Semester: VIII Subject: AIFB Academic Year: 2024-25

Mathematical Expectation:-

In finance, mathematical expectation (often called the expected value) refers to the average or mean outcome of a random variable, such as the future returns of an asset, taking into account all positive outcomes weighted by their probabilities. It's a fundamental concept used to model and analyze the behaviour of financial assets, investments and decision-making under uncertainty.

Consider:

$X \longrightarrow$ Discrete Random Variable.

$x_1 \quad x_2 \quad x_3 \quad \ldots\ldots \quad x_n \longrightarrow x_i$ is the possible value of the random variable X.

$P(x_1) \quad P(x_2) \quad P(x_3) \ldots\ldots P(x_n) \longrightarrow$ Probability of outcome.

The rule is

$$P(x_i) \geq 0, \quad \sum_{i=1}^{n} P(x_i) = 1.$$

The formula for mathematical Expectation is

$$E(X) = \sum_{i=1}^{n} x_i P(x_i)$$

$$= x_1 P(x_1) + x_2 \cdot P(x_2) + x_3 \cdot P(x_3) + \ldots + x_n P(x_n)$$

Application of Mathematical Expectation in Finance:

(1) Expected Return on Investment (ROI):

→ Calculate the expected return of an investment.

→ If an investor is considering different possible returns based on market condition. (or) economic factors, the expected return helps access the most

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likely outcome overtime.

Example:

Suppose a stock has following return:

→ 40% chance of a 10% return

→ 30% chance of a 5% return

→ 30% chance of a -3% return

Solution:

Expected Return } = (0.40 * 10%) + (0.30 × 5%) + (0.30 × -3)
E(Return)

= 4 + 1.5 - 0.9

E(Return) = 4.6%

The return of investment is 4.6%.

(2) Risk Management:

It is often combined with other measures like variance or standard deviation to access risk. The Sharpe ratio, for example, uses expected return and standard deviation to evaluate risk-adjusted performance.

(3) Insurance: Expected value is used to calculate premiums of Insurance.

According to example discussed 4.6% does not tell potential range of returns (like high return or low return), so it is important to complement expected value with measures of risk, Standard Deviation and Variance.