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Portfolio Management Strategies

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CWM®

I. INTRODUCTION

Before starting with portfolio, let us understand what is investments.

Investment means buying an asset for example stocks, real estate, bonds, mortgages which may provide a future income and increases its value.

Characteristics of Investments

- Risk
- Return
- Safety
- Liquidity
- Marketability
- Concealability
- Capital growth
- Stability of income
- Tax Benefits

Now let's understand what is a portfolio, a portfolio is group of invested financial instruments. To maintain a healthy portfolio, we need to manage our portfolio. Portfolio Management is described as an integrated set of steps undertaken in a consistent manner to create and maintain an appropriate portfolio.

Portfolio Management is an ongoing process in which –

- Investment objectives and constraints are identified and specified
- Investment strategies are developed
- Portfolio composition is decided
- Portfolio performance is measured and monitored
- Any necessary rebalancing is implemented

A. Investment Objectives

The investor's objectives are his or her investment goals expressed in terms of both risk and returns. The relationship between risk and returns requires that goals not to be expressed only in terms of returns. Expressing goals only in terms of returns can lead to inappropriate investment practices.

For example – a person may have stated a goal such as “double my investment in 5 years”. Before that statement becomes part of the policy statement, he/she must be aware about the investment risks in the particular instrument.

B. Risk Objectives

In formulating a risk objective, the investor must arise the following questions.

- 1> How do I measure risk?
- 2> What is my willingness to take the risk?
- 3> What is my ability to take risk?
- 4> What are the specific risk objectives?

C. Return Objectives

The second element of the investment policy framework is the return objective, which must be consistent with the risk objectives. The following questions should arise.

- 1> How is return calculated?
- 2> How much return do I need?
- 3> What are the specific return objectives?

D. Portfolio Optimization

Stated at its simplest, portfolio construction involves selection of securities to be included in the portfolio and the determination of portfolio funds (weights) to be placed in each security. The Markowitz model provides the basis for a scientific portfolio construction resulting in efficient portfolios.

“An efficient portfolio is one with the highest level of expected return for a given level of risk, or the lowest risk for a given level of expected return”.

On a formal basis, the Markowitz model provides an organized framework for portfolio optimization, which allows investors to construct portfolio that are efficient.

The basic concepts pioneered by Markowitz are –

- 1> Monitoring market conditions.
- 2> Changes in investor's circumstances
- 3> Change in wealth
- 4> Change in time horizon
- 5> Change in liquidity
- 6> Change in liquidity requirements
- 7> Change in tax circumstances
- 8> Change in legal or regulatory considerations
- 9> Change in unique needs.

E. Rebalancing Portfolio

Even the most carefully constructed portfolio is not intended to remain intact without change. The key is to know how and when to do such rebalancing because a trade-off is involved.

The cost of trading involves commissions, possible impact on the market price, and the time involved in deciding the trade. The cost of not trading involves holding positions that are not the best suited for the portfolio's owner, holding asset allocation plan, holding a portfolio that is no longer adequately diversified and so forth.

Rebalancing reduces the risks of sharp losses in general, a rebalanced portfolio is less volatile than one that is not balanced. Investors should concentrate on keeping their chosen asset allocation percentages in line over the long run.

Rebalancing simply means periodically reviewing your portfolio to ensure that it is still fulfilling your investing goals.

F. Performance Management

The portfolio management process is designed to facilitate making investment decisions in an organised, systematic manner. Clearly it is important to evaluate the effectiveness of the overall decision-making process. The measurement of portfolio performance allows investors to determine the success of the portfolio management process.

II. LITERATURE REVIEW

Different strategies should be utilised for different market conditions, the time planning of an investment plays a significant role in the profitability of the strategy.

A. Jaroslaw Gruszka

Excess returns can be achieved by correctly timing changes in yields and yield spreads motivates active bond portfolio management strategies.

B. Naomi E. Boyd and Jeffrey M Mercer

The direct use of portfolio management tools in the market can cause sub-optimal solutions, so risk aversion constant of utility functions should be adopted.

C. Mete Emin Atmaca

Risk sensitive criterion amounts to maximising a portfolio's risk adjusted growth rate.

D. Tomasz R. Bielecki and Stanley R. Pliska

Determining strategic positions in the balancing market and identifying corresponding economic in an analysis allows an economically starting optimal starting point for real-time balancing and create a marketplace for flexible capacity, that is more often than alternative marketplaces.

E. Christoph Moller

In testing the efficiency of the $1/n$ rule, the authors find that it outperforms the mean variance rule for individual small portfolios out of sample, but for large portfolios (i.e., institutional investors) the Markowitz strategy is superior. The advantage of the $1/n$ rule in the out-of-sample analysis is the absence of exposures to estimation errors.

F. Ran Duchin & Haim Levy

III. METHODOLOGY

The portfolio perspective refers to evaluating individual investments by their contribution to the risk and return of the investors portfolio. The alternative to taking a portfolio perspective is to examine the risk and return of the individual investments in isolation. An investor who holds all his wealth in a single stock, because he believes it to be the best stock available is not taking the portfolio perspective. His portfolio is risky compared to holding a diversified portfolio of stocks. Modern portfolio theory concludes that the extra risk from holding only a single security is not rewarded with high expected return. Conversely diversification allows an investor to reduce portfolio risk without necessarily reducing the portfolio's expected return.

Before we start with the risk and return part, let us understand how to classify data.

A. Visualizing and Describing Data

The term data encompasses information in any form. Data can be classified into 3 different perspectives.

- ➔ Numerical and Categorical data
- ➔ Time-series and cross-sectional data
- ➔ Structured and un-structured data

Numerical data – Numerical data are the values that can be counted or measured. Numerical data can be DISCRETE or CONTINUOUS. Discrete data are countable, such as days, months, weeks, etc. . Continuous data can take fractional value, such as an annual return.

Categorical data – it consists of labels that can be used to classify set of data into groups. Categorical data can be nominal and ordinal, nominal data are labels that cannot be ranked in a logical order. Ordinal data are labels that can be ranked in a logical order.

Time-series data – it is a set of observation taken periodically most often at equal intervals over time.

Cross-sectional data – it is a set of comparable observations all taken at one specific point of time.

[Time-series data and Cross-sectional data may be combined to form a panel data]

Structured data – data that are structured in a defined way.

Un-structured data – refers to information that is presented in a form with no specific structure.

Data are typically organized into array for analysis. A time-series is an example of a one-dimensional array.

A frequency distribution is a tabular presentation of statistical data that aids the analysis of large data sets. Frequency distribution summarize statistical data by assigning them to specified groups or intervals.

Let us understand frequency distribution with an example

The annual returns of X, common stock.

10.4%	22.5%	11.1%	-12.4%
9.8%	17%	2.8%	8.4%
34.6%	-28.6%	0.6%	5%
-17.6%	5.6%	8.9%	40.4%
-1.0 %	-4.2%	-5.2%	21%

Tally and interval count for returns data.

Interval	Tallies	Abs. Freq.
-30% $\leq R_t < -20\%$	/	1
-20% $\leq R_t < -10\%$	//	2
-10% $\leq R_t < 0\%$	///	3
0% $\leq R_t < 10\%$	//// //	7
10% $\leq R_t < 20\%$	///	3
20% $\leq R_t < 30\%$	//	2
30% $\leq R_t < 40\%$	/	1
40% $\leq R_t < 50\%$	/	1
TOTAL		20

Relative Frequency is another useful way to present data, it is calculated by dividing the abs. freq. of each interval by the total number of observations.

Interval	Abs. Freq.	Relative Frequency
-30% $\leq R_t < -20\%$	1	1/20 = 0.05 (5%)
-20% $\leq R_t < -10\%$	2	2/20 = 0.10 (10%)
-10% $\leq R_t < 0\%$	3	3/20 = 0.15 (15%)
0% $\leq R_t < 10\%$	7	7/20 = 0.35 (35%)
10% $\leq R_t < 20\%$	3	3/20 = 0.15 (15%)
20% $\leq R_t < 30\%$	2	2/20 = 0.10 (10%)
30% $\leq R_t < 40\%$	1	1/20 = 0.05 (5%)
40% $\leq R_t < 50\%$	1	1/20 = 0.05 (5%)
TOTAL	20	100

B. Measure of Central Tendency

It identifies the centre or average of a data set. This central point can be then used to present the typical or expected value in the data set.

To compute population mean, all the observed values in the population are summed as ($\sum X$) and is divided by the number of observations in the population.

$$\mu = \frac{\sum_{i=1}^N X_i}{N}$$

The sample mean is the sum of all the values in a sample of a population, $\sum X$ divided by the number of observations.

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

1) Measurement of Investment Return.

Holding period return (HPR) – it is the simple percentage increase in the value of an investment over a given time period.

$$HPR = \frac{\text{end of period value}}{\text{beginning of period value}} - 1 \quad \text{or} \quad \frac{P_t + \text{Div } t}{P_0} - 1$$

2) Average Returns

The arithmetic mean return is the simple average of a series of periodic returns. It has statistical property of being an unbiased estimator of the true mean of the underlying distribution of the returns.

$$\text{Arithmetic mean return} = \frac{(R_1 + R_2 + R_3 + R_4 + \dots + R_n)}{n}$$

The geometric mean return is compound annual rate. When periodic rates of a return vary from period to period.

$$\text{Geometric mean} = \sqrt[n]{(1 + R_1) * (1 + R_2) * (1 + R_3) * (1 + R_4) * \dots * (1 + R_n)} - 1$$

C. Other Return Measures

Gross return – refers to the total return on a security portfolio before deducting fees of the management and administration of the investment account.

Pre-tax nominal return – refers to the return prior to paying tax.

Real return – is the nominal return adjusted inflation.

D. Variance (Standard Deviation) of returns for an Individual security

In finance, the variance and standard deviation of the returns are common measures of investment return and risk.

We can calculate the population variance (σ^2) when we know the return (R_t), for each period, the total number of periods (T), and mean or expected value of the population's distribution (μ).

$$\sigma^2 = \frac{\sum_{t=1}^T (R_t - \mu)^2}{T}$$

In the world of finance, we are typically analysing only a sample of returns data Rather than the entire population. To calculate sample variance (s^2), using a sample of (T) historical returns and the mean, \bar{R} , of the observations, we use the following formulae.

$$s^2 = \frac{\sum_{t=1}^T (R_t - \bar{R})^2}{T - 1}$$

E. Covariance and Correlation of Return for two Securities

Covariance measures the extent to which two variables move overtime.

Here we focus on the calculation of the covariance between two assets' returns using historical data.

$$\text{Cov}(1,2) = \frac{\sum_{t=1}^n \{[rt1 - R1][rt2 - R2]\}}{n - 1}$$

Where:

n = number of periods

rt1 = return of asset 1 in period 1

rt2 = return of asset 2 in period 2

R1 = mean return on asset A

R2 = mean return on asset B

Correlation is the standard measure of co-movement.

$$\rho_{1,2} = \frac{\text{Cov}_{1,2}}{\sigma_1 \sigma_2}$$

The term $\rho_{1,2}$ is called correlation coefficient between the returns of securities 1 and 2, the correlation has no units, it is the pure measure of the co-movement of the two stocks' returns and is bounded by -1 to +1.

A correlation of +1 means the deviation from the mean is always proportional in the same direction.

A correlation of -1 means the deviation from the mean is always proportional in the opposite direction.

A correlation of 0 means there is no linear relationship between two stocks returns.

F. Managing Risk Through Diversification

Risk is a fundamental part of investing. While risk cannot be eliminated, it can be managed. Diversification is a technique that reduces the risk by allocating investments among various financial instruments, it aims to maximize returns with the least possible risk.

G. Markowitz Portfolio Theory

In the early 1960s, the investment community talked about risk, but there was not specific measure for the term. To build a portfolio model, investors had to quantify their risk variable.

The Markowitz model is based on a few assumptions –

- 1> Investors consider each investment alternatives as being represented by a probability distribution of expected returns over some holding period.
- 2> Investors maximize one-period expected utility and their utility curve demonstrates diminishing marginal utility of wealth.
- 3> Investors estimate the risk of the portfolio on the basis of the variability of the expected return.
- 4> Investors base decisions solely on expected return and risk.
- 5> For a given level of risk, investors prefer higher level of returns.

Under these assumptions, a single asset portfolio or a portfolio of assets is considered to be efficient.

H. Capital Market Theory

Capital market theory extends portfolio theory and develops a model for pricing risky assets. The final product, the capital asset pricing model (CAPM), will allow us to determine the required rate of returns for any risky assets.

$$E(R) = R_f + \beta(R_m - R_f)$$

Where-

$E(R)$ – Expected Return

R_f – Risk Free Rate

β - Beta (Risk involved)

R_m – Market rate of return

I. Arbitrage Pricing Theory

APT was developed by Ross in the mid 1970, and has 3 major assumptions:

- 1> Capital markets are perfectly competitive
- 2> Investors always prefer more wealth to less wealth with certainty
- 3> The stochastic process generating asset returns can be expressed as a linear function of a set of K risk factors.

$$E(R_t) = \lambda_0 + \lambda_1 b_{t1} + \lambda_2 b_{t2} + \dots + \lambda_k b_{tk}$$

Where:

λ_0 = The expected return on an asset with zero systematic risk

λ_j = The risk premium related to the j^{th} common risk factor

B_{ij} = The pricing relationship between the risk premium and the assets.

J. Asset Allocation

Asset allocation is the process of deciding how to distribute an investor's wealth among different countries and asset classes for investment purposes.

In determining the right asset allocation strategy, we have to consider

- ➔ Unique financial situation
- ➔ Comfort of investment risk and flexibility
- ➔ Retirement goals and time frame

There are commonly 2 types of asset allocation strategic and tactical.

K. Portfolio Construction

It is a disciplined, personalized process, in constructing a portfolio the individual risk and return characteristics of the underlying investments must be considered along with the unique needs, goals and risk considerations.

There are 2 approaches

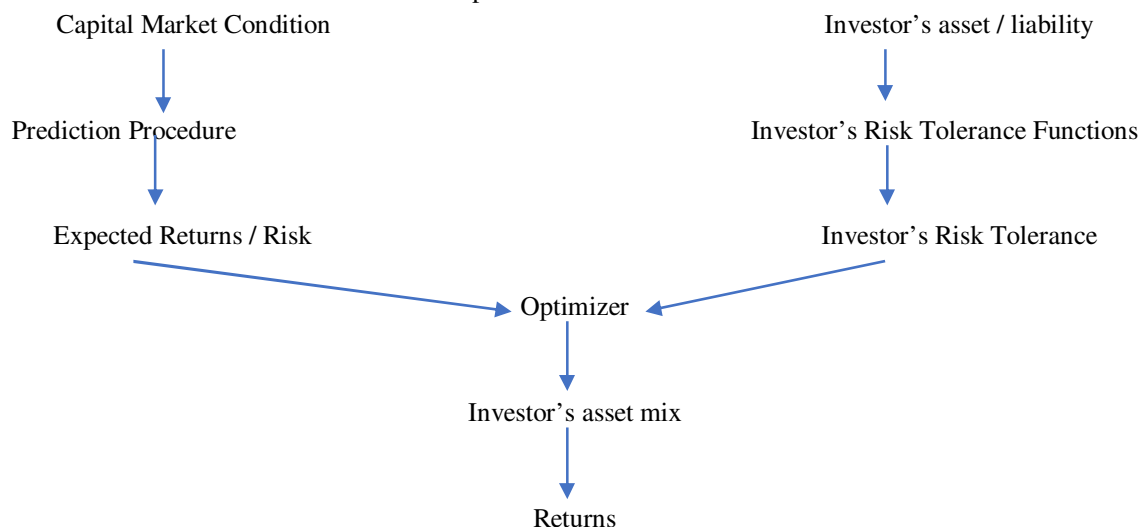
- a> Traditional Approach
- b> Modern Approach

Traditional approach – Under this approach, the financial plan of an individual is evaluated with regard to an individual's needs in term of income and capital appreciation and appropriate securities are selected to meet those needs. It consists of 5 steps.

- 1> Analysis of constraints – It involves analysis of constraints of the investor within which the objectives will be formulated. The constraints may be decided on the basis of
 - Income needs
 - Liquidity needs
 - Safety of principle
 - Time horizon
 - Tax consideration
 - Temperament
- 2> Determination of Objectives – It involves formulation of objectives within the given framework of constraints, which reflects the risk bearing capacity and the income requirements of the investor. Some of the common objectives are
 - Current Income
 - Growth in income
 - Capital Appreciation
 - Preservation of Capital
- 3> Selection of Portfolio – The optimum asset mix for an investor depends upon his/her investment objectives.
- 4> Risk and Return analysis – It involve analysis of risk and return involved in following a particular course of action. Major risk categories that an investor can tolerate are determined and efforts are made to minimize these risks to get expected returns.
- 5> Diversification – It involves assigning relative portfolio weights to different securities on the basis of which the portfolio is diversified. Diversification is done on the basis of investor's need of income and risk bearing capacity.

Modern Approach – It is also known as Markowitz Approach, which emphasises on selecting a stock on the basis of risk and return analysis. Unlike traditional approach which considers an investor's need for income and capital appreciation as basis of selection of stocks, the modern approach takes into account the investors need in form of market returns or dividend and his tolerance for risks as a basis of selection of stocks.

Steps In Asset Allocation



L. Risk Adjusted Return Measures

- 1) **Sharpe Ratio** – It measures the risk adjusted returns of an investment, the ratio is average return earned in excess of the risk-free rate per unit of volatility or total risk.

$$S = \frac{E(Ra - Rb)}{\sigma A}$$

S = Sharpe Ratio

E = Expected value

Ra = Asset return

Rb = Risk-free Rate

σA = Standard deviation of the assets excess return

Limitation of Sharpe ratio

- 1> It does not take responsibility of portfolio risk.
 - 2> Considers all investments to have a normal pattern.
 - 3> Comparing the Sharpe ratio of two or more funds only shows the risk adjusted returns.
- 2) **Treynor Ratio** – It is a performance metric for determining how much excess return was generated for each unit of risk taken on by portfolio.

$$T = \frac{(Rp - Rf)}{\beta p}$$

T = Treynor Ratio

Rp = Portfolio Return

Rf = Risk-free Rate

βp = Beta of portfolio

Limitation of Treynor Ratio

- 1> Does not apply when β is negative.
- 2> Depends on historical data
- 3> The metric does not provide any basis to determine how much better one investment is from another.

IV. DATA ANALYSIS

Suppose we have to calculate the stock returns of ABC's portfolio over the last five years as 25%, 34%, 19%, 54% and 17%

In this context the sample mean can be used as an estimate of the mean of the given distribution.

$$X = \frac{\sum_{i=1}^n Xi}{n}$$

$$x = \frac{25 + 34 + 19 + 54 + 17}{5}$$

$$X = 29.8\%$$

This calculation was easy as there were no given conditions.

The computation of weighted mean recognizes that different observations may have a disproportionate influence on the mean. The weighted mean of a set of numbers is computed with.

$$X = \sum_{i=1}^n wi * Xi$$

For an example.

Below given is an example of a well-diversified portfolio of Mr. Raj

	Weights	Returns
Stocks	50%	12%
Bonds	40%	7%
Cash	10%	3%

For this type of a given portfolio, we have to consider the weights as well as the given returns in order to calculate the expected return.

$$X = \sum_{i=1}^n w_i * X_i$$

$$X = (0.5 * 0.12) + (0.4 * 0.07) + (0.10 * 0.03)$$

$$X = 0.091 \text{ or } 9.10\%$$

The geometric mean/Holding period return is often used when calculating investment return over a multiple period of time or when measuring compound growth rates. The general formulae is:

$$\sqrt[n]{(1 + R_1) * (1 + R_2) * (1 + R_3) * (1 + R_4) * \dots * (1 + R_n)} - 1$$

Suppose you have come across a situation where you have to calculate the compound annual rate of return over the last 3 consecutive years for a single stock providing -9.34% , 23.45% , 8.92% respectively.

$$R = \sqrt[3]{(1 - 0.0934) * (1 + 0.2345) * (1 + 0.0892)} - 1$$

$$R = \sqrt[3]{1.21903} - 1$$

$$R = 6.825\%$$

Another type of mean which is less used, but is useful while calculating the average cost of share purchased over a given time frame is the Harmonic Mean.

Let's understand with a basic example.

Supposed you have purchased Rs 1000 of mutual fund shares each month, and over the last three months, the prices paid per share were Rs.8, Rs. 9, Rs.10. Now you want to calculate the average price paid.

$$H_r = \frac{n}{\frac{1}{p_1} + \frac{1}{p_2} + \frac{1}{p_3}}$$

n = time

p1 = price paid in 1st month

p2 = price paid in 2nd month

p3 = price paid in 3rd month

$$H_r = \frac{3}{\frac{1}{8} + \frac{1}{9} + \frac{1}{10}}$$

$H_r = 8.926$ per share

Please keep in mind that the average price paid per share (Rs. 8.926) is less than the arithmetic average of the share prices ($\frac{8+9+10}{3} = 9$).

As we now know about all the types of returns, let us learn about covariance and correlation, covariance measures the extent to which two variables move together over-time, and the standardized measure of co-movement is called correlation.

Calculating the mean return, return variance, return covariance, correlation.

Given a part of portfolio of an investor:

Year	Asset A	Asset B
1	5%	7%
2	-2%	-4%
3	12%	18%

Mean return of Asset A = $(5-2+12)/3 \Rightarrow 5\%$

Mean return of Asset B = $(7-4+18)/3 \Rightarrow 7\%$

$$\text{Sample Variance of returns for Asset A} = \frac{(5-5)^2 + (-2-5)^2 + (12-5)^2}{3-1} = 49$$

Sample Standard Deviation of returns of asset A = $\sqrt{49} = 7\%$

$$\text{Sample Variance of returns for Asset B} = \frac{(7-7)^2 + (-4-7)^2 + (18-7)^2}{3-1} = 121$$

Sample Standard Deviation of returns of asset A = $\sqrt{121} = 11\%$

Sample covariance of returns for Asset A and Asset B =

$$\frac{(5-5)(7-7) + (-2-5)(-4-7) + (12-5)(18-7)}{3-1} = 77$$

$$\text{Correlation of return for Asset A and Asset B} = \frac{77}{7 \times 11} = 1$$

In this portfolio the return of Asset A and Asset B are perfectly positively correlated.

Now we know how to calculate the riskiness or standard deviation of a single security, but during managing large portfolios, we must know how to calculate the riskiness of the portfolio.

$$\sigma_{\text{portfolio}} = \sqrt{w_1^2 \sigma^2 + w_2^2 \sigma^2 + 2 \cdot w_1 \cdot w_2 \cdot (\rho_{1,2}) \cdot \sigma_1 \cdot \sigma_2}$$

For an example you have a portfolio in which 30% is invested in stocks having a standard deviation of 20%, and 70% invested in bonds having a standard deviation of 12%. The correlation (ρ) of bond and stock returns is 0.60. What will be the riskiness of the portfolio?

$$\sigma_{\text{portfolio}} = \sqrt{(0.3^2)(0.2^2) + (0.7^2)(0.12^2) + 2 \cdot (0.3) \cdot (0.7) \cdot (0.60) \cdot (0.2) \cdot (0.12)}$$

$$\sigma_{\text{portfolio}} = 12.9\%$$

Till now we have covered the mathematics of calculating the risk and return of a portfolio with a percentage of weights (W_A) invested in a risky portfolio (P) and a weight of $W_B = 1 - W_A$ Invested in a risk-free asset.

$$E(R_P) = W_A \cdot E(R_A) + W_B \cdot E(R_B)$$

Calculation and interpretation of Beta

The sensitivity of an asset's return to return on the market index in the context of market model is referred to as its beta. Beta is a standardized measure of the covariance of the asset's return with the market return.

$$\beta_i = \frac{\text{covariance of Asset } i \text{'s return with the market}}{\text{variance of the market return}} = \frac{\text{Cov}(im)}{\sigma^2_m}$$

Here we can use the definition of the correlation between the returns of Asset i with the returns on the market index.

$$\rho(im) = \frac{\text{Cov}(im)}{\sigma_i \cdot \sigma_m}$$

$$\text{To get : } \text{Cov}_{im} = \rho(im) \cdot \sigma_i \cdot \sigma_m$$

Substituting for $\text{Cov}(im)$ in the equation for $\beta(i)$, we can also calculate Beta as:

$$\beta(i) = \frac{\rho(im) \sigma_i \sigma_m}{\sigma^2_m} = \rho(im) \left(\frac{\sigma_i}{\sigma_m} \right)$$

For an example the Standard deviation of the return on the market index is estimated as 20%. If asset A's standard deviation is 30% and its correlation of return with the market index is 0.8, the asset's beta will be

$$\beta_i = 0.80 * \frac{0.30}{0.20}$$

$$\beta_i = 1.2$$

As we have discussed about CAPM (Capital Asset Pricing Model) before, now let's see the application of the model.

Suppose you are holding an asset, with an expected return on market of 8% , the risk free rate is 2%, and the beta (β) of the stock is 1.2, and you want to calculate the expected return on the asset.

$$E(R_A) = 2\% + 1.2 (8\% - 2\%)$$

$$E(R_A) = 9.2\%$$

Now let's take a real-life scenario of Mr. Singh, who has a well-diversified equity portfolio given below –

Weightage	Name of Security	Expected Return
5%	Mawana Sugars	15%
7%	Finolex Industries	20%
2%	TCS	14%
1%	HDFC Bank	10%
10%	Reliance Industries	25%
8%	Ajanta Soya	6%
13%	Vodafone Idea	-10%
4%	Federal Bank	-2%
25%	Tata Motors	20%
25%	Tata Steel	8%

With the help of the given data we can be able to calculate the arithmetic mean of Mr. Singh's portfolio.

$$\text{Arithmetic Weighted Mean } (X) = \sum_{i=1}^n w_i * X_i$$

$$X = (0.05*15)+(0.07*20) + (0.02*14) + (0.01*10) + (0.10*25) + (0.08*6) - (0.13*10) - (0.04*2) + (0.25*20) + (0.25*8)$$

$$X = 11.13\%$$

We have to also check the risk in the portfolio of Mr. Singh.

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\sum_{i=1}^T (R_{it} - x)^2}{T}}$$

$$\text{Standard Deviation } (\sigma) = 10.6792\%$$

$$\text{Coefficient of Variance} = \frac{\text{Standard Deviation } (\sigma)}{\text{Return } (X)}$$

$$\text{Coefficient of Variance} = 0.96$$

Weightage	Name of Security	Beta (β)
5%	Mawana Sugars	0.96
7%	Finolex Industries	1.03
2%	TCS	0.77
1%	HDFC Bank	1.06
10%	Reliance Industries	1.15
8%	Ajanta Soya	0.78
13%	Vodafone Idea	1.3
4%	Federal Bank	1.2
25%	Tata Motors	1.68
25%	Tata Steel	1.37

Hence the portfolio beta (β) can be calculated by

$$(\beta_p) = \sum_{i=1}^n w_i * X_i$$

$$\beta_p = 1.303$$

According to CAPM we can now be able to calculate the expected portfolio return of Mr. Singh, which is –

$$E(R) = R_f + \beta(R_m - R_f)$$

$R_f = 4.40\%$ (According to returns on T-bills 2022)

$R_m = 12.03\%$

Hence,

$$E(r) = 4.40 + 1.303 (12.03 - 4.40)$$

$$E(r) = 14.34 \%$$

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