**Quantitative Analysis of Fund Performance: Risk-Adjusted Rewards for Small, Mid, and Large Cap Funds**

**Overview:**

The Indian equity market comprises various categories of funds, including small-cap, mid-cap, and large-cap, each offering different risk and return profiles. Small-cap funds typically invest in smaller companies with high growth potential but also higher volatility. Mid-cap funds focus on medium-sized companies, offering a balance between growth and stability. Large-cap funds, on the other hand, invest in well-established companies, providing more stable returns but lower growth potential. This project aimed to quantitatively analyse the risk-adjusted rewards of these three fund categories using historical data. By using various statistical methods, including normalization, linear regression, and correlation analysis, the study provided insights into the performance and risk characteristics of these funds from January 1, 2020, to December 31, 2023. The findings serve as a valuable resource for investors looking to optimize their portfolios by understanding the trade-offs between risk and reward across different market segments.

**Objective:**

The primary objective of this project was to analyse the risk-adjusted reward of Indian small, mid, and large-cap funds using data from January 1, 2020, to December 31, 2023. The analysis aimed to assess the performance of these funds over four years, focusing on their rewards, volatility, and correlation.

**Data Collection:**

The primary objective of this project was to analyse the risk-adjusted reward of Indian small, mid, and large-cap funds using data from January 1, 2020, to December 31, 2023. All four years data of these three funds have been sourced from BSE India website.

[https:/www.bseindia.com/Indices/IndexArchiveData.html](https://www.bseindia.com/Indices/IndexArchiveData.html)

**Methodology:**

* Data Normalization and Visualization:

The first step involved normalizing the data to ensure consistency and comparability. Normalization was achieved by adjusting the daily prices of the funds to a common scale, making it easier to compare their performances. The normalized data was then visualized on a graph, allowing for a clear comparison of the performance trends of small, mid, and large-cap funds over the specified period.

* Linear Regression Analysis:

To evaluate the rewards of each fund, a linear regression model was employed. This method allowed for the estimation of the relationship between the dependent variable (the fund along the Y-axis) and the independent variable (the fund along the X-axis).  Yi=β0+ β1 Xi +Ui

[Yi = Dependent variable (small cap/ mid cap/ large cap based on the table),

Xi = Independent variable (small cap/ mid cap/ large cap based on the table),

Ui = Error term/ Residual]

The following steps were undertaken:

* Contingency Table Creation: A contingency table was created with small, mid, and large-cap funds in both rows and columns. This setup enabled the analysis of all pairwise combinations of funds, treating each fund as both a dependent and an independent variable at different times.
* Intercept Calculation:

|  |  |  |  |
| --- | --- | --- | --- |
| **Table of Intercept Parameter** | | | |
|  | **Small Cap** | **Mid Cap** | **Large Cap** |
| **Small Cap** |  | -5280.87 | -14461.05 |
| **Mid Cap** | 4090.74 |  | -6756.60 |
| **Large Cap** | 2434.02 | 1633.98 |  |

For each pair, the intercept term was calculated, representing the expected value of the dependent variable when the independent variable is zero. The intercepts provided a baseline for the relationship between the funds.

* Slope Calculation:

|  |  |  |  |
| --- | --- | --- | --- |
| **Table of Coefficient Parameter** | | | |
|  | **Small Cap** | **Mid Cap** | **Large Cap** |
| **Small Cap** |  | **1.34** | **6.46** |
| **Mid Cap** | **0.74** |  | **4.80** |
| **Large Cap** | **0.15** | **0.20** |  |

The slope for each pair was then calculated, indicating the rate of change in the dependent variable concerning the independent variable. The slope provided insights into how the performance of one fund influenced another.

* Residual Calculation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Table of Residuals** | | | |
| **Current Values** |  | 42673.76 | 36839.22 | 8326.88 |
|  |  | **Small Cap** | **Mid Cap** | **Large Cap** |
| 42673.76 | **Small Cap** |  | -1492.87 | 3305.63 |
| 36839.22 | **Mid Cap** | 1224.87 |  | 3605.67 |
| 8326.88 | **Large Cap** | -369.43 | -604.64 |  |

Residuals were computed to measure the deviation of the actual values from the predicted values (Ŷ) based on the regression model. The residual for each pair was calculated by subtracting the predicted value (Ŷ) from the actual last-day value of the dependent variable (Y). The predicted value (Ŷ) was obtained using the corresponding intercept, slope, and the last-day value of the independent variable (X).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Table of Residual%** | | | |
| **Current Values** |  | 42673.76 | 36839.22 | 8326.88 |
|  |  | **Small Cap** | **Mid Cap** | **Large Cap** |
| 42673.76 | **Small Cap** |  | -3.50 | 7.75 |
| 36839.22 | **Mid Cap** | 3.32 |  | 9.79 |
| 8326.88 | **Large Cap** | -4.44 | -7.26 |  |

Residual percentages were then calculated to quantify the relative difference between actual and predicted values.

* Correlation Analysis:

|  |  |  |  |
| --- | --- | --- | --- |
| **Table of R/Correlation** | | | |
|  | **Small Cap** | **Mid Cap** | **Large Cap** |
| **Small Cap** |  | 1.00 | 0.97 |
| **Mid Cap** | 1.00 |  | 0.98 |
| **Large Cap** | 0.97 | 0.98 |  |

The correlation between each pair of funds was calculated, providing a measure of the strength and direction of the linear relationship between the two variables. A correlation matrix was created to display the correlations for all pairs, helping to understand the degree of association between the performances of different funds.

* Reward Calculation:

|  |
| --- |
| **Average/Reward** |
| 1.35 |
| 4.29 |
| -3.80 |

The reward for each fund was calculated by taking the sum product of the residual percentage and correlation for each pair. This approach allowed for the assessment of each fund's reward based on its deviations from expected performance and its relationship with other funds.

* Volatility Calculation:

|  |  |  |  |
| --- | --- | --- | --- |
| **Volatility of each fund** | | | |
|  | **Small Cap** | **Mid Cap** | **Large Cap** |
| **Standard Dev** | 1.25 | 1.25 | 1.26 |
| **Volatility** | 19.88 | 19.87 | 20.01 |

The annual volatility of each fund was determined using the standard deviation method. After calculating percentage change in values of each fund from their previous day value, standard deviation has been seen to calculate variability/volatility in each fund’s return compared to their average return. This measure provided an indication of the risk associated with each fund by assessing the extent to which the fund's returns deviated from their average value over the period.

* Risk-Adjusted Reward Calculation:

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk Adjusted Reward** | | | |
|  | **Reward** | **Volatility** | **Risk Adjusted Reward** |
| **Small Cap** | 1.35 | 19.88 | 0.07 |
| **Mid Cap** | 4.29 | 19.87 | 0.22 |
| **Large Cap** | -3.80 | 20.01 | -0.19 |

Finally, the risk-adjusted reward was calculated by dividing the reward by the annual volatility for each fund. This ratio provided a measure of the return generated per unit of risk, enabling a comparison of the risk-adjusted performance of small, mid, and large-cap funds.

* Results:

The analysis revealed distinct differences in the risk-adjusted rewards among small-cap, mid-cap, and large-cap funds in the Indian equity market.

* **Mid-cap fund:** The mid-cap funds stood out as the best performers in terms of risk-adjusted reward. This finding indicates that, among the three categories, Mid-cap funds emerged as the best performers with a risk-adjusted reward of 0.22. This indicates that mid-cap funds provided the most efficient balance between risk and return, delivering substantial rewards relative to the risks taken. over the analysed period from January 1, 2020, to December 31, 2023.
* **Small-cap fund:** The small-cap funds had a risk-adjusted reward of 0.07. Although small-cap funds often present opportunities for high returns due to their focus on smaller, potentially high-growth companies, they also come with increased volatility and risk.
* **Large-cap fund:** Large-cap funds showed a negative risk-adjusted reward of -0.19. This result indicates that, over the analysed period, large-cap funds did not provide adequate returns relative to the risks involved.
* Conclusion:

The results clearly demonstrate that mid-cap funds provided the most favourable risk-adjusted returns, making them the optimal choice for investors looking to balance risk and reward. Small-cap funds, while offering potential high returns, carried significant risks, resulting in a lower risk-adjusted reward. Large-cap funds, typically seen as safer investments, underperformed in this analysis, highlighting the importance of not only considering potential returns but also the efficiency of those returns relative to risk. These findings offer valuable insights for investors in making informed decisions based on the balance of risk and reward across different market segments.