Continuation of Risk and return

Asset Pricing

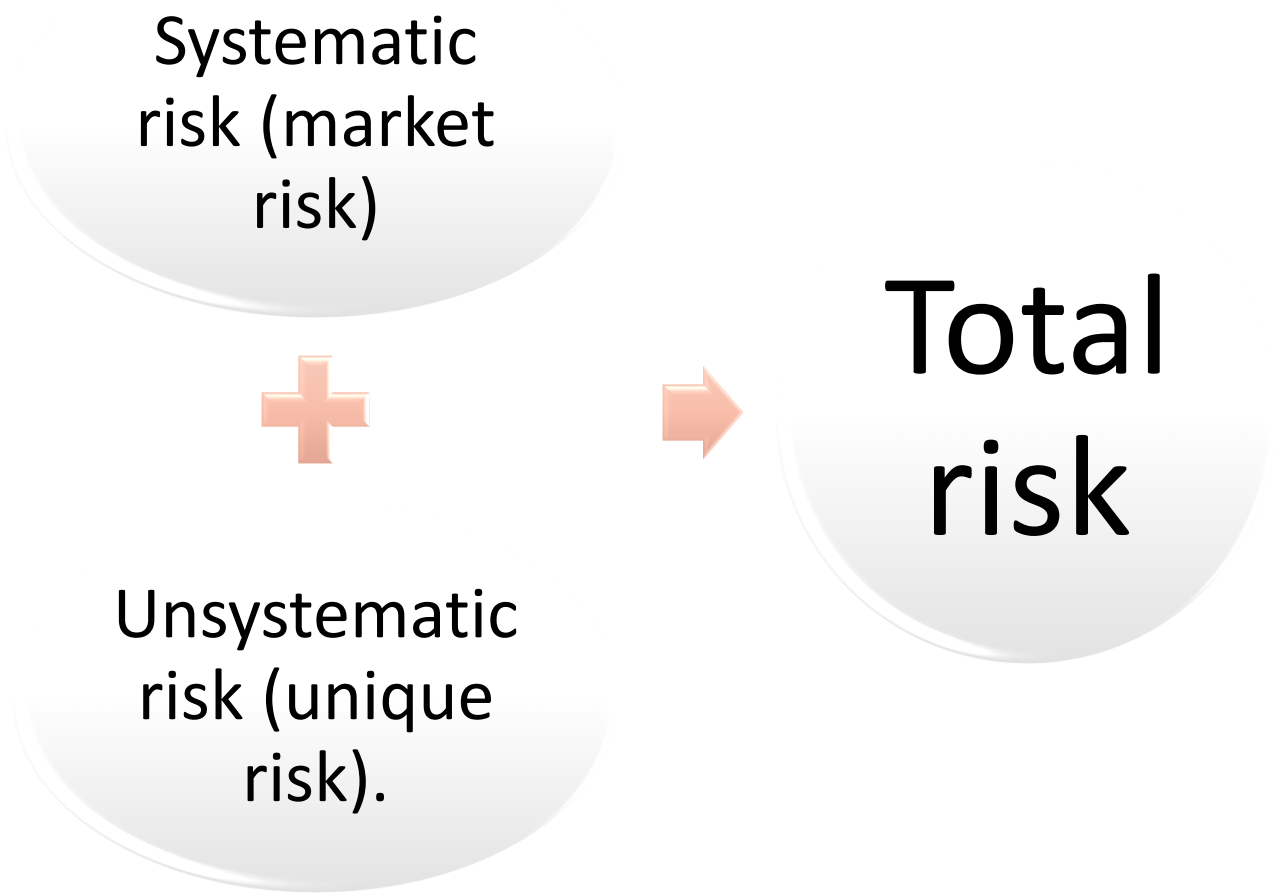
Underlying Concept

- Value of a financial asset depends on its risk-return profile in relation to the market.
- A security will be purchased only if it improves the risk-expected return characteristics of the market portfolio.

Asset Pricing Models

- Capital Asset Pricing Model (CAPM)
- Arbitrage Pricing Theory (APT)

Forms of Risk



Unsystematic Risk

Unsystematic risk refers to the variability of return on securities or portfolios that is not explained by general market movements.

It is risk unique to a particular company or industry.

Since unsystematic risk is independent of general economic, political, and such other factors, it can be reduced or eliminated through diversification.

It is also referred to as ***unique risk*** , ***specific risk*** or ***idiosyncratic risk***.

Systematic Risk

Systematic risk refers to the variability of returns on securities or portfolios that is associated with changes in return on the market as a whole.

It is also referred to as ***portfolio risk*** or ***market risk***.

Systematic risk cannot be diversified.

Sources of Systematic Risk

- Changes in the economy (e.g. recession in economy)
- Changes in taxes
- Changes in interest rates
- Changes in exchange rates
- Changes in oil supply

… Systematic Risk

Measurement of Systematic Risk

The extent to which a security's return is affected by systematic risk depend on its sensitivity to systematic risk.

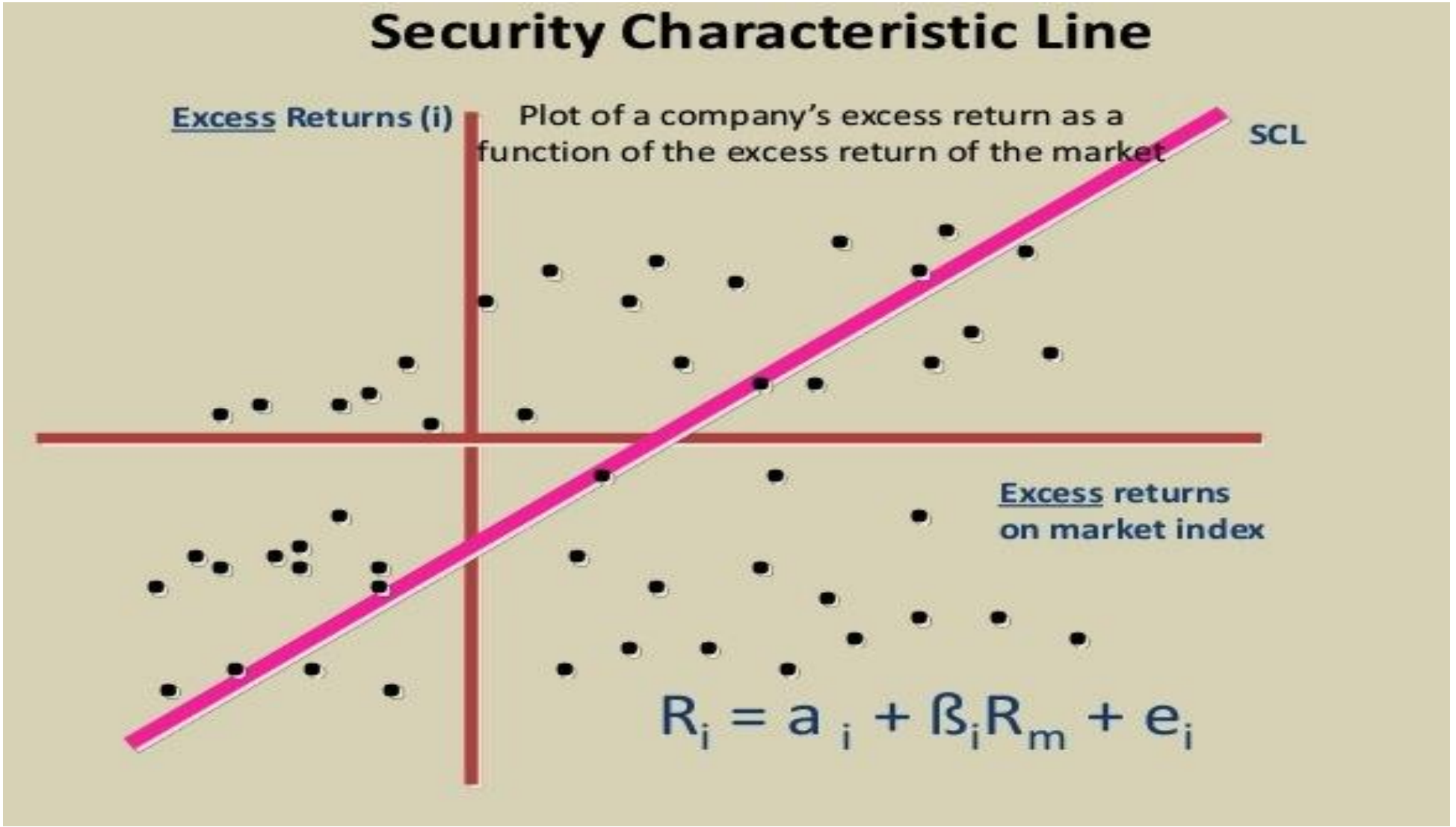
A security's sensitivity to systematic risk is measured by a "***beta***" factor.

Measurement of Systematic Risk

The beta is the slope of the security's ***characteristic line***.

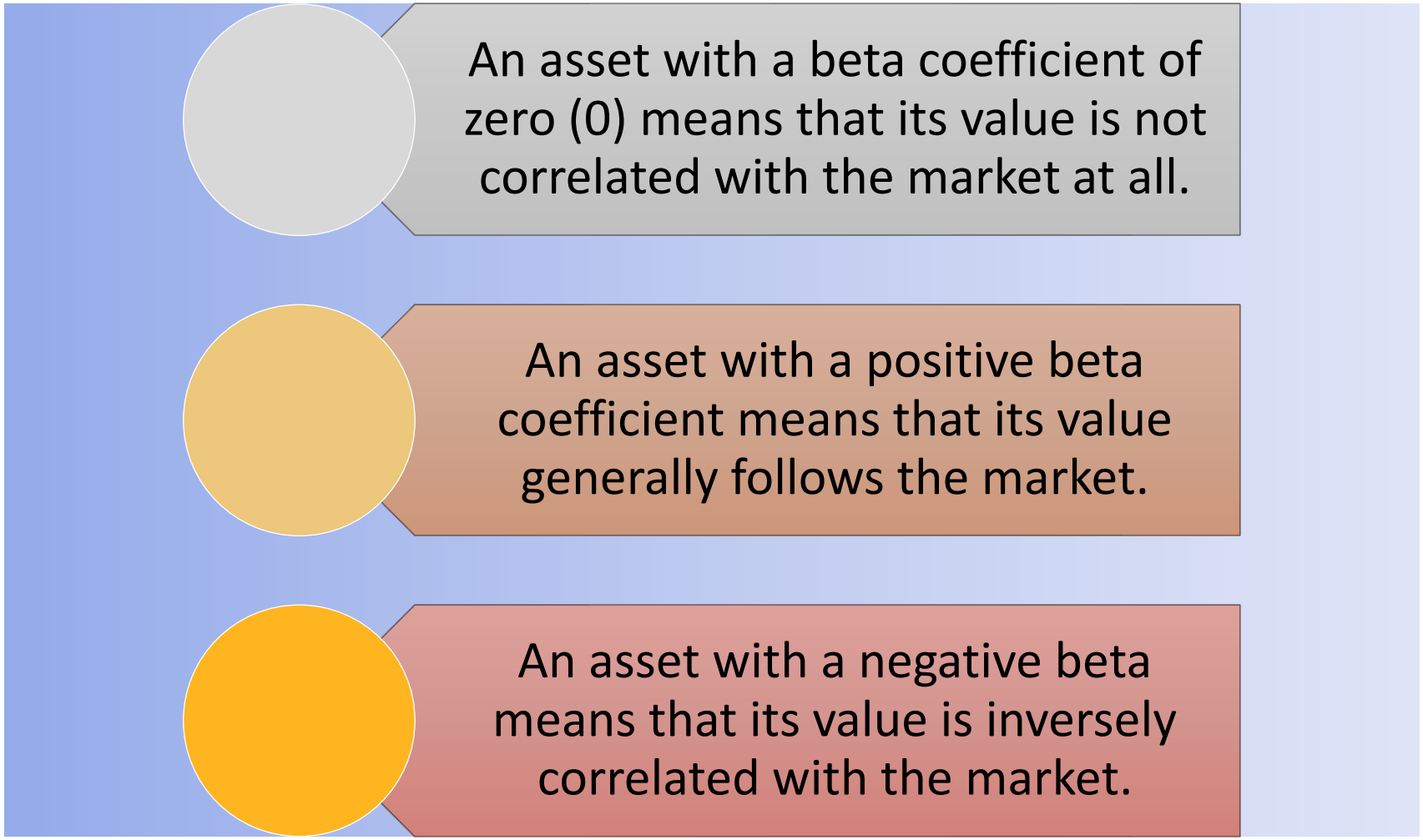
The ***characteristic line*** describes the relationship between an individual security's returns and market portfolio returns.

If historic data of excess returns of a security over the risk-free return is regressed on excess of market returns over the risk-free rate, the slope of the resulting security's characteristic line is the beta factor of that security.


Security Characteristic Line
Excess Returns (i)
Plot of a company's excess return as a function of the excess return of the market
SCL
Excess returns on market index
$R_i = a_i + \beta_i R_m + e_i$

Interpretation of Beta Factor

Beta Value	Implication	Illustrative Example
Beta factor = 1	The security is as sensitive as the market to systematic risk and so is likely to rise and fall in value equal to the market in general.	If market portfolio return rise by 10% then the return of this security will rise by the same proportion (i.e. 10%).
Beta Factor > 1	The security is more sensitive to systematic risk than the market and so is likely to rise and fall in value more than the market in general.	If the market improves by 10% then the improvement in returns from this security are likely to be more than 10%.
Beta Factor < 1	The security is less sensitive to systematic risk than the market and so is likely to rise and fall in value less than the market in general.	If the market falls by 10% then the fall in returns from this security are likely to be less than 10%.



… Interpretation of Beta Coefficient

Calculation of Beta Coefficient

Statistical Estimation Using Regression

- Regress excess of security's returns over the risk free rate ($R_{i,t} - R_f$) on the excess of market portfolio's returns over the risk free rate ($R_{m,t}$ - R_f).
- Estimate statistically the beta coefficient using the following regression equation (i.e. Security's Characteristic Line)

$$SCL: R_{i,t} - R_f = \alpha_i + \beta_i\left(R_{m,t} - R_f\right) + \varepsilon_{i,t}$$

- α_i is the security's alpha and β_i is its beta coefficient

Calculation of Beta Coefficient

- The beta factor of a security (denoted i) can be computed using any of the following equations:

$$\beta = \frac{\text{Cov (Stock, Market)}}{\text{Var (Market)}}$$

$$\beta_j = \frac{(std\ dev.\ of\ i) * (correl.\ of\ returns\ of\ i\ with\ market)}{std\ dev.\ of\ the\ market} = \frac{\sigma_i \rho_{i,m}}{\sigma_m}$$

Portfolio Beta Coefficient

- Portfolio beta coefficient is computed as the sum of the weighted average of the beta factor of each component asset

General Formula for Portfolio Beta

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

... Calculation of Beta Coefficient

Beta Coefficient for a 2-Asset Portfolio

$$\beta_i = w_A\beta_A + w_B\beta_B$$

Beta Coefficient for a 3-Asset Portfolio

$$\beta_i = w_A\beta_A + w_B\beta_B + w_C\beta_C$$

... Calculation of Beta Coefficient

Capital Asset Pricing Model

Pricing Principle

- The price paid must ensure that the market portfolio's risk-expected return characteristic improves when the security is added to the market portfolio

Use of the CAPM

- To describes the relationship between risk and expected returns.
- To estimate a security's theoretical required rate of return (discount rate)
- The model's theoretical required return can be used to discount future cash flows from the asset to their present value to establish the security's correct price.

Underlying Principle of CAPM

Underlying Principle

- The price paid must ensure that the market portfolio's risk-expected return characteristic improves when the security is added to the market portfolio and so the relevant measure of risk for pricing purpose is systematic risk.
- Investors will be compensated for only systematic risk (unavoidable risk).
- In equilibrium, a security is supposed to provide an expected return that matches up to its systematic risk.
- The greater the systematic risk of a security, the greater the expected return from the security.

Assumptions of CAPM

Underlying Assumptions of CAPM
• An efficient capital market. • Total risk can be broken into systematic and unsystematic risk. • Unsystematic risk can be completely diversified away. • A risk free security exists. • Beta values remain constant throughout time. • All of a company's shareholders hold well-diversified portfolios. • Investors are in general agreement about the likely performance of individual securities and that their expectations are based on a common holding period (i.e. investors have the same risk profile).

The CAPM Equation

The Theoretical Required Expected Return

- The CAPM derives a security's theoretical required expected return as the sum of the risk-free rate and a risk premium based on the systematic risk of the security.
- The estimated required rate of return is what is appropriate to compensate for the stock's systematic risk.

Mathematical Formulation

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f)$$

- Where:
  - R_i = the expected return for stock i
  - R_f = the risk free rate
  - R_m = the expected return for the market portfolio
  - B_i = the beta factor for stock i
  - $(R_m - R_f)$= market risk premium

Estimated Price and Observed Price

Estimated Price

- The asset's price computed using the CAPM's theoretical required expected return as discount rate.

Observed Price

- The price of the asset in the market.

Returns and Stock Prices

Relationship between Estimated Price (EP) and Observed Price (OP)	Implication	Direction of Movement Towards Equilibrium
EP= OP	The stock is properly priced and so it is expected to provide a rate of return equal to what is required	There is equilibrium
EP > OP	The stock is underpriced and so it is expected to provide a rate of return greater than that required.	Investors will buy the stock to enjoy the superior expected returns. This action will cause the price to rise and the return to drop to what is required.
EP < OP	The share is overpriced and so it is expected to provide a lower return than that required.	Investors holding this stock will sell it. This action will cause the price to drop and the return to rise to what is required.

Arbitrage Pricing Theory

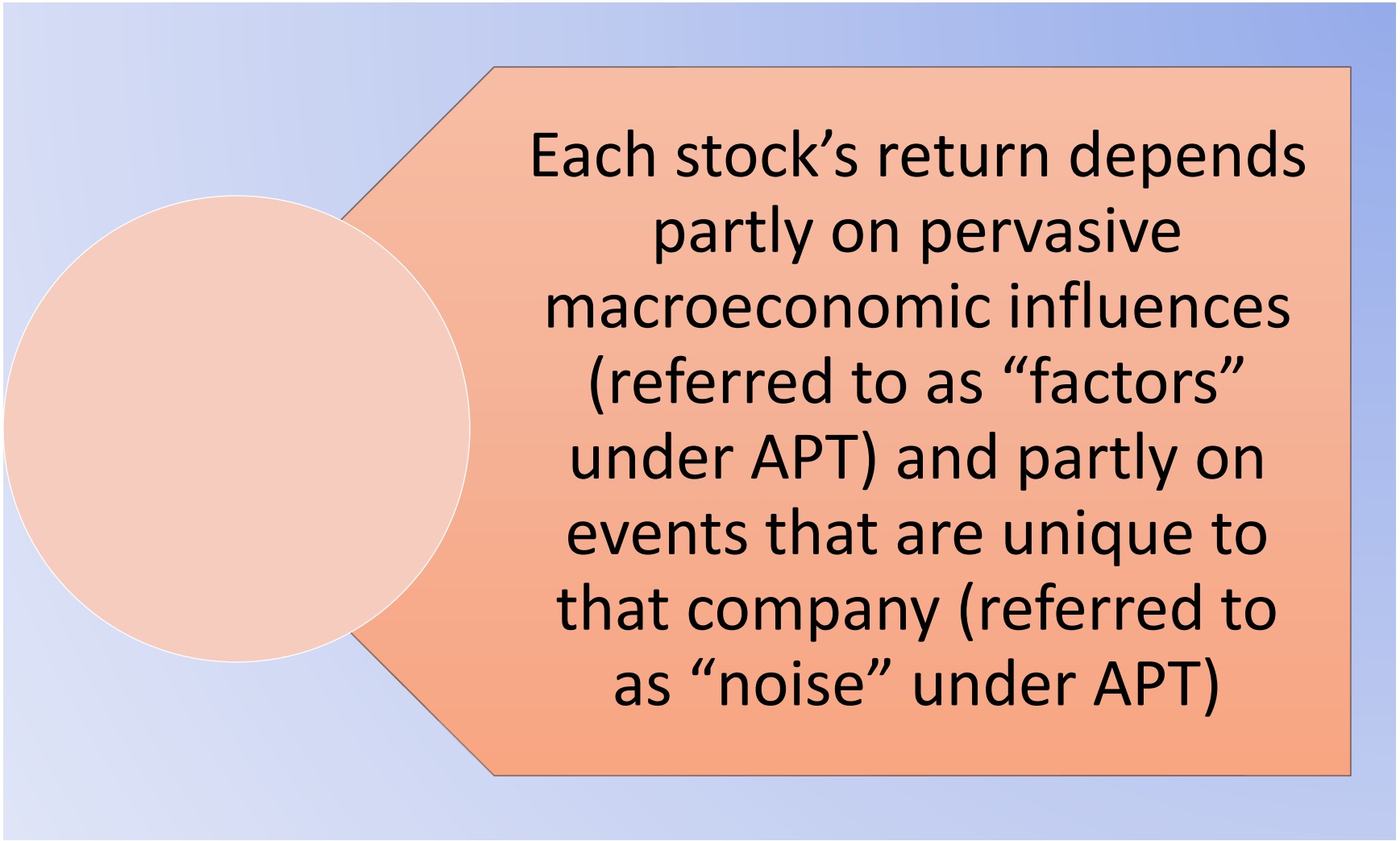
An asset pricing model based on the idea that an asset's returns can be predicted using the relationship between that same asset and many common risk factors.

Unlike the CAPM, the APT does not require market's expected return.

The APT uses the risky asset's expected return and the risk premium of a number of macro-economic factors.

Arbitrageurs use the APT model to profit by taking advantage of mispriced securities. A mispriced security will have a price that differs from the theoretical price predicted by the model.

Fundamental Assumption of APT



General Form of APT Model

Underlying Principle

- Under APT, expected return of a risky financial asset is modelled as a linear function of various macroeconomic factors.

General Formula

$$R_i = E(R_i) + b_{i,1}F_1 + b_{i,2}F_2 + b_{i,3}F_3 + \cdots + b_{i,n}F_n + \epsilon_i$$

$$E(R_i) - R_f = b_{i,1}(F_1 - R_f) + b_{i,2}(F_2 - R_f) + b_{i,3}(F_3 - R_f) + \cdots + b_{i,n}(F_n - R_f)$$

Steps Involved in APT

First

- Derive the asset's rate of return from the model

Second

- Use the model-derived rate of return to discount cash flows from the asset to their present value to determine the asset's correct price

Third

- Compare model-derived price to discounted expected end of period price to determine whether it is priced too low or too high, and take the appropriate arbitrage strategy

Step 1

- Identify the macroeconomic factors that could affect either the asset's cash flows or rate at which they are discounted and find appropriate measure for each factor

Step 2

- Estimate the expected risk premium for each factor
- Factor risk premium is given by $(F_n - R_f)$

Step 3

- Estimate the factor sensitivities
- $R_i - R_f = b_1(RP_1) + b_2(RP_2) + b_3(RP_3) + \ldots + b_n(RP_n)$

Computing Return under APT

Step 4

- Estimate the asset's expected risk premium
- This is the sum of the product asset's beta for each factor and expected risk premium for each factor
- $R_i - R_f = b_1(RP_1) + b_2(RP_2) + b_3(RP_3) + \ldots + b_n(RP_n)$

Step 5

- Estimate the asset's expected return
- This is the sum of risk-free rate and the asset's expected risk premium
- $E(R) = R_f + \Sigma\ (b_j)(RP_j)$

… Computing Return under APT

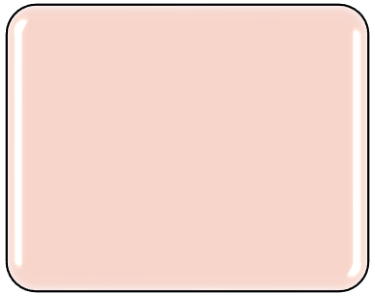
Random Walk Hypothesis

Past stock prices are of no value in forecasting future prices because past, current, and future prices merely reflect market responses to information that comes into the market at random.

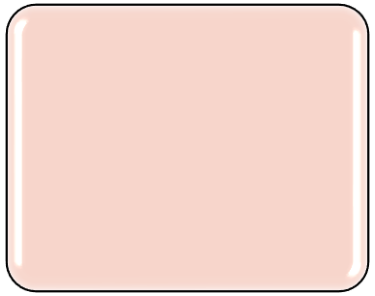
Price movements are random and no more predictable than the pattern of the walk of a drunk.

The hypothesis implies that technical analysis is useless in its attempts to predict future price movements in the market.

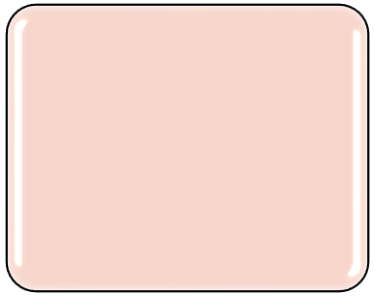
Efficient Market Hypothesis



After rigorous study of the random walk hypothesis scholars agree that the random walk of stock prices is explained by the efficient market hypothesis



The EMH states that financial markets are efficient and that prices already reflect all known information concerning a stock or other security and that prices rapidly adjust to any new information



The EMH explains the random walk by suggesting that only new information would move stock prices and since new information is unknown and occurs at random, future change in stock prices is also unknown and thus change randomly

Efficient Financial Markets (EFM)

Meaning of EFM

- A financial market in which current prices fully reflect all available relevant information.

Assumptions of EFM

- Information is widely available to all investors
- Investors use available information to analyze the economy, the markets, and individual securities to make trading decisions
- Most events that have a major impact on stock prices, such as labor strikes, major lawsuits, and accidents, are random, generally unpredictable events and when they do happen, they are quickly broadcast to investors
- Investors will react quickly to any new information

Forms of Market Efficiency

Weak-form Efficiency

- Current prices fully reflect historical sequence of stock prices and trading volume.

Semi strong-form Efficient

- Current prices fully reflect all publicly available informationsuch as news, accounting reports, company management, patents, products of the company, and analysts' recommendations.

Strong-form Efficiency

- Current prices fully reflect all information, both public and private typically held by corporate insiders, such as officers and executives of the corporation.

Market Imperfections

The market is not always efficient and so there is an opportunity to make some gains if you invest upon careful analysis of available information