Measuring the Investment Risk of Equity Funds

A Reference for Fund Directors

May 2018

Introduction

Why this Reference?

Investment risk includes both intended or expected risk from the investment process and unintended risk that may result from investment decisions, assumptions, market movements, and other factors. While the fund's adviser manages this risk, directors have an important oversight role.

This Reference provides an overview of the statistical measures that may be used to evaluate investment risk in equity funds and that may be included in reports provided to directors. It has 4 sections:

- **Key Factors** | 4 key factors to consider when reviewing risk measures.
- **Common Uses** | a summary of the most common uses of the risk measures.
- **Follow Up** | questions that directors might ask to learn more about how the adviser measures investment risk.
- **A to Z** | a glossary with definitions of common risk measures. Includes the arguments for and against specific measures and reviews when measures may be used. The definitions are summarized in tables at the end of the glossary.

For more background,
be sure to read the
Mutual Fund Directors Forum
February 2017 publication

Role of the Mutual Fund Director in the Oversight of the Risk Management Function

Key Factor #1

Ex Post vs. Ex Ante

Risk statistics can be divided into two categories: ex post and ex ante.

- **Ex post**

  Ex post statistics measure risk over a period in the **past**. They measure historical price or return volatility. Standard deviation, the Sharpe ratio and alpha are commonly-used ex post risk statistics.

  Ex post measures can be computed for any period (e.g., daily, weekly or monthly), but they are generally annualized to make comparisons easier.

  > *Example:* Morningstar uses historical monthly returns for a given time period (one-, three-, five-, 10-, 15- or 20–year) to arrive at a monthly standard deviation for that period. The monthly standard deviation figure is then annualized.

  Ex post statistics provide an accurate measurement of price or return volatility in the past. However, they may not be a good predictor for the future, either because of changes in portfolio composition or because of changes in the behavior of holdings in the portfolio.

Ex post or ex ante?

The A to Z glossary provides detail.

Key Factor #1

Ex Post vs. Ex Ante (continued)

- **Ex ante**

  Ex ante statistics forecast the **future** level of risk by looking at the current holdings within the fund. They provide insight into the fund's level of volatility and how it might perform in future.

  Example: Active share is an ex ante risk measure. It looks at the overlap between a fund's holdings and the components of an index to provide insight on how closely the fund's performance might track the index in future.

  Like all statistical forecasts, ex ante measures are not always good predictors of future volatility or performance.

  - Ex ante forecasts are based on a fund's current holdings, which means that they may not be good predictors if the fund's composition changes significantly.
  - Ex ante statistics are often based on the past volatility and correlation of stocks held in the fund. This historical data is not necessarily a good predictor of stocks' future price behavior.

Ex post or ex ante?

The A to Z glossary provides detail.

Key Factor #2

Risk and Performance

Risk statistics can be divided into two categories along another dimension:

- **Risk only**

  One set of measures looks at **risk only** without taking performance into account.

  > *Example:* Standard deviation is an example of a risk-only measure, since it looks only at the variation in net asset value – and not whether that NAV is rising, falling, outperforming, underperforming or none of the above.

- **Risk vs. performance**

  The other set of measures considers **risk within the context of performance**. In other words, they evaluate whether the risk taken generated sufficient reward in terms of performance.

  > *Example:* The Morningstar rating ranks funds according to their risk-adjusted performance.

  Both risk and performance can be measured and analyzed independently, but trustees also may be interested in examining the two attributes in unison, as risk-adjusted performance. The combination allows for a more meaningful comparison of the performance of two funds with different levels of risk.

  All risk vs. performance statistics are **ex post** measures.

Risk only or risk vs. performance?

The A to Z glossary provides detail.

Key Factor #3

Price Volatility Focus

All of the measures in this Reference evaluate risk by looking at price volatility, meaning the movements in the fund's NAV or in the market value of its portfolio investments.

Price volatility is a risk in and of itself because, under adverse conditions, an investment with higher volatility will likely experience a larger loss than an investment with lower volatility.

At the same time, price volatility can be an indicator for other sources of risk. For example, the stocks of companies with substantial financial leverage may exhibit higher price volatility than average because their businesses are more sensitive to changes in the economy.

As a result, price volatility is used as an approximation for the overall level of risk. That approximation works reasonably well for widely-held and liquidly-traded securities, because the prices of these investments adjust quickly to changes in business fundamentals.

However, that may not necessarily be the case for thinly-traded investments, such as private placements. Because trading is infrequent, the price of these investments can remain unchanged for an extended period, even as company fundamentals change from day to day.

Key Factor #4

Evolving Definitions and Approaches

The definitions of risk measures are evolving, as new frameworks are developed and as the concepts they promulgate migrate into everyday use.

> *Example:* A quantitative analyst would define "alpha" as out/underperformance versus the index in excess of the risk-free rate, adjusted for risk. However, in informal usage, the term "alpha" has evolved to mean the absolute value of the difference between fund performance and benchmark performance.

At the same time, risk management has evolved tremendously over the past 50 years, and new approaches are constantly being developed. However, in general, the objectives of risk management remain the same:

- Understanding the types of risk being assumed by a fund and
- Evaluating whether the type and level of risk are appropriate given the fund's investment objective.

Common Uses

What a Director is Likely to See

The A to Z glossary provides additional information about these risk measures.

While all of the risk measures in this Reference may be used with certain types of funds and in certain contexts, some are particularly common. Namely:

- ### Total Risk

  Beta and **standard deviation** are commonly used to assess the total risk of a fund.

- ### Downside Risk

  Bear market percentile rank, **semi-deviation**, the **Sortino ratio** and **upside-downside capture ratios** provide insights into a fund's performance in adverse environments. They may be most useful if the fund's objective is to limit downside risk.

- ### Differentiation from an Index

  Tracking error (ex ante) and **active share** provide insights into how closely a fund is expected to track the performance of a benchmark index. They are most valuable when used with funds with relatively high **R^2 (R-squared)** statistics.

  In most cases, funds with a high tracking error will also have a high active share, but there are circumstances where this general rule may not apply.

Common Uses

What a Director is Likely to See (cont.)

- ### Index Funds

  Index funds are normally focused on reducing **tracking error (ex post)**.

- ### Return for Risk Assumed

  The **information ratio**, the **Sharpe ratio** and the **Treynor ratio** provide insights on a fund's excess return relative to the risk it assumed.

  Generally, a fund's risk/return ranking will normally be similar for all three ratios. That's because the ratios are based on the same principle, even though their methodologies differ somewhat.*

  *The Sharpe and Treynor ratios look at return in excess of the risk-free rate, while the information ratio looks at return in excess of the benchmark; the information and Sharpe ratios use standard deviation as the measure of risk, while the Treynor ratio uses beta.

- ### Fixed Income Funds and Other Fund Types

  While this Reference focuses on equity funds, many of the measures it discusses are often used to assess the risk of fixed income funds and other fund types. However, these funds will often use additional risk measures including portfolio duration and convexity.

Follow Up

Possible Questions

Questions that directors might ask to learn more about equity fund risk at their complex:

- **Which risk measures for this fund and why?**

  Why are the identified risk measures used for this fund?

  If a measure is being added or otherwise changed, why? Does the change reflect a revised investment approach?

- **Which risk measures are used for comparisons?**

  What measures can be used for comparing funds within a fund's peer category?

  What measures can be used for comparing funds within the complex?

- **Is performance consistent with risk?**

  Is performance consistent with ex ante risk measures? If not, why not?

  Is performance the result of a risk known in advance? Or did it arise from an unanticipated risk? From a portfolio management decision?

- **Why this level of risk?**

  Given the risk measure used, is this level of risk consistent with the fund's objective?

  How does the investment team determine the appropriate level of risk?

A to Z
of Risk Measures

Active Share

Ex ante | Risk only

Active share measures the **percentage of a portfolio that is actively managed**. It equals the overlap between an actively-managed portfolio and its benchmark index. It ranges from 0% to 100%.

If overlap between the fund and the index is low, the fund has a high active share. A fund with no overlap with the index has an active share of 100%.

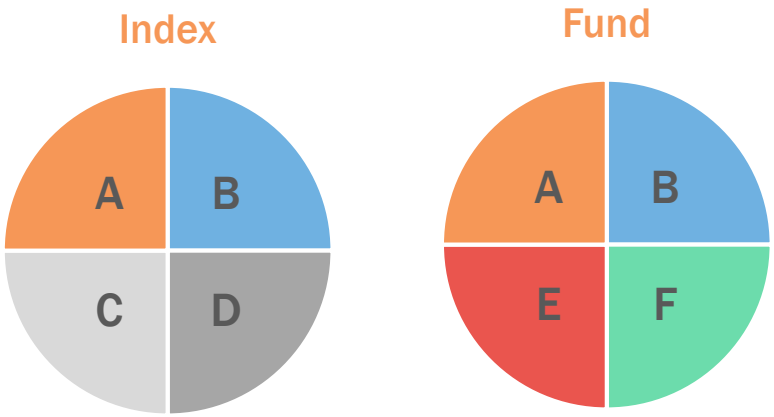
If overlap is high, the fund has a low active share. An index fund has an active share of 0%.

Active share is normally used to measure the risk of actively-managed equity funds.

Computing Active Share

Active share is calculated by comparing the weightings of holdings in the benchmark index and the weightings of holdings in the portfolio. It equals 100% less the percentage of the portfolio that overlaps the index.

Example: An index and a fund each hold 4 equally-weighted stocks. The fund holds 2 of the 4 stocks in the index, as illustrated below.



The active share of the fund is 50% -- equal to 100% minus the two holdings that overlap the index (namely, Stock A with a 25% weight and Stock B with a 25% weight).

Active Share (continued)

Proponents Say . . .

- Active share has the virtue of **simplicity**. The measure is easy to understand and easy to compute. As a result, active share is often used in academic research.
- Active share provides a quick assessment of the **fund's capacity to outperform an index**. A fund with low active share will be more likely to perform in line with the index than a fund with a high active share. As a result, funds with higher active share may be able to support higher fees.
- Active share is **correlated with outperformance**. A study by Professor Martijn Cremers found that funds with a combination of high active share and long duration significantly outperformed over a 30 year period.*

Critics Say . . .

- Active share is **too simple** and doesn't capture the overall risk of the portfolio.

  Going back to the example on the preceding page, assume that Stocks C and D in the index are energy stocks and that the portfolio manager replaces them with two other energy stocks (Stocks E and F) in the fund. Active share may be high, but the fund may still perform in line with the index.

  Alternatively, if new Stocks E and F are biotech stocks, active share might be understating risk relative to the index.

  In critics' view, tracking error is a better measure of ex ante risk.
- **High active share doesn't equal outperformance.** There's no theoretical reason why high active share should generate higher returns than the index. In fact, the Cremers study shows that high active share funds outperformed only during the first half of the 30-year period studied.*

* Martijn Cremers, "Active Share and the Three Pillars of Active Management: Skill, Conviction and Opportunity," December 2016

Alpha (α)

Alpha measures the level of out/underperformance versus a benchmark **after adjusting for risk**.

Alpha is positive if a fund outperforms, and negative if it underperforms.

Informally Speaking . . .

The term alpha can also refer to the **absolute value** of the difference between fund performance and benchmark performance. The technical term for this difference is **excess return**.

In other words, alpha is a term that is often used loosely to refer to out/underperformance. However, quantitative analysts have a more precise definition.

Computing Alpha | An Example

Assumptions:

- Fund return over period = 12%
- Fund's risk = 10% higher than the market
- Benchmark index return over period = 10%

In this scenario, the fund's expected return is 11%, which equals the index return of 10% times 1.1 (to reflect the higher risk.)

The fund's alpha equals the actual return of 12% less the expected return of 11% or a positive 1%.

The measure of risk is not specified in this general definition, and any risk statistic (such as standard deviation) can be used. However, beta is most commonly used.

Compared to Jensen's Alpha

Jensen's alpha is a specific version of the general formula for alpha; it mandates the use of beta as the risk measure. As a result, a calculation of alpha using beta can be called either "Jensen's alpha" (specific version) or just "alpha" (general formula).

Bear Market Percentile Rank

The bear market percentile rank is provided by Morningstar to measure how well a fund has performed during **down markets only**.

A fund with a high rank has performed relatively well in bear markets.

Bear market rank may be useful for conservative funds or those with an objective of limiting downside risk.

Step 1

Identify bear market months during the past 5 years (3%+ decline for stock market; 1%+ decline for bond market)

Step 2

For each fund, add up returns during the bear market months to arrive at the "total bear market return"

Step 3

Separate stock and bond funds, then calculate the fund's percentile rank within its group

Beta (β)

Ex ante or ex post | Risk only

Beta measures a fund's **risk relative to the market**.

A fund with a beta of 1.0 has risk equivalent to that of the market. A beta above 1.0 signals higher risk, while a beta below 1.0 signals lower risk.

Beta will be useful for funds that are managed relative to a market index and that hold frequently-traded securities.

Ex Post Beta

An ex post beta is calculated based on past returns of the fund and the market index.

Ex Ante Beta

Alternatively, an ex ante beta can be calculated. It equals the weighted average of the betas of the securities held by the fund.

Calculating Beta

Beta is determined by performing a regression analysis of stock or security returns versus market returns. All returns are reduced by the risk-free rate (normally the Treasury bill rate).

Technically Speaking. . .

Beta measures **systematic risk** that cannot be diversified away.

Calmar Ratio

Ex post | Risk vs. performance

The Calmar ratio compares fund performance to the **maximum drawdown** (which is the decline from peak to trough value).

The higher the Calmar ratio, the more return generated per unit of risk.

The Calmar ratio was developed for commodity pools and hedge funds. It may be particularly relevant for absolute return funds or those with an objective of limiting volatility.

Step 1

Calculate 3-year fund return and annualize

Step 2

Identify peak and trough valuations and calculate percentage decline from peak to trough (= maximum drawdown)

Step 3

Divide annualized return by maximum drawdown

Compared to the Sterling Ratio

The Calmar ratio uses maximum drawdown to measure risk, while the Sterling ratio uses average annual drawdown.

Information Ratio

Ex post | Risk vs. performance

The information ratio compares **excess return** versus the benchmark **to total risk**.

The higher the information ratio, the more outperformance generated per unit of risk.

Computing the Information Ratio

The information ratio equals:

- Excess return, which equals the fund return minus the benchmark return (often referred to as "alpha")

Divided by:

- The fund's standard deviation for the relevant period.

Compared to the Sharpe Ratio

The information ratio is a generalized version of the Sharpe ratio, substituting a benchmark for the risk-free rate.

Jensen's Alpha

Alpha measures the level of out/underperformance versus a benchmark **after adjusting for beta**.

Alpha is positive if a fund outperforms, and negative if it underperforms.

Technically Speaking . . .

Returns are reduced by the risk-free rate, and beta is applied only to excess return over the risk-free rate. The example avoids this adjusting by assuming that the risk-free rate is 0%.

Computing Jensen's Alpha | An Example

Assumptions:

- Fund return over period = 12%
- Fund's beta = 1.1
- Benchmark index return over period = 10%
- Risk-free rate = 0%

In this scenario, the fund's expected return is 11%, which equals the index return of 10% times its beta of 1.1.

The fund's alpha equals the actual return of 12% less the expected return of 11% or a positive 1%.

Compared to Alpha

The general formula for alpha allows for the use of measures of risk other than beta, such as standard deviation (though beta is the risk measure that is most commonly used). In contrast, the formula for Jensen's alpha mandates the use of beta. As a result, a calculation of alpha using beta can be called either "Jensen's alpha" (specific version) or just "alpha" (general formula).

Modigliani RAP

Ex post | Risk vs. performance

The Modigliani Risk-Adjusted Performance (RAP) measure calculates **risk-adjusted performance** which is expressed as out/underperformance versus the benchmark.

Compared to the Sharpe Ratio

The Modigliani RAP ranks funds in the same order as the Sharpe Ratio, but it expresses results in basis points (of out/underperformance) rather than as a ratio.

Step 1

Assume that a fund adds leverage (or delevers) until its standard deviation is equal to that of the benchmark

Step 2

Calculate what performance would have been with that amount of leverage

Step 3

Compute excess return of the calculated return versus the benchmark

Monte Carlo Simulation

A Monte Carlo simulation illustrates portfolio risk by showing the results of **random combinations of historical returns**.

Monte Carlo simulations are most commonly used in financial planning as a way to illustrate the volatility of stock returns.

They are not generally used to assess the risk of a particular fund.

Methodology

A Monte Carlo simulation starts with the data set of past returns.

> *Example:* A simulation might be based on the monthly returns to the S&P 500 since 1950.

The computer then randomly selects from that data set to create future scenarios.

> *Example:* To illustrate possible performance paths over the next year, the computer randomly selects 12 monthly returns and graphs the change in portfolio value over the course of the simulated year.

The computer repeats this process multiple times to illustrate a range of scenarios.

> *Example:* The computer generates 20 scenarios and creates 20 graphs.

Compared to Value at Risk

A Monte Carlo simulation is one method for computing Value at Risk.

Morningstar Rating

The Morningstar rating ranks **risk-adjusted performance**.

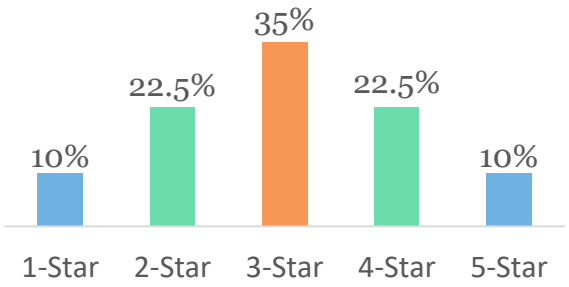
Behind the Star Ratings | Risk-Adjustment

Morningstar assigns funds a rating using a scale of 1 to 5 stars.

Within their category, funds are ranked by risk-adjusted performance. In the computation, Morningstar uses a proprietary measure of risk that accounts for all variation in return, but puts more emphasis on downward variations.

The goal is to reward consistent performance and prevent strong short-term performance from masking risk.

Rating Distribution



Of Note

- If a fund has changed categories, its historical performance is given less weight.
- While share classes are evaluated separately (because their individual expense structures produce different returns), a single portfolio counts only once within the rating distribution scale.

R-Squared (R^2)

R-squared measures the **correlation** of the fund's returns to the benchmark's returns.

An R-squared can range from 0 to 100. An index fund will have an R-squared close to 100.

R-squared is an important indicator of the usefulness of certain measures of risk. For example, the higher a fund's R-squared, the more accurate tracking error will be as a measure of its risk.

Interpreting R-Squared

R-squared indicates how much a fund's performance can be attributed to the benchmark's performance.

> *Example:* An R-squared of 35 means that 35% of the fund's performance is explained by changes in the benchmark.

A high R-squared (closer to 100) indicates that beta is an important statistic for the fund. A low R-squared (closer to zero) suggests that the benchmark is not particularly relevant to performance.

Technically Speaking . . .

R-squared is the **coefficient of determination** computed during a regression analysis.

Semi-Deviation

Ex post | Risk only

The semi-deviation is the standard deviation of only those returns that are **below the average return**.

It is also called the downside deviation or the semi-standard deviation.

Semi-deviation may be useful for conservative funds or those with an objective of limiting downside risk.

Computing the Semi-Deviation

The semi-deviation looks only at periods when the fund return is below average.

Interpreting the Semi-Deviation

The semi-deviation provides insights on a fund's behavior in down markets.

Technically Speaking . . .

The semi-deviation is the square root of the **semi-variance**.

Sharpe Ratio

The Sharpe ratio compares fund **return** over the risk-free rate to **total risk**.

The higher the Sharpe ratio, the more return generated per unit of risk.

The Sharpe ratio is flexible and allows for comparisons of different types of funds.

Computing the Sharpe Ratio

The Sharpe ratio equals:

- Fund return minus the risk-free rate (usually the Treasury bill rate)

Divided by:

- The fund's standard deviation for the relevant period.

Sharpe Ratio (continued)

The Sharpe ratio and its variants have similar advantages and disadvantages.*

Proponents Say . . .

- These ratios have the virtue of **simplicity**.
- These ratios provide a single measure that allows for **comparison** of many types of funds.

Critics Say . . .

- These ratios have **little intrinsic meaning**. They are best used for comparing funds. (An exception is the Modigliani RAP measure, which expresses its result in basis points of out/underperformance.)
- These ratios are highly **time-dependent**, meaning that they can vary greatly depending on the time period selected for analysis.
- These ratios are highly **correlated with performance**, so that these ratios look best when performance is best.

*The variants of the Sharpe ratio are the information ratio, the Sortino ratio and the Treynor ratio. While not a ratio, Modigliani RAP (Risk Adjusted Performance) also has similar positives and negatives.

Sortino Ratio

The Sortino Ratio compares fund return over the risk-free rate to **downside risk**.

The higher the Sortino Ratio, the more return generated per unit of risk.

The Sortino ratio may be useful for conservative funds or those with an objective of limiting downside risk.

Computing the Sortino Ratio

The Sortino ratio equals:

- Fund return minus the risk-free rate (usually the Treasury bill rate)

Divided by:

- The fund's semi-deviation (or downside deviation) for the relevant period.

Compared to the Sharpe Ratio

The Sortino ratio penalizes funds only for volatility when returns are below average. The Sharpe ratio penalizes funds for all volatility.

Sterling Ratio

Ex post | Risk vs. performance

The Sterling ratio compares fund performance to the **average drawdown** (meaning the average decline from peak to trough value in each year).

The higher the Sterling ratio, the more return generated per unit of risk.

The Sterling ratio was developed for commodity pools and hedge funds. It may be useful for absolute return funds or those with an objective of limiting volatility.

Step 1

Calculate 3-year fund return and annualize

Step 2

Calculate percentage decline from peak to trough in each year, then average the annual drawdowns

Step 3

Divide annualized return by the average drawdown

Compared to the Calmar Ratio

The Sterling ratio uses average annual drawdown to measure risk, while the Calmar ratio uses maximum drawdown.

Standard Deviation

Ex post | Risk only

The standard deviation measures the **dispersion of returns** around the average.

Technically Speaking . . .

The standard deviation is the square root of the **variance**.

Interpreting the Standard Deviation

If a fund's returns are normally distributed:

- Approximately **68%** of the time, the fund's returns will fall into a range equal to the average return plus or minus **one standard deviation**
- Approximately **95%** of the time, the fund's returns will fall into a range equal to the average return plus or minus **two standard deviations**

Example: If the average monthly return is 0.5% and the annual monthly standard deviation is 0.1%:

- 68% of monthly returns will normally be between 0.4% and 0.6%
- 95% of monthly returns will normally be between 0.3% and 0.7%

A fund's standard deviation is often easiest to assess by comparing it to the standard deviation of a relevant index or another fund.

Tracking Error (Ex Post)

Ex post | Risk only

Ex post tracking error can mean either:

the **absolute value** of the difference between a fund's performance and the performance of the benchmark

or

the **standard deviation** of those differences over time.

The latter measure is sometimes called the **tracking volatility**.

Tracking error may be useful to assess the performance of index funds.

Interpreting Ex Post Tracking Error

The lower the tracking error, the closer the fund's performance is to the performance of the benchmark.

Tracking Error (Ex Ante)

Ex ante | Risk only

Ex ante tracking error is an estimate of the fund's future risk. It is calculated using the volatility and correlation of the fund's holdings.

Tracking error is expressed as a percentage. The lower the tracking error, the closer the fund is expected to track to the benchmark.

Ex ante tracking error may be useful for funds with a high R-squared.

Computing Ex Ante Tracking Error

Tracking errors are usually computed using **multi-factor models** such as the Barra risk models. These models combine large amounts of historical data and sophisticated statistical techniques to estimate the risk of the fund's holdings and the correlations between them.

The models are called "multi-factor" because they assess a portfolio's exposure to many factors that drive returns such as momentum, volatility, value, size, growth, liquidity and leverage. By contrast, calculation of beta involves just one factor: exposure to the market.

Interpreting Ex Ante Tracking Error

Tracking error is expressed as a percentage and can be interpreted similarly to a standard deviation. That is, 68% of the time, performance is expected to be within a range of benchmark performance plus or minus the percentage tracking error.

Tracking Error (Ex Ante) (continued)

Proponents Say . . .

- Ex ante tracking error provides the most **holistic** view of a fund's risk.
- Theory supports a **link** between ex ante tracking error and performance.
- Tracking error is **easy to interpret**.
- Multi-factor analysis generating tracking error estimates can provide other **portfolio insights**.

Critics Say . . .

- Ex ante tracking error **understates risk**. Because of differences in the way that the two measures are calculated, ex post tracking error is almost always larger than ex ante tracking error.*
- Calculations are **complex** and dependent on data integrity, meaning that it can be difficult to identify errors.
- Ex ante tracking error is **sensitive to the overall level of correlation** within the benchmark. When correlations are low, ex ante tracking error may be understated, and active share may provide a better measure of risk.

* Soosun Hwang and Stephen E. Satchell, "Tracking Error: Ex-Ante versus Ex-Post Meaures."

Treynor Ratio

The Treynor ratio compares fund return over the risk-free rate to **beta**.

The higher the Treynor ratio, the more return generated per unit of risk.

The Treynor ratio may be useful for highly diversified funds, where beta is a relevant measure.

Computing the Treynor Ratio

The Treynor ratio equals:

- Fund return minus the risk-free rate (usually the Treasury bill rate)

Divided by:

- The fund's beta.

Compared to the Sharpe Ratio

The Treynor ratio penalizes funds only for risk that cannot be diversified away, as measured by beta. The Sharpe ratio penalizes funds for all risk.

Upside-Downside Capture Ratios

The upside capture ratio is the fund's **return in up months** for the benchmark divided by the benchmark return in those months.

The downside capture ratio is the fund's **return in down months** for the benchmark divided by the benchmark return in those months.

The upside-downside capture ratios may be useful for funds with an objective of outperforming in up or down markets.

Interpreting the Capture Ratios

A fund has outperformed:

- In up markets, when its upside capture ratio is over 100.
- In down markets, when its downside capture ratio is less than 100.

A fund has underperformed:

- In up markets, when its upside capture ratio is less than 100.
- In down markets, when its downside capture ratio is over 100.

Of Note

When Morningstar computes upside-downside capture ratios, it uses the following benchmarks:

- S&P 500 for all U.S. equity funds
- MSCI EAFE for all international equity funds
- Barclays Capital U.S. Aggregate Bond Index for all bond funds

Value at Risk (VaR)

Ex ante | Risk only

Value at risk estimates **how much an investment might lose** in a specified time period, given a specified probability.

VaR analysis is generally seen as most helpful in illustrating the potential interaction of multiple variables.

While that is not the case for traditional equity funds, a VaR approach could be useful for funds holding large positions in complex securities, including derivatives or structured securities.

Defining VaR

Value at risk is a single, summary statistical measure of possible portfolio losses. It's easiest to understand through an example.

> Example:
>
> If a portfolio of stocks has a one-day 5% VaR of $1 million, that means that there is a 5% probability that the portfolio will fall in value by more than $1 million over a one-day period if there is no trading.

Common probabilities used are 1%, 2.5% and 5%. Common holding periods are 1, 2, and 10 days and 1 month.

Calculating VaR

Common methods for calculating VaR are historical simulation, Monte Carlo simulation and variance-covariance analysis.

Volatility

Ex post | Risk only

Volatility is the annualized standard deviation of **daily percentage price changes**.

Informally Speaking . . .

Volatility is a general term for price change.

Step 1

For all days in the period, compute daily percentage returns by calculating the natural log of Price Day X+1 divided by Price Day X

Step 2

Calculate standard deviation of daily percentage returns

Step 3

Annualize standard deviation by multiplying by the square root of the number of trading days in the period

Summary

Risk only | Ex ante

Active share	Overlap between fund and benchmark index
Beta	Weighted average of the betas of the securities in the portfolio
Monte Carlo simulation	Illustration of portfolio risk by showing the results of random combinations of historical returns
Absolute Tracking error	Estimate of the fund's future risk based on volatility and correlation of fund holdings
Value at Risk	Estimate of how much an investment might lose in a specified time period, given a specified probability

Summary

Risk only | Ex post

Beta	Fund's risk relative to the market
Semi-deviation (or downside deviation)	Standard deviation of returns below the mean
Standard deviation	Dispersion of returns around the average
Tracking error	Absolute difference between fund performance and benchmark performance
Tracking error (or tracking volatility)	Standard deviation of the differences between fund performance and benchmark performance over time
Volatility	Annualized standard deviation of daily percentage price changes

Summary

Risk vs. performance | Ex post | Ratios

Ratio	Performance (Numerator)	Risk (Denominator)
Calmar ratio	Annualized total return	Maximum drawdown (= % decline from peak value to trough value)
Information ratio	Fund return less benchmark return (or excess return)	Standard deviation
Sharpe ratio	Fund return less risk-free rate (usually the Treasury bill rate)	Standard deviation
Sortino ratio	Fund return less risk-free rate (usually the Treasury bill rate)	Semi-deviation (or downside deviation)
Sterling ratio	Annualized total return	Average annual drawdown (= % decline from peak value to trough value in each year)
Treynor ratio	Fund return less risk-free rate (usually the Treasury bill rate)	Beta
Upside-downside capture ratio	Fund return in up (or down) months	Benchmark return in up (or down) months

Summary

Risk vs. performance | Ex post | Other measures

Alpha	Out/underperformance vs. benchmark after adjusting for risk
Alpha (informal)	Absolute value of difference in performance between fund and benchmark
Bear market percentile rank	Relative performance during bear market months
Jensen's alpha (also called alpha)	Out/underperformance vs. benchmark after adjusting for beta
Modigliani RAP	Risk-adjusted out/underperformance compared to the benchmark
Morningstar rating	Ranks risk-adjusted performance
R-squared (R^2)	Correlation of the fund's returns to benchmark's returns

Credits

Thank you to:

- Theresa Hamacher for suggesting and drafting this guide

- Dave Butler and the risk team at Calamos Investments for reviewing the draft