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# Risk Measures In Finance: Congruent or Contrasting?

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## Abstract

*Risk has been defined and measured in different ways by academicians and practitioners. The choice of proxy for risk measurement can have a direct and conclusive impact on investment decisions. The question that we aim to answer in the study is: Does the choice of risk-adjusted performance measure really make a difference in the ranking of equity portfolios? To approach the issue, we categorise risk-adjusted performance measures in four groups: Volatility Based Risk Measures (Sharpe and M2 Ratios); Sensitivity Based Risk Measures (Treynor's Ratio, Jensen's Alpha and Information Ratio); Downside Risk Measures (Sortino Ratio) and Tail Risk Based Measures (Modified Sharpe Normal VaR, Modified Sharpe Cornish Fisher VaR, Modified Sharpe Historical VaR and Modified Sharpe Expected Shortfall). We calculate values of all these risk-adjusted measures for 111 equity growth oriented mutual fund schemes spread across AMCs (Asset Management Companies) in India for a period of 10 years starting June 2005 to June 2015. We use Spearman's and Kendall's rank correlation and prepare a cross-sectional matrix to find out the extent of congruence among ranking of schemes according to all risk-adjusted measures. We find a substantial degree of positive and significant concordance among rankings obtained by equity portfolios on the basis of different for risk-adjusted measures with rank correlations ranging from 0.61 to 0.99. The results of the study indicate that the choice of risk-adjusted measure is broadly inconsequential to investment decisions in the context of Indian equity markets. The findings are relevant for retail and institutional investors, fund managers, market regulators and academicians.*

**Key Words:** Risk-Adjusted Performance Measures, Mutual Funds, Rank Correlation, Value at Risk, Jensen's Alpha, Modified Cornish-Fisher VaR

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## Introduction

Risk is an important determinant of investment decisions. Conceptually, risk has been approached with a different thought-process altogether by different academicians and researchers. Quantification of risk has evolved overtime since the advent of Harry Markowitz's idea of using standard deviation as a proxy for risk in 1952. The investors always want to minimize risk and maximize the returns. It was during the late 1990's that mutual funds gained importance in India as an investment alternative by providing an opportunity to diversify risk across a bundle of securities. Mutual fund is a diversified portfolio managed by asset managers on the basis of technical and fundamental analysis. There exist ample measures on risk-adjusted performance evaluation of a variety of investment alternatives spread across diverse asset classes. For a performance appraisal of securities to be 'valid', 'reliable' and 'acceptable ', the measurement of risk becomes an issue of key importance. The choice of proxy for risk measurement can have a direct and conclusive effect on investment decisions.

From Sharpe Ratio (Sharpe, 1966) based on volatility to coherent risk measures based on tail distribution analysis, risk measures have witnessed an overwhelming transformation. Indeed, Sharpe Ratio is the most widely known and used performance measure for the Mutual Fund Industry. However, because it is based on mean-variance theory, it is a meaningful measure of performance when either risk perceived by investors can be expressed exclusively by standard deviation or when returns are normally distributed. Other measures, such as the Treynor Ratio, are also based on the mean-variance world, although they also focus on other aspects of performance. Recently, there is a growing literature on performance evaluation that tries to take into account higher moments of distribution. We see two reasons for the emergence of these measures: first, there is a new paradigm of investors' perception of risk that goes beyond the variance; and second, many asset return's distributions have actually non-normal distributions.

The first reason is linked to the increasing use in the last 15 years of a number of risk measures that focus on the left tail of return's distribution, like the Value at Risk (VaR), Expected Shortfall and others. This leads to a search for performance measures that consider these kinds of risk measures. Sharpe Ratio is commonly interpreted as a reward-to- risk ratio. Thus, many researches replace standard deviation in the Sharpe ratio by risk measures that focus on the left tail of distributions. (Sortino and Van der Meer, 1991) replace the standard deviation by the downside deviation. (Dowd, 2000) uses the Value-at- Risk (VaR) measure instead of standard deviation. The second reason why performance measures are going beyond mean-variance is because assets, portfolios and funds return's distributions are actually not normally distributed.

(Eling and Schuhmacher, 2007) investigate the consistency of various performance evaluation measures in ranking 2,763 hedge funds over the period from 1985 to 2004. Results show that the rank correlation coefficients between the performance measures are 90% and above.

(Eling, 2008) conducts further tests on 38,954 funds that cover a large variety of asset classes, including stocks, bonds, real estates, commodities and hedge funds over the period from 1996 to 2005. Results indicate that the choice of any measure does not have significant influence on the ranking of funds.

(Zakamouline, 2009) challenges Eling and Schumacher's approach, mainly claiming that the majority of the return distributions they analyze is close to normal, and that the Spearman rank correlation coefficient they base their conclusions on may be biased.

(Ornelas, Silva Júnior and Fernandes, 2010) compare 13 performance measures with the traditional Sharpe Ratio using a sample of US Fixed-Income, Equity and Asset Allocation Mutual Funds. Results show that choice of the performance measure is actually important for mutual fund ranking and selection.

(Razafitombo, 2010) investigate relative appropriateness of a variety of performance measures. Test results show inconsistencies between the rankings of different measures over time. Moreover, inconsistencies are also present in the same measure over different periods. The study concludes that various measures should be employed in a multi-criteria approach to evaluate fund performance in order to achieve unbiased results.

(Prokop, 2012) suggests that although the general result that most of the ratios considered provide very similar performance rankings is supported, the degree of their congruency varies over time.

(Auer, 2015) shows that some of the most popular performance measures, i.e., the Sharpe ratio and 12 alternative reward-to-risk ratios based on drawdowns, partial moments and the Value at Risk, yield almost identical rank orderings across futures-based commodity investments in energy, precious metals, industrial metals, agriculture, and livestock.

## Objective

Risk-adjusted performance measures typically employed in portfolio management focus on different aspects of an investment asset's return distribution. Some of them treat positive and negative returns in the same way, some emphasize the upside potential, and some put more weight on avoiding downside risk. From a conceptual point of view, the measure chosen should be in line with the specific investor's investment objectives, and it should capture the attributes of the asset's risk-and-return profile that are most important to him or her. Thus, performance evaluation is an inherently subjective, investor-specific task.

The basic motive of the study is to verify the relevance of different proxies of risk that exist in finance. Our aim is to study whether these different methods of risk measurement yield different ranking of equity portfolios when it comes to selection of portfolios for investment purpose on a risk adjusted basis. This idea has been applied to ten risk-adjusted performance measures which primarily differ with regard to conceptual orientation and quantification of risk. We test statistical hypotheses of no pair-wise correlation among rankings of equity mutual fund schemes based on different risk-adjusted performance measures.

The research hypothesis of the study is the prevalence of rank correlation in the rankings obtained by equity mutual fund schemes in India based on different risk-adjusted performance measures.

## Data & Methodology

In the present study, we take daily Net Asset Value (NAV) data for 111 Indian equity mutual fund schemes (growth). The source of data is Bloomberg's database. The daily data was converted into monthly data by taking the NAVs of last traded day in the month. All the performance measures are calculated based on monthly data only. The period of study is from July 2005 to June 2015.

We retrieved the monthly data for Government of India 91-day Treasury Bill Yield from EPW's Time Series Database and BSE-500 index monthly values from BSE Website. The retrieved Treasury bill yields were annualised so they were divided by 12 to get monthly yield. The broad market based BSE-500 has been taken as the benchmark index to evaluate mutual fund performance. We converted the monthly price values into returns by taking the log of first difference. The final sample consisted of 111 mutual funds having data for 119 months.

In the present study four categories of performance measures are used: Volatility based, Sensitivity based, Downside-risk based, and Tail based measures. Each of these categories incorporates different measures.

### A. Volatility Based Measures

(i) **Sharpe Ratio** – Sharpe ratio is used to measure performance when returns are normally distributed. Also known as reward-to-variability ratio, Sharpe ratio measures the association between the returns earned by an investor over and above the risk-free rate of return for each unit of total risk. The total risk is defined as standard deviation of return generating portfolio.

$$\text{Sharpe Ratio} = \frac{\text{Fund's excess return}}{\text{Standard Deivation of fund}}$$

where excess return represents the return over and above the risk-free rate

(ii) **M2 Ratio –** Developed by Modigliani and Modigliani (M2) and known as Modigliani measure, this ratio expresses a fund's performance relative to the market in percentage terms. The fund with the highest Modigliani measure, like the fund with the highest Sharpe ratio, would have the highest return for any level of risk. The excess returns are calculated over and above risk-free rate.

$$\text{Modigliani Measure} = \frac{\text{Fund's excess return} * \text{Standard deviation of benchmark index excess return}}{\text{Standard Deivation of fund's excess returen}}$$

**B. Sensitvity Based Measures**

(i) **Treynor's Ratio –** Similar to Sharpe ratio, Treynor's ratio also measures the association between portfolio returns in excess of risk-free rate of return divided by risk, where, risk is defined as beta or sensitivity of portfolio returns to returns of a benchmark index.

$$\text{Treynor's Ratio} = \frac{\text{Fund's excess return}}{\text{Beta}}$$

(ii) **Jensen's Alpha –** Jensen's Alpha provides a long-term view of fund manager's ability to add value or provide superior fund returns. This measure indicates the difference between a portfolio'sactual and expected return given its level of systematic risk. Jensen's Alpha is computed using the following regression equation:

$$R_i - R_f = \alpha + \beta\,[R_m - R_f] + \varepsilon_i$$

where Ri is the return of the fund, Rf is the risk-free rate of return, is the Jensen's Alpha, $\beta$ is the Beta or sensitivity, Rm is the return of benchmark index, and is the error term

(iii) **Information Ratio -** It is derived by comparing a fund to its benchmark. Information ratio measures the ability of a fund manager to generate returns over and above a benchmark after adjusting it for tracking error. Tracking error is defined as standard deviation of difference between fund return and benchmark index return.

$$\text{Information Ratio} = \frac{\text{(Fund return - Benchmark index return)}}{\text{Standard deviation (Fund return - Benchmark index return)}}$$

**C. Downside Risk Based Measures:**

(i) **Sortino Ratio** – In Sharpe ratio, standard deviation in the denominator does not differentiate between good and bad deviations, however, most investors being risk averse dislike losses but are happy with excess returns. Therefore, there are two categories of risk: favorable risk and unfavorable risk. Any return earned above the minimum acceptable return is favorable, and any return earned below the minimum acceptable return is unfavorable. Sortino ratio utilizes only those returns which are earned below a minimum acceptable limit to be used to get a true picture of the fund's performance. In our study, the threshold level of return is 0%.

$$\text{Sortino Ratio} = \frac{\text{Fund's excesss return over threshold}}{\text{Semi - standard Deviation}}$$

**D. Tail Based Measures**

(i) **Modified Sharpe Historical Value at Risk** - Historical VaR is the most widely implemented Non-parametric approach for estimating Value at Risk (VaR). This method uses the empirical distribution of financial returns, thus VaR ($\alpha$) is the $\alpha$ quantile of empirical distribution.

Consider a sample of past returns. The historical VaR at level of significance for period t+1 is given by:

$$VaR_{\alpha} = -Q_{1-\alpha}(r_t, r_{t-1,\ldots,} r_{t-\omega+1})$$

Where, $r_t$ is return of the asset under consideration at time t and is the relevant quantile function at level of significance.

Modified Sharpe Historical VaR is excess return (over and above the risk-free rate) divided by Historical VaR.

(ii) **Modified Sharpe Normal Value at Risk** - Standard VaR estimates the potential loss over a specific time horizon for a given probability. It is a forward-looking measure but it is critiqued for being ignorant about the extreme loss a portfolio could incur in the left tail of the distribution.

$$VaR\ (\alpha) = F^{-1}(\alpha) = \mu_t + \sigma_t\ (\alpha)$$

Where, □ represents mean, represents historical standard deviation, denotes confidence level and t denotes time period considered.

Modified Sharpe Normal VaR is excess return (over and above the risk-free rate) divided by Normal VaR.

(iii) **Modified Sharpe Cornish Fisher Value at Risk -** When returns do not follow normal distribution, Normal VaR is not efficient and to tackle the issue of non-normal distribution, Modified VaR (MVaR) is used by simply incorporating skewed and leptokurtic nature of returns in a fresh set of modified Z scores. This MVaR is based on Cornish-Fisher expansion to estimate VaR in the left-tail of the distribution. Cavenaile and Lejeune (2012) explain that MVaR should not be used with confidence levels below 95.84% so as to maintain consistency with investors' preferences for kurtosis. Thus, estimation of MVaR with 95% confidence level may give inconsistent results. As a result, we compute our results using 99% confidence level for MVaR, hence for all the other measures the confidence level is also same except the expected shortfall for which 95% confidence level is maintained.

Modified Sharpe Cornish Fisher VaR is excess return (over and above the risk-free rate) divided by MVaR.

(iv) **Modified Sharpe Expected Shortfall -** While the VaR tells us nothing more than to expect a loss higher than the VaR itself, Expected Shortfall measures the expected value of our losses if we get a loss in excess of VaR. Modified Sharpe Expected Shortfall is excess return (over and above the risk-free rate) divided by Expected Shortfall.

Further, the mutual fund schemes are ranked according to the ten performance measures mentioned above. The correlation among the ranks of the schemes is calculated using following two rank correlation measures;

1) **Spearman's** $\rho$ – It is a non-parametric measure of statistical dependence of variables. The formula used In test statistic is as follows;

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

where, $d = x_i - y_i$ is the difference between ranks. $n$ = total number of observations. $\rho$ = Spearman's Rank Correlation Coefficient.

2) Kendall's τ – Kendall's Rank Correlation Coefficient is used to measure association between two or more than two quantiles. The tau test is the non-parametric hypothesis testing for analyzing statistical dependence, used the Kendall's τ methodology. The Kendal t statistic is defined as follows:

$$\tau = (no.\ of\ concordant pairs) - (no.\ of\ disconcordant pairs)/\ (\tfrac{1}{2}\, n(n-1))$$

where, any pair of observations $(x_i, y_i)$ and $(x_j, y_j)$ are said to be concordant if the ranks for both elements agree: that is, if both $x_i > x_j$ and $y_i > y_j$ or if both $x_i < x_j$ and $y_i < y_j$.

## Analysis and Interpretation

In this section we have structured our discussion in three sub-sections. In line with the objective of comparing the ranks obtained by 111 schemes according to different risk measures, we have tried to simplify our analysis by calculating Spearman's and Kendall's coefficient of rank correlation among rankings corresponding to all risk adjusted measures. If we analyse measures of rank correlation for all 10 ratios against each other, we get 55 coefficients of Spearman's rank correlation and 55 coefficients of Kendall's rank correlation. It is difficult to interpret 110 coefficients simultaneously and draw meaning conclusions. To simplify our study, we do an inter-group analysis of rank correlation coefficients obtained for

the different pairs of risk measures. In this way our analysis gets divided into 6 sub-sections in which each class of risk measures is compared against another class of risk measures. Our objective is to verify whether there is consistency in the ranking of schemes according to a particular class of risk measures in relation to the ranking of schemes according to another risk measure.

### i. Volatility Based Measures and Sensitivity Based Measures

Volatility based risk measures use standard deviation to quantify risk whereas sensitivity based risk measures use beta or tracking error to quantify risk. In this study, we have calculated two risk adjusted measures to represent volatility based measures i.e. Sharpe Ratio and M2 Ratio. To represent sensitivity based measures we have three ratios namely Treynor's Ratio, Jensen's Alpha and Information Ratio. Following is a matrix showing rank correlation coefficients among these 5 ratios belonging to two different classes.

**Table 1: Rank Correlation Matrix: Volatility Based Measures vs Senstivity Based Measures**

| Performance Measures | Sharpe Ratio | Treynor's Ratio | Jensen's Alpha | Information Ratio | $M^2$ Ratio |
|---|---|---|---|---|---|
| Sharpe Ratio | 1 | .955** | .971** | .936** | 1.000** |
| Treynor's Ratio | .835** | 1 | .986** | .944** | .955** |
| Jensen's Alpha | .879** | .919** | 1 | .928** | .971** |
| Information Ratio | .792** | .819** | .789** | 1 | .936** |
| $M^2$ Ratio | 1.000** | .835** | .879** | .792** | 1 |

*statistically significant at 5% level of significance
** statistically significant at 1% level of significance

The upper triangular part of the matrix (values above the diagonal) represents Spearman's coefficient of rank correlation and the lower triangular part of the matrix represents Kendall's coefficient of rank correlation. This format of the correlation matrix is followed for all comparisons made across different classes of risk measures.

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As we can see in the table, there is a perfect positive rank correlation between Sharpe and M2 Ratio. This is due to the fact that both use the same proxy for risk as standard deviation. Similarly, there is a sufficiently high degree of statistically significant positive correlation among sensitivity based measures i.e. Treynor's ratio, Jensen's Alpha and Information Ratio as they use the concept of responsiveness to changes in a benchmark index as a proxy or risk. Comparing the interclass correlations, we find a strong and statistically significant Spearman's and Kendall's rank correlation among the volatility and sensitivity based measures. This rank correlation ranges from 0.792 (Kendall's Tau) and 0.971 (Spearman's Rho). The fact that these correlations are statistically significant even at 1% level of significance indicates that this congruence in ranking is not due to a chance but there is strong positive correlation among these ratios. For instance, a Kendall's Tau of 0.879 between Jensen's Alpha and Sharpe/M2 Ratio shows that there is a probability of 87.9% of observing concordant pairs of ranks according to these risk adjusted measures.

In summary there is a positive, strong and statistically significant correlation in the ranking of mutual fund schemes according to volatility and sensitivity based risk adjusted measures.

Our null hypothesis of no rank correlation between volatility and sensitivity based risk adjusted measures is rejected.

**ii. Volatility Based Measures and Downside Risk Based Measures**

Downside risk measures use observations only lower than a specified threshold in order to calculate standard deviation and the resultant value is used as a proxy for risk. In this study, we have calculated Sortino Ratio to represent downside risk measures. Following is a matrix showing rank correlation coefficients among 3 ratios belonging to two Volatility and Downside Risk Based Measures.

**Table 2: Rank Correlation Matrix: Volatility Based Measures vs Downside Risk Based Measures**

| Performance Measures | Sharpe Ratio | $M^2$ Ratio | Sortino Ratio |
|---|---|---|---|
| Sharpe Ratio | 1 | 1.000** | .973** |
| $M^2$ Ratio | 1.000** | 1 | .973** |
| Sortino Ratio | .880** | .880** | 1 |

***statistically significant at 5% level of significance**
**** statistically significant at 1% level of significance**

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As shown in the table, we find a very strong and statistically significant Spearman's and Kendall's rank correlation among the volatility and downside risk based measures. The rank correlation ranges from 0.880 (Kendall's Tau) and 0.973 (Spearman's Rho). The fact that these correlations are statistically significant even at 1% level of significance indicates that this congruence in ranking is not due to a chance but there is strong positive correlation among the rankings obtained from these ratios. This shows that the even though the returns are not symmetric, the rankings obtained using standard deviation (which assumes symmetric returns) and semi-standard deviation (which only focuses on left side of the distribution beyond a specified threshold) are highly congruent. A Kendall's Tau of 0.88 between Sortino and Sharpe/M2 Ratio shows that there is a probability of 88% of observing concordant pairs of ranks according to these risk adjusted measures.

In summary there is a positive, strong and statistically significant correlation in the ranking of mutual fund schemes according to volatility and downside risk based measures. Our null hypothesis of no rank correlation between volatility and downside risk based measures is rejected.

**iii. Volatility Based Measures and Tail Based Measures**

Tail based risk measures only use extreme losses as a proxy for risk. In this study, we have

calculated Modified Sharpe Historical VaR, Modified Sharpe Normal VaR, Modified Sharpe Cornish Fisher VaR and Modified Sharpe Expected Shortfall to represent tail based risk measures. Following is a matrix showing rank correlation coefficients among 5 ratios belonging to Volatility and Tail Based Measures:

**Table 3: Rank Correlation Matrix: Volatility Based Measures vs Tail Based Measures**

| Performance Measures | Sharpe Ratio | $M^2$ Ratio | Modified Sharpe Historical VaR | Modified Sharpe Normal VaR | Modified Sharpe CF VaR | Modified Sharpe Expected Shortfall |
|---|---|---|---|---|---|---|
| Sharpe Ratio | 1 | 1.000** | .950** | 1.000** | .806** | .974** |
| $M^2$ Ratio | 1.000** | 1 | .950** | 1.000** | .806** | .974** |
| Modified Sharpe Historical VaR | .823** | .823** | 1 | .949** | .844** | .965** |
| Modified Sharpe Normal VaR | .992** | .992** | .821** | 1 | .804** | .973** |
| Modified Sharpe CF VaR | .659** | .659** | .683** | .656** | 1 | .897** |
| Modified Sharpe Expected Shortfall | .884** | .884** | .851** | .882** | .762** | 1 |

*statistically significant at 5% level of significance
** statistically significant at 1% level of significance

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As shown in the table, we find a very weak but positive rank correlation among the volatility and tail based risk based measures. The rank correlation ranges from 0.659 (Kendall's Tau) and 0.992 (Kendall's Rho). The fact that these correlations are statistically significant significance indicates that this congruence in ranking is not due to a chance but there is strong positive correlation among the rankings obtained from these ratios. This shows that in the even after capturing skewness and kurtosis, the rankings obtained using standard deviation (which assumes symmetric returns) and tail based measures (which only focus on extreme losses) are broadly identical. A Kendall's Tau of 0.884 between Modified Sharpe Expected Shortfall and Sharpe/M2 Ratio shows that there is a probability of 88.4% of observing concordant pairs of ranks according to these risk adjusted measures.

In summary there is a strong, positive and statistically significant correlation in the ranking of mutual fund schemes according to volatility and tail based risk based measures. Our null hypothesis of no rank correlation between volatility and tail based measures is rejected.

**iv. Sensitivity Based Measures and Downside Risk Based Measures**

Following is a matrix showing rank correlation coefficients among 4 ratios belonging to Sensitivity and Tail Based Based Measures.

**Table 4: Rank Correlation Matrix: Sensitivity Based Measures vs Downside Risk Based Measures**

| Performance Measures | Treynor's ratio | Jensen's Alpha | Information Ratio | Sortino Ratio |
|---|---|---|---|---|
| Treynor's ratio | 1 | .986** | .944** | .943** |
| Jensen's Alpha | .919** | 1 | .928** | .955** |
| Information Ratio | .819** | .789** | 1 | .913** |
| Sortino Ratio | .815** | .845** | .757** | 1 |

*statistically significant at 5% level of significance
** Statistically significant at 1% level of significance

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As shown in the table, we find a very strong positive rank correlation among the sensitivity and downside risk based measures. The rank correlation ranges from 0.757 (Kendall's Tau) and 0.955 (Spearman's Rho). The fact that these correlations are statistically significant even at 1% level of significance indicates that this high congruence in ranking is not merely due to chance but chance but there is strong positive correlation among the rankings obtained from these ratios. This shows that even after incorporating the effect of skewness and kurtosis in return series, the rankings obtained sensitivity and downside risk measures are highly congruent. A Kendall's Tau of 0.845 between Sortino Ratio and Jensen's Alpha shows that there is a probability of 84.5% of observing concordant pairs of ranks according to these risk adjusted measures.

In summary there is a positive, strong and statistically significant correlation in the ranking of mutual fund schemes according to sensitivity and downside risk based measures. Our null hypothesis of no rank correlation between sensitivity and downside risk based measures is rejected.

**v. Sensitivity Based Measures and Tail Based Measures**

Following is a matrix showing rank correlation coefficients among 5 ratios belonging to Sensitivity and Tail Based Measures:

**Table 5: Rank Correlation Matrix: Sensitivity Based Measures vs Tail Based Measures**

| Performance Measures | Treynor's Ratio | Jensen's Alpha | Information Ratio | Modified Sharpe Historical VaR | Modified Sharpe Normal VaR | Modified Sharpe CF VaR | Modified Sharpe Expected Shortfall |
|---|---|---|---|---|---|---|---|
| Treynor's Ratio | 1 | .986** | .944** | .925** | .950** | .816** | .944** |
| Jensen's Alpha | .919** | 1 | .928** | .931** | .968** | .811** | .957** |
| Information Ratio | .819** | .789** | 1 | .900** | .931** | .782** | .917** |
| Modified Sharpe Historical VaR | .784** | .794** | .741** | 1 | .949** | .844** | .965** |
| Modified Sharpe Normal VaR | .827** | .872** | .785** | .821** | 1 | .804** | .973** |
| Modified Sharpe CF VaR | .657** | .654** | .611** | .683** | .656** | 1 | .897** |
| Modified Sharpe Expected Shortfall | .817** | .850** | .762** | .851** | .882** | .762** | 1 |

*statistically significant at 5% level of significance
** statistically significant at 1% level of significance

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As shown in the table, we find a very weak but positive rank correlation among the sensitivity and tail based risk based measures. The rank correlation ranges from 0.611 (Kendall's Tau) and 0.968 (Spearman's Rho). The fact that these correlations are statistically significant even at 1% level of significance indicates that this high congruence in ranking is not merely due to chance but chance but there is strong positive correlation among the rankings obtained from these ratios. However it is interesting to note that Modified Sharpe Cornish Fisher VaR has a relatively weak but significant and positive Kendall's rank correlation with Treynor's Ratio, Jensen's Alpha and Information Ratio. This shows that due to the effect of skewness and kurtosis, the rankings obtained using beta/tracking error as risk measures and Modified Sharpe Cornish Fisher VaR may turn out to be different. A Kendall's Tau of 0.762 between Expected Shortfall and Information Ratio shows that there is a probability of 76.2% of observing concordant pairs of ranks according to these risk adjusted measures.

In summary there is a strong, positive and statistically significant correlation in the ranking of mutual fund schemes according to sensitivity and tail based risk based measures. Our null hypothesis of no rank correlation between sensitivity and tail based measures is rejected.

**v. Downside Risk Based Measures and Tail Based Measures**

Following is a matrix showing rank correlation coefficients among 5 ratios belonging to downside risk and tail based risk Measures:

**Table 6: Downside Risk Based Measures and Tail Based Measures**

| Performance Measures | Sortino Ratio | Modified Sharpe Historical VaR | Modified Sharpe Normal VaR | Modified Sharpe CF VaR | Modified Sharpe Expected Shortfall |
|---|---|---|---|---|---|
| Sortino Ratio | 1 | .957** | .972** | .899** | .995** |
| Modified Sharpe Historical VaR | .835** | 1 | .949** | .844** | .965** |
| Modified Sharpe Normal VaR | .879** | .821** | 1 | .804** | .973** |
| Modified Sharpe CF VaR | .767** | .683** | .656** | 1 | .897** |
| Modified Sharpe Expected Shortfall | .947** | .851** | .882** | .762** | 1 |

*statistically significant at 5% level of significance
** statistically significant at 1% level of significance

For any given pair of risk adjusted measures, the null hypothesis is that there is no rank correlation between rankings given by these measures. As shown in the table, we find a strong and positive rank correlation among the downside risk and tail based risk based measures. The rank correlation ranges from 0.767 (Kendall's Tau) and 0.995 (Spearman's Rho). The fact that these correlations are statistically significant even at 1% level of significance indicates that this high congruence in ranking is not merely due to chance but chance but there is strong positive correlation among the rankings obtained from these ratios. This shows that the rankings obtained using semi-standard deviation as a risk measure and tail based risk measures are broadly identical.

In summary there is a strong, positive and statistically insignificant correlation in the ranking of mutual fund schemes according to sensitivity and tail based risk based measures. Our null hypothesis of no rank correlation between sensitivity and tail based measures is rejected.

## Conclusion

The existence of different risk measures is evident of the fact how a concept can be viewed and quantified differently by different people. The question with regard to relevance of such different approaches for making investment decisions is important in order to find out whether the empirical application of these measures for ranking securities yields different results or not. We used Spearman's and Kendall's rank correlation and prepare a cross-sectional matrix to find out the extent of congruence among risk-adjusted measures across four groups of risk-adjusted measures based on how they define and measure risk. To summarise, we find that all the groups of risk-adjusted measures share a strong, positive and

significant rank correlation with each other. However, Modified Sharpe Cornish Fisher VaR has a relatively weak but significant and positive Kendall's rank correlation with Treynor's Ratio, Jensen's Alpha and Information Ratio. This shows that due to the effect of skewness and kurtosis, the rankings obtained using beta/tracking error and Modified Cornish Fisher VaR as proxies for risk may turn out to be different. The results of the study indicate that broadly, there is a substantial degree of concordance among rankings obtained by equity portfolios on the basis of different proxies for risk measurement used in finance. Thus, we conclude that the choice of risk-adjusted measure holds little relevance for making investment decisions in the equity segment of mutual fund market in India.

## References

Cornish, E. A., & Fisher, R. A. (1937). Moments and Cumulants in the Specification of Distributions. Review of the International Statistical Institute, 5, 307-320.

Favre, L., & Galeano, J. A. (2002). Mean-Modified Value-at-Risk Optimization with Hedge Funds. Journal of Alternative Investment, 6, 21-25.

Grau-Carles, P., Sainz, J., Otamendi, J., & Doncel, L. (2009). Different risk-adjusted fund performance measures: a comparison. In SSRN Research Paper Series.

Hsieh, H.-H., & Hodnett, K. (n.d.). A review of performance evaluation measures for Actively- Managed Portfolios. Journal of Economics and Behavioral Studies, 5(12), 815–824.

Jorion, P. (2001). Value at Risk: The New Benchmark for Controlling Market Risk. McGraw-Hill.

BIBLIOGRAPHY Markovitz, H. (1952). Portfolio Selection. Journal of Finance, 7(March), 77-91.

Mean-Variance Portfolio Allocation with a Value at Risk Constraint. (2003). Revista de Economía Financiera, 1(1), 4-14.

Modigliani, F., & Modigliani, L. (1997). Risk-Adjusted Performance Measurement in a Downside Risk Framework. Journal of Portfolio Management, 23(2), 45-54.

Nagar, V., Gupta, R., & Krishnamurthi, C. (2013). Impact on the Rankings of Mutual Funds Due to Choice of Performance Measurel: An Asian Perspective. European Journal of Economics, Finance and Administrative Sciences., 61.

Pedersen, C. S., & Rudholm, T. (2003). Selecting a Risk-Adjusted Shareholder Performance Measure. Journal of Asset Manangement, 4(3), 152-172.

Sharpe, W. F. (1966). Mutual Fund Performance. The Journal of Business.

Simons, K. (1998). Risk-Adjusted Performance of Mutual Funds. New England Economic Review, September/, 33–48.

Sortino, F. A., & Price, L. N. (1994). Performance Measurement in a Downside Risk Framework. Journal of Investing, 3(3).

Sortino, F. A., & Van der Meer, R. (1991). Downside Risk. Journal of Portfolio Management, 17(4), 27-31.

Treynor, J. L. (1965). Hoe to Rate Management of Investment Funds. Harvard Business Review, 43(1), 63-75.

Zangari, P. (1996). A VaR Methodology for Portfolios That Include Options. J P Morgan.

Eling, M. and Schuhmacher, F. (2007). Does the choice of performance measure influence the evaluation of hedge funds?. Journal of Banking & Finance, 31(9), pp.2632-2647.

Eling, M. (2008). Does the Measure Matter in the Mutual Fund Industry?. Financial Analysts Journal, 64(3), pp.54-66.

Razafitombo, H. (2010). A Statistical Analysis of Mutual Fund Performance Measures: The Relevance of IRs, Betas, and Sharpe Ratios. The Journal of Index Investing, 1(2), pp.89-106. Zakamouline, V. (2009). The Choice of Performance Measure Does Influence the Evaluation of Hedge Funds. SSRN Electronic Journal.

Prokop, J. (2012). Further Evidence on the Role of Ratio Choice in Hedge Fund Performance Evaluation. Journal of Finance and Investment Analysis, 1(3), pp.181-195

Ornelas, J., Silva Júnior, A. and Fernandes, J. (2010). Yes, the choice of performance measure does matter for ranking of us mutual funds. International Journal of Finance & Economics, 17(1), pp.61-72.

Dowd, K. (2000). Adjusting for Risk: An Improved Sharpe Ratio, International Review of Economics and Finance 9, pp. 209–222.