PERFORMANCE APPRAISAL STATISTICS

LONGS PEAK ADVISORY SERVICES

	Statistic	Calculation	Description
Absolute Return Measures	Holding Period Return (HPR)	$$\frac{\text{Ending Market Value} - \text{Beginning Market Value}}{\text{Beginning Market Value}}$$	Used to calculate the performance of a specific holding period. Often this is used to calculate sub-period returns between cash flows or full-month returns for months with no external cash flows.
	Time-Weighted Return (TWR)	$$\text{TWR} = [(1 + \text{HPR}_1)(1 + \text{HPR}_2)(1 + \text{HPR}_3)...(1 + \text{HPR}_t)]^{n/t} - 1$$ n = number of periods per unit t	Geometrically linked holding period returns can be used to calculate Time-Weighted Returns (TWR) which remove the effect of external cash flows. These returns are useful when analyzing a manager's ability to implement their strategy because the returns are not distorted by the timing and amount of client-driven, external cash flows. The formula shown in the calculation column is the annualized TWR. For a cumulative TWR, the n/t exponent can be removed.
	Internal Rate of Return (IRR)	$$0 = \text{CF}_0 + \frac{\text{CF}_1}{1+\text{IRR}} + \frac{\text{CF}_2}{(1+\text{IRR})^2} + ... + \frac{\text{CF}_n}{(1+\text{IRR})^n}$$	Internal Rate of Return (IRR) is the most common return measure that is considered "Money-Weighted." Money-Weighted returns are impacted by the timing and amount of external cash flows; therefore, they are most useful when determining a client's actual return or when assessing a manager's ability to manage a strategy when the manager had control of the timing and amount of external cash flows (e.g., Private Equity).
Relative Return Measures	Arithmetic Excess Return	$$\text{annualized strategy return} - \text{annualized benchmark return}$$	Arithmetic Excess Return is a quick and simple way to demonstrate a strategy's outperformance over its benchmark. The geometric method is generally considered more accurate than the arithmetic method, but both are commonly used.
	Geometric Excess Return	$$\frac{1 + \text{annualized strategy return}}{1 + \text{annualized benchmark return}} - 1$$	Geometric Excess Return demonstrates a strategy's outperformance over its benchmark. The geometric method is generally considered more accurate than the arithmetic method, but both are commonly used.
	Upside Capture Ratio	$$\frac{\text{geometric average of strategy returns}}{\text{geometric average of benchmark returns}}$$ using only the periods when benchmark returns are positive	The Upside Capture Ratio (UC) is a measure of the strategy's overall performance in up markets. The UC measures capture when the benchmark return is positive. It is best to compare the results to 100%. For the UC ratio, it is ideal to have the result greater than 100% because that signals that the strategy outperformed during up-market periods. It is common to look at this result with the Downside Capture Ratio so that one can get the full picture.
	Downside Capture Ratio	$$\frac{\text{geometric average of strategy returns}}{\text{geometric average of benchmark returns}}$$ using only the periods when benchmark returns are negative or zero	The Downside Capture Ratio (DC) is a measure of the strategy's overall performance in down markets. The DC measures capture when the benchmark return is zero or negative. It is best to compare the results to 100%. For DC, it is ideal to have the result to be less than 100% because it signals the strategy outperformed during down-market periods. It is common to look at this result with the Upside Capture Ratio so that one can get the full picture.
	Market Capture Ratio	$$\frac{\text{up} - \text{market capture ratio}}{\text{down} - \text{market capture ratio}}$$	The Market Capture Ratio calculates the strategy's gain or loss relative to the gain or loss of the benchmark. It measures the asymmetry of return. A Market Capture Ratio of greater than 1 indicates positive asymmetry. Since it is ideal to have an Upside Capture Ratio of greater than 100% and a Downside Capture Ratio of less than 100%, a full Market Capture Ratio that is greater than 1 indicates the strategy is generally performing well. However, in order to clearly understand what drives the Capture Ratio, you need to know the results of its components.

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If you have questions about investment performance or if you would like a performance appraisal report created for your strategies, please contact Sean P. Gilligan, CFA, CPA, CIPM at sean@longspeakadvisory.com or +1.720.917.9621.

Statistic	Calculation	Description
Sharpe Ratio	$$\frac{\text{average strategy return} - \text{average risk-free rate}}{\text{strategy standard deviation}}$$	The Sharpe Ratio is one of the most popular performance appraisal measures. It measures the excess return for taking on additional risk. The Sharpe Ratio is used to compare and rank managers with similar strategies. Investors prefer a higher Sharpe Ratio when comparing similarly managed strategies.
Sortino Ratio	$$\frac{\text{average strategy return} - \text{minimum acceptable return}}{\text{downside deviation}}$$	Similar to the Sharpe Ratio, the Sortino Ratio is also used to compare and rank managers with similar strategies. However, unlike Sharpe, Sortino measures incremental average strategy return over a minimum acceptable return per unit of downside risk rather than total risk. The Sortino Ratio may be more appropriate than the Sharpe Ratio when assessing strategies with asymmetrical positive spikes in performance since the Sharpe Ratio would penalize the manager for these spikes in performance, while the Sortino Ratio would not.
Treynor Ratio	$$\frac{\text{average strategy return} - \text{average risk-free rate}}{\beta_{\text{strategy}}}$$	The Treynor Ratio measures the excess strategy return per unit of systematic risk. The difference between the Sharpe Ratio and the Treynor Ratio is that the Sharpe Ratio adjusts for total risk (both systematic and unsystematic risk) and the Treynor Ratio adjusts only for systematic risk (market risk). While the Sharpe Ratio is calculated using its own volatility, the Treynor Ratio relies on beta, which requires the use of a meaningful benchmark. The Treynor Ratio is best used when evaluating strategies that may be added to a fully-diversified portfolio. Treynor is less useful when the intent is to place an investor's total portfolio in a single strategy.
Jensen's Alpha	$$\text{average strategy return} - \text{CAPM}$$	Jensen's Alpha measures a strategy's excess return over the expected return of the strategy as determined by using the Capital Asset Pricing Model (CAPM). This measures the portfolio manager's ability to achieve a return beyond what is expected for the level of risk employed.
Calmar Ratio	$$\frac{\text{annualized strategy return}}{\text{maximum drawdown (displayed as a positive value)}}$$	The Calmar Ratio compares the annualized strategy return to the Maximum Drawdown of the strategy. It is recommended that this measure is used to compare multiple strategies rather than to analyze one strategy in isolation. Using the Maximum Drawdown as an indication of risk rather than standard deviation or beta can cause the Calmar ratio to be misleading if the Maximum Drawdown was an outlier compared to otherwise stable returns; however, the ratio is considered to be a valid indication of manager skill, especially for hedge fund managers where large drawdowns could signal poor management.

Absolute Risk-Adjusted Return Measures

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	Statistic	Calculation	Description
Relative Risk-Adjusted Return Measures	Information Ratio	$$\dfrac{\text{average strategy return } - \text{ average benchmark return}}{\text{tracking error}}$$	The Information Ratio demonstrates the strategy's excess return, scaled by risk. Rather that using total risk (standard deviation) or systematic risk (beta) to account for risk, the Information Ratio uses Tracking Error. Since Tracking Error indicates the strategy's consistency with the benchmark, the Information Ratio indicates the level of consistency in which the strategy has achieved its excess returns.
	M^2	$$(\text{sharpe ratio} \times \sigma_{\text{benchmark}}) + \text{average risk–free rate}$$ or, equivalently $$(\text{average strategy return } - \text{ average risk-free rate})\dfrac{\sigma_{\text{benchmark}}}{\sigma_{\text{strategy}}} + \text{average risk–free rate}$$	M^2 is a measure of strategy return that is adjusted for the total risk (measured by standard deviation) of the strategy relative to that of the benchmark. M^2 tells us what the return for the strategy would have been if it had the same total risk as the benchmark. It is a risk-adjusted return measure that allows for the comparison of portfolios with different levels of risk. Like with the Sharpe Ratio, this statistic can be used as a ranking device or for individual interpretation.
Absolute Risk Measures	Standard Deviation	$$\sqrt{\dfrac{\sum_{i=1}^{n}(\text{HPR}_i - \mu)^2}{n}}$$	Standard Deviation of a strategy's returns measures the strategy's volatility. Volatility is an indication of the strategy's total risk, which includes both systematic risk (market risk) and unsystematic risk (e.g., security or industry-specific risk). It is most useful for traditional investment strategies where return streams are expected to be symmetrical.
	Semi-Deviation	$$\sqrt{\dfrac{\sum_{\text{HPR}_i<\mu}^{n}(\text{HPR}_i - \mu)^2}{n}}$$	Semi-Deviation is similar to Standard Deviation except it assesses the volatility of only the returns that are less than the average return for the given period. This is a useful statistic when the investor thinks that only returns less than the average return are risky. Semi-Deviation is most useful for alternatives managers that have strategies that are expected to have asymmetrical return streams (e.g., positive spikes in performance without large negative returns).
	Maximum Drawdown	largest peak-to-trough loss within a specified period	Maximum Drawdown is the largest peak-to-trough loss within a specified period. This measure indicates the worst loss an investor could have experienced if they had invested at the strategy's high point and sold the strategy at the subsequent low point.
	Skewness	$$\dfrac{m_3}{m_2^{3/2}} \quad \text{such that} \quad m_r = \dfrac{\sum_{i=1}^{n}(x_i - \mu)^r}{n}$$	Skewness characterizes the degree of asymmetry of a distribution around its mean. A Skewness of 0 means the data is normally distributed (i.e., is shaped like a normal bell curve). Positive Skewness indicates the data has a large number of outliers distributed above the mean. The opposite is true for negative Skewness. Skewness compares the size of each tail to determine the symmetry of the data. Investors should prefer positive skewness.
	Kurtosis	$$\dfrac{1}{n}\sum_{i=1}^{n}(\dfrac{x_i - \mu}{\sigma_s})^4$$	Similar to Skewness, Kurtosis also assesses the distribution of the data (i.e., the shape of the curve compared to a normal bell curve). It illustrates how peaked or flat the distribution is when compared with the normal distribution. Rather than comparing the tails, Kurtosis compares the center of the distribution to the combination of the tails. A normal distribution has a Kurtosis of 3; greater than 3 indicates a peaked distribution with fat tails while less than 3 indicates a less peaked distribution with thin tails.

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Relative Risk Measures	Beta	$$\frac{\text{covariance of strategy and benchmark returns}}{\text{benchmark variance}}$$	Beta is a measure of a strategy's systematic risk (market risk). It describes how the strategy's returns move relative to the market. For example, a strategy with a beta of 1 is expected to move exactly in line with the market while a strategy with a beta of 1.2 moves in the same direction as the market, but with more dramatic swings. A strategy with a negative beta moves in the opposite direction as the market and a strategy with a 0 beta has no correlation with market movements.
	Tracking Error	standard deviation of the arithmetic excess returns for a given number of periods	Tracking Error measures how closely a strategy follows the benchmark. This is also referred to as tracking risk. A passive investment strategy should have a Tracking Error close to zero. Active managers should have a higher Tracking Error, but not so high as to indicate benchmark misspecification.
	Batting Average	$$\frac{\text{number of months strategy beat benchmark}}{\text{total number of months}}$$	Batting Average allows for portfolio managers to see how often they are beating their strategy's benchmark. For example, if a portfolio manager's Batting Average is 0.500, then they are outperforming the benchmark half of the time. In contrast, a portfolio manager whose Batting Average is 1.000 would be beating the benchmark every month for the given period.
	R^2	$$(\text{correlation of strategy and benchmark returns})^2$$	Coefficient of Determination (R^2) is a measure of the goodness of fit of the relationship between the dependent and independent variables in a regression analysis; for example, the percentage of variation in the return of a strategy that is explained by the market return. R^2 measures on a 0% to 100% scale how much of the movement in the strategy's returns are explained by its benchmark.

About Longs Peak Advisory Services

Longs Peak Advisory Services, LLC was founded in 2015 with the objective of helping investment managers and asset owners improve their investment performance reporting. Whether that means calculating investment performance statistics to help firms market a new strategy, helping firms become GIPS® compliant, or filling the role of a fully outsourced performance department, our team is available to support your organization's investment performance needs. Visit our website at www.longspeakadvisory.com to learn more about our services.

A Note About Performance Appraisal Measures

When calculating performance appraisal measures that compare return to risk, such as in the Sharpe Ratio, the return used in the numerator of the ratio should be the arithmetic mean of the return stream, not the geometric mean. Strategies with significant volatility have lower geometric means than arithmetic means. This is because the geometric mean penalizes the return stream for risk-taking. Because risk is already being accounted for in the denominator, there is no need to include it in the numerator; in fact, including it would be double-counting the risk taken. Because of this, it is more appropriate to use the arithmetic mean than geometric mean.