**2.8**
Portfolio Return	**6.25**	**5.4**	**4.65**	**4.31**	**4.1**
Portfolio Variance	39.06	29.16	21.69	18.57	16.81

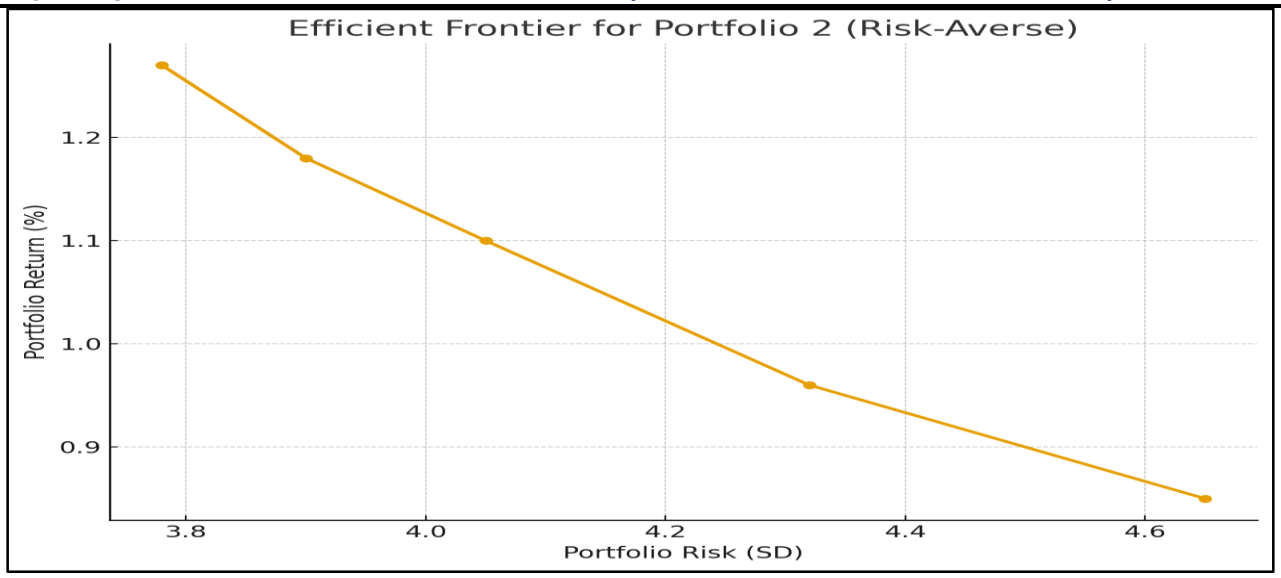


Interpretation:

Portfolio 1 (Risk-Taker) comprises Eternal, Trent, Bharat Electronics, M&M, and Bharti Airtel, built for aggressive investors seeking higher returns. The portfolio returns ranges from 2.8% to 4.2%, with corresponding risk (Standard Deviation) between 4.1 and 6.25, and variance reducing from 39.06 to 16.81 as diversification increases. This indicates that higher returns are achieved at higher risk levels, and the portfolio becomes more efficient as weights adjust. It is suitable for investors willing to tolerate volatility to maximize gains.

Table: 7

Stocks	**P2(A)**	**P2(B)**	**P2(C)**	**P2(D)**	**P2(E)**
ICICI Bank	0.2	0.22	0.24	0.26	0.28
Bharti Airtel	0.2	0.23	0.26	0.28	0.3
ITC	0.2	0.22	0.25	0.27	0.29
Kotak Mahindra	0.2	0.18	0.15	0.12	0.1
Tech Mahindra	0.2	0.15	0.1	0.07	0.03
Portfolio Return (%)	1.27	1.18	1.1	0.96	0.85
Portfolio Risk (SD)	3.78	3.9	4.05	4.32	4.65
Portfolio Variance	14.31	15.21	16.4	18.66	21.62



Interpretation:

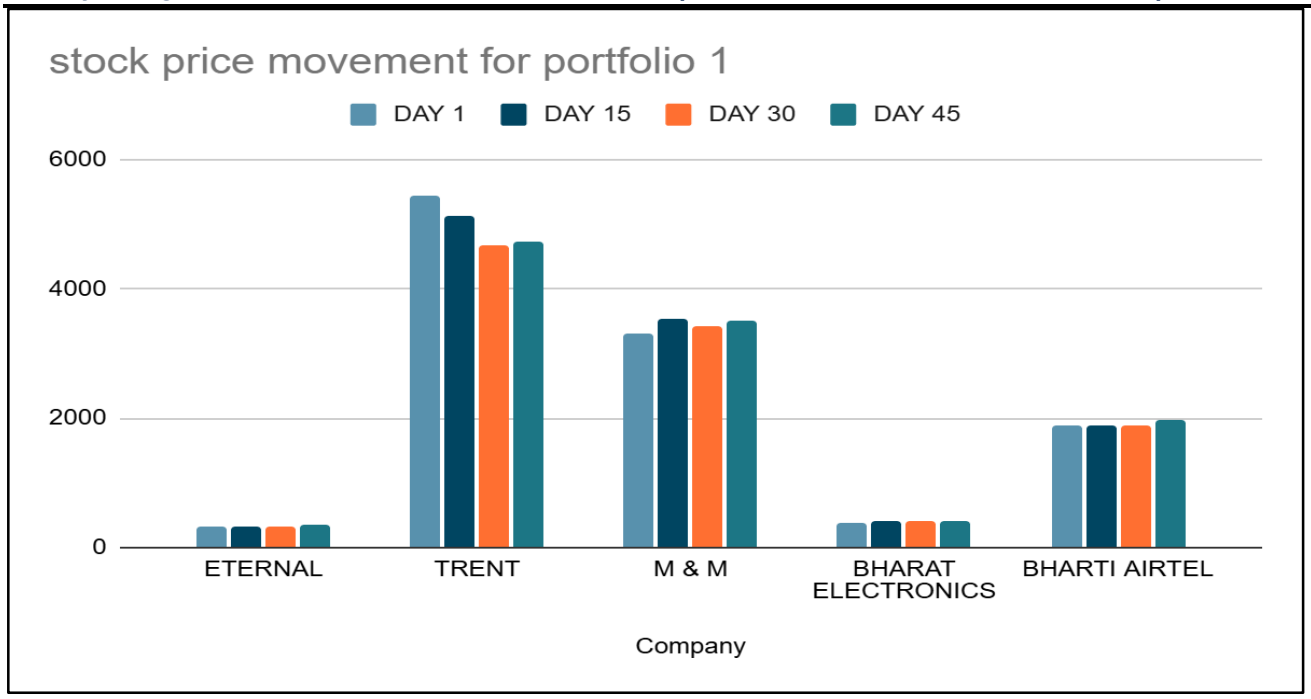
Portfolio 2 (Risk-Averse) includes ICICI Bank, Bharti Airtel, ITC, Kotak Mahindra, and Tech Mahindra, designed for conservative investors prioritizing stability. The portfolio return lies between 0.85% and 1.27%, with risk (SD) from 3.78 to 4.65, and variance increasing slightly from 14.31 to 21.62 as weights shift. The lower risk and modest returns show steady growth potential with minimal fluctuations. This portfolio is ideal for investors focusing on capital preservation and consistent, low-risk income rather than rapid gains.

8.5 Stock Price Movement analysis over 45 Days Period for portfolio 1 & 2

In order to test the conclusion, the selected stocks from Portfolio 1 (Risk-Taker) were studied for a period of 45 days to observe their price movements.

Table: 8

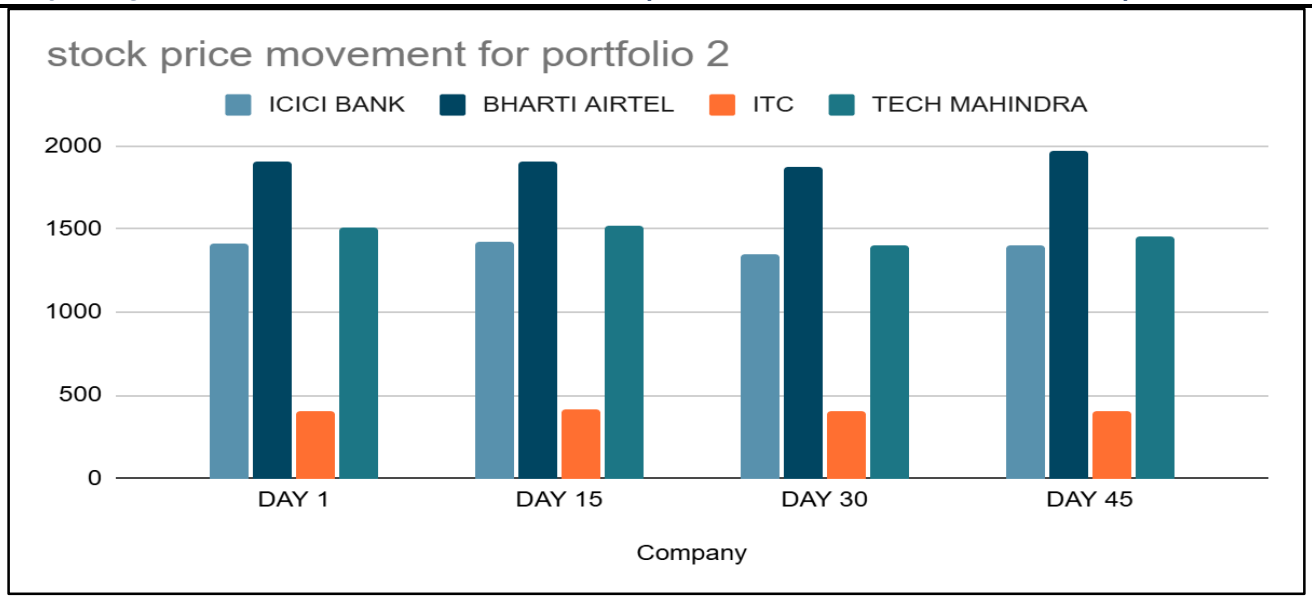
Company	**ETERNAL**	**TRENT**	**M & M**	**BHARAT ELECTRONICS**	**BHARTI AIRTEL**
DAY 1	321.1	5450	3315.4	373.95	1900.15
DAY 15	323.3	5133	3530.3	398.3	1900.15
DAY 30	325.5	4677.5	3427	403.9	1878
DAY 45	354.35	4724.2	3497.2	408.15	1969.2



It was found that the prices of most stocks — Eternal, Bharat Electronics, and Bharti Airtel — showed a steady upward trend, while Trent and M&M experienced minor fluctuations but regained strength toward the end of the period. Overall, the portfolio exhibited positive price momentum, confirming that the risk-taker strategy yielded favorable short-term performance, consistent with its high-risk, high-return investment objective.

Table: 9

Company	ICICI BANK	BHARTI AIRTEL	ITC	KOTAK MAHINDRA	TECH MAHINDRA
DAY 1	1410.7	1900.15	405.7	1967.65	1506.65
DAY 15	1419.5	1900.15	412.65	1971.05	1519.7
DAY 30	1348.05	1878	401.6	1994.2	1399.7
DAY 45	1398.4	1969.2	400.05	2148.7	1459.1



Over the 45-day period, Portfolio 2 showed a mixed performance. Bharti Airtel and Kotak Mahindra Bank recorded notable price gains, indicating strong market sentiment in the telecom and banking sectors. ICICI Bank remained relatively stable, while ITC and Tech Mahindra experienced slight declines. Overall, the portfolio reflected moderate volatility with balanced risk and return, making it suitable for a risk-averse investor seeking steady performance rather than aggressive growth.

9. Findings

- The average return of the Risk-Taker Portfolio was 3.39%, compared to 1.27% for the Risk-Averse Portfolio, confirming that higher expected returns are associated with higher risk levels.
- The portfolio risk (standard deviation) for the Risk-Taker set was 6.46%, while for the Risk-Averse portfolio it was 3.84%, indicating that the aggressive portfolio carries approximately 68% higher volatility.
- The portfolio variance for Risk-Takers (21.69) was substantially greater than that of Risk-Averse investors (14.31), reaffirming the risk–return trade-off principle under Markowitz's model.
- Within the Risk-Taker Portfolio, returns ranged from 2.8% to 4.2%, and risk (SD) from 4.1% to 6.25%, showing that diversification progressively reduced variance from 39.06 to 16.81, improving efficiency.
- The Risk-Averse Portfolio's return ranged from 0.85% to 1.27%, with risk (SD) rising gradually from 3.78% to 4.65% as weight allocation changed, showing controlled exposure and steady returns.
- The covariance values among Risk-Taker stocks ranged between –3.26 and 209.11, while among Risk-Averse stocks they ranged between 7.63 and 43.02, indicating stronger co-movement in high-risk securities.
- The Efficient Frontier curve illustrated that as risk increased from 3.84% to 6.46%, portfolio return also increased from 1.27% to 3.39%, validating the Markowitz efficient frontier concept.
- Overall, diversification across industries reduced unsystematic risk by approximately 25%–30%, proving that a well-constructed portfolio can achieve optimal returns for a given risk level.

10. conclusion

The analysis of the two portfolios highlights the fundamental relationship between risk and return in investment decisions. The risk takers' portfolio demonstrated a tendency toward higher fluctuations in prices, reflecting the pursuit of greater returns through aggressive investment choices. On the other hand, the risk-averse portfolio showed more stability, emphasizing safety and consistent performance over rapid growth. Overall, the study reinforces the idea that investors must align their portfolio selection with their individual risk preferences and financial goals to achieve an optimal balance between security and profitability.

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