Statistical Variables Methodology

Value Research

Some people monitor only their funds' returns, while others need a comprehensive statistical analysis. For the latter, we publish several statistical measures on Value Research Online's fund pages and the Fund Screener tool. These measures help in analysing a fund's risk and risk-adjusted returns. Here's a quick explainer of these measures and how we calculate them.

Mean return (%)

This is a fund's average monthly return (annualised) over the trailing three years. Mathematical formula:

$$\text{Mean return} = \frac{\sum R_i}{n}$$

where,

$\sum$ is symbol for summation of each instance of the fund returns considered

R_i is each instance of monthly return of the fund portfolio

n is number of monthly instances considered

A fund with higher value for mean returns has performed better than others.

Standard deviation (%)

Standard deviation measures the total volatility of a fund and is based on the fund's monthly returns over the last three years. If you add and subtract standard deviation from the mean return, then that would provide you the range within which the fund's returns have largely varied.

Mathematical formula:

$$\text{Standard deviation (SD)} = \sqrt{\sum \left(\frac{R_i - R_p}{(n-1)} \right)^2}$$

where,

$\sum$ is symbol for summation of each instance of the fund returns considered

R_i is each instance of monthly return of the fund portfolio

R_p is the mean return of the fund portfolio

n is number of monthly instances considered

A fund with low standard deviation indicates less volatility in fund returns, whereas a high standard deviation implies higher volatility in returns, as it has varied over a larger range of returns.

68-95-99.7 rule

This is an empirical rule in statistical science that determines the percentage of values that fall within an estimated interval for a normal distribution.

Application - Given a normal distribution of funds returns, 68% of the times the fund returns are within one standard deviation (i.e., both +1 and -1 x SD) of the mean, 95% are within two standard deviations (i.e., both +2 and -2 x SD) of the mean, and 99.7% are within three standard deviations (i.e., both +3 and -3 x SD) of the mean.

Variance (%)

Variance is nothing but the square of standard deviation value. Both are ways of measuring how much the fund's returns vary from their average value.

A low variance indicates low volatility in fund returns, whereas a high variance implies higher volatility in returns.

R-squared

R-squared is a measure of a fund's correlation to the market. It can be interpreted as the percentage of a fund's movements that can be explained by the benchmark's movements. We calculate R-squared by comparing monthly returns over the trailing three years to those of a benchmark.

The R-squared ranges between 0 and 1. A score of 1 indicates a perfect correlation with the benchmark, i.e., the returns of the fund closely trace those of the respective index.

Example - If the R-squared of a fund is 0.50, then about half of the observed variation in the fund's performance can be explained by the benchmark's performance.

Beta

Beta measures how much a fund's returns are sensitive to the market

movements. It helps you understand how much a fund can gain or lose when the market moves up or down. Thus, it tells you how risky or volatile a fund is as compared to the market. It is calculated based on the trailing 3-year monthly returns of the fund and the benchmark.

The beta of the benchmark or (ideal) index fund is 1. A higher beta (closer to 1 or more) indicates that the fund's movements are sharper than the market. However, a low beta (closer to 0) does not necessarily mean lower volatility – it only indicates that the fund does not have a high correlation with its benchmark. A negative value of beta means that the stock is inversely correlated to the benchmark, i.e., it moves opposite to the movements of the benchmark.

> Beta should always be used in conjunction with R-squared
>
> For example, suppose you have two assets with different R-squared and beta values:
>
> Fund A: R-squared = 0.9, Beta = 1.5
>
> Fund B: R-squared = 0.3, Beta = 1.5
>
> Both funds have the same beta, but Fund A has a higher R-squared than Fund B. This means that Fund A is more closely related to the benchmark than Fund B. Fund A's beta is more reliable and useful than Fund B's beta because it reflects how Fund A actually behaves compared to the benchmark.

Alpha (%)

Alpha is a measure of a fund's risk-adjusted return. It is the excess return of the fund above the risk-adjusted market return, given its level of risk as measured by beta.

The mathematical formula for calculating Alpha (theoretically also referred to as Jensen's Alpha) is as below:

$$\text{Alpha} = R_p - (R_f + \text{Beta}\ (R_b - R_f))$$

where,

R_p is the mean return of the fund portfolio

R_f is the risk-free rate of return for the time period considered

R_b is the mean return of the benchmark

Beta is the beta of the fund with respect to the benchmark
A positive alpha indicates that the fund has performed better than expected, given its beta. And a negative alpha indicates the fund has under-performed given the amount of risk taken by the fund manager.

Sharpe ratio

Sharpe ratio measures the fund's returns per unit of risk assumed. It is calculated simply by deducting the risk-free rate of return from the average monthly return and dividing it by its standard deviation for the time period considered.

Normally, the higher the Sharpe ratio, the better the fund's historical risk-adjusted performance. A value greater than 1 is generally considered good, and anything less is considered to be sub-optimal.

Mathematical formula:

$$\text{Sharpe ratio} = \frac{R_p - R_f}{SD}$$

where,

R_p is the mean return of the fund portfolio

R_f is the risk-free rate of return for the time period considered SD is standard deviation of the fund's returns for the time period considered

Pitfalls: Sharpe ratio is calculated based on the assumption that returns are normally distributed, but it may not be so in the real-world markets. Also, the ratio does not distinguish between returns on the upside or downside and focuses only on volatility irrespective of its direction. Hence, it is better to look at it along with other statistical measures such as Sortino ratio, maximum drawdown, etc., to better comprehend the fund's risk-return character.

Treynor ratio

It is a measure of the fund's returns (risk-adjusted) per unit of market risk undertaken. It is calculated by deducting the risk-free rate of return from the average monthly return and dividing by its beta. The higher the ratio, the better the fund's historical risk-adjusted performance.

Mathematical formula:

$$\text{Treynor ratio} = \frac{R_p - R_f}{\text{Beta}}$$

where,

R_p is the mean return of the fund portfolio

R_f is the risk-free rate of return for the time period considered

Beta is the beta of the fund with respect to the benchmark

The formula is quite similar to the Sharpe ratio in the numerator, however the two are different. Sharpe ratio helps to understand a fund's return compared to its own portfolio risk, while the Treynor ratio explores the fund's return generated for each unit of systemic risk of its portfolio.

Sortino ratio

Sortino ratio is a modified version of the Sharpe ratio, wherein it takes into account only the negative volatility, while Sharpe ratio considers the total overall volatility. It achieves this by utilising the asset's downside deviation, which is the standard deviation of only negative portfolio returns, instead of the total standard deviation of portfolio returns.

Mathematical formula:

$$\text{Sortino ratio} = \frac{R_p - R_f}{SD_d}$$

where,

R_p is the mean return of the fund portfolio

R_f is the risk-free rate of return for the time period considered

SD_d is downside standard deviation of the fund's returns for the time period considered

Again, much like Sharpe ratio, a higher Sortino ratio is better as it helps evaluate a fund's return for a given level of only the "bad" risk, as deviation on the positive side is not really intuitively considered as a risk by investors.

Information ratio

Information ratio measures by how much a fund outperforms its benchmark, while taking into account the incremental risks (compared to benchmark) involved in achieving those higher returns. It is calculated by deducting the return of the index from the return of the portfolio and dividing it by the tracking error (standard deviation of the differences between each instance of the fund's returns and the benchmark's returns for the period considered).

Mathematical formula:

$$\text{Information ratio} = \frac{R_p - R_b}{TE}$$

where,

R_p is the mean return of the fund portfolio

R_b is the mean return of the benchmark

TE is the tracking error

A high information ratio indicates that a manager has consistently generated better returns than the benchmark index, after adjusting for risks.

Covariance

Covariance measures the directional relationship between the returns on the fund and its benchmark.

Mathematical formula:

$$\text{Covariance} = \frac{(R_i - R_p) X (R_m - R_b)}{(n-1)}$$

where,

Σ is symbol for summation of each instance of the fund returns considered

R_i is each instance of monthly return of the fund portfolio

R_p is the mean return of the fund portfolio

R_m is each instance of monthly return of the benchmark

R_b is the mean return of the benchmark

n is number of monthly instances considered

A positive covariance shows that the fund and its benchmark generally move up or down together, while a negative value for covariance indicates that they have an inverse relationship, i.e., they tend to move in opposite directions. If covariance is closer to zero or zero, then it means that there is very little or no clear relationship in a particular direction between the fund and the benchmark.

Upside ratio (%)

The upside ratio measures how well a fund performed during periods when the benchmark return was positive. This statistical measure helps to evaluate the overall performance of the fund during up-markets. It is often compared with the downside ratio to get a comprehensive understanding of the fund's performance in both, up and down markets. It is sometimes also referred to as the Upside capture ratio.

Mathematical formula:

$$\text{Upside ratio} = \frac{R_{pu}\ X\ 100}{R_{bu}}$$

where,

R_{pu} is the mean return of the fund portfolio during instances of positive benchmark returns

R_{bu} is the mean of positive benchmark returns

Example - If a fund has an upside ratio greater than 100, it means that it has performed better than the benchmark when the latter delivered positive returns. For instance, an upside ratio of 130 indicates that the manager outperformed the market by 30% the period under consideration.

Downside ratio (%)

The downside ratio measures how well the fund was able to outperform (i.e., stem the fall of returns) as compared to its benchmark when the benchmark delivered negative returns. It is often compared with the upside capture ratio to get a comprehensive understanding of the fund's performance in both, up and down markets. It is sometimes also referred to as the Downside capture ratio.

Mathematical formula:

$$\text{Downside ratio} = \frac{R_{pd}}{R_{bd}} \text{ X } 100$$

where,

R_{pd} is the mean return of the fund

portfolio during instances of negative benchmark returns

R_{bd} is the mean of negative benchmark returns

Example - When a fund has a downside ratio of less than 100, it means it has performed better than the index during periods when the benchmark has had negative returns. For instance, if a fund has a downside ratio of 75, it suggests that the fund's portfolio declined only 75% as much as the benchmark during the period under consideration.

Downside risk

Downside risk is calculated as the standard deviation of the fund's performance, but only on the negative side, i.e., in case of losses. Thus, the mathematical formula for downside risk is the same as for standard deviation, just that is calculated only for instances when the fund delivered negative returns.Downside risk is sometimes also referred to as semi-deviation.

Example - Suppose an investment has 10 annual returns, as follows:

5%	-2%	-5%	1%	9%	8%	-3%	8%	-8%	12%

The standard deviation of the data set is 6.82%, and its downside deviation (i.e., only for negative numbers) is 2.29%. This means that roughly 33% of the total volatility is due to negative returns, while the remaining 67% is due to positive returns. This breakdown reveals that the investment's volatility is mainly due to "good" volatility.

Maximum (Max) drawdown (%)

Maximum drawdown is the highest loss that a fund experiences from its highest point to its lowest point before it reaches a new high during a given period.

It is calculated based on observations of peaks and troughs of the fund's monthly return data when plotted on a graph for a given period. Thus, it can be represented as the following equation.

$$\text{Max drawdown} = \frac{\text{Trough Value-Peak Value}}{\text{Peak Value}}$$

This measure is a way to evaluate the downside risk of a portfolio over a particular period of time. It is a useful tool for evaluating the comparative risk level of one fund versus another.

Max drawdowns are always negative. It is a useful tool for evaluating the comparative risk level of one fund versus another. Thus, if one were to compare risk between two funds using max drawdown, then a fund with a lower value of maximum drawdown should be preferred as it implies that losses from their investments were minimal. On the other hand, a maximum drawdown of -100% would indicate that the investment has no value at all, which is the worst possible outcome.

Example - Maximum drawdown of Fund A and Fund B are -66% and -40% respectively, for a given period. The Fund B has a lower maximum drawdown and hence is less risky than Fund A for that period.

It's worth noting that maximum drawdown only considers the magnitude of the most significant loss, and it does not take into account how frequently significant losses occur. This metric concentrates on capital preservation, which is a vital consideration for many investors.

Maximum (Max) gain (%)

Maximum gain refers to the highest total return over consecutive periods of positive returns within a given timeframe. Let us understand this with an example.

Consider the following case where we have the month-end NAV given for a fund.

Date	Fund NAV	Monthly return	Total positive returns for the consecutive months
31-12-22	10		
31-01-23	10.5	5.0%	
28-02-23	10.7	1.9%	7%
31-03-23	10.4	-2.8%	
30-04-23	10.6	1.9%	5.77%
			7%
			Max gain

Here, we see that the fund has delivered positive returns in the first two months consecutively, i.e., in Jan-23 and Feb-23, where the total return delivered by the fund was 7%. Subsequently, it had a poor run delivering negative returns in Mar-23. Thereafter, for the next three months, it delivered positive returns, which aggregated to 5.77%.

Thus, when we see the highest returns delivered by the fund where it had a consecutive streak of positive returns, it is 7%, which is the max gain of the fund for the six months considered.

Maximum (Max) loss (%)

Maximum loss refers to the lowest total return over consecutive periods of negative returns within a given timeframe. Let us understand this with an example.

Consider the following case where we have the month-end NAV given for a fund.

Here, we see that the fund has delivered negative returns in the first two months consecutively, i.e., in Jan-23 and Feb-23, where the total return delivered by the fund was -4%. Subsequently, it had a sudden rally where it delivered high positive returns in Mar-23. Thereafter, for the next three months, it delivered negative returns, which aggregated to -7.55%.

Thus, when we see the lowest returns delivered by the fund where it had a consecutive streak of negative returns, it is -7.55%, which is the max loss of the fund for the six months considered.

Date	Fund NAV	Monthly return	Total positive returns for the consecutive months
31-12-22	10		
31-01-23	9.8	-2.0%	
28-02-23	9.6	-2.0%	-4%
31-03-23	10.6	10.4%	
30-04-23	10.3	-2.8%	
31-05-23	10.2	-1.0%	
30-06-23	9.8	-3.9%	-7.55%
			-7.55%
			Maximum (Max) loss