Quantifying Investment Risk

Investing in financial markets can carry significant risks and long-term adverse effects. Modern portfolio theory (MPT) assesses the maximum expected portfolio return for a given amount of portfolio risk. Within the framework of MPT, an optimal portfolio is constructed on the basis of asset allocation, diversification and rebalancing. Asset allocation, in conjunction with diversification, is the strategy of dividing a portfolio among various asset classes. Optimal diversification involves holding multiple instruments that are not positively correlated.

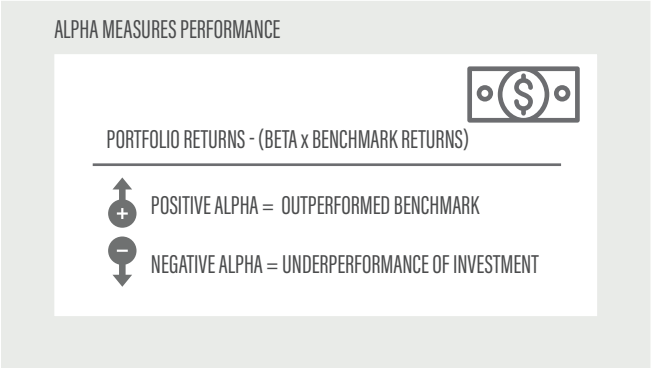
While diversification, and asset allocation can improve returns, systematic and unsystematic risks are inherent in investing. The efficient frontier does its best to minimize an investor's exposure to such risk. Introduced by Harry Markowitz in 1952, the concept identifies an optimal level of diversification, and asset allocation given the intrinsic risks of a portfolio. Along with the efficient frontier, statistical measures and methods including value at risk (VaR), and capital asset pricing model (CAPM) can be used to measure risk.

Alpha and Beta

When it comes to quantifying value and risk, two statistical tools, alpha and beta, can be useful for investors. Both risk ratios are used in MPT and are designed to determine the risk/reward profile of investment securities.

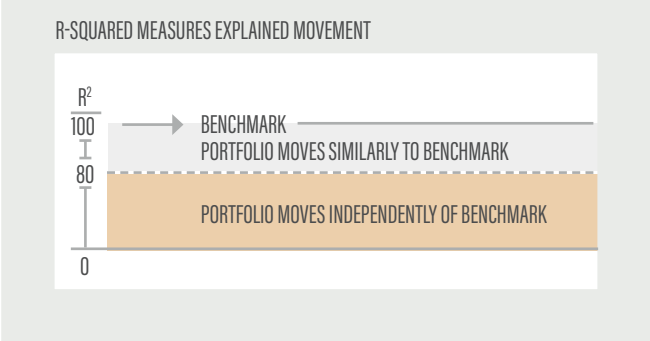
Alpha measures the performance of an investment portfolio and compares it to a benchmark index, such as the S&P 500®. The difference between the returns of a portfolio and the benchmark is referred to as alpha. A positive alpha of 1 means the portfolio has outperformed the benchmark by 1%; likewise, a negative alpha indicates the underperformance of an investment.

Beta measures the volatility of a portfolio compared to a benchmark index. The statistical measure beta is used in the CAPM, which uses risk and return to price an asset. Unlike alpha, beta captures the movements and swings in asset prices. A beta greater than 1 indicates higher volatility whereas a beta under 1 means the security will be more stable. For example, Company A with a beta coefficient of 0.86 represents a potentially safer investment than Company B which has a beta of 1.32. A savvy financial advisor or fund manager would avoid high alpha and beta investments for risk-averse clients.



R-squared

In statistics, R-squared represents a notable component of regression analysis. The coefficient R represents the correlation between two variables: for investment purposes, **R-squared measures the explained movement of a fund or security in relation to a benchmark.** A high R-squared shows that a portfolio's performance is in line with the index. Financial advisors can use R-squared in tandem with beta to provide investors with a comprehensive picture of asset performance.



Standard Deviation

By definition, standard deviation is a statistical procedure used to quantify any variation from the average return of a data set. In finance, **standard deviation uses the return of an investment to measure the investment's volatility.** The measurement differs slightly from beta as it compares volatility to the historical returns of the security rather than a benchmark index. Standard deviation and other technical indicators insist that history tends to repeat itself. High standard deviations are indicative of volatility, and lower standard deviations are associated with stable assets.

> Variance tells you how a single variable varies, covariance tells you how two variables vary together.

Sharpe Ratio

One of the most popular tools in financial analysis, the Sharpe ratio, is a measurement of the expected excess return of an investment in relation to its return volatility. The Sharpe ratio measures the average return in excess of the risk-free rate per unit of uncertainty to determine how much additional return an investor can receive with the added volatility of holding riskier assets. **A ratio of 1 or greater is considered to have a better risk-to-reward tradeoff.**

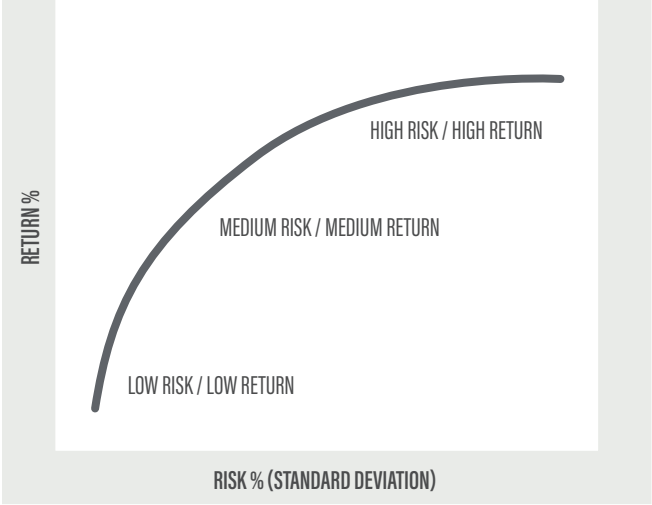
PORTFOLIO RETURN

$$\frac{\text{RATE OF RETURN OF A RISK FREE ASSET (E.G.-U.S. T-BILLS)}}{\text{PORTFOLIO STANDARD DEVIATION}}$$

Efficient Frontier

Efficient frontiers are derived from mean variance analysis, which attempts to create more efficient investment choices. The typical investor prefers high expected returns with low risk. The efficient frontier is constructed accordingly, using a set of optimal portfolios that offer the highest expected return for a specific risk level. Portfolios below the frontier curve are considered sub-optimal while those above are considered unattainable. The optimal choice with respect to the efficient frontier approach occurs when the straight line of the risk-free assets lies tangent to the risky asset frontier.

Figure 1



Capital Asset Pricing Model

CAPM is an equilibrium theory built on the relationship between risk and expected return. The theory helps investors measure the risk and expected return of an investment to appropriately price the asset. In particular, investors must be compensated for the time value of money and risk. The risk-free rate, typically a Treasury bond or stock index, represents the time value of money for placing money in any investment. Simply put, the mean return of a security should be linearly related to its beta coefficient—this shows that riskier investments earn a premium over the benchmark rate. Following a risk-to-reward framework, the expected return, under a CAPM model, will be higher when the investor bears greater risks.

Value-at-Risk

The value-at-risk (VaR) approach to portfolio management is a simple way to measure risk. Calculated based on time period, confidence level and pre-determined loss amount, VaR statistics provide investors with a worst-case scenario analysis. If an investment has a 5% VaR, the investor faces a 5% chance of losing the entire investment in any given month. The VaR methodology isn't the most comprehensive measure of risk; however, due to its simplistic approach, it remains one of the most popular measures in portfolio management.

VALUE-AT-RISK

Conclusion

Investing in financial markets is inherently risky. Many individuals use financial advisors and wealth managers to increase returns and reduce the risk of investments. These financial professionals use statistical measures and risk/reward models to differentiate volatile assets from stable ones. Modern portfolio theory uses five statistical indicators—alpha, beta, standard deviation, R-squared, and the Sharpe ratio—to do this. Likewise, the capital asset pricing model and value-at-risk are widely employed to measure the risk to reward tradeoff with assets and portfolios.

Financial professionals use statistical measures and risk/reward models to differentiate volatile assets from stable ones.

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The S&P 500 Index is a capitalization-weighted index of 500 stocks. The S&P 500 Index is designed to measure performance of the broad domestic economy through changes in the aggregate market value of 500 stocks representing all major industries.

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