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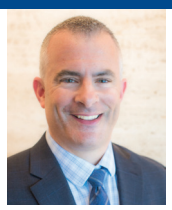
The "Alphabet" of Risk:

17 Modern Portfolio Theory (MPT) Statistics and Concepts for Understanding and Measuring Investment Risk, Risk-Adjusted Returns, and Relative Performance



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#1

Modern Portfolio Theory

Under *modern portfolio theory,* investors focus on managing risk as well as maximizing return. According to *MPT,* the riskiness of a portfolio depends on the covariance of its individual holdings, rather than the average riskiness of the separate investments *(Dobbs, 2015)*.

#2

Efficient Frontier

The combination of assets that will maximize return for a given level of risk *(Dobbs, 2015)*.

MEASURING RISK

#3

Standard Deviation

Measures the variability of returns of an asset compared to its mean or expected return. *Standard deviation* measures total risk. The greater the dispersion of an investment's returns around the average return, the greater the *Standard deviation* and the greater the risk (Dobbs, 2015).

Approximately 68% of outcomes are + or - 1 standard deviation from the mean

Approximately 95% of outcomes are + or - 2 standard deviations from the mean

Approximately 99.7% of outcomes are + or - 3 standard deviations from the mean

Steps to calculate standard deviation:

1. Difference between the observation and the average return.
2. Square the differences.
3. Total squared differences.
4. Divide the sum by one less than the number of observations.
5. Take the square root.

The "Alphabet" of Risk continued

#4

Systematic Risk

Risk that affects the entire market, such as market risk, interest rate risk, inflation risk, foreign currency risk, or reinvestment risk. *Systematic risk* cannot be eliminated through diversification because it affects the entire market *(Dobbs, 2015).*

#5

Nonsystematic Risk

Risk unique to a single stock, business, or industry. Nonsystematic risk can be eliminated through diversification. It is significantly reduced with a portfolio of 15 stocks, but most portfolio managers will utilize 20 to 60+ stocks to minimize the impact of nonsystematic risk *(Dobbs, 2015).*

#6

Beta Coefficient

Beta measures "market risk" or systematic risk or volatility for a diversified portfolio. It measures the volatility of a return relative to the benchmark. For example, if it were the return of a large capitalization US stock portfolio, the S&P 500 could be used as the relative benchmark. For example, a portfolio or stock with a *beta* of 1 would move precisely with the market or benchmark, while a *beta* of 1.2 would be 20% riskier (or more sensitive or responsive) than the market or benchmark. A *beta* of .8 is 20% less risky (or less sensitive or responsive) than the market or benchmark. While *beta* for a portfolio of securities is fairly stable over time, the *beta* for an individual security is more likely to be unstable over time *(Dobbs, 2015).*

The formula for *beta* is *beta* = COV p,m / SDm2

#7

VIX

The *VIX* is a ticker symbol for the Chicago Board of Options Exchange (CBOE) Volatility Index, which measures the expectation of market participants of volatility over the next 30 days. The index is built to measure volatility utilizing a broad spectrum of S&P 500 index put and call options. The *VIX,* sometimes referred to as an "investor fear gauge" is used by investors, risk managers, and speculators alike to measure market risk. If the *VIX* reading is greater than 30, there is an implication of greater degree of risk and volatility. In contrast, if the *VIX* reading is less than 20, volatility and risk is considered to be low and market participants could be characterized as calm and complacent *(Dobbs, 2015).*

MEASURING RISK-ADJUSTED RETURNS

#8

Capital Asset Pricing Model (CAPM)

The required rate of return for any risky asset depends upon the return an individual earns on a risk-free asset (90-day Treasury bill) plus a risk premium. The risk premium is adjusted by the "systematic risk" or beta associated with that asset *(Dobbs, 2015).*

Expected Return (i) = Risk-Free Rate + Beta{Expected Return market – Risk-Free Rate}

Therefore, the greater the systematic risk of a portfolio or investment, the greater the expected return.

#9

Alpha

This *MPT* statistic determines how much the realized return differs from the expected return, given the level of beta, or market risk. Using the CAPM from above, if the expected return for a certain level of market risk = 7%, and the portfolio returned 8%, then the "alpha" = 1%. *Alpha* is like a "report card" for a portfolio manager, where a positive *alpha* indicates a superior manager with a higher risk-adjusted return. *Alpha* demonstrates when a portfolio manager is superior or inferior in security selection and market timing. Since *alpha* does not evaluate the ability of a portfolio manager to diversify, it is best suited for analyzing a diversified portfolio of mutual funds, rather than a sector fund *(Dobbs, 2015).*

The formula for *alpha* is as follows: a = Rp - [Rf + Bp(Rm-Rf)], simply the difference between the actual return and the expected return from the Capital Asset Pricing Model.

#10

Coefficient of Variation

Ratio of the standard deviation divided by the mean. The larger value indicates greater dispersion relative to the arithmetic mean of the return. To compare a series of very different values *coefficient of variation* is preferred to using only standard deviation. Unlike standard deviation which is a measure of absolute dispersions, *coefficient of variation* is a measure of relative dispersions *(Dobbs, 2015).*

The "Alphabet" of Risk continued

Example:

Stock A has a standard deviation of 7 and an average return of 5%.

Stock B has a standard deviation of 10 and an average return of 12%.

A has 1.4 coefficient of variation. (7/5 = 1.4)

B has .83 coefficient of variation. (10/12=.83)

Since the relative dispersion is less for B then A, there is less risk to purchase B.

#11

Sharpe Ratio

This MPT statistic standardizes the return in excess of the risk free rate by the variability of the returns. It has been called the "reward-to-volatility ratio." A higher *Sharpe ratio* is better. *Sharpe ratio* is a risk-adjusted return measurement that evaluates the ability of a manager to diversify. The *Sharpe ratio* is often used to evaluate portfolio managers of mutual funds. Similar to other MPT statistics *Sharpe ratio* should not be used in a vacuum, rather it should be utilized in concert with other statistics to evaluate investments or investment managers *(Dobbs, 2015).*

The formula for *Sharpe ratio* is SR = {Rp – Rf} / SDp

It measures the excess return above the risk-free rate, divided by the standard deviation. Another way to describe Sharpe Ratio is excess return per unit of risk.

#12

Sortino Ratio

The *Sortino ratio* is a variation of the *Sharpe ratio* that distinguishes harmful volatility from total overall volatility by using the asset's "downside deviation." The higher the *Sortino ratio* the better *(Dobbs, 2015).*

The formula for *Sortino ratio* is *Sortino ratio* = <R>-Rf / SDnp

#13

Treynor Ratio

This MPT statistic measures risk-adjusted return to the extent to which realized return exceeds the *risk-free rate* divided by a portfolio's *beta*. *Treynor* does not measure the ability of a portfolio manager to diversify. *Treynor* is used when dealing with a diversified portfolio of mutual funds. Since *Treynor* uses beta it is not a good or relevant risk adjusted return measurement for sector funds *(Dobbs, 2015).*

The formula for Treynor ratio is T = Rp - Rf/B

#14

The Coefficient of Determination or R^2 (R-Squared)

This *MPT* statistic measures the strength of the relationship or dependence of one variable (a manager's return) to another variable (the benchmark return). It is the percentage of a manager's return directly caused by the benchmark. It is used to determine if *beta* is meaningful. An R^2 of 99 would indicate a very strong relationship and might be an index fund of the benchmark, while an R^2 of 15 would give *beta* little meaning because the variation of return would be caused by something other than the movement of the market. A low R^2 number would indicate substantial *nonsystematic risk*. For the purposes of R^2, one should compare an investment to the proper index. For example, a small capitalization investment should be compared to a small capitalization index, such as the "Russell 2000" *(Dobbs, 2015).*

The formula for R^2 = [1 – (Unexplained variation/Total variation)]

MEASURING PERFORMANCE COMPARED TO A BENCHMARK

#15

Information Ratio

It is a ratio of portfolio returns above the returns of a benchmark or index to the volatility of those returns. The *information ratio* measures excess returns relative to an index. In addition, the ratio demonstrates the consistency of the performance of the investment manager *(Dobbs, 2015).*

The formula for *information ratio* is
Information Ratio = Rp - Ri / Sp-i

#16

Correlation Coefficient

It is a measure of how different returns vary for different stocks. It is calculated by determining the covariance between two investments divided by multiplying their standard deviations together. Covariance is how a return varies from other returns. A positive covariance means variables move in the same direction. A negative covariance means variables move in opposite directions. Larger numbers indicate a stronger relationship and smaller numbers indicate a weaker relationship. Covariance is an absolute number.

The "Alphabet" of Risk continued

The numerical values of the *correlation coefficient* range from +1 to -1. A *correlation coefficient* of 1 would mean a perfect positive correlation. If two variables move exactly opposite of each other, the value of the *correlation coefficient* is -1. Low numerical values indicate little relationship. There is an inverse relationship between correlation and diversification *(Dobbs, 2015)*.

The formula for the *correlation coefficient* is:
correlation coefficient = COV A, B / SDA X SDB

#17

Active Share

It determines the amount of the manager's portfolio composition that is unique compared to the benchmark index. *Active share* compares the relative percentage of each equity holding in the portfolio to the relative percentage of each stock position in the corresponding benchmark index. Typically, *active share* will be between 0% and 100%, where values close to 0% imply a "closet index" and values closer to 100% represent a more unique portfolio relative to the index. All else being equal, a relatively high *active share* may provide some beneficial non-correlation and diversification, which could potentially lower the overall portfolio risk, without necessarily compromising portfolio return. In contrast, a relatively low *active share* may make sense for investors seeking greater market exposure in a low cost index, fully aware of the systematic risk and high correlation to the benchmark *(Nuveen, 2017)*.

Investors can utilize a broad array of MPT statistics and concepts to evaluate investment managers and make more informed choices about which investments are appropriate for their portfolio and in what proportion to their overall portfolio is reasonable. In addition, investors should analyze qualitative characteristics such as a manager's investment thesis, experience, credentials, co-investment, and other relevant qualitative factors.

Formula Key

- B: Beta
- Bp: beta of the portfolio
- COV p,m: covariance of portfolio and market
- COV A,B: covariance of portfolio A and portfolio B
- R^2: coefficient of determination
- Ri: return of the index
- Rp: return of portfolio
- <R>: expected return
- Rf: risk-free rate of return
- Rm: return of market
- Rb: return of benchmark
- SDp: standard deviation of portfolio
- SDm: standard deviation of the market
- SDnp: standard deviation of negative performance or "downside deviation"
- Sp-i: Tracking error (standard deviation of the difference between returns of the portfolio and returns of the index.)

Citations

Dobbs, J., CIMA®, CPWA®, CFP®. (2015). *The Investment Advisor Body of Knowledge: Readings for the CIMA Certification* 74-86, 310-391, 744-789, 1069. Hoboken: John Wiley & Sons

Nuveen. (2017). *Essential Performance Metrics to Evaluate and Interpret Investment Returns.* Chicago, IL.