Capital Assets Pricing Model (CAPM)

The capital asset pricing model (CAPM) is a model that describes the linear relationship between systematic risk and expected return for assets, particularly stocks. It shows that the expected return on a security is equal to the risk-free return plus a risk premium, which is based on the beta of that security.

The formula of CAPM, $E[R_i] = R_f + \beta_{im} [E(R_m) - R_f]$

$E[R_i]$ = Risk-free retrun + risk premium

Risk Premium = $\beta_{im} [E(R_m) - R_f]$

Market Risk Premium = $[E(R_m) - R_f]$

Assumptions of Capital Assets Pricing Model (CAPM)

1. All investors are efficient investors, who want to target points on the efficient frontier.

2. All investors are price takers

3. Investors can borrow or lend any amount of money at the risk free rate of return

4. All investors have homogeneous expectations.

5. All investors have the same one-period time horizon such as one month, six months, or one year.

6. All investments are infinitely divisible and perfectly liquid.

7. There is no taxes

8. There are no transaction costs.

9. There is no inflation or any change in interest rates, or inflation is fully anticipated.

10. The quantities of all assets are given and fixed.

Capital Market Line

The capital market line (CML) describes the equilibrium relationship between expected return and total risk for efficiently diversified portfolios. The CML is used to show the rates of return, which depends on risk-free rates of return and levels of risk for a specific portfolio.
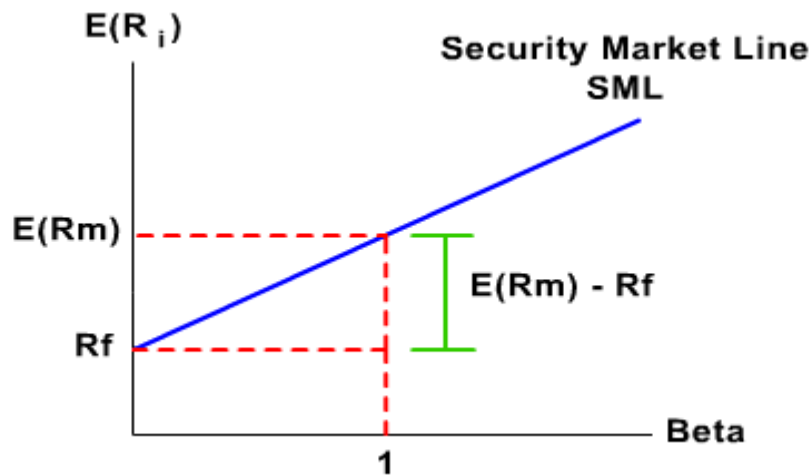
The equation of CML is, $E[R_p] = R_f + \sigma_p [(E[R_m] - R_f)/\sigma_m]$
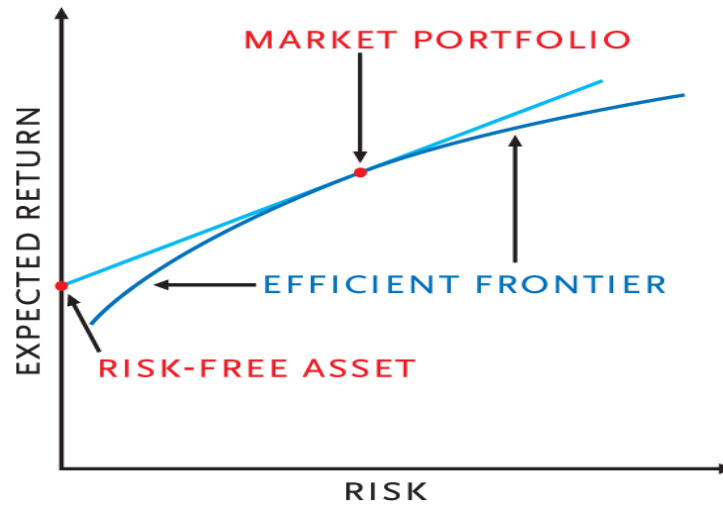
Security Market Line

SML, which is also called a Characteristic Line, is a graphical representation of the capital assets pricing model (CAPM). It shows the relationship between the expected return of a security and its risk measured by its beta coefficient.

The equation of SML is, $E[R_i] = R_f + \beta_{im} (E[R_m] - R_f)$

Distinguish between Security Market Line (SML) and Capital Market Line (CML)

Security Market Line (SML)	Capital Market Line (CML)
The graphical presentation of Capital Assets Pricing Model (CAPM) is called SML.	The Capital Market Line (CML) describes the risk/return relationship for efficient portfolios.
The SML measures the risk through beta coefficient.	The CML measures the risk through standard deviation, or through a total risk factor.

The graph of Security Market Line defines both efficient and non-efficient portfolios.	The graph of Capital Market Line define efficient portfolios
The SML demonstrates the risk or return for individual stocks.	The CML determines the risk or return for efficient portfolios.
The equation of SML is, $$E[R_i] = R_f + \beta_{im} (E[R_m] - R_f)$$	The equation of CML is, $$E[R_p] = R_f + \sigma_p [(E[R_m] - R_f)/\sigma_m]$$
Slope of SML = $(R_m - R_f)/ \beta$	Slope of CML = $\sigma_p [(E[R_m] - R_f)/\sigma_m]$
SML considers only systematic risk.	CML considers both systematic and unsystematic risk

Portfolio

A portfolio means a combination of two or more securities or assets. A large number of portfolios can be formed a given set of assets. Each portfolio has risk-return characteristics of its own. Portfolio theory, originally developed by Professor Henry Markowitz, shows that portfolio risk, unlike portfolio return, is more than a simple aggregation of the risks of individual assets. This depends on the interplay between the returns on assets comprising the portfolio. As rational or efficient investors, construct a portfolio of investment rather than invest in a single asset.

According to Gitman, "Portfolio is a collection or group of assets."

According to I.M. Panday, "A portfolio is a bundle or a combination of individual assets or securities."

According to E.G. Benton, "Portfolio theory is method of assets selection that considers the combined risk of all assets held by them."

Efficient Portfolio / Optimal Portfolio

The feasible set of portfolios represents all portfolios that can be constructed from a given set of assets. One important use of portfolio risk concepts is to select efficient portfolio, defined as those portfolios that provide the highest expected return for any degree of risk or the lowest degree of risk for any expected return.

According to L.J. Gitman, "Efficient portfolio is a portfolio that maximizes return for a given level of risk or minimizes risk for a given level of return."

According to Brigham & Ehrhardt, "An efficient portfolio is one of that offers the most return for a given amount of risk, or the least risk for a given amount of return."
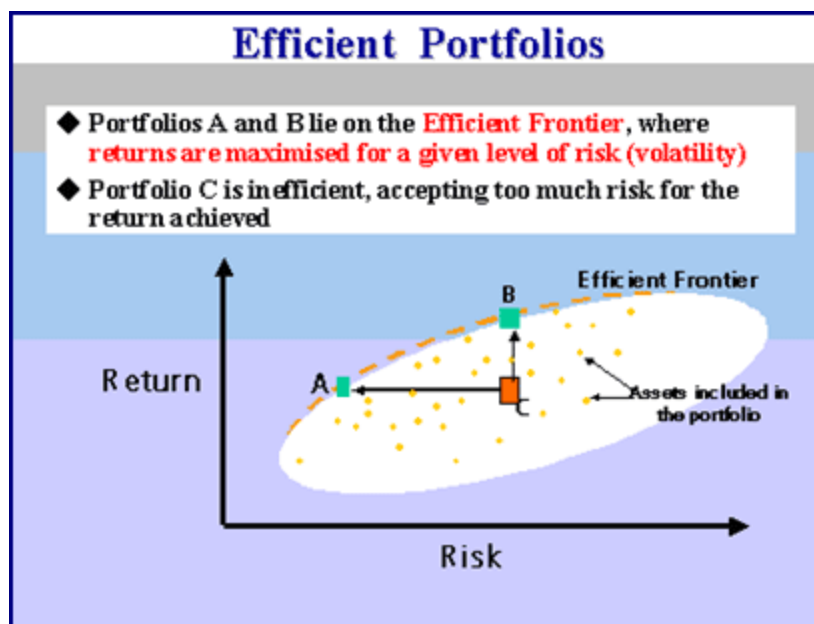
Beta coefficient

A beta coefficient measures how likely the price of a security or a stock will change to a movement in the market price. The Beta of a stock or security is also used to measure the systematic risks associated with that investment.

$$\beta = \frac{Cov(R_a,R_M)}{Var(R_M)}$$

Where $Cov(R_a, R_M)$ is a covariance between the return of a given security and market return, and $Var(R_M)$ is a variance of market return.

The interpretation of the key values of beta is shown below.

1. **β < 0.** Return of a security drives in the opposite direction from the market return. A negative value is very rare for long positions but is normal for short positions.

2. **β = 0.** There is no correlation between a security return and the market return. For example, zero beta coefficients have fixed income securities because the return doesn't depend on market return movements. Another example is cash under the condition of zero inflation because its value doesn't change over time unlike market return.

3. **0 < β <1.** Return of a security moves in the same direction as market return, but its volatility is less than market volatility.

4. **β = 1.** The security return and market return move in the same direction and have equal volatility.

5. **β >1.** The return of a security moves in the same direction as the market and has higher volatility than the market return.

Beta of portfolio: The beta of a portfolio is a weighted average of all beta coefficients of its constituent securities.

$$\beta_P = \sum_{i=1}^{N} w_i \times \beta_i$$

Where, w_i is the proportion of a given security in a portfolio, β_i is the beta coefficient of a given security, and N is the number of securities in a portfolio.