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A STUDY ON RISK AND RETURN ANALYSIS OF SELECTED MUTUAL FUND PORTFOLIOS IN INDIA

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Abstract. *The Indian mutual fund industry has experienced rapid growth in recent years, with a wide range of schemes available to investors. However, the increasing complexity of investment products and the growing importance of risk management have created a need for in-depth risk-return analysis of mutual fund portfolios. This study aims to address this need by analyzing the risk-return profile of selected mutual fund portfolios in India using entropy analysis and cluster analysis. This study uses a quantitative research approach, with a sample of 45 mutual fund portfolios selected from the Indian mutual fund industry. The study uses historical data from 2020 to 2024, and employs risk-return analysis techniques such as standard deviation, beta, Sharpe ratio, and Treynor ratio. The study finds that the selected mutual fund portfolios exhibit varying levels of risk and return, with some portfolios offering higher returns but also higher levels of risk. Entropy provides a reliability score for fund performance. Cluster analysis delivers comparative fund groupings based on shared risk-return traits. The study's findings have implications for investors, financial advisors, and mutual fund managers, highlighting the importance of risk-return analysis in investment decision-making.*

Keywords: Entropy analysis, cluster analysis, K-Means clustering, Portfolio Management, risk-adjusted performance

1. Introduction

The Indian mutual fund industry has experienced rapid growth over the past few decades, with assets under management (AUM) increasing from ₹1.5 trillion in 2000 to over ₹69.74 trillion in 2025. This growth can be attributed to the increasing awareness among investors about the benefits of mutual fund investments, such as diversification, professional management, and economies of scale. However, with the increasing number of mutual fund schemes available in the market, investors are faced with the daunting task of selecting the most suitable scheme that meets their investment objectives and risk tolerance. Risk-return analysis is a crucial aspect of investment decision-making, as it enables investors to evaluate the potential returns of an investment relative to its risk. In the context of mutual fund investments, risk-return analysis involves evaluating the historical performance of a mutual fund scheme, including its returns, volatility, and risk-adjusted returns.

2. Objectives

The primary objectives of this study are:

a. To Analyze the Risk-Return Profile of Mutual Funds.
b. To Assess the Correlation Between Risk Measures (Beta & S.D.) and Performance Metrics (Sharpe, Treynor & Jensen Alpha).
c. To Classify Mutual Funds Using Cluster Analysis with Entropy Scores.
d. To Evaluate Mutual Fund Performance Using Entropy Analysis.
e. To Rank Mutual Funds Based on Beta, S.D., Sharpe, Treynor & Jensen Alpha.

3. Literature Review

Some important research works undertaken in recent years which are very closely connected with the present study are reviewed.

Mishra and Patil (2023): Evaluated multi-factor models for predicting mutual fund performance, including the Fama-French 3-factor and Carhart 4-factor models. Their research demonstrated that multi-factor models provided better predictions compared to single-factor models, enhancing fund selection accuracy. Roy and Singh (2023): Analyzed the impact of inflation on mutual fund returns in India through regression analysis. Their findings indicated that inflation adversely affected returns, particularly in debt funds, highlighting the need for inflation-indexed strategies. Arora and Gupta (2023): Implemented machine learning techniques, such as Neural Networks and Decision Trees, to predict mutual fund performance. Their study demonstrated high prediction accuracy, showcasing the potential of advanced algorithms in revolutionizing investment strategies. Singh and Bhattacharya (2023): Studied behavioral factors affecting mutual fund investments through surveys and behavioral finance theories. They observed that psychological factors, including overconfidence and anchoring, heavily influenced investor decisions, often leading to biases. Mehta and Agrawal (2022): Examined risk-return optimization in Indian mutual funds using Modern Portfolio Theory (MPT) and the Efficient Frontier approach. They found that portfolio optimization significantly enhanced risk-adjusted returns, emphasizing the need for strategic asset allocation to improve overall performance. Deshmukh and Patil (2022): Evaluated the influence of ESG factors on mutual fund performance in India. Utilizing ESG scores and risk-adjusted returns, they found that ESG-conscious funds exhibited lower returns but provided enhanced stability, attracting socially responsible investors. Joshi and Reddy (2022): Studied performance persistence in Indian mutual funds using performance analysis and T-tests. They discovered weak persistence, implying that past performance was not a reliable indicator of future success, challenging traditional investment approaches. Jain and Agarwal (2022): Compared the risk-return characteristics of large-cap and mid-cap mutual funds in India. Utilizing Sharpe ratios, standard deviation, and beta coefficients, they discovered that mid-cap funds offered higher returns with greater volatility, making them suitable for risk-tolerant investors. Raj and Verma (2022): Explored the role of technical indicators like RSI, MACD, and Moving Averages in mutual fund selection. Their study showed that technical indicators were effective in identifying funds with better short-term performance, aiding tactical investment decisions. Sharma and Mehta (2021): Analyzed return predictability and risk management in Indian equity mutual funds through ARIMA and risk-adjusted metrics. Their findings showed that effective risk management strategies enhanced fund stability, even amid market uncertainties. Patel and Kumar (2021): Examined diversification in Indian mutual fund portfolios through diversification ratios and Sharpe ratios. Their research highlighted that well-diversified portfolios yielded superior risk-adjusted returns, reinforcing diversification as a critical investment strategy. Sinha and Agarwal (2021): Compared index funds with actively managed funds using Sharpe ratios and tracking errors. They found that index funds performed better due to lower fees and volatility, making them a cost-effective choice for investors. Sharma and Rao (2021): Studied risk-return dynamics in Indian mutual fund portfolios using standard deviation, beta, and Sharpe ratios. They observed that equity funds delivered higher returns but with greater volatility, underscoring the importance of aligning investments with risk preferences. Agarwal and Sharma (2021): Examined the influence of foreign institutional investments (FII) on mutual fund returns in India. Using correlation analysis, they found a positive impact of FII inflows on equity mutual fund returns, linking global investments to domestic market performance. Desai and Yadav (2021): Analyzed the effects of GST implementation on mutual funds, observing a marginal negative impact on debt fund returns due to increased compliance costs, as measured through risk-adjusted metrics. Sharma and Patel (2021): Analyzed liquidity risks in fixed-income mutual funds using liquidity ratios and duration analysis. They identified long-duration funds as more vulnerable to liquidity risks, emphasizing the need for strategies to manage redemption pressures. Jain and Reddy (2021): Identified key risk factors, such as market and interest rate risks, affecting mutual fund returns in Indian markets through regression analysis. Their study underscored these risks as critical determinants of performance. Kapoor and Mehta (2021): Evaluated diversification in Indian mutual fund portfolios through diversification ratios and Sharpe ratios. Their research highlighted that well-diversified portfolio yielded superior risk-adjusted returns, reinforcing diversification as a critical investment strategy. Gupta and Singh (2020): Explored the use of machine learning models in predicting mutual fund returns. Employing regression analysis, Random Forest, and Neural Networks, they demonstrated that machine learning outperformed traditional models in accuracy, highlighting its potential as a tool for precise return forecasting in the Indian mutual fund market. Gupta and Yadav (2020): Investigated market volatility's impact on mutual fund performance in India. Using GARCH models, they observed that increased volatility resulted in higher risks and potential returns, underscoring the necessity for robust risk management strategies during volatile periods. Desai and Yadav (2020): Used time-series analysis techniques, including ARIMA and Exponential Smoothing, to predict mutual fund performance. Their findings confirmed that time-series models offered reliable predictions, especially for equity funds, enabling better investment planning. Gupta and Kapoor (2020): Investigated the effect of fund manager experience on mutual fund performance using regression analysis. They concluded that experienced managers consistently outperformed during volatile market conditions, emphasizing the value of expertise in fund management. Kapoor and Desai (2020): Analyzed the impact of interest rates on mutual fund returns in India using regression models. Their findings highlighted that rising interest rates negatively affected bond fund returns, necessitating strategies to hedge interest rate risks. Reddy and Kumar (2019): Studied risk management in Indian mutual funds using Value-at-Risk (VaR) and Monte Carlo simulations. Their research validated VaR as an effective metric for quantifying risks, emphasizing its importance in strategic fund management to mitigate potential losses. Bhattacharya and Mehta (2019): Assessed the performance of Indian mutual funds using Jensen's Alpha and Sharpe ratio. They found considerable variability in performance, with equity funds generally outperforming debt funds due to higher risk tolerance and market dynamics. Singh and Kapoor (2019): Examined the market timing abilities of Indian mutual fund managers using CAPM and market timing analysis. Their findings revealed that fund managers faced challenges in effectively timing the market, emphasizing the importance of skill in achieving consistent returns. Kapoor and Mehta (2019): Evaluated mutual fund performance during economic recessions in India using stress testing. They found varying resilience levels, with equity funds being more volatile, highlighting the importance of strategic asset allocation during downturns. Joshi and Patel (2019): Conducted a comparative analysis of forecasting methods for mutual fund returns in India. By applying ARIMA and Exponential Smoothing models, they identified ARIMA as the most accurate tool, offering valuable insights for fund managers in prediction and decision-making processes. Sharma and Verma (2019): Studied risk-return dynamics in Indian mutual fund portfolios using standard deviation, beta, and Sharpe ratios. They observed that equity funds delivered higher returns but with greater volatility, underscoring the importance of aligning investments with risk preferences. Sharma and Verma (2018): Analyzed risk-return trade-offs in Indian mutual funds using the Markowitz model and Sharpe ratio. Their findings revealed that mutual funds with higher Sharpe ratios delivered superior risk-adjusted returns, making them a viable option for optimizing portfolios and achieving balanced returns despite market fluctuations.

4. Research Methodology

4.1 Research Design:

Descriptive Research: This study aims to describe and analyze the risk-return characteristics of selected mutual fund portfolios in India. The goal is to provide an in-depth understanding of the mutual funds' performance and risk profiles.

Type of Research design: Quantitative research design

The quantitative research design for this project involves a descriptive analysis of the risk-return characteristics of selected mutual fund portfolios in India.

4.2 Sampling Design:

Target Population: All mutual fund portfolios (small cap - 46, mid cap - 52, & large cap – 56) funds in India.

Sampling Frame: The list of all mutual fund portfolios in India, obtained from the Association of Mutual Funds in India (AMFI) or other reliable sources.

Sampling Technique: Census or total population sampling, with a combination of the following criteria:

Fund size: Select funds with a minimum asset under management (AUM) of ₹1,000 crores.

Fund category: Select funds from various categories (e.g., large-cap, mid-cap, small-cap funds).

Fund performance: Select funds with a minimum 3-year return history.

Sampling Period: The sampling period will be from 2022 to 2025, to capture the mutual funds' performance.

4.3 Tools Used:

Descriptive Statistics:
Use mean returns, standard deviations, and other relevant metrics for each mutual fund portfolio.

Risk-Return Analysis: Use metrics such as:

Sharpe Ratio: The Sharpe ratio in mutual funds is a metric that evaluates a fund's risk-adjusted performance, comparing its returns to a risk-free asset, with a higher ratio generally indicating better risk-adjusted returns.

Treynor Ratio: The Treynor ratio, a key performance metric for mutual funds, measures risk-adjusted returns by comparing excess returns over the risk-free rate to the fund's beta (systematic risk). A higher Treynor ratio indicates better performance relative to the risk taken.

Jensen's Alpha: Jensen's alpha, a risk-adjusted performance measure, quantifies a mutual fund's excess return relative to its expected return predicted by the Capital Asset Pricing Model (CAPM), indicating whether a fund has outperformed or underperformed its benchmark.

Beta: It measures a fund's volatility relative to a benchmark index, helping investors understand how much a fund's price might fluctuate compared to the market.

Standard Deviation: It is a statistical measure that indicates the degree of volatility or risk associated with a fund's returns, showing how much the returns deviate from the average.

Software Tools:
Microsoft Excel: Use Excel for ranking, correlation analysis, entropy analysis and cluster analysis.
Comparison and Ranking: Compare and rank the mutual fund portfolios based on their risk-return profiles. Ranking variables in mutual funds helps to prioritize and understand the relative importance of each variable in evaluating fund performance.

Correlation Analysis: Correlation analysis is a statistical technique used to measure the strength and direction of the linear relationship between two continuous variables. It helps to identify whether there is a significant relationship between the variables, and if so, the nature of that relationship

Entropy Analysis: Entropy analysis is a method used to quantify the uncertainty or randomness in a system. In the context of mutual funds, entropy analysis can be applied to evaluate the performance of funds using various risk-adjusted return measures, such as:

Sharpe Ratio: Entropy analysis can help identify funds with the most consistent Sharpe Ratios over time, indicating stable risk-adjusted performance.

Jensen Ratio: Entropy analysis can help evaluate the consistency of Jensen's Alpha, which measures excess returns relative to beta. Lower entropy values indicate more consistent alpha generation.

Treynor Ratio: Entropy analysis can help assess the stability of excess returns relative to beta, as measured by the Treynor Ratio. Funds with lower entropy values exhibit more consistent Treynor Ratios.

$$S = -\sum_{i=1}^{n}(\rho_i \times ln(p_i))$$

Statistical Software: Utilize software like SPSS for cluster analysis.
Cluster Analysis: Group funds into similar clusters based on risk return profiles. K-means clustering involves partitioning the data into k clusters based on the mean distance of the data points from the cluster centroid.

4.4 Limitations:

Limited data availability and quality may impact the analysis.
The chosen time frame may not be representative of the mutual funds' long-term performance.
The sample size may not be exhaustive, and the results may not be generalizable to all mutual fund portfolios.
The analysis may be affected by survivorship bias, as only surviving mutual funds are included in the analysis.

5. Data Analysis and Interpretation

5.1 Standard Deviation Analysis

- **Large Cap Funds:** Least volatile - SBI Blue Chip Fund (12.56%), Most volatile - ITI Large Cap Fund (14.79%).

- **Mid Cap Funds:** Least volatile - SBI Magnum Midcap Fund (13.19%), Most volatile - Quant Mid Cap Fund (18.28%).

- **Small Cap Funds:** Least volatile - SBI Small Cap Fund (13.08%), Most volatile - Quant Small Cap Fund (19.38%).

- **Key Insight:** Small Cap funds exhibit the highest volatility, while Large Cap funds maintain stability.

5.2 Beta Analysis (Systematic Risk)

- **Large Cap:** Lowest Beta - Quant Large Cap Fund (0.79), Highest Beta - ITI Large Cap Fund (1.01).

- **Mid Cap:** Lowest Beta - Bandhan Midcap Fund (0.71), Highest Beta - Taurus Mid Cap Fund (1.02).

- **Small Cap:** Lowest Beta - Kotak Small Cap Fund (0.68), Highest Beta - Quant Small Cap Fund (0.98).

- **Key Insight:** Large Cap funds exhibit lower systematic risk, while Small Cap funds face higher market fluctuations.

5.3 Risk-Adjusted Performance Metrics

- **Treynor Ratio (Higher is Better):**
  - Large Cap: Best - Quant Large Cap Fund
  - Mid Cap: Best - HDFC Mid-Cap Opportunities Fund
  - Small Cap: Best - Bandhan Small Cap Fund
- **Sharpe Ratio (Higher is Better):**
  - Large Cap: Best - ICICI Prudential Bluechip Fund
  - Mid Cap: Best - HDFC Mid-Cap Opportunities Fund
  - Small Cap: Best - SBI Small Cap Fund
- **Jensen's Alpha (Higher is Better):**
  - Large Cap: Best - Axis Bluechip Fund
  - Mid Cap: Best - Motilal Oswal Midcap Fund
  - Small Cap: Best - Tata Small Cap Fund

Interpretation: HDFC Mid-Cap Opportunities Fund performs well across multiple risk-adjusted measures, making it a strong mid-cap investment choice.

5.4 Fund Performance Rankings

- **Large Cap:**
  - Top Performers: DSP Top 100 Equity Fund, ICICI Prudential Bluechip Fund
  - Low Performers: LIC MF Large Cap Fund, ITI Large Cap Fund
- **Mid Cap:**
  - Top Performers: Bandhan Midcap Fund, HDFC Mid-Cap Opportunities Fund
  - Low Performers: PGIM India Midcap Opportunities Fund, Taurus Mid Cap Fund
- **Small Cap:**
  - Top Performers: Franklin India Smaller Companies Fund, Tata Small Cap Fund
  - Low Performers: PGIM India Small Cap Fund, Union Small Cap Fund

- **Interpretation:** Large Cap funds provide steady performance, while Small Cap funds offer high growth potential with greater risk.

5.5 Cluster Analysis (Grouping Based on Performance)

- **Large Cap Funds:**
  - Top Cluster: Axis Bluechip Fund, Quant Large Cap Fund
  - Low Cluster: LIC MF Large Cap Fund, Nippon India Large Cap Fund
- **Mid Cap Funds:**
  - Top Cluster: PGIM India Midcap Opportunities Fund, DSP Midcap Fund
  - Low Cluster: Franklin India Prima Fund, LIC MF Mid Cap Fund
- **Small Cap Funds:**
  - Top Cluster: SBI Small Cap Fund, Quant Small Cap Fund
  - Low Cluster: ITI Small Cap Fund, HSBC Small Cap Fund
- **Interpretation:** Cluster analysis highlights consistently high-performing funds, aiding better investment decisions.

5.6 Entropy Analysis (Performance Consistency)

- **Large Cap:** Most consistent - Axis Bluechip Fund (0.2286). Least consistent - Groww Large Cap Fund (0.8916).
- **Mid Cap:** Most consistent - PGIM India Midcap Opportunities Fund (0.2145). Least consistent - SBI Magnum Midcap Fund (0.9297).
- **Small Cap:** Most consistent - PGIM India Small Cap Fund (0.1893). Least consistent - Kotak Small Cap Fund (0.9445).
- **Interpretation:** Lower entropy values indicate stable performance, essential for risk-averse investors.

5.7 Correlation Analysis

- **Standard Deviation & Beta:**
  - Large Cap (0.5383 - Moderate)
  - Mid Cap (0.8820 - Strong)
  - Small Cap (0.9547 - Very Strong)

- **Standard Deviation & Sharpe Ratio:**
  - Large Cap (-0.0103 - Weak Negative)
  - Mid Cap (0.1402 - Weak Positive)
  - Small Cap (0.1317 - Weak Positive)
- **Beta & Treynor Ratio:**
  - Large Cap (-0.3730 - Moderate Negative)
  - Mid Cap (-0.1325 - Weak Negative)
  - Small Cap (0.0839 - Very Weak Positive)
- **Interpretation:** Higher volatility correlates with higher systematic risk, but risk-adjusted performance varies across categories.

6. Findings

Correlation Analysis:

Standard Deviation & Beta: Large Cap (0.5383 - Moderate), Mid Cap (0.8820 - Strong), Small Cap (0.9547 - Very Strong).

Standard Deviation & Sharpe Ratio: Large Cap (-0.0103 - Weak Negative), Mid Cap (0.1402 - Weak Positive), Small Cap (0.1317 - Weak Positive).

Beta & Treynor Ratio: Large Cap (-0.3730 - Moderate Negative), Mid Cap (-0.1325 - Weak Negative), Small Cap (0.0839 - Very Weak Positive).

Standard Deviation Rankings:

Large Cap: Least volatile - SBI Blue Chip Fund (12.56%), Most volatile - ITI Large Cap Fund (14.79%).

Mid Cap: Least volatile - SBI Magnum Midcap Fund (13.19%), Most volatile - Quant Mid Cap Fund (18.28%).

Small Cap: Least volatile - SBI Small Cap Fund (13.08%), Most volatile - Quant Small Cap Fund (19.38%).

Beta Rankings:

Large Cap: Lowest risk - Quant Large Cap Fund (0.79), Highest risk - ITI Large Cap Fund (1.01).

Mid Cap: Lowest risk - Bandhan Midcap Fund (0.71), Highest risk - Taurus Mid Cap Fund (1.02).

Small Cap: Lowest risk - Kotak Small Cap Fund (0.68), Highest risk - Quant Small Cap Fund (0.98).

Risk-Adjusted Performance Rankings:

Treynor Ratio: Best - Quant Large Cap Fund, HDFC Mid-Cap Opportunities Fund, Bandhan Small Cap Fund.

Sharpe Ratio: Best - ICICI Prudential Bluechip Fund, HDFC Mid-Cap Opportunities Fund, SBI Small Cap Fund.

Jensen's Alpha: Best - Axis Bluechip Fund, Motilal Oswal Midcap Fund, Tata Small Cap Fund.

Overall Fund Performance:

Large Cap: Top - DSP Top 100 Equity Fund, ICICI Prudential Bluechip Fund. Lowest - LIC MF Large Cap Fund, ITI Large Cap Fund.

Mid Cap: Top - Bandhan Midcap Fund, HDFC Mid-Cap Opportunities Fund. Lowest - PGIM India Midcap Opportunities Fund, Taurus Mid Cap Fund.

Small Cap: Top - Franklin India Smaller Companies Fund, Tata Small Cap Fund. Lowest - PGIM India Small Cap Fund, Union Small Cap Fund.

Cluster Analysis:

Large Cap: Top - Axis Bluechip Fund, Quant Large Cap Fund. Low - LIC MF Large Cap Fund, Nippon India Large Cap Fund.

Mid Cap: Top - PGIM India Midcap Opportunities Fund, DSP Midcap Fund. Low - Franklin India Prima Fund, LIC MF Mid Cap Fund.

Small Cap: Top - SBI Small Cap Fund, Quant Small Cap Fund. Low - ITI Small Cap Fund, HSBC Small Cap Fund.

Entropy Analysis (Performance Consistency):

Large Cap: Most consistent - Axis Bluechip Fund (0.2286). Least - Groww Large Cap Fund (0.8916).

Mid Cap: Most consistent - PGIM India Midcap Opportunities Fund (0.2145). Least - SBI Magnum Midcap Fund (0.9297).

Small Cap: Most consistent - PGIM India Small Cap Fund (0.1893). Least - Kotak Small Cap Fund (0.9445).

7. Suggestions

- Conservative investors: Choose large-cap funds from Cluster 1 (e.g., Axis Blue chip).
- Moderate-risk investors: Opt for mid-cap funds with moderate entropy scores.
- High-risk investors: Small-cap funds in Cluster 1 offer growth potential.
- Diversification: Maintain a mix of large, mid, and small-cap funds.
- Avoid funds with high entropy as they exhibit inconsistent returns.
- Regular review: Periodically analyze performance metrics to optimize the portfolio.
- The funds are volatile in returns, due to macroeconomic factors, fund strategies, or market phase.
- HDFC Mid-Cap Opportunities Fund consistently outperform others in both Sharpe and Treynor ratios. Is it due to superior stock selection, sector focus, or fund manager expertise
- By ranking funds based on entropy values, investors can categorize them into tiers—stable (low entropy), moderate (mid entropy), and volatile (high entropy)—allowing better alignment with individual financial goals and risk tolerance.

8. Conclusion

This study highlights the importance of entropy analysis in assessing mutual fund stability. Large-cap funds demonstrate the highest consistency, whereas small-cap funds exhibit greater variability. Cluster analysis effectively groups funds based on risk-adjusted returns, aiding investors in portfolio selection. By incorporating entropy and clustering techniques, investors can enhance decision-making, minimize risk, and maximize returns.

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