

Investment Performance, Analytics, and Risk

Glossary of Terms

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ACCUMULATED BENEFIT OBLIGATION (ABO)

The Accumulated Benefit Obligation (ABO) is the present value of pension benefits earned based on current salaries, ignoring any assumptions about salary increases. The ABO is used in pension accounting to determine the minimum pension liability.

ASSET ALLOCATION

Asset Allocation is the process of allocating assets between asset classes such as Equities, Bonds, Cash, and Alternative Investments. It takes into account the investor's goals, risk tolerance and investment horizon.

ALPHA

Alpha is a measure of performance on a risk-adjusted basis since it takes into consideration the risk-free rate. Alpha is also used to refer to the excess return of the portfolio relative to the return of the [benchmark](#).

ALTERNATIVE INVESTMENTS

Alternative Investments refer to any non-traditional asset with potential economic value that would not be found in a standard investment portfolio of Equities, Bonds, and Cash. Examples include real estate, private equity and hedge funds.

ARBITRAGE PRICING THEORY (APT)

The Arbitrage Pricing Theory is an asset pricing model alternative to the [Capital Asset Pricing Model \(CAPM\)](#). Unlike the CAPM, which specifies returns as a linear function of only [systematic risk](#), APT specifies returns as a linear function of more than a single risk factor.

ATTRIBUTION

Attribution is a measure to determine the source of return in a given period. It is commonly used to evaluate an asset class, money manager, or individual security relative to market [benchmarks](#). Common types of attribution analyses are [asset allocation](#) and [security selection](#). Attribution models can also be factor based, attributing performance to a set amount of pre-defined factors.

ACTIVE INVESTMENT MANAGEMENT

Active Investment Management intentionally seeks to out-perform a [benchmark](#) using analytical research, forecasts and judgment and experience to make investment decisions. This is in contrast to [passive investment management](#).

ANNUALIZED RETURNS

Annualized Returns are the compound average annual return earned by the portfolio over the evaluation period.

BASIS POINT (BP)

A Basis Point is a unit that is equal to 1/100th of 1% (0.01% or 0.0001). It is typically used as a unit when discussing portfolio performance.

BENCHMARK

A Benchmark is a standard against which the performance of a portfolio can be measured. Generally, broad market and market segment stock and bond indices are used for this purpose.

BLENDED BENCHMARK

A Blended Benchmark is created by blending two or more underlying [benchmarks](#). This can be achieved by either applying fixed or floating weights to the underlying benchmark.

CASH FLOW

A Cash Flow is an inflow or outflow of cash or securities from the portfolio, usually instructed by the client.

COUNTRY OF RISK

The Country of Risk is traditionally the country where the majority of the company's operations are based or where it is headquartered. Country of Risk is also called the company's domestic country.

CURRENCY HEDGING

Currency Hedging is the process of neutralizing the currency exposures within a portfolio by using [derivatives](#) such as currency forwards, futures and options.

CAPITAL ASSET PRICING MODEL (CAPM)

The Capital Asset Pricing Model is an economic theory describing the relationship between security returns and risk. It is a single factor model that predicts the expected return using the risk-free rate and the security's sensitivity to the market portfolio (beta).

CUSTOM BENCHMARK

A Custom Benchmark is a [benchmark](#) that has been customized to reflect a client's requirements and long-term objectives. It can be a mixture of other benchmarks weighted to represent the actual portfolio allocation.

CREDIT DEFAULT SWAPS (CDS)

Credit Default Swaps are swap contracts in which one party accepts the credit risk on an underlying instrument in exchange for a stream of coupon payments. The buyer of a CDS receives credit protection, whereas the seller of the swap compensates the buyer in the event of a credit event.

CURRENCY OVERLAY

Currency Overlay is the separation of currency risk management to a specialist manager. This is used in international investment portfolios to separate the management of currency risk from the [asset allocation](#) and [security selection](#) decisions of the investor's money managers.

DERIVATIVES

Derivatives are an instrument whose price is dependent upon, or derived from, one or more underlying assets. The Derivative itself is merely a contract between two or more parties. Its value is determined by fluctuations in the underlying asset price. Examples of Derivatives include futures, options and swaps.

DIVERSIFICATION

Diversification is a risk management technique in which the investments are spread across asset classes and geographic regions to reduce the overall risk of the portfolio.

EFFICIENT FRONTIER

An Efficient Frontier is a curve connecting the set of mean variance efficient portfolios in a risk-reward graph, and is created using the [Modern Portfolio Theory](#). The portfolios lying on this line are expected to provide the highest return per unit of risk.

FUNDED STATUS

The Funded Status of a pension plan is represented by the fair market value of assets minus the [projected benefit obligation](#), a measure of how much the pension plan will have to pay in the future. In a fully funded pension plan, the fair market value of plan assets is enough to cover at least 100% of current benefits earned by employees.

$$\text{FUNDED STATUS} = \frac{\text{FAIR MARKET VALUE OF ASSETS}}{\text{PLAN'S PBO}}$$

GEOMETRIC MEAN

Geometric Mean is a measure of central tendency calculated by multiplying a series of numbers and taking the n th root of the product, where n is the number of items in the series. The Geometric Mean is often used when finding an average for numbers presented as percentages.

GLOBAL INVESTMENT PERFORMANCE STANDARDS (GIPS)

Global Investment Performance Standards are ethical standards for creating performance presentations that ensure fair representation and full disclosure of investment performance results.

GROSS OF FEE PERFORMANCE

Gross of Fee Performance is the total return that excludes the fee/expense impacts by incorporating them as compensating [cash flows](#). When there are negative expenses, this return is always larger than the [net of fee performance](#).

HEDGE FUNDS

Hedge Funds use aggressive strategies that are unavailable to mutual funds, including selling short, leverage, program trading, swaps, arbitrage, and [derivatives](#). Hedge funds are currently exempt from many of the rules and regulations governing other mutual funds. This allows them to accomplish aggressive investing goals.

HEDGING

Hedging is the use of derivatives to protect a portfolio against a fall in value. An example is [currency hedging](#).

INDEX

An Index is a statistical indicator providing a representation of the value of the securities that constitute it. Indices often serve as barometers for a given market or industry and as [benchmarks](#) against which financial or economic performance is measured.

INTERACTION EFFECT

Interaction Effect is the interaction of the allocation and selection decisions in a performance [attribution](#) model. It equals the product of the difference between the portfolio and benchmark weights and returns in the portfolio segment.

INTERNAL RATE OF RETURN (IRR)

The Internal Rate of Return is the growth rate that will link the ending value of the account to the beginning value, plus all intermediate [cash flows](#). It measures the compound growth rate in the value of the portfolio over the evaluation period.

LIABILITY DRIVEN INVESTING (LDI)

Liability Driven Investing (LDI) shifts the pension plan's focus toward minimizing the risk of underperforming the potential growth of plan liabilities. It attempts to reduce the mismatch between the interest rate sensitivity of plan liabilities to plan assets. Pension liabilities behave similarly to bonds -- the present value of expected future benefit obligations fluctuates with changes in long-term interest rates -- and mismatches in duration between assets and liabilities are an interest rate bet that is difficult to get right consistently over time. LDI can be implemented through the use of fixed income, long-term securities such as U.S. Treasury strips and zero-coupon bonds, or derivatives (e.g., interest rate swaps).

MODIFIED BAI

Modified BAI is a [Money-Weighted Rate of Return \(MWRR\)](#) measure that employs the iterative [Internal Rate of Return](#) approach to calculate portfolio investment performance.

MODIFIED DIETZ

Modified Dietz is a [Money-Weighted Rate of Return \(MWRR\)](#) method similar to the [Modified BAI](#). This method uses a simplified non-iterative formula that still weights the flows dependant on the flow date. This method produces very similar results to the Modified BAI method, but can be calculated more quickly and easily than the iterative [Internal Rate of Return](#) calculation used in the Modified BAI.

MONEY-WEIGHTED RATE OF RETURN (MWRR)

The Money-Weighted Rate of Return is the growth rate of an average amount of money invested in a portfolio over the evaluation period. Popular methods of calculation include the iterative [Modified BAI](#) method or simpler non-iterative [Modified Dietz](#) method.

MODERN PORTFOLIO THEORY

Modern Portfolio Theory describes how risk-averse investors can construct portfolios to maximize expected return for a given level of risk. Investors can select a mean-variance efficient portfolio from the [efficient frontier](#) that is in line with their tolerance for risk.

NET ASSET VALUE (NAV)

The Net Asset Value is the market value of the portfolio, and is used extensively in mutual fund reporting.

NET OF FEE PERFORMANCE

Net of Fee Performance is the total return that includes the fee/expense impacts by not incorporating them as compensating [cash flows](#). When there are negative expenses, this return is always smaller than the [gross of fee performance](#) return.

OVER THE COUNTER (OTC)

Over the Counter refers to instruments that are not traded on a formal exchange. Examples of securities that are traded OTC include forwards and swaps.

PASSIVE INVESTMENT MANAGEMENT

Passive Investment Management strategies attempt to replicate the performance of a predetermined [benchmark](#). This strategy is also known as indexing.

PROJECTED BENEFIT OBLIGATION (PBO)

The Projected Benefit Obligation (PBO) is the present value of pension benefits earned, including projected salary increases. The PBO is calculated as the basis for most pension accounting calculations.

REGRESSION

Regression is a statistical process that attempts to determine the linear relationship between the dependent variable and a series of independent variables, or risk factors.

RISK ADJUSTED RETURN

Risk Adjusted Return is an ex-post risk measure in which the portfolio return is adjusted by the [standard deviation](#) or beta of the portfolio. Examples of Risk Adjusted Return measures include the [Sharpe Ratio](#) and [Treyner Measure](#).

SECURITY SELECTION

Security Selection is the process of selecting the stocks or bonds or other investment instruments to include in a portfolio.

STANDARD DEVIATION

Standard Deviation is a statistical measure of dispersion measuring volatility. It is defined as the square root of the variance, with variance being the average of the squared deviations from the mean.

STANDARD ERROR

Standard Error is the [Standard Deviation](#) of the difference between the measured or estimated values and the true values. Standard Errors are significant because they reflect how much sampling fluctuation a statistic will show.

SYSTEMATIC RISK

Systematic Risk, or market risk, is the risk that is common to an entire class of assets. Interest rates, recession or wars are types of systematic or non-diversifiable risk.

T-DISTRIBUTION

The t-distribution or student t-distribution is a probability distribution that arises in the problem of estimating the mean of a normally distributed population when the sample size is small. It is the basis of the popular student t-test for the statistical significance of the difference between two sample means.

TIME-WEIGHTED RATE OF RETURN (TWRR)

The Time-Weighted Rate of Return is a measure of return that reflects the compound rate of growth over a stated evaluation period of one unit of money initially invested in the account. Its calculation requires that the account be valued every time an external [cash flow](#) occurs.

TOTAL RETURN

Total Return is the investment-related growth rate in a portfolio's value due to both income and capital appreciation over the evaluation period.

TRACKER FUND

A Tracker Fund is a portfolio that follows a passive investment management strategy, which attempts to perform in line with a predetermined index.

VESTED BENEFIT OBLIGATION (VBO)

The Vested Benefit Obligation (VBO) is the portion of the benefit obligation not dependent on future employee service because the employee has either earned benefits by reaching retirement age or has otherwise met plan requirements. The VBO is calculated as a measure of the pension obligation if the plan were to be terminated immediately.

WEIGHTED AVERAGE RETURN

Weighted Average Return is a process in which a combined return is calculated from two or more constituents (e.g., portfolios, countries, asset classes, etc).

$$\text{WEIGHT \% OF PORTFOLIO 1} \quad \times \quad \text{RETURN OF PORTFOLIO 1} \quad = \quad \text{CONTRIBUTION OF PORTFOLIO 1}$$

$$\text{WEIGHT \% OF PORTFOLIO 2} \quad \times \quad \text{RETURN OF PORTFOLIO 2} \quad = \quad \text{CONTRIBUTION OF PORTFOLIO 2}$$

$$\text{TOTAL CONTRIBUTIONS} \quad = \quad \text{CONTRIBUTION OF PORTFOLIO 1} \quad + \quad \text{CONTRIBUTION OF PORTFOLIO 2}$$

YIELD CURVE

A Yield Curve is a graphic line chart that shows the relationship between yield and term to maturity, or the term structure of interest rates. The curve is typically upward sloping because bonds with longer maturities usually offer a higher yield.

BETA

Beta is a measure of the volatility, or [systematic risk](#), of a security or portfolio in relation to the overall market. A Beta of 1 indicates that the security's price is expected to move in the same direction and by the same percentage as a movement in the market. A Beta greater than 1 indicates that the security is expected to move by a greater percentage than a corresponding movement in the market, and therefore the security is considered to be more risky than the market. A Beta less than 1 indicates that the security is expected to move by a lesser percentage than a corresponding movement in the market, and therefore the security is considered to be less risky than the market. Portfolio Beta is the weighted average of the Betas of the securities held in the portfolio.

CORRELATION COEFFICIENT

The Correlation Coefficient measures the closeness of the relationship between two sets of variables. The correlation coefficient will vary from -1 to +1. +1 indicates that the two variables move exactly in line together, and -1 indicates that they move in equal but opposite directions. A result close to 0 implies that they are unrelated.

EX-POST RISK

Ex-Post Risk refers to the past risks of a portfolio (ex-post = after the fact). It is the analysis of actual historic return streams of a portfolio and [benchmark](#) in order to ascertain the historic variability of that return stream over time. A related but opposite term is [Ex-Ante Risk](#).

EXCESS RETURN

Excess Return is the remainder after subtracting the [benchmark](#) return from the portfolio return. This number can be calculated over various time periods. A portfolio that out-performs its benchmark over a particular period will have a positive Excess Return. The Average or Mean of Excess Returns is often displayed in non-percentage terms as basis points.

INFORMATION RATIO

The Information Ratio measures a portfolio's performance against risk and return relative to a [benchmark](#) or alternative measure. It is calculated by dividing the Excess Return by the [Standard Deviation of Excess Return \(Tracking Error\)](#). The higher the Information Ratio, the greater the added value for a given level of risk, relative to the benchmark.

$$\text{INFORMATION RATIO} = \frac{\text{EXCESS RETURN}}{\text{TRACKING ERROR}}$$

JENSEN'S ALPHA

Jensen's Alpha is used to determine the [Excess Return](#) over the required rate of return as predicted by the [Capital Asset Pricing Model \(CAPM\)](#) given the portfolio's [beta](#) and the average market return. This is then used in the Jensen's Alpha Ratio.

JENSEN'S ALPHA RATIO

Jensen's Alpha Ratio is similar to the [Information Ratio](#). It is a risk-adjusted performance measure that represents the average return on a portfolio over and above that predicted by the [Capital Asset Pricing Model \(CAPM\)](#), given the portfolio's [beta](#) and the average market return (Jensen's Alpha). It is the ratio of the Average Jensen's Alpha over the [Standard Deviation of Jensen's Alpha](#).

$$\text{JENSEN'S ALPHA RATIO} = \frac{\text{AVERAGE JENSEN'S ALPHA}}{\text{STANDARD DEVIATION OF JENSEN'S ALPHA}}$$

LARGEST EXCESS RETURN

The Largest Excess Return is the largest difference between the portfolio return and the benchmark return over a given period. The result is displayed in non-percentage terms as [basis points](#).

M SQUARED (M²)

M Squared derives a risk-adjusted performance measure by adjusting the risk of a particular portfolio so that it matches the risk of a market portfolio and then calculating the appropriate return for that portfolio. The result is displayed in [basis points](#), with a higher number indicating an out-performance against the market portfolio.

MAX GAIN PER PERIOD BENCHMARK

Max Gain per Period Benchmark is the largest positive return or gain achieved by the [benchmark](#) over a given period.

MAX GAIN PER PERIOD PORTFOLIO

Max Gain per Period Portfolio is the largest positive return or gain achieved by the portfolio over a given period.

MAX LOSS PER PERIOD BENCHMARK

Max Loss per Period Benchmark is the largest negative return or loss achieved by the [benchmark](#) over a given period.

MAX LOSS PER PERIOD PORTFOLIO

Max Loss per Period Portfolio is the largest negative return or loss achieved by the portfolio over a given period.

MEAN OF RETURNS

The Mean of Returns is the average percentage return achieved by the portfolio or [benchmark](#) over a given period.

MEDIAN EXCESS RETURN

The Median Excess Return can be found by arranging all the observations from lowest value to highest value and simply picking the middle one. If an even number of observations exist, an average of the two middle numbers is taken.

NEGATIVE SEMI-DEVIATION OF RETURNS

Negative Semi-Deviation of Returns is the [Standard Deviation](#) of only the returns [below](#) the average return.

POSITIVE SEMI-DEVIATION OF RETURNS

Positive Semi-Deviation or Returns is the [Standard Deviation](#) of only the returns [above](#) the average return.

PROPORTION

Proportion is the proportion of the number of quarters for which the manager delivered a positive Jensen's alpha over the total number of quarters that constitute the performance measurement period. For example, over a 20-quarter period, if the manager delivered 15 positive quarterly Jensen's alphas, then the proportion would be 0.75 (15/20). Proportion thus measures how consistently the manager was able to deliver a positive Jensen's alpha.

R SQUARED (R^2)

R Squared is a statistical measure that represents the percentage of a portfolio's or security's movements that are explained by movements in a [benchmark index](#). R-Squared values range from 0 to 100%. A score of 100 means all movements of a security are completely explained by movements in the index.

RISK ADJUSTED RETURN

Risk Adjusted Return is an ex-post risk measure in which the portfolio return is adjusted by the [standard deviation](#) or [beta](#) of the portfolio. Examples of Risk Adjusted Return measures include the [Sharpe Ratio](#) and [Treyner Measure](#).

SHARPE RATIO

Sharpe Ratio, also known as the “reward to variability ratio,” relates the reward to the portfolio’s risk, as measured by the portfolio’s [standard deviation](#). By using the standard deviation, Sharpe Ratio measures the total risk of the portfolio, not just in relation to the market. The larger the Sharpe Ratio, the better the portfolio’s risk-adjusted performance has been.

$$\text{SHARPE RATIO} = \frac{\text{RETURN} - \text{RISK-FREE RETURN}}{\text{STANDARD DEVIATION OF RETURNS}}$$

SMALLEST EXCESS RETURN

The Smallest Excess Return is the smallest difference between the portfolio return and the benchmark return over a given period. The result is displayed in non-percentage terms as [basis points](#).

SORTINO RATIO

Sortino Ratio is an extension of the [Sharpe Ratio](#). While the Sharpe Ratio takes into account any volatility in return of an asset, the Sortino Ratio differentiates volatility due to up and down movements. The up movements are considered desirable and are not accounted for in the volatility. The larger the Sortino Ratio, the better its risk-adjusted performance has been.

$$\text{SORTINO RATIO} = \frac{\text{RETURN} - \text{RISK-FREE RETURN}}{\text{NEGATIVE SEMI-DEVIATION OF RETURNS}}$$

STANDARD DEVIATION OF BENCHMARK RETURNS

[Standard Deviation](#) of Benchmark Returns is a statistical measure of dispersion measuring volatility of [benchmark](#) returns over a given period.

STANDARD DEVIATION OF BETA

[Standard Deviation](#) of Beta is a statistical measure of dispersion measuring volatility of Betas across securities or time periods.

STANDARD DEVIATION OF EXCESS RETURN (TRACKING ERROR)

[Standard Deviation](#) of [Excess Return](#), or Tracking Error, is a statistical measure of dispersion measuring volatility of excess returns over a given period.

STANDARD DEVIATION OF JENSEN'S ALPHA

Standard Deviation of Jensen's Alpha is a statistical measure of dispersion measuring volatility of Jensen's Alpha over a given period.

STANDARD DEVIATION OF PORTFOLIO RETURNS

Standard Deviation of Portfolio Returns is a statistical measure of dispersion measuring volatility of portfolio returns over a given period.

TRACKING ERROR

Tracking Error, or Standard Deviation of Excess Return, is a statistical measure of dispersion measuring volatility of excess returns over a given period.

TREYNOR RATIO

The Treynor Ratio, also known as the "reward to volatility ratio," measures the excess return achieved by a fund manager per unit of risk incurred. It is a measure of risk adjusted return based on systematic risk. The larger the Treynor Ratio, the better its risk-adjusted performance has been.

$$\text{TREYNOR RATIO} = \frac{\text{RETURN} - \text{RISK-FREE RETURN}}{\text{BETA}}$$

T-STATISTIC OF EXCESS RETURN

T-Statistic of Excess Return measures the statistical significance of the manager's average excess return. The greater the manager's average excess return, or the smaller the standard deviation of excess return, the greater the t-statistic. A t-statistic greater than 2.00 usually indicates that the manager was able to consistently deliver a significant positive excess return.

$$\text{T-STATISTIC OF EXCESS RETURN} = \frac{\text{AVERAGE EXCESS RETURN}}{\text{STANDARD DEVIATION OF EXCESS RETURNS}} \times \sqrt{\text{NUMBER OF EXCESS RETURN OBSERVATIONS}}$$

T-STATISTIC OF JENSEN'S ALPHA

T-Statistic of Jensen's Alpha measures the statistical significance of the manager's average alpha. The greater the manager's average alpha, or the smaller the Standard Deviation of alphas, the greater the t-statistic. An alpha t-statistic greater than 2.00 usually indicates that the manager was able to consistently deliver a significant positive alpha.

$$\text{T-STATISTIC OF JENSEN'S ALPHA} = \frac{\text{AVERAGE JENSEN'S ALPHA}}{\text{STANDARD DEVIATION OF ALPHAS}} \times \sqrt{\text{NUMBER OF ALPHA OBSERVATIONS}}$$

Ex-Post
Risk

BACK TESTING

Back Testing validates that actual losses are in line with forecasted losses. There are two distinct types of Back Testing. The first approach (also called “dirty” Back Testing) compares [ex-ante](#) VaR estimates with [ex-post](#) values of actual P/L (profit and loss) in the defined periods. The second approach (also called “clean” Back Testing) compares ex-ante VaR estimates with the ex-post values of hypothetical P/L assuming positions remained static for the defined period.

CONDITIONAL VAR (CVAR)

Conditional VaR is the average of all the losses greater than (conditionally to going beyond VaR) VaR specified with the same [confidence interval](#) that VaR was estimated. For example, if VaR is calculated at a 99% [confidence level](#), CVaR averages the worst 1% losses. Conditional VaR is also known as Expected Shortfall.

CONFIDENCE INTERVAL

A Confidence Interval represents a range of values within which the actual value of a parameter will lie, given a probability $1 - \alpha$, called a [confidence level](#).

CONFIDENCE LEVEL

A Confidence Level is a probability $1 - \alpha$ associated with a [confidence interval](#) when estimating a parameter. Here, α is called the level of significance.

EX-ANTE RISK

Ex-Ante Risk refers to the future projected risks of a portfolio (ex-ante = before the event). It is the analysis of current portfolio holdings to estimate future return streams and their projected variability based upon statistical or historical assumptions. A related but opposite term is [Ex-Post Risk](#).

EXPECTED SHORTFALL (ES)

Expected Shortfall is the average of all the losses greater than (conditionally to going beyond VaR) VaR specified with the same [confidence interval](#) that VaR was estimated. For example, if VaR is calculated at a 99% [confidence level](#), ES averages the worst 1% losses. Expected Shortfall is also known as Conditional VaR.

HISTORICAL SIMULATIONS VAR

Historical Simulations is a straightforward methodology to compute VaR by randomly selecting a set of past changes in the risk factors and revaluing the assets or portfolio as of today (i.e., keeping the current weights of each risk factor). Then, one ranks the computed values of the portfolio from the lowest to the highest and finds the desired level of significance (generally 1% or 5% lowest value).

The main advantages of this methodology are that it does not require making any (restricting) assumptions about the distribution of the risk factors like the [Monte Carlo](#) methodology does. Historical Simulations are also less computer-intensive than the Monte Carlo methodology. The main drawbacks of this methodology are the strong but incomplete assumption that the past is a good indicator for the future, and the lack of "what-if" analysis capability whereby one can tailor the changes of all risk factors like in a Monte Carlo methodology.

INCREMENTAL VAR

Incremental VaR is best thought of as the amount that the total VaR across all positions would change by if the size of a particular position were incrementally changed (i.e., by a small amount).

MARGINAL VAR

Marginal VaR is best thought of as the amount that the total VaR across all positions would decrease by if a particular position were completely removed.

MONTE CARLO SIMULATIONS VAR

Monte Carlo Simulations is a methodology based on the repeated generation of one or more risk factors that affect the security values in order to produce a probability distribution of estimated security values of a given portfolio.

The first step is to stipulate the probability distribution of the risk factors. The second step is to generate pseudo-random values for each risk factor using the specified probability distribution, and re-price every security (and therefore revalue the portfolio) after each run. In order to ensure reliability on the outcome of these simulations (i.e., if one reruns the simulations, the outcome does not divert too much from the outcome of a previous range of simulations), a minimum of 1,000 runs is a generally acceptable practice in the industry (though 5,000 or even 10,000 runs would be better). The final step is to sort the simulated values of the portfolio and pick the relevant VaR number corresponding to the desired α , or level of significance (generally 1% or 5%).

The main advantages of Monte Carlo Simulations are that they can handle non-linear instruments by surveying a wider range set of possibilities than the [Historical Simulations](#) methodology, and that they can perform “what-if” analysis very easily.

The main drawbacks of Monte Carlo Simulations lie in that they are very much computer-intensive and are prone to model risk – the accuracy and reliability of the outcome are only as good as the underlying assumptions about the probability distributions of the risk factors. Finally, Monte Carlo Simulations do not provide any insight on the behavior of the VaR being a numerical solution as opposed to the analytical form of the [Parametric VaR](#) methodology.

PARAMETRIC VAR

Parametric VaR (also called the Variance-Covariance method) is a very straightforward and quick approach to compute VaR because it assumes a normal probability distribution for both the changes in market prices and rates and the changes in portfolio value. Its simplicity is also one of its drawbacks as Parametric VaR cannot apply to nonlinear positions such as options. It may also underestimate extreme events since it relies on a normal probability distribution, which does not exhibit fat tails (like a Student probability distribution).

A definition of Parametric VaR is calculated as follows:

$$VaR_p = P \times z_{1-\alpha} \times \left(\frac{s}{\sqrt{t}} \right)$$

Where:

- P = Market value of the Portfolio
- z = Reliability factor (equals 1.65 for a 95% confidence level and equals 2.33 for a 99% confidence level)
- s = annual portfolio standard deviation of return (total risk); therefore, s / \sqrt{t} represents an estimate of the standard deviation of the portfolio over the holding period
- t = Number of days of the holding period

SENSITIVITY ANALYSIS

Sensitivity Analysis is a sub-category of [stress testing](#) that shocks one or several risk factors by a relatively small change (+/- 5 basis points on a particular [yield curve](#), for instance) and revalues the portfolio to ascertain the sensitivity of the portfolio to this small change of one or several risk factors. Sensitivity Analysis can be performed at every level within a portfolio – from the total portfolio level down to the security or even risk factor level.

STRESS TESTING

Stress Testing is a method to identify extreme or adverse events that could trigger catastrophic losses in a portfolio of financial instruments. Stress Testing can be applied at the market, sector, curve industry, or even security level.

There are three generic types of Stress Tests. First, historical scenarios recreate the market conditions of an extreme event (9/11, Black Monday, etc.) and calculate the impact on the current portfolio. Second, hypothetical scenarios can be one of the following: modifying the covariance matrix, specifying factor shocks to create an event, and conducting a [sensitivity analysis](#). Third, algorithmic approaches either determine the impact on the current portfolio of a factor push in a direction that would generate a loss to the portfolio or define the set of changes in the risk factors that would generate the maximum loss for the portfolio.

VALUE-AT-RISK (VAR)

Value-at-Risk lies in the worst expected loss over a given horizon at a given confidence level under normal market conditions. VaR provides a single number summarizing the organization's exposure to market risk and the likelihood of an unfavorable move in the portfolio's positions. It also provides a predictive tool to prevent portfolio managers from exceeding risk tolerances that have been developed in the portfolio policies. It can be measured at the portfolio, sector, asset class, and security levels.

For example, suppose a \$100 million portfolio has a monthly VaR of \$8.3 million with a 99% confidence level. There is a 1% chance for losses greater than \$8.3 million in any given month of a defined holding period under normal market conditions.

VaR is just an estimate, not a uniquely defined value. It assumes that the portfolio composition remains constant throughout the holding period. Unlike the [Expected Shortfall](#), VaR does not provide any information on the losses that exceed its value (i.e., VaR is not the "worst case scenario").

Multiple VaR methodologies are available, and each has its own benefits and drawbacks as shown in the table below.

	Parametric	Historical	Monte Carlo
Advantages	Easy to calculate	Easy to calculate	Ability to use any return distribution or asset correlation
	Easy to understand	Easy to understand	Most appropriate method for non-linear securities
	Minimal data requirements	Does not assume normal distribution	
	Can be applied to various time periods	Not as data intensive as Monte Carlo	
		Can be applied to various time periods	
Disadvantages	Assumes normal distribution	Assumes historical correlations will repeat	Requires many assumptions
	Difficult to estimate correlations in complex portfolios		Requires extensive computing power and time
	Less accurate for non-linear securities (i.e. MBS)		

Ex-Ante
Risk

VARIANCE-COVARIANCE MATRIX

A Variance-Covariance Matrix is a symmetric matrix that contains the variance of the risk factors on its main diagonal and the covariances between two risk factors elsewhere.

BETA

Beta is a measure of the volatility, or **systematic risk**, of a security or portfolio in relation to the overall market. A Beta of 1 indicates that the security's price is expected to move in the same direction and by the same percentage as a movement in the market. A Beta greater than 1 indicates that the security is expected to move by a greater percentage than a corresponding movement in the market, and therefore the security is considered to be more risky than the market. A Beta less than 1 indicates that the security is expected to move by a lesser percentage than a corresponding movement in the market, and therefore the security is considered to be less risky than the market. Portfolio Beta is the weighted average of the Betas of the securities held in the portfolio.

COMPANY PRICE TO BOOK RATIO (P/B)

The P/B Ratio (also known as the "price-equity ratio") is used to compare a stock's market value to its book value. A low P/B Ratio is an indication that a stock may be undervalued. This ratio also gives some idea of whether you're paying too much for what would be left if the company went bankrupt immediately.

$$\text{COMPANY PRICE TO BOOK} = \frac{\text{STOCK PRICE}}{\text{TOTAL ASSETS} - \text{INTANGIBLE ASSETS \& LIABILITIES PER SHARE}}$$

DEBT TO CAPITAL

Debt to Capital is a measure of a company's financial leverage, calculated as the company's debt divided by its total capital. Debt includes all short-term and long-term obligations. Total capital includes the company's debt and shareholders' equity, which includes common stock, preferred stock, minority interest and net debt. The higher the Debt-to-Capital ratio, the more debt the company possesses compared to its equity. This tells investors whether a company is more prone to using debt financing or equity financing.

$$\text{DEBT TO CAPITAL} = \frac{\text{DEBT}}{\text{SHAREHOLDER EQUITY} + \text{DEBT}}$$

DIVIDEND GROWTH

Dividend Growth reflects the percentage growth rate in a company's reported dividends over a period of time. Dividend Growth is an important input in stock valuation models that value the stock by discounting the company's future dividends.

DIVIDEND YIELD

Dividend Yield is the yield a company pays out to its shareholders in the form of dividends. The Dividend Yield expresses the return, excluding capital return, on investment for a stock. When comparing two stocks, the one with the larger Dividend Yield indicates greater income potential.

$$\text{DIVIDEND YIELD} = \frac{\text{ANNUAL DIVIDENDS PER SHARE}}{\text{PRICE PER SHARE}}$$

EARNINGS PER SHARE (EPS)

Earnings per Share is the portion of a company's profit allocated to each outstanding share of common stock. EPS serves as an indicator of a company's profitability and is generally considered to be the single most important variable in determining a share's price. It is also a major component of the [price to earnings ratio](#). The larger the EPS, the more profit earned per share.

$$\text{EARNINGS PER SHARE} = \frac{\text{NET INCOME} - \text{DIVIDENDS ON PREFERRED STOCK}}{\text{AVERAGE OUTSTANDING}}$$

MARKET CAPITALIZATION

Market Capitalization reflects the monetary market value of all of a company's [Shares Outstanding](#). "Market Cap" is used to determine a company's size. The stocks of large, medium and small companies are referred to as "large-cap," "mid-cap," and "small-cap," respectively.

$$\text{MARKET CAPITALIZATION} = \text{COMPANY'S SHARES OUTSTANDING} \times \text{CURRENT MARKET PRICE OF ONE SHARE}$$

PRICE TO EARNINGS RATIO

The Price to Earnings Ratio compares the market value per share with [earnings per share](#), and is used as a measure of relative value. As a rule, you would expect higher earnings growth in the future from a stock with a high P/E ratio.

$$\text{P/E} = \frac{\text{MARKET VALUE PER SHARE}}{\text{EARNINGS PER SHARE}}$$

RETURN ON EQUITY

Return on Equity reveals how much profit a company earned in comparison to the total amount of shareholder's equity (book value of equity). It is useful to compare the profitability of similar companies in the same industry. It measures a firm's efficiency at generating profits from every dollar of net assets (assets minus liabilities), and shows how well a company uses investment dollars to generate earnings growth.

$$\text{RETURN ON EQUITY} = \frac{\text{NET INCOME}}{\text{AVERAGE SHAREHOLDER'S EQUITY}}$$

SALES GROWTH

Sales Growth is the percentage change in a company's annual sales from one year to the next. It is indicative of a company's future growth prospects, using its past performance as a track record. Sales Growth is displayed as a percentage.

SHARES OUTSTANDING

Shares Outstanding reflects the total number of shares outstanding of the company, including restricted securities held by the company's employees, and shares held by the public. It excludes shares repurchased by the company under a buyback program. Shares Outstanding multiplied by the company's current stock price produces the company's [Market Capitalization](#).

AVERAGE COUPON

Average Coupon is the average [coupon rate](#) of the securities held in a portfolio. It is calculated via the [weighted average method](#) using the ending market values to derive the appropriate weights.

AVERAGE LIFE

Average Life is an estimate of the number of periods to [maturity](#), taking the possibility of early payments into account. Average Life is calculated using the weighted average time to the receipt of all future cash flows.

BOND CREDIT RATING

A Bond Credit Rating is a grade given to bonds that indicates their credit quality. Private independent rating services such as Moody's and Standard and Poor's provide evaluations of a bond issuer's financial strength and its ability to repay a bond's principal and interest in a timely fashion.

Moody's	S&P	Grade
Aaa	AAA	High
Aa1	AA+	High
Aa2	AA	
Aa3	AA-	
A1	A+	Medium
A2	A	
A3	A-	
Baa1	BBB+	Medium
Baa2	BBB	
Baa3	BBB-	
Ba1	BB+	Low / "Junk"
Ba2	BB	
Ba3	BB-	
B1	B+	Low / "Junk"
B2	B	
B3	B-	
Caa1	CCC+	Low / "Junk"
Caa2	CCC	
Caa3	CCC-	
Ca	CC	
C	C	
-	SD	In default
-	D	

CASH FLOW DURATION

Cash Flow Duration is the weighted average time to receipt of effective cash flows. Effective cash flows represent a weighted average of the cash flows predicted under a variety of interest rate scenarios given the optionality of a bond.

CASH FLOW YIELD

Cash Flow Yield is calculated in the same way as the [yield to maturity](#), but takes into account the optionality of a bond when determining the cash flows of the security. Effective cash flows represent a weighted average of the cash flows predicted under a variety of interest rate scenarios.

CONVEXITY

Convexity is a measure of the curvature in the relationship between bond prices and yields. When added to duration, it provides a more accurate measure of the sensitivity of bond price to a large change in interest rates than duration does alone.

COUPON RATE

Coupon Rate is the interest rate stated on a bond, note or other fixed income security when the security is issued. It is expressed as a percentage of the principal (face value) and can be paid at various intervals during the year, typically annually or semiannually.

CURRENT YIELD

Current Yield is calculated as the annual coupon payment divided by the current market value of the bond. The Current Yield will be higher than the coupon rate of the bond if the market price is trading at a discount (below par or 100), and will be lower than the coupon rate if the bond is trading at a premium (above par or 100).

DURATION TO MATURITY

Duration to Maturity, also known as Macaulay Duration, is the weighted average term to maturity of the future cash flows of a bond or bond portfolio.

EFFECTIVE CONVEXITY

Effective [Convexity](#) is calculated using the effective cash flows of a bond, given a security's embedded optionality.

EFFECTIVE DURATION

Effective Duration is an option-adjusted measure of risk to a level shift in the yield curve. The statistic is an estimate of the marginal percentage change in value given a 100 basis point shift in the level of the yield curve. Effective duration is similar to modified duration, but differs by taking into account embedded optionality within bonds, by using effective or expected cash flows given various interest rate scenarios.

EFFECTIVE DURATION (ALTERNATE DEFINITION)

Effective Duration (D2) is an option-adjusted measure of risk to a slope shift in the yield curve. The statistic is an estimate of the marginal percentage change in value given a 100 basis point shift in the slope of the yield curve. Slope might alternatively be described as a steepening or flattening of the yield curve, or, more loosely, as a widening or narrowing of the spread between 30-year and cash spot rates.

EFFECTIVE DURATION (ALTERNATE DEFINITION)

Effective Duration (D3) is an option-adjusted measure of risk to a curvature shift in the yield curve. The statistic is an estimate of the marginal percentage change in value given a 100 basis point shift in the curvature of the yield curve. Curvature might alternatively be described as a bulging or saucering of the intermediate component of the yield curve, or, more loosely, as a widening or narrowing of the spread between 7-year spot yields and both cash and 30-year spot rates.

EFFECTIVE SPREAD

Effective Spread is the basis point spread which, when added to each point along the yield curve, results in a security valuation equal to the security's market value. The Effective Spread is adjusted for the optionality of a bond to reflect its true spread over the term structure. It is also referred to as Option Adjusted Spread (OAS).

KEY RATE DURATION

Key Rate Duration measures a bond's or portfolio's price sensitivity to independent shifts at the 11 "key" maturities along a yield curve. These 11 key maturities are at the 3-month and 1, 2, 3, 5, 7, 10, 15, 20, 25, and 30-year portions of the curve. In essence, Key Rate Duration, while holding the yield for all other maturities constant, allows the duration of a portfolio to be calculated for a one basis point change in interest rates. The sum of the Key Rate Durations along the curve is equal to the effective duration.

MATURITY DATE

The Maturity Date of the bond is the day the final interest payment is made and the principal amount returned to investors.

MODIFIED CASH FLOW DURATION

Modified Cash Flow Duration is the [Cash Flow Duration](#) divided by the quantity one plus one half the [Cash Flow Yield](#). It gives the expected change in value predicted for a 100 [basis point](#) parallel change in the cash flow yield.

$$\text{MODIFIED CASH FLOW DURATION} = \frac{\text{CASH FLOW DURATION}}{1 + \frac{\text{CASH FLOW YIELD}}{2}}$$

MODIFIED DURATION

Modified Duration is the [duration to maturity](#) divided by the quantity one plus one-half the [yield to maturity](#). Conceptually, this is the percentage change in value predicted for a 100 [basis point](#) parallel change in the [yield curve](#). Therefore, it is a measure of the sensitivity of the bond or portfolio to a change in interest rates. This measure does not take into account the potential optionality embedded in securities.

$$\text{MODIFIED DURATION} = \frac{\text{DURATION TO MATURITY}}{1 + \frac{\text{YIELD TO MATURITY}}{2}}$$

NOMINAL YIELD (STATIC YIELD)

The Nominal Yield, or [Static Yield](#), is the internal rate of return of the security based on the given market price. It is the single discount rate that equates a security price (inclusive of accrued interest) with its projected cash flows.

For callable bonds, the yield represents the "yield to worst." For mortgages, it represents the yield given base prepayments for a given [yield curve](#) environment. For futures, the yield denotes the carry and is included in the calculation for aggregate yield. These futures positions are weighted by notional value. Nominal Yield is not applicable for options, swaps, and other [derivative](#) instruments.

OPTION ADJUSTED SPREAD (OAS)

Option Adjusted Spread is the [basis point](#) spread which, when added to each point along the [yield curve](#), results in a security valuation equal to the security's market value. The Effective Spread is adjusted for the optionality of a bond to reflect its true spread over the term structure. It is also referred to as [Effective Spread](#).

SPREAD DURATION

Spread Duration is the percentage change in value of a bond for a 100 [basis point](#) parallel shift in the security or portfolio's [effective spread](#). The calculation is identical to that for [effective duration](#) except that the security's effective spread is adjusted up and down rather than interest rates.

STATIC YIELD (NOMINAL YIELD)

The Static Yield, or [Nominal Yield](#), is the internal rate of return of the security based on the given market price. It is the single discount rate that equates a security price (inclusive of accrued interest) with its projected cash flows.

For callable bonds, the yield represents the "yield to worst." For mortgages, it represents the yield given base prepayments for a given [yield curve](#) environment. For futures, the yield denotes the carry and is included in the calculation for aggregate yield. These futures positions are weighted by notional value. Nominal Yield is not applicable for options, swaps, and other [derivative](#) instruments.

YIELD TO MATURITY

Yield to Maturity is the annualized return an investor would earn for holding the bond through to maturity. It assumes coupon income can be reinvested at the same rate.

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