

Portfolio Theory

BASIC CONCEPTS AND FORMULAE

1. Introduction

Portfolio theory guides investors about the method of selecting securities that will provide the highest expected rate of return for any given degree of risk or that will expose the investor to a degree of risk for a given expected rate of return.

2. Different Portfolio Theories

Some of the important theories of portfolio management are:

(a) Traditional Approach

The traditional approach to portfolio management concerns itself with the investor's profile; definition of portfolio objectives with reference to maximising the investors' wealth which is subject to risk; investment strategy; diversification and selection of individual investment.

(b) Dow Jones Theory

The Dow Jones theory classifies the movements of the prices on the share market into three major categories:

- **Primary movements:** They reflect the trend of the stock market and last from one year to three years, or sometimes even more.
- **Secondary movements:** They are shorter in duration and are opposite in direction to the primary movements.
- **Daily fluctuations:** These are irregular fluctuations which occur every day in the market. These fluctuations are without any definite trend.

Dow Jones theory identifies the turn in the market prices by seeing whether the successive peaks and troughs are higher or lower than earlier.

(c) Efficient Market Theory

The basic premise of this theory is that all market participants receive and act on all the relevant information as soon as it becomes available in the stock market. There exists three levels of market efficiency:-

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- *Weak form efficiency* – Prices reflect all information found in the record of past prices and volumes.
- *Semi – Strong efficiency* – Prices reflect not only all information found in the record of past prices and volumes but also all other publicly available information.
- *Strong form efficiency* – Prices reflect all available information public as well as private.

(d) Random Walk Theory

Random Walk hypothesis states that the behaviour of stock market prices is unpredictable and that there is no relationship between the present prices of the shares and their future prices. Basic premises of the theory are as follows:

- Prices of shares in stock market can never be predicted. The reason is that the price trends are not the result of any underlying factors, but that they represent a statistical expression of past data.
- There may be periodical ups or downs in share prices, but no connection can be established between two successive peaks (high price of stocks) and troughs (low price of stocks).

(e) Markowitz Model of Risk-Return Optimization

According to the model, investors are mainly concerned with two properties of an asset: risk and return, but by diversification of portfolio it is possible to trade off between them. The essence of the theory is that risk of an individual asset hardly matters to an investor. The investor is more concerned to the contribution it makes to his total risk.

Efficient Frontier: Markowitz has formalised the risk return relationship and developed the concept of efficient frontier. For selection of a portfolio, comparison between combinations of portfolios is essential. The investor has to select a portfolio from amongst all those represented by the efficient frontier. This will depend upon his risk-return preference. As different investors have different preferences with respect to expected return and risk, the optimal portfolio of securities will vary considerably among investors.

As a rule, a portfolio is not efficient if there is another portfolio with:

- A higher expected value of return and a lower standard deviation (risk).
- A higher expected value of return and the same standard deviation (risk)
- The same expected value but a lower standard deviation (risk)

(f) Capital Asset Pricing Model (CAPM)

CAPM model describes the linear relationship risk-return trade-off for securities/portfolios. A graphical representation of CAPM is the Security Market Line, (SML), which indicates the rate of return required to compensate at a given level of risk. The risks to which a security/portfolio is exposed are divided into two groups, diversifiable and non-diversifiable.

The **diversifiable risk** can be eliminated through a portfolio consisting of large number of well diversified securities. Whereas, the **non-diversifiable risk** is attributable to factors that affect all businesses like Interest Rate Changes, Inflation, Political Changes, etc.

As diversifiable risk can be eliminated by an investor through diversification, the non-diversifiable risk is the only risk a business should be concerned with. The CAPM method also is solely concerned with non-diversifiable risk.

The non-diversifiable risks are assessed in terms of beta coefficient, β , through fitting regression equation between return of a security/portfolio and the return on a market portfolio.

$$R_j = R_f + \beta (R_m - R_f)$$

Where,

R_f = Risk free rate

R_m = Market Rate

β = Beta of Portfolio

(g) Arbitrage Pricing Theory Model (APT)

The APT was developed by Ross in 1976. It holds that there are four factors which explain the risk premium relationship of a particular security- inflation and money supply, interest rate, industrial production and personal consumption. It is a multi-factor model having a whole set of Beta Values – one for each factor. Further, it states that the expected return on an investment is dependent upon how that investment reacts to a set of individual macro-economic factors (degree of reaction measured by the Betas) and the risk premium associated with each of the macro – economic factors.

$$E(R_i) = R_f + I_1 b_{i_1} + I_2 b_{i_2} + I_3 b_{i_3} + I_4 b_{i_4}$$

Where, I_1, I_2, I_3, I_4 are average risk premium for each of the four factors in the model and $b_{i_1}, b_{i_2}, b_{i_3}, b_{i_4}$ are measures of sensitivity of the particular security i to each of the four factors.

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(h) Sharpe Index Model

William Sharpe developed the Single index model. The single index model is based on the assumption that stocks vary together because of the common movement in the stock market and there are no effects beyond the market (i.e. any fundamental factor effects) that account the stocks co-movement. The expected return, standard deviation and co-variance of the single index model represent the joint movement of securities. The return on stock is:

$$R_i = a_i + b_i R_m + \hat{I}_i$$

The mean return is:

$$R_i = a_i + b_i R_m + \hat{I}_i$$

Where,

R_i = expected return on security i

a_i = intercept of the straight line or alpha co-efficient

b_i = slope of straight line or beta co-efficient

R_m = the rate of return on market index

$\hat{I}_i$ = error term.

The variance of security's return:

$$s_i^2 = b_i^2 s_m^2 + s_{\hat{I}_i}^2$$

The covariance of returns between securities i and j is:

$$s_{ij} = b_i b_j s_m^2$$

Systematic risk = $b_i^2 \times$ variance of market index

$$= b_i^2 s_m^2$$

Unsystematic risk = Total variance - Systematic risk.

$$\hat{I}_i^2 = s_i^2 - \text{Systematic risk.}$$

Thus, the total risk = Systematic risk + Unsystematic risk.

$$= b_i^2 s_m^2 + \hat{I}_i^2.$$

Portfolio variance can be derived

$$s_p^2 = \sum_{i=1}^N x_i b_i \sigma_m^2 + \sum_{i=1}^N x_i^2 \hat{\sigma}_i^2$$

Expected return on the portfolio

$$R_p = \sum_{i=1}^N x_i (a_i + b_i R_m)$$

A portfolio's alpha value is a weighted average of the alpha values for its component securities using the proportion of the investment in a security as weight.

$$s_p = \sum_{i=1}^N x_i a_i$$

A portfolio's beta value is the weighted average of the beta values of its component stocks using relative share of them in the portfolio as weights.

$$s_p = \sum_{i=1}^N x_i b_i$$

(i) Sharpe's Optimal Portfolio

Sharpe had provided a model for the selection of appropriate securities in a portfolio. The selection of any stock is directly related to its excess return-beta ratio.

$$\frac{R_i - R_f}{B_i}$$

Where,

R_i = Expected return on stock

R_f = Return on a risk less asset

B_i = Expected change in the rate of return on stock "i" associated with one unit change in the market return.

3. Portfolio Management

The objective of portfolio management is to achieve the maximum return from a portfolio which has been delegated to be managed by an individual manager or a financial institution. The manager has to balance the parameters which define a good investment i.e. security, liquidity and return. The goal is to obtain the highest return for the investor of the portfolio.

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(a) Objectives of Portfolio Management

- (i) Security/Safety of Principal;
- (ii) Stability of Income;
- (iii) Capital Growth;
- (iv) Marketability i.e. the ease with which a security can be bought or sold;
- (v) Liquidity i.e. nearness to money;
- (vi) Diversification; and
- (vii) Favourable Tax Status.

(b) Activities in Portfolio Management

The following three major activities are involved in an efficient portfolio management:

- (i) Identification of assets or securities, allocation of investment and identifying asset classes.
- (ii) Deciding about major weights/proportion of different assets/securities in the portfolio.
- (iii) Security selection within the asset classes as identified earlier.

(c) Basic Principles of Portfolio Management

- (i) Effective investment planning for the investment in securities; and
- (ii) Constant review of investment.

(d) Factors Affecting Investment Decision in Portfolio Management

Given a certain amount of funds, the investment decision basically depends upon the following factors:

- (i) Objectives of Investment Portfolio
- (ii) Selection of Investment, and
- (iii) Timing of Purchases.

(e) Formulation of Portfolio Strategy

- (i) **Active Portfolio Strategy (APS):** An APS is followed by most investment professionals and aggressive investors who strive to earn superior return after adjustment for risk.
- (ii) **Passive Portfolio Strategy:** Passive strategy rests on the tenet that the capital market is fairly efficient with respect to the available information.

4. Equity Style Management

Pioneered by Nobel laureate William Sharpe, equity style management is derived from a correlation analysis of various equity style categories such as value, growth, small cap, large cap and foreign stocks.

5. Principles and Management of Hedge Funds

Hedge Fund is an aggressively managed portfolio of investments that uses advanced investment strategies such as leverage, long, short and derivative positions in both domestic and international markets with the goal of generating high returns.

6. International Portfolio Management

The objective of portfolio investment management is to consider an optimal portfolio where the risk-return trade off is optimal. The return may be maximum at a certain level of risk or the risk may be minimum at a certain level of return. It is therefore necessary to determine whether optimization of international portfolio can be achieved by striking a balance between risk and return.

7. Important Formulae**(a) Expected Return from a Security**

$$1 + R_{HC} = [1 + (S_1 - S_0 + I) / S_0] \cdot 1 + e$$

Where,

S_0 = Home country currency value of security during preceding time period t_0

S_1 = Home country currency value of security during succeeding time period t_1

I = Income from interest and dividend

e = Change in exchange rate.

(b) Portfolio Return

$$R_P = R_A W_A + R_B W_B$$

(c) Covariance between two sets of returns A_1 , and A_2 is given by:

$$\text{Cov}(A_1, A_2) = P_1(A_1 - \bar{A})(A_2 - \bar{A}) + P_2(A_1 - \bar{A})(A_2 - \bar{A})$$

$$\text{Correlation Coefficient } r_{12} = \frac{\text{Cov}(A_1, A_2)}{S_1 S_2}$$

(d) Portfolio Risk

$$S_p = \sqrt{w_1^2 \text{Var } A_1 + w_2^2 \text{Var } A_2 + 2(w_1)(w_2) \text{Cov}(A_1, A_2)}$$

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Question 1

Write short note on Factors affecting investment decisions in portfolio management.

Answer

Factors affecting Investment Decisions in Portfolio Management

- (i) **Objectives of investment portfolio:** There can be many objectives of making an investment. The manager of a provident fund portfolio has to look for security (low risk) and may be satisfied with none too higher return. An aggressive investment company may, however, be willing to take a high risk in order to have high capital appreciation.
- (ii) **Selection of investment**
 - (a) What types of securities to buy or invest in? There is a wide variety of investments opportunities available i.e. debentures, convertible bonds, preference shares, equity shares, government securities and bonds, income units, capital units etc.
 - (b) What should be the proportion of investment in fixed interest/dividend securities and variable interest/dividend bearing securities?
 - (c) In case investments are to be made in the shares or debentures of companies, which particular industries show potential of growth?
 - (d) Once industries with high growth potential have been identified, the next step is to select the particular companies, in whose shares or securities investments are to be made.
- (iii) **Timing of purchase:** At what price the share is acquired for the portfolio depends entirely on the timing decision. It is obvious if a person wishes to make any gains, he should "buy cheap and sell dear" i.e. buy when the shares are selling at a low price and sell when they are at a high price.

Question 2

- (a) *What sort of investor normally views the variance (or Standard Deviation) of an individual security's return as the security's proper measure of risk?*
- (b) *What sort of investor rationally views the beta of a security as the security's proper measure of risk? In answering the question, explain the concept of beta.*

Answer

- (a) A rational risk-averse investor views the variance (or standard deviation) of her portfolio's return as the proper risk of her portfolio. If for some reason or

another the investor can hold only one security, the variance of that security's return becomes the variance of the portfolio's return. Hence, the variance of the security's return is the security's proper measure of risk.

While risk is broken into diversifiable and non-diversifiable segments, the market generally does not reward for diversifiable risk since the investor himself is expected to diversify the risk himself. However, if the investor does not diversify he cannot be considered to be an efficient investor. The market, therefore, rewards an investor only for the non-diversifiable risk. Hence, the investor needs to know how much non-diversifiable risk he is taking. This is measured in terms of beta.

An investor therefore, views the beta of a security as a proper measure of risk, in evaluating how much the market reward him for the non-diversifiable risk that he is assuming in relation to a security. An investor who is evaluating the non-diversifiable element of risk, that is, extent of deviation of returns viz-a-viz the market therefore consider beta as a proper measure of risk.

(b) If an individual holds a diversified portfolio, she still views the variance (or standard deviation) of her portfolios return as the proper measure of the risk of her portfolio. However, she is no longer interested in the variance of each individual security's return. Rather she is interested in the contribution of each individual security to the variance of the portfolio.

Under the assumption of homogeneous expectations, all individuals hold the market portfolio. Thus, we measure risk as the contribution of an individual security to the variance of the market portfolio. The contribution when standardized properly is the beta of the security. While a very few investors hold the market portfolio exactly, many hold reasonably diversified portfolio. These portfolios are close enough to the market portfolio so that the beta of a security is likely to be a reasonable measure of its risk.

In other words, beta of a stock measures the sensitivity of the stock with reference to a broad based market index like BSE sensex. For example, a beta of 1.3 for a stock would indicate that this stock is 30 per cent riskier than the sensex. Similarly, a beta of a 0.8 would indicate that the stock is 20 per cent ($100 - 80$) less risky than the sensex. However, a beta of one would indicate that the stock is as risky as the stock market index.

Question 3

Distinguish between 'Systematic risk' and 'Unsystematic risk'.

Answer

Systematic risk refers to the variability of return on stocks or portfolio associated with changes in return on the market as a whole. It arises due to risk factors that affect the

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overall market such as changes in the nations' economy, tax reform by the Government or a change in the world energy situation. These are risks that affect securities overall and, consequently, cannot be diversified away. This is the risk which is common to an entire class of assets or liabilities. The value of investments may decline over a given time period simply because of economic changes or other events that impact large portions of the market. Asset allocation and diversification can protect against systematic risk because different portions of the market tend to underperform at different times. This is also called market risk.

Unsystematic risk however, refers to risk unique to a particular company or industry. It is avoidable through diversification. This is the risk of price change due to the unique circumstances of a specific security as opposed to the overall market. This risk can be virtually eliminated from a portfolio through diversification.

Question 4

Briefly explain the objectives of "Portfolio Management".

Answer

Objectives of Portfolio Management

Portfolio management is concerned with efficient management of portfolio investment in financial assets, including shares and debentures of companies. The management may be by professionals or others or by individuals themselves. A portfolio of an individual or a corporate unit is the holding of securities and investment in financial assets. These holdings are the result of individual preferences and decisions regarding risk and return.

The investors would like to have the following objectives of portfolio management:

- (a) Capital appreciation.
- (b) Safety or security of an investment.
- (c) Income by way of dividends and interest.
- (d) Marketability.
- (e) Liquidity.
- (f) Tax Planning - Capital Gains Tax, Income tax and Wealth Tax.
- (g) Risk avoidance or minimization of risk.
- (h) Diversification, i.e. combining securities in a way which will reduce risk.

It is necessary that all investment proposals should be assessed in terms of income, capital appreciation, liquidity, safety, tax implication, maturity and marketability i.e., saleability (i.e., saleability of securities in the market). The investment strategy should be based on the above objectives after a thorough study of goals of the investor, market situation, credit policy and

economic environment affecting the financial market.

The portfolio management is a complex task. Investment matrix is one of the many approaches which may be used in this connection. The various considerations involved in investment decisions are liquidity, safety and yield of the investment. Image of the organization is also to be taken into account. These considerations may be taken into account and an overall view obtained through a matrix approach by allotting marks for each consideration and totaling them.

Question 5

Discuss the various kinds of Systematic and Unsystematic risk?

Answer

There are two types of Risk - Systematic (or non-diversifiable) and unsystematic (or diversifiable) relevant for investment - also, called as general and specific risk.

Types of Systematic Risk

- (i) *Market risk:* Even if the earning power of the corporate sector and the interest rate structure remain more or less unchanged prices of securities, equity shares in particular, tend to fluctuate. Major cause appears to be the changing psychology of the investors. The irrationality in the security markets may cause losses unrelated to the basic risks. These losses are the result of changes in the general tenor of the market and are called market risks.
- (ii) *Interest Rate Risk:* The change in the interest rate has a bearing on the welfare of the investors. As the interest rate goes up, the market price of existing fixed income securities falls and vice versa. This happens because the buyer of a fixed income security would not buy it at its par value or face value if its fixed interest rate is lower than the prevailing interest rate on a similar security.
- (iii) *Social or Regulatory Risk:* The social or regulatory risk arises, where an otherwise profitable investment is impaired as a result of adverse legislation, harsh regulatory climate, or in extreme instance nationalization by a socialistic government.
- (iv) *Purchasing Power Risk:* Inflation or rise in prices lead to rise in costs of production, lower margins, wage rises and profit squeezing etc. The return expected by investors will change due to change in real value of returns.

Classification of Unsystematic Risk

- (i) *Business Risk:* As a holder of corporate securities (equity shares or debentures) one is exposed to the risk of poor business performance. This may be

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caused by a variety of factors like heightened competition, emergence of new technologies, development of substitute products, shifts in consumer preferences, inadequate supply of essential inputs, changes in governmental policies and so on. Often of course the principal factor may be inept and incompetent management.

(ii) *Financial Risk*: This relates to the method of financing, adopted by the company, high leverage leading to larger debt servicing problem or short term liquidity problems due to bad debts, delayed receivables and fall in current assets or rise in current liabilities.

(iii) *Default Risk*: Default risk refers to the risk accruing from the fact that a borrower may not pay interest and/or principal on time. Except in the case of highly risky debt instrument, investors seem to be more concerned with the perceived risk of default rather than the actual occurrence of default. Even though the actual default may be highly unlikely, they believe that a change in the perceived default risk of a bond would have an immediate impact on its market price.

Question 6

Discuss the Capital Asset Pricing Model (CAPM) and its relevant assumptions.

Answer

Capital Asset Pricing Model: The mechanical complexity of the Markowitz's portfolio model kept both practitioners and academics away from adopting the concept for practical use. Its intuitive logic, however, spurred the creativity of a number of researchers who began examining the stock market implications that would arise if all investors used this model. As a result what is referred to as the Capital Asset Pricing Model (CAPM), was developed.

The Capital Asset Pricing Model was developed by Sharpe, Mossin and Linter in 1960. The model explains the relationship between the expected return, non diversifiable risk and the valuation of securities. It considers the required rate of return of a security on the basis of its contribution to the total risk. It is based on the premises that the diversifiable risk of a security is eliminated when more and more securities are added to the portfolio. However, the systematic risk cannot be diversified and is or related with that of the market portfolio. All securities do not have same level of systematic risk. The systematic risk can be measured by beta, β under CAPM, the expected return from a security can be expressed as:

Expected return on security = $R_f + \text{Beta} (R_m - R_f)$

The model shows that the expected return of a security consists of the risk-free rate of interest and the risk premium. The CAPM, when plotted on the graph paper is known as the Security Market Line (SML). A major implication of CAPM is that not only every security but all portfolios too must plot on SML. This implies that in an efficient market, all securities are expected returns commensurate with their riskiness, measured by β .

Relevant Assumptions of CAPM

- (i) The investor's objective is to maximize the utility of terminal wealth;
- (ii) Investors make choices on the basis of risk and return;
- (iii) Investors have identical time horizon;
- (iv) Investors have homogeneous expectations of risk and return;
- (v) Information is freely and simultaneously available to investors;
- (vi) There is risk-free asset, and investor can borrow and lend unlimited amounts at the risk-free rate;
- (vii) There are no taxes, transaction costs, restrictions on short rates or other market imperfections;
- (viii) Total asset quantity is fixed, and all assets are marketable and divisible.

Thus, CAPM provides a conceptual frame work for evaluating any investment decision where capital is committed with a goal of producing future returns. However, there are certain limitations of the theory. Some of these limitations are as follows:

- (i) **Reliability of Beta:** Statistically reliable Beta might not exist for shares of many firms. It may not be possible to determine the cost of equity of all firms using CAPM. All shortcomings that apply to Beta value apply to CAPM too.
- (ii) **Other Risks:** It emphasis only on systematic risk while unsystematic risks are also important to share holders who do not possess a diversified portfolio.
- (iii) **Information Available:** It is extremely difficult to obtain important information on risk-free interest rate and expected return on market portfolio as there are multiple risk-free rates for one while for another, markets being volatile it varies over time period.

Question 7

Discuss the Random Walk Theory.

Answer

Many investment managers and stock market analysts believe that stock market prices can never be predicted because they are not a result of any underlying factors but are mere statistical ups and downs. This hypothesis is known as Random Walk hypothesis which states that the behaviour of stock market prices is unpredictable and that there is no relationship between the present prices of the shares and their future prices. Proponents of this hypothesis argue that stock market prices are independent. A British statistician, M. G. Kendell, found that changes in security prices behave nearly as if they are generated by a suitably designed roulette wheel for which each outcome is statistically independent of the past history. In other words, the fact that there are peaks and troughs in stock exchange prices is a mere statistical

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happening – successive peaks and troughs are unconnected. In the layman's language it may be said that prices on the stock exchange behave exactly the way a drunk would behave while walking in a blind lane, i.e., up and down, with an unsteady way going in any direction he likes, bending on the side once and on the other side the second time.

The supporters of this theory put out a simple argument. It follows that:

- (a) Prices of shares in stock market can never be predicted. The reason is that the price trends are not the result of any underlying factors, but that they represent a statistical expression of past data.
- (c) There may be periodical ups or downs in share prices, but no connection can be established between two successive peaks (high price of stocks) and troughs (low price of stocks).

Question 8

Explain the three form of Efficient Market Hypothesis.

Answer

The EMH theory is concerned with speed with which information effects the prices of securities. As per the study carried out technical analyst it was observed that information is slowly incorporated in the price and it provides an opportunity to earn excess profit. However, once the information is incorporated then investor can not earn this excess profit.

Level of Market Efficiency: That price reflects all available information, the highest order of market efficiency. According to FAMA, there exist three levels of market efficiency:-

- (i) *Weak form efficiency* – Price reflect all information found in the record of past prices and volumes.
- (ii) *Semi – Strong efficiency* – Price reflect not only all information found in the record of past prices and volumes but also all other publicly available information.
- (iii) *Strong form efficiency* – Price reflect all available information public as well as private.

Question 9

Discuss how the risk associated with securities is effected by Government policy.

Answer

The risk from Government policy to securities can be impacted by any of the following factors.

- (i) Licensing Policy
- (ii) Restrictions on commodity and stock trading in exchanges
- (iii) Changes in FDI and FII rules.

- (iv) Export and import restrictions
- (v) Restrictions on shareholding in different industry sectors
- (vi) Changes in tax laws and corporate and Securities laws.

Question 10

A stock costing ₹ 120 pays no dividends. The possible prices that the stock might sell for at the end of the year with the respective probabilities are:

Price	Probability
115	0.1
120	0.1
125	0.2
130	0.3
135	0.2
140	0.1

Required:

- (i) Calculate the expected return.
- (ii) Calculate the Standard deviation of returns.

Answer

Here, the probable returns have to be calculated using the formula

$$R = \frac{D}{P_0} + \frac{P_1 - P_0}{P_0}$$

Calculation of Probable Returns

Possible prices (P ₁)	P ₁ -P ₀	[(P ₁ -P ₀)/ P ₀] x 100
₹	₹	Return (per cent)
115	-5	-4.17
120	0	0.00
125	5	4.17
130	10	8.33
135	15	12.50

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140	20	16.67
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Calculation of Expected Returns

Possible return	Probability	Product
X_i	$p(X_i)$	$X_i \cdot p(X_i)$
-4.17	0.1	-0.417
0.00	0.1	0.000
4.17	0.2	0.834
8.33	0.3	2.499
12.50	0.2	2.500
16.67	0.1	1.667
		<u>7.083</u>
		$X = 7.083$

Expected return $X = 7.083$ per

Calculation of Standard Deviation of Returns

Probable	Probability	Deviation	Deviation squared	Product
return X_i	$p(X_i)$	$(X_i - X)$	$(X_i - X)^2$	$(X_i - X)^2 p(X_i)$
-4.17	0.1	-11.253	126.63	12.66
0.00	0.1	-7.083	50.17	5.017
4.17	0.2	-2.913	8.49	1.698
8.33	0.3	1.247	1.56	0.467
12.50	0.2	5.417	29.34	5.869
16.67	0.1	9.587	91.91	9.191
				<u>91.91</u>
				$\sigma^2 = 34.902$

Variance, $\sigma^2 = 34.902$ per cent

Standard deviation, $\sigma = \sqrt{34.902} = 5.908$ per cent

Question 11

Mr. A is interested to invest ₹1,00,000 in the securities market. He selected two securities B and D for this purpose. The risk return profile of these securities are as follows :

Security	Risk (σ)	Expected Return (ER)
B	10%	12%

D	18%	20%
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Co-efficient of correlation between B and D is 0.15.

You are required to calculate the portfolio return of the following portfolios of B and D to be considered by A for his investment.

- (i) 100 percent investment in B only;
- (ii) 50 percent of the fund in B and the rest 50 percent in D;
- (iii) 75 percent of the fund in B and the rest 25 percent in D; and
- (iv) 100 percent investment in D only.

Also indicate that which portfolio is best for him from risk as well as return point of view?

Answer

We have $E_p = W_1E_1 + W_2E_2 + \dots + W_nE_n$

and for standard deviation $\sigma_p^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \sigma_{ij}$

$$\sigma_p^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \rho_{ij} \sigma_i \sigma_j$$

Two asset portfolio

$$\sigma_p^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_1 \sigma_2 \rho_{12}$$

Substituting the respective values we get,

- (i) All funds invested in B

$$E_p = 12\%$$

$$\sigma_p = 10\%$$

- (ii) 50% of funds in each of B & D

$$E_p = 0.50 \times 12\% + 0.50 \times 20\% = 16\%$$

$$\sigma_p^2 = (0.50)^2 (10\%)^2 + (0.50)^2 (18\%)^2 + 2(0.50)(0.50)(0.15)(10\%)(18\%)$$

$$\sigma_p^2 = 25 + 81 + 13.5 = 119.50$$

$$\sigma_p = 10.93\%$$

- (iii) 75% in B and 25% in D

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$$E_p = 0.75\% \times 12\% + 0.25\% \times 20\% = 14\%$$

$$\sigma_p^2 = (0.75)^2(10\%)^2 + (0.25)^2(18\%)^2 + 2(0.75)(0.25)(0.15)(10\%)(18\%)$$

$$\sigma_p^2 = 56.25 + 20.25 + 10.125 = 86.625$$

$$\sigma_p = 9.31\%$$

(iv) All funds in D

$$E_p = 20\%$$

$$\sigma_p = 18.0\%$$

Portfolio	(i)	(ii)	(iii)	(iv)
Return	12	16	14	20
σ	10	10.93	9.31	18

In the terms of return, we see that portfolio (iv) is the best portfolio. In terms of risk we see that portfolio (iii) is the best portfolio.

Question 12

Consider the following information on two stocks, A and B :

Year	Return on A (%)	Return on B (%)
2006	10	12
2007	16	18

You are required to determine:

- The expected return on a portfolio containing A and B in the proportion of 40% and 60% respectively.
- The Standard Deviation of return from each of the two stocks.
- The covariance of returns from the two stocks.
- Correlation coefficient between the returns of the two stocks.
- The risk of a portfolio containing A and B in the proportion of 40% and 60%.

Answer

- (i) Expected return of the portfolio A and B

$$E(A) = (10 + 16) / 2 = 13\%$$

$$E(B) = (12 + 18) / 2 = 15\%$$

$$R_p = \sum_{i=1}^N X_i R_i = 0.4(13) + 0.6(15) = 14.2\%$$

(ii) Stock A:

$$\text{Variance} = 0.5 (10 - 13)^2 + 0.5 (16 - 13)^2 = 9$$

$$\text{Standard deviation} = \sqrt{9} = 3\%$$

Stock B:

$$\text{Variance} = 0.5 (12 - 15)^2 + 0.5 (18 - 15)^2 = 9$$

$$\text{Standard deviation} = 3\%$$

(iii) Covariance of stocks A and B

$$\text{Cov}_{AB} = 0.5 (10 - 13) (12 - 15) + 0.5 (16 - 13) (18 - 15) = 9$$

(iv) Correlation of coefficient

$$r_{AB} = \frac{\text{Cov}_{AB}}{S_A S_B} = \frac{9}{3 \times 3} = 1$$

(v) Portfolio Risk

$$\begin{aligned} S_P &= \sqrt{X_A^2 S_A^2 + X_B^2 S_B^2 + 2X_A X_B (S_A S_B S_{AB})} \\ &= \sqrt{(0.4)^2 (3)^2 + (0.6)^2 (3)^2 + 2(0.4)(0.6)(3)(3)(1)} \\ &= \sqrt{1.44 + 3.24 + 4.32} = 3\% \end{aligned}$$

Question 13

Consider the following information on two stocks X and Y:

Year	Return on X (%)	Return on Y (%)
2008	12	10
2009	18	16

You are required to determine:

- The expected return on a portfolio containing X and Y in the proportion of 60% and 40% respectively.
- The standard deviation of return from each of the two stocks.
- The covariance of returns from the two stocks.
- Correlation co-efficient between the returns of the two stocks.
- The risk of portfolio containing X and Y in the proportion of 60% and 40%.

Answer

- Expected return of the portfolio X and Y

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$$E(X) = (12 + 18)/2 = 15\%$$

$$E(Y) = (10 + 16)/2 = 13\%$$

$$R_P = 0.6(15) + 0.4(13) = 14.2\%$$

(ii) Stock X

$$\text{Variance} = \frac{\sum_{t=1}^n (X_t - \bar{X})^2}{N}$$

$$\text{Variance} = 0.5(12 - 15)^2 + 0.5(18 - 15)^2 = 9$$

$$\text{Standard deviation} = \sqrt{9} = 3\%$$

Stock Y

$$\text{Variance} = \frac{\sum_{t=1}^n (Y_t - \bar{Y})^2}{N}$$

$$\text{Variance} = 0.5(10 - 13)^2 + 0.5(16 - 13)^2 = 9$$

$$\text{Standard deviation} = \sqrt{9} = 3\%$$

(iii) Covariance of Stocks X and Y

$$\text{Covariance} = \frac{\sum_{t=1}^n (X_t - \bar{X})(Y_t - \bar{Y})}{N}$$

$$\text{Cov}_{XY} = 0.5(12 - 15)(10 - 13) + 0.5(18 - 15)(16 - 13) = 9$$

(iv) Correlation of Coefficient

$$g_{XY} = \frac{\text{COV}_{XY}}{S_X S_Y} = \frac{9}{3 \times 3} = 1$$

(v) Portfolio Risk

$$\begin{aligned} S_P &= \sqrt{(0.6)^2(3)^2 + (0.4)^2(3)^2 + 2(0.6)(0.4)(3)(3)(1)} \\ &= \sqrt{3.24 + 1.44 + 4.32} = \sqrt{9} = 3\% \end{aligned}$$

Question 14

John inherited the following securities on his uncle's death:

Types of Security	Nos.	Annual Coupon %	Maturity Years	Yield %
Bond A (₹1,000)	10	9	3	12
Bond B (₹1,000)	10	10	5	12
Preference shares C (₹100)	100	11	*	13*
Preference shares D (₹100)	100	12	*	13*

*likelihood of being called at a premium over par.

Compute the current value of his uncle's portfolio.

Answer

Computation of current value of John's portfolio

- (i) 10 Nos. Bond A, ₹1,000 par value, 9% Bonds maturity 3 years:

₹

Current value of interest on bond A

1-3 years: ₹ 900 × Cumulative P.V. @ 12% (1-3 years)

= ₹ 900 × 2.402 2,162

Add: Current value of amount received on maturity of Bond A

End of 3rd year: ₹ 1,000 × 10 × P.V. @ 12% (3rd year)

= ₹ 10,000 × 0.712 7,120 9,282

- (ii) 10 Nos. Bond B, ₹1,000 par value, 10% Bonds maturity 5 years:

Current value of interest on bond B

1-5 years: ₹ 1,000 × Cumulative P.V. @ 12% (1-5 years)

= ₹ 1,000 × 3.605 3,605

Add: Current value of amount received on maturity of Bond B

End of 5th year: ₹ 1,000 × 10 × P.V. @ 12% (5th year)

= ₹ 10,000 × 0.567 5,670 9,275

- (iii) 100 Preference shares C, ₹100 par value, 11% coupon

$\frac{11\% \times 100 \text{ Nos.} \times \text{Rs. } 100}{13\%} = \frac{1,100}{0.13}$ 8,462

- (iv) 100 Preference shares D, ₹100 par value, 12% coupon

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$$\frac{12\% \times 100 \text{ Nos.} \times \text{Rs.} 100}{13\%} = \frac{1,200}{0.13} \quad \begin{array}{r} 9,231 \\ 17,693 \\ \hline \end{array}$$

Total current value of his portfolio [(i) + (ii) + (iii) + (iv)] 36,250

Question 15

Following is the data regarding six securities:

	A	B	C	D	E	F
Return (%)	8	8	12	4	9	8
Risk (Standard deviation)	4	5	12	4	5	6

- (i) Assuming three will have to be selected, state which ones will be picked.
- (ii) Assuming perfect correlation, show whether it is preferable to invest 75% in A and 25% in C or to invest 100% in E.

Answer

(i) Security A has a return of 8% for a risk of 4, whereas B and F have a higher risk for the same return. Hence, among them A dominates.

For the same degree of risk 4, security D has only a return of 4%. Hence, D is also dominated by A.

Securities C and E remain in reckoning as they have a higher return though with higher degree of risk.

Hence, the ones to be selected are A, C & E.

(ii) The average values for A and C for a proportion of 3 : 1 will be :

$$\text{Risk} = \frac{(3 \times 4) + (1 \times 12)}{4} = 6\%$$

$$\text{Return} = \frac{(3 \times 8) + (1 \times 12)}{4} = 9\%$$

Therefore:	75% A	E
	25% C	—
Risk	6	5
Return	9%	9%

For the same 9% return the risk is lower in E. Hence, E will be preferable.

Question 16

The Investment portfolio of a bank is as follows:

Government Bond	Coupon Rate	Purchase rate (F.V. ₹ 100 per Bond)	Duration (Years)
G.O.I. 2006	11.68	106.50	3.50
G.O.I. 2010	7.55	105.00	6.50
G.O.I. 2015	7.38	105.00	7.50
G.O.I. 2022	8.35	110.00	8.75
G.O.I. 2032	7.95	101.00	13.00

Face value of total Investment is ₹ 5 crores in each Government Bond.

Calculate actual Investment in portfolio.

What is a suitable action to churn out investment portfolio in the following scenario?

1. Interest rates are expected to lower by 25 basis points.
2. Interest rates are expected to raise by 75 basis points.

Also calculate the revised duration of investment portfolio in each scenario.

Answer

Calculation of Actual investment of Portfolio

Security	Purchase price	Investment (₹ in lakhs)
GOI 2006	106.50	532.50*
GOI 2010	105.00	525.00
GOI 2015	105.00	525.00
GOI 2022	110.00	550.00
GOI 2032	101.00	<u>505.00</u>
	Total	<u>2,637.50</u>

$$* \frac{\text{₹ 5 crores}}{\text{₹ 100} \times 1,00,000} \times \text{₹ 106.50}$$

$$\text{Average Duration} = \frac{3.5 + 6.5 + 7.5 + 8.75 + 13.00}{5} = \frac{39.25}{5} = 7.85$$

Suitable action to churn out investment portfolio in following scenario is to reduce risk and to maximize profit or minimize losses.

- (1) Interest rates are expected to be lower by 25 basis points in such case increase the

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average duration by purchasing GOI 2032 and Disposing of GOI 2006.

$$\begin{aligned}\text{Revised average duration shall be} &= \frac{39.25 - 3.5 + 13}{5} \\ &= \frac{48.75}{5} = 9.75 \text{ years}\end{aligned}$$

- (2) Interest rates are expected to rise by 75 basis points in such case reduce the average duration by (*) Purchasing GOI 2010 and disposing of GOI 2032.

$$\text{Revised average duration shall be} = \frac{39.25 - 13 + 6.5}{5} = \frac{32.75}{5} = 6.55 \text{ years}$$

- (*) Purchasing of GOI 2006 is not beneficial as maturity period is very short and 75 basis points is comparatively higher change.

Question 17

The historical rates of return of two securities over the past ten years are given. Calculate the Covariance and the Correlation coefficient of the two securities:

Years:	1	2	3	4	5	6	7	8	9	10
Security 1: (Return per cent)	12	8	7	14	16	15	18	20	16	22
Security 2: (Return per cent)	20	22	24	18	15	20	24	25	22	20

Answer

Calculation of Covariance

Year	R_1	Deviation ($R_1 - \bar{R}_1$)	Deviation ($R_1 - \bar{R}_1$) ²	R_2	Deviation ($R_2 - \bar{R}_2$)	Deviation ($R_2 - \bar{R}_2$) ²	Product of deviations
1	12	-2.8	7.84	20	-1	1	2.8
2	8	-6.8	46.24	22	1	1	-6.8
3	7	-7.8	60.84	24	3	9	-23.4
4	14	-0.8	0.64	18	-3	9	2.4
5	16	1.2	1.44	15	-6	36	-7.2
6	15	0.2	0.04	20	-1	1	-0.2
7	18	3.2	10.24	24	3	9	9.6

8	20	5.2	27.04	25	4	16	20.8
9	16	1.2	1.44	22	1	1	1.2
10	22	7.2	51.84	20	-1	1	-7.2
$R_1 = \frac{148}{10} = 14.8$			$\Sigma = 207.60$	$R_2 = \frac{210}{10} = 21$			$\Sigma = 84.00$

$$\text{Covariance} = \frac{\sum_{i=1}^N [R_1 - \bar{R}_1][R_2 - \bar{R}_2]}{N} = -8/10 = -0.8$$

Standard Deviation of Security 1

$$\sigma_1 = \sqrt{\frac{(R_1 - \bar{R}_1)^2}{N}}$$

$$\sigma_1 = \sqrt{\frac{207.60}{10}} = \sqrt{20.76}$$

$$\sigma_1 = 4.56$$

Standard Deviation of Security 2

$$\sigma_2 = \sqrt{\frac{(R_2 - \bar{R}_2)^2}{N}}$$

$$\sigma_2 = \sqrt{\frac{84}{10}} = \sqrt{8.40}$$

$$\sigma_2 = 2.90$$

Alternatively, Standard Deviation of securities can also be calculated as follows:.

Calculation of Standard Deviation

Year	R ₁	R ₁ ²	R ₂	R ₂ ²
1	12	144	20	400
2	8	64	22	484
3	7	49	24	576
4	14	196	18	324
5	16	256	15	225

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6	15	225	20	400
7	18	324	24	576
8	20	400	25	625
9	16	256	22	484
10	22	484	20	400
	148	2398	210	4494

Standard deviation of security 1:

$$\begin{aligned}\sigma_1 &= \sqrt{\frac{N \sum R_1^2 - (\sum R_1)^2}{N^2}} \\ &= \sqrt{\frac{(10 \times 2398) - (148)^2}{10 \times 10}} = \sqrt{\frac{23980 - 21904}{100}} \\ &= \sqrt{20.76} = 4.56\end{aligned}$$

Standard deviation of security 2:

$$\begin{aligned}s_2 &= \sqrt{\frac{N \sum R_2^2 - (\sum R_2)^2}{N^2}} \\ &= \sqrt{\frac{(10 \times 4494) - (210)^2}{10 \times 10}} = \sqrt{\frac{44940 - 44100}{100}} \\ &= \sqrt{\frac{840}{100}} = \sqrt{8.4} = 2.90\end{aligned}$$

Correlation Coefficient

$$r_{12} = \frac{\text{Cov}}{s_1 s_2} = \frac{-0.8}{4.56 \times 2.90} = \frac{-0.8}{13.22} = -0.0605$$

Question 18

An investor has decided to invest ₹ 1,00,000 in the shares of two companies, namely, ABC and XYZ. the projections of returns from the shares of the two companies along with their probabilities are as follows:

Probability	ABC(%)	XYZ(%)
.20	12	16

.25	14	10
.25	-7	28
.30	28	-2

You are required to

- Comment on return and risk of investment in individual shares.
- Compare the risk and return of these two shares with a Portfolio of these shares in equal proportions.
- Find out the proportion of each of the above shares to formulate a minimum risk portfolio.

Answer

(i)

Probability	ABC (%)	XYZ (%)	1X2 (%)	1X3 (%)
(1)	(2)	(3)	(4)	(5)
0.20	12	16	2.40	3.2
0.25	14	10	3.50	2.5
0.25	-7	28	-1.75	7.0
0.30	28	-2	<u>8.40</u>	<u>-0.6</u>
Average return			<u>12.55</u>	<u>12.1</u>

Hence the expected return from ABC = 12.55% and XYZ is 12.1%

Probability	$(ABC - \overline{ABC})$	$(ABC - \overline{ABC})^2$	1X3	$(XYZ - \overline{XYZ})$	$(XYZ - \overline{XYZ})^2$	(1)X(6)
(1)	(2)	(3)	(4)	(5)	(6)	
0.20	-0.55	0.3025	0.06	3.9	15.21	3.04
0.25	1.45	2.1025	0.53	-2.1	4.41	1.10
0.25	-19.55	382.2025	95.55	15.9	252.81	63.20
0.30	15.45	238.7025	<u>71.61</u>	-14.1	198.81	<u>59.64</u>
			<u>167.75</u>			<u>126.98</u>

$$S^2_{ABC} = 167.75(\%)^2 ; S_{ABC} = 12.95\%$$

$$S^2_{XYZ} = 126.98(\%)^2 ; S_{XYZ} = 11.27\%$$

- In order to find risk of portfolio of two shares, the covariance between the two is necessary here.

Probability	$(ABC - \overline{ABC})$	$(XYZ - \overline{XYZ})$	2X3	1X4
-------------	--------------------------	--------------------------	-----	-----

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(1)	(2)	(3)	(4)	(5)
0.20	-0.55	3.9	-2.145	-0.429
0.25	1.45	-2.1	-3.045	-0.761
0.25	-19.55	15.9	-310.845	-77.71
0.30	15.45	-14.1	-217.845	<u>-65.35</u>
				<u>-144.25</u>

$$S^2_P = (0.5^2 \times 167.75) + (0.5^2 \times 126.98) + 2 \times (-144.25) \times 0.5 \times 0.5$$

$$S^2_P = 41.9375 + 31.745 - 72.125$$

$$S^2_P = 1.5575 \text{ or } 1.56(\%)$$

$$S_P = \sqrt{1.56} = 1.25\%$$

$$E(R_P) = (0.5 \times 12.55) + (0.5 \times 12.1) = 12.325\%$$

Hence, the return is 12.325% with the risk of 1.25% for the portfolio. Thus the portfolio results in the reduction of risk by the combination of two shares.

(iii) For constructing the minimum risk portfolio the condition to be satisfied is

$$X_{ABC} = \frac{\sigma_X^2 - r_{AX}\sigma_A\sigma_X}{\sigma_A^2 + \sigma_X^2 - 2r_{AX}\sigma_A\sigma_X} \text{ or}$$

$$= \frac{\sigma_X^2 - \text{Cov}_{AX}}{\sigma_A^2 + \sigma_X^2 - 2\text{Cov}_{AX}}$$

σ_X = Std. Deviation of XYZ

σ_A = Std. Deviation of ABC

r_{AX} = Coefficient of Correlation between XYZ and ABC

Cov_{AX} = Covariance between XYZ and ABC.

Therefore,

$$\% \text{ ABC} = \frac{126.98 - (-144.25)}{126.98 + 167.75 - [2 \times (-144.25)]}$$

$$\frac{271.23}{583.23} = 0.46 \text{ or } 46\%$$

$$\% \text{ ABC} = 46\%, \text{ XYZ} = 54\%$$

$$(1 - 0.46) = 0.54$$

Question 19

The distribution of return of security 'F' and the market portfolio 'P' is given below:

Probability	Return%	
	F	P
0.30	30	-10
0.40	20	20
0.30	0	30

You are required to calculate the expected return of security 'F' and the market portfolio 'P', the covariance between the market portfolio and security and beta for the security.

Answer

Security F

Prob(P)	R _f	PxR _f	Deviations of F (R _f – ER _f)	(Deviation) ² of F	(Deviations) ² P _x
0.3	30	9	13	169	50.7
0.4	20	8	3	9	3.6
0.3	0	0	-17	289	86.7
		ER _f =17			<u>Var_f=141</u>

$$\text{STDEV } s_f = \sqrt{141} = 11.87$$

Market Portfolio, P

R _M %	P _M	Exp. Return R _M x P _M	Dev. of P (R _M -ER _M)	(Dev. of P) ²	(Dev.) ² P _M	(Deviation of F) x (Deviation of P)	Dev. of F x Dev. of P x P
-10	0.3	-3	-24	576	172.8	-312	-93.6
20	0.4	8	6	36	14.4	18	7.2
30	0.3	9	16	256	76.8	-272	-81.6
		ER _M =14			Var _M =264 S _M =16.25		=Co Var P _M =- 168

$$\text{Beta} = \frac{\text{Co Var P}_M}{S_M^2} = \frac{-168}{264} = -.636$$

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Question 20

Given below is information of market rates of Returns and Data from two Companies A and B:

	Year 2007	Year 2008	Year 2009
Market (%)	12.0	11.0	9.0
Company A (%)	13.0	11.5	9.8
Company B (%)	11.0	10.5	9.5

You are required to determine the beta coefficients of the Shares of Company A and Company B.

Answer

Company A:

Year	Return % (Ra)	Market return % (Rm)	Deviation R(a)	Deviation Rm	D Ra - DRm	Rm ²
1	13.0	12.0	1.57	1.33	2.09	1.77
2	11.5	11.0	0.07	0.33	0.02	0.11
3	<u>9.8</u>	<u>9.0</u>	- 1.63	- 1.67	<u>2.72</u>	<u>2.79</u>
	<u>34.3</u>	<u>32.0</u>			<u>4.83</u>	<u>4.67</u>

Average Ra = 11.43

Average Rm = 10.67

$$\text{Covariance} = \frac{\sum (R_m - \bar{R}_m)(R_a - \bar{R}_a)}{N}$$

$$\text{Covariance} = \frac{4.83}{3} = 1.61$$

$$\text{Standard Deviation}(\sigma_m) = \frac{\sum (R_m - \bar{R}_m)^2}{N}$$

$$= \frac{4.67}{3} = 1.557$$

$$\beta = \frac{1.61}{1.557} = 1.03$$

Company B:

Year	Return % (R _b)	Market return % (R _m)	Deviation R(b)	Deviation R _m	$\frac{D R_b}{D R_m}$	R _m ²
1	11.0	12.0	0.67	1.33	0.89	1.77
2	10.5	11.0	0.17	0.33	0.06	0.11
3	<u>9.5</u>	<u>9.0</u>	- 0.83	- 1.67	<u>1.39</u>	<u>2.79</u>
	<u>31.0</u>	<u>32.0</u>			<u>2.34</u>	<u>4.67</u>

Average R_b = 10.33

Average R_m = 10.67

$$\text{Covariance} = \frac{\sum (R_m - \bar{R}_m)(R_b - \bar{R}_b)}{N}$$

$$\text{Covariance} = \frac{2.34}{3} = 0.78$$

$$\text{Standard Deviation}(\sigma_m) = \frac{\sum (R_m - \bar{R}_m)^2}{N}$$

$$= \frac{4.67}{3} = 1.557$$

$$\beta = \frac{0.78}{1.557} = 0.50$$

Question 21

The returns on stock A and market portfolio for a period of 6 years are as follows:

Year	Return on A (%)	Return on market portfolio (%)
1	12	8
2	15	12
3	11	11
4	2	-4
5	10	9.5
6	-12	-2

You are required to determine:

- (i) Characteristic line for stock A
- (ii) The systematic and unsystematic risk of stock A.

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Answer

Characteristic line is given by

$$\alpha + \beta R_m$$

$$\beta_i = \frac{S_{xy} - n\bar{x}\bar{y}}{S_x^2 - n(\bar{x})^2}$$

$$\alpha_i = \bar{y} - \beta \bar{x}$$

Return on A (Y)	Return on market (X)	xy	x ²	(x - $\bar{x}$)	(x - $\bar{x}$) ²	(y - $\bar{y}$)	(y - $\bar{y}$) ²
12	8	96	64	2.25	5.06	5.67	32.15
15	12	180	144	6.25	39.06	8.67	75.17
11	11	121	121	5.25	27.56	4.67	21.81
2	-4	-8	16	-9.75	95.06	-4.33	18.75
10	9.5	95	90.25	3.75	14.06	3.67	13.47
<u>-12</u>	<u>-2</u>	<u>24</u>	<u>4</u>	<u>-7.75</u>	<u>60.06</u>	<u>-18.33</u>	<u>335.99</u>
38	34.5	508	439.25		240.86		497.34

$$\bar{y} = 38/6 = 6.33$$

$$\bar{x} = 34.5/6 = 5.75$$

$$\beta = \frac{S_{xy} - n\bar{x}\bar{y}}{S_x^2 - n(\bar{x})^2} = \frac{508 - 6(5.75)(6.33)}{439.25 - 6(5.75)^2} = \frac{508 - 218.385}{439.25 - 198.375}$$

$$= \frac{289.615}{240.875} = 1.202$$

$$a = \bar{y} - b \bar{x} = 6.33 - 1.202(5.75) = -0.58$$

Hence the characteristic line is $-0.58 + 1.202(R_m)$

$$\text{Total Risk of Market} = \sigma_{m^2} = \frac{S(x - \bar{x})^2}{n} = \frac{240.86}{6} = 40.14(\%)$$

$$\text{Total Risk of Stock} = \frac{497.34}{6} = 82.89(\%)$$

$$\text{Systematic Risk} = \beta_i^2 \sigma_2 = (1.202)^2 \times 40.14 = 57.99(\%)$$

$$\begin{aligned} \text{Unsystematic Risk is} &= \text{Total Risk} - \text{Systematic Risk} \\ &= 82.89 - 57.99 = 24.90(\%) \end{aligned}$$

Question 22

The rates of return on the security of Company X and market portfolio for 10 periods are given below:

Period	Return of Security X (%)	Return on Market Portfolio (%)
1	20	22
2	22	20
3	25	18
4	21	16
5	18	20
6	-5	8
7	17	-6
8	19	5
9	-7	6
10	20	11

- (i) What is the beta of Security X?
(ii) What is the characteristic line for Security X?

Answer

(i)

Period	R_X	R_M	$R_X - \bar{R}_X$	$R_M - \bar{R}_M$	$(R_X - \bar{R}_X)(R_M - \bar{R}_M)$	$(R_M - \bar{R}_M)^2$
1	20	22	5	10	50	100
2	22	20	7	8	56	64
3	25	18	10	6	60	36
4	21	16	6	4	24	16
5	18	20	3	8	24	64
6	-5	8	-20	-4	80	16

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7	17	-6	2	-18	-36	324
8	19	5	4	-7	-28	49
9	-7	6	-22	-6	132	36
10	<u>20</u>	<u>11</u>	5	-1	<u>-5</u>	<u>1</u>
	150	120			357	706
	ΣR_X	ΣR_M			$\Sigma (R_X - \bar{R}_X)(R_M - \bar{R}_M)$	$\Sigma (R_M - \bar{R}_M)^2$

$$\bar{R}_X = 15 \quad \bar{R}_M = 12$$

$$s^2_M = \frac{\sum (R_M - \bar{R}_M)^2}{n} = \frac{706}{10} = 70.60$$

$$\text{Cov}_{XM} = \frac{\sum (R_X - \bar{R}_X)(R_M - \bar{R}_M)}{n} = \frac{357}{10} = 35.70$$

$$\text{Beta}_X = \frac{\text{Cov}_{XM}}{s^2_M} = \frac{35.70}{70.60} = 0.505$$

$$(ii) \quad \bar{R}_X = 15 \quad \bar{R}_M = 12$$

$$y = a + bx$$

$$15 = a + 0.505 \times 12$$

$$\begin{aligned} \text{Alpha (a)} &= 15 - (0.505 \times 12) \\ &= 8.94\% \end{aligned}$$

$$\text{Characteristic line for security X} = a + b \times R_M$$

Where, R_M = Expected return on Market Index

$$\therefore \text{Characteristic line for security X} = 8.94 + 0.505 R_M$$

Question 23

Following is the data regarding six securities:

	U	V	W	X	Y	Z
Return (%)	10	10	15	5	11	10
Risk (%) (Standard deviation)	5	6	13	5	6	7

(i) Which of three securities will be selected?

- (ii) Assuming perfect correlation, analyse whether it is preferable to invest 80% in security U and 20% in security W or to invest 100% in Y.

Answer

- (i) When we make risk-return analysis of different securities from U to Z, we can observe that security U gives a return of 10% at risk level of 5%. Simultaneously securities V and Z give the same return of 10% as of security U, but their risk levels are 6% and 7% respectively. Security X is giving only 5% return for the risk rate of 5%. Hence, security U dominates securities V, X and Z.

Securities W and Y offer more return but it carries higher level of risk.

Hence securities U, W and Y can be selected based on individual preferences.

- (ii) In a situation where the perfect positive correlation exists between two securities, their risk and return can be averaged with the proportion.

Assuming the perfect correlation exists between the securities U and W, average risk and return of U and W together for proportion 4 : 1 is calculated as follows:

$$\text{Risk} = (4 \times 5\% + 1 \times 13\%) / 5 = 6.6\%$$

$$\text{Return} = (4 \times 10\% + 1 \times 15\%) / 5 = 11\%$$

Therefore:	80% U	100% Y
	20% W	—
Risk	6.6%	6%
Return	11%	11%

When we compare risk of 6.6% and return of 11% with security Y with 6% risk and 11% return, security Y is preferable over the portfolio of securities U and W in proportion of 4 : 1

Question 24

Expected returns on two stocks for particular market returns are given in the following table:

Market Return	Aggressive	Defensive
7%	4%	9%
25%	40%	18%

You are required to calculate:

- (a) The Betas of the two stocks.
 (b) Expected return of each stock, if the market return is equally likely to be 7% or 25%.

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- (c) The Security Market Line (SML), if the risk free rate is 7.5% and market return is equally likely to be 7% or 25%.
- (d) The Alphas of the two stocks.

Answer

- (a) The Betas of two stocks:

$$\begin{aligned}\text{Aggressive stock} & - & 40\% - 4\%/25\% - 7\% = 2 \\ \text{Defensive stock} & - & 18\% - 9\%/25\% - 7\% = 0.50\end{aligned}$$

- (b) Expected returns of the two stocks:-

$$\begin{aligned}\text{Aggressive stock} & - & 0.5 \times 4\% + 0.5 \times 40\% = 22\% \\ \text{Defensive stock} & - & 0.5 \times 9\% + 0.5 \times 18\% = 13.5\%\end{aligned}$$

- (c) Expected return of market portfolio = $0.5 \times 7\% + 0.5 \times 25\% = 16\%$

$$\backslash \text{ Market risk prem.} = 16\% - 7.5\% = 8.5\%$$

$$\backslash \text{ SML is, required return} = 7.5\% + \beta_i 8.5\%$$

- (d) $R_s = \alpha + \beta R_m$

Where

α = Alpha

β = Beta

R_m = Market Return

For Aggressive Stock

$$22\% = \alpha_A + 2(16\%)$$

$$\alpha_A = -10\%$$

For Defensive Stock

$$13.5\% = \alpha_D + 0.50(16\%)$$

$$\alpha_D = 5.5\%$$

Question 25

A study by a Mutual fund has revealed the following data in respect of three securities:

Security	σ (%)	Correlation with Index, P_m
A	20	0.60
B	18	0.95
C	12	0.75

The standard deviation of market portfolio (BSE Sensex) is observed to be 15%.

- (i) What is the sensitivity of returns of each stock with respect to the market?
- (ii) What are the covariances among the various stocks?
- (iii) What would be the risk of portfolio consisting of all the three stocks equally?
- (iv) What is the beta of the portfolio consisting of equal investment in each stock?
- (v) What is the total, systematic and unsystematic risk of the portfolio in (iv) ?

Answer

- (i) Sensitivity of each stock with market is given by its beta.

Standard deviation of market Index = 15%

Variance of market Index = 0.0225

Beta of stocks = $\sigma_i r / \sigma_m$

A = $20 \times 0.60 / 15 = 0.80$

B = $18 \times 0.95 / 15 = 1.14$

C = $12 \times 0.75 / 15 = 0.60$

- (ii) Covariance between any 2 stocks = $\beta_1 \beta_2 \sigma_m^2$

Covariance matrix

Stock/Beta	0.80	1.14	0.60
A	400.000	205.200	108.000
B	205.200	324.000	153.900
C	108.000	153.900	144.000

- (iii) Total risk of the equally weighted portfolio (Variance) = $400(1/3)^2 + 324(1/3)^2 + 144(1/3)^2 + 2(205.20)(1/3)^2 + 2(108.0)(1/3)^2 + 2(153.900)(1/3)^2 = 200.244$

- (iv) β of equally weighted portfolio = $\beta_p = \frac{1}{N} \sum \beta_i = \frac{0.80 + 1.14 + 0.60}{3}$
 $= 0.8467$

- (v) Systematic Risk $\beta_p^2 \sigma_m^2 = (0.8467)^2 (15)^2 = 161.302$

Unsystematic Risk = Total Risk – Systematic Risk
 $= 200.244 - 161.302 = 38.942$

Question 26

Mr. X owns a portfolio with the following characteristics:

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	Security A	Security B	Risk Free security
Factor 1 sensitivity	0.80	1.50	0
Factor 2 sensitivity	0.60	1.20	0
Expected Return	15%	20%	10%

It is assumed that security returns are generated by a two factor model.

- (i) *If Mr. X has ₹ 1,00,000 to invest and sells short ₹ 50,000 of security B and purchases ₹ 1,50,000 of security A what is the sensitivity of Mr. X's portfolio to the two factors?*
- (ii) *If Mr. X borrows ₹ 1,00,000 at the risk free rate and invests the amount he borrows along with the original amount of ₹ 1,00,000 in security A and B in the same proportion as described in part (i), what is the sensitivity of the portfolio to the two factors?*
- (iii) *What is the expected return premium of factor 2?*

Answer

- (i) Mr. X's position in the two securities are +1.50 in security A and -0.5 in security B. Hence the portfolio sensitivities to the two factors:-

$$\text{b prop. 1} = 1.50 \times 0.80 + (-0.50 \times 1.50) = 0.45$$

$$\text{b prop. 2} = 1.50 \times 0.60 + (-0.50 \times 1.20) = 0.30$$

- (ii) Mr. X's current position:-

$$\text{Security A} \quad ₹ 3,00,000 / ₹ 1,00,000 = 3$$

$$\text{Security B} \quad -₹ 1,00,000 / ₹ 1,00,000 = -1$$

$$\text{Risk free asset} \quad -₹ 100000 / ₹ 100000 = -1$$

$$\text{b prop. 1} = 3.0 \times 0.80 + (-1 \times 1.50) + (-1 \times 0) = 0.90$$

$$\text{b prop. 2} = 3.0 \times 0.60 + (-1 \times 1.20) + (-1 \times 0) = 0.60$$

- (iii) The portfolio created in part (ii) is a pure factor 2 portfolio.

Expected return on the portfolio in part (b) is:

$$R_p = 3 \times 0.15 + (-1) \times 0.20 + (-1) \times 0.10$$

$$= 0.15 \text{ i.e. } 15\%$$

$$\backslash \text{ Expected return premium} = 15\% - 10\% = 5\%$$

Question 27

Mr. Tempest has the following portfolio of four shares:

Name	Beta	Investment ₹ Lac.
Oxy Rin Ltd.	0.45	0.80
Boxed Ltd.	0.35	1.50
Square Ltd.	1.15	2.25
Ellipse Ltd.	1.85	4.50

The risk free rate of return is 7% and the market rate of return is 14%.

Required.

(i) Determine the portfolio return. (ii) Calculate the portfolio Beta.

Answer

Market Risk Premium (A) = 14% – 7% = 7%

Share	Beta	Risk Premium (Beta x A) %	Risk Free Return %	Return %	Return ₹
Oxy Rin Ltd.	0.45	3.15	7	10.15	8,120
Boxed Ltd.	0.35	2.45	7	9.45	14,175
Square Ltd.	1.15	8.05	7	15.05	33,863
Ellipse Ltd.	1.85	12.95	7	19.95	89,775
Total Return					<u>1,45,933</u>

Total Investment ₹ 9,05,000

(i) Portfolio Return = $\frac{₹ 1,45,933}{₹ 9,05,000} \times 100 = 16.13\%$

(ii) Portfolio Beta

Portfolio Beta = Risk Free Rate + Risk Premium x β = 16.13%

$$7\% + 7\beta = 16.13\%$$

$$\beta = 1.30$$

Alternative Approach

First we shall compute Portfolio Beta using the weighted average method as follows:

$$\begin{aligned} \text{Beta}_P &= 0.45 \times \frac{0.80}{9.05} + 0.35 \times \frac{1.50}{9.05} + 1.15 \times \frac{2.25}{9.05} + 1.85 \times \frac{4.50}{9.05} \\ &= 0.45 \times 0.0884 + 0.35 \times 0.1657 + 1.15 \times 0.2486 + 1.85 \times 0.4972 = 0.0398 + 0.058 + 0.2859 + 0.9198 = 1.3035 \end{aligned}$$

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Accordingly,

- (i) Portfolio Return using CAPM formula will be as follows:

$$\begin{aligned}R_P &= R_F + \text{Beta}_P(R_M - R_F) \\&= 7\% + 1.3035(14\% - 7\%) = 7\% + 1.3035(7\%) \\&= 7\% + 9.1245\% = 16.1245\%\end{aligned}$$

- (ii) Portfolio Beta

As calculated above 1.3035

Question 28

Amal Ltd. has been maintaining a growth rate of 12% in dividends. The company has paid dividend @ ₹ 3 per share. The rate of return on market portfolio is 15% and the risk-free rate of return in the market has been observed as 10%. The beta co-efficient of the company's share is 1.2.

You are required to calculate the expected rate of return on the company's shares as per CAPM model and the equilibrium price per share by dividend growth model.

Answer

Capital Asset Pricing Model (CAPM) formula for calculation of expected rate of return is

$$\begin{aligned}E_R &= R_f + \beta (R_m - R_f) \\E_R &= \text{Expected Return} \\ \beta &= \text{Beta of Security} \\ R_m &= \text{Market Return} \\ R_f &= \text{Risk free Rate} \\&= 10 + [1.2 (15 - 10)] \\&= 10 + 1.2 (5) \\&= 10 + 6 = 16\% \text{ or } 0.16\end{aligned}$$

Applying dividend growth mode for the calculation of per share equilibrium price:-

$$E_R = \frac{D_1}{P_0} + g$$

$$\text{or } 0.16 = \frac{3(1.12)}{P_0} + 0.12 \quad \text{or} \quad 0.16 - 0.12 = \frac{3.36}{P_0}$$

$$\text{or } 0.04 P_0 = 3.36 \quad \text{or} \quad P_0 = \frac{3.36}{0.04} = ₹ 84$$

Therefore, equilibrium price per share will be ₹ 84.

Question 29

A Ltd. has an expected return of 22% and Standard deviation of 40%. B Ltd. has an expected return of 24% and Standard deviation of 38%. A Ltd. has a beta of 0.86 and B Ltd. a beta of 1.24. The correlation coefficient between the return of A Ltd. and B Ltd. is 0.72. The Standard deviation of the market return is 20%. Suggest:

- (i) *Is investing in B Ltd. better than investing in A Ltd.?*
- (ii) *If you invest 30% in B Ltd. and 70% in A Ltd., what is your expected rate of return and portfolio Standard deviation?*
- (iii) *What is the market portfolios expected rate of return and how much is the risk-free rate?*
- (iv) *What is the beta of Portfolio if A Ltd.'s weight is 70% and B Ltd.'s weight is 30%?*

Answer

- (i) A Ltd. has lower return and higher risk than B Ltd. investing in B Ltd. is better than in A Ltd. because the returns are higher and the risk, lower. However, investing in both will yield diversification advantage.

$$(ii) r_{AB} = .22 \times 0.7 + .24 \times 0.3 = 22.6\%$$

$$\sigma_{AB}^2 = 0.40^2 \times 0.7^2 + 0.38^2 \times 0.3^2 + 2 \times 0.7 \times 0.3 \times 0.72 \times 0.40 \times 0.38 = 0.1374$$

$$S_{AB} = \sqrt{S_{AB}^2}$$

$$= \sqrt{.1374} = .37 = 37\% *$$

* Answer = 37.06% is also correct and variation may occur due to approximation.

- (iii) This risk-free rate will be the same for A and B Ltd. Their rates of return are given as follows:

$$r_A = 22 = r_f + (r_m - r_f) 0.86$$

$$r_B = 24 = r_f + (r_m - r_f) 1.24$$

$$r_A - r_B = -2 = (r_m - r_f) (-0.38)$$

$$r_m - r_f = -2 / -0.38 = 5.26\%$$

$$r_A = 22 = r_f + (5.26) 0.86$$

$$r_f = 17.5\% *$$

$$r_B = 24 = r_f + (5.26) 1.24$$

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$$r_f = 17.5\%^*$$

$$r_m - 17.5 = 5.26$$

$$r_m = 22.76\%^{**}$$

*Answer = 17.47% might occur due to variation in approximation.

**Answer may show small variation due to approximation. Exact answer is 22.73%.

$$\begin{aligned} \text{(iv)} \quad b_{AB} &= b_A \cdot W_A + b_B \cdot W_B \\ &= 0.86 \cdot 0.7 + 1.24 \cdot 0.3 = 0.974 \end{aligned}$$

Question 30

XYZ Ltd. has substantial cash flow and until the surplus funds are utilised to meet the future capital expenditure, likely to happen after several months, are invested in a portfolio of short-term equity investments, details for which are given below:

Investment	No. of shares	Beta	Market price per share ₹	Expected dividend yield
I	60,000	1.16	4.29	19.50%
II	80,000	2.28	2.92	24.00%
III	1,00,000	0.90	2.17	17.50%
IV	1,25,000	1.50	3.14	26.00%

The current market return is 19% and the risk free rate is 11%.

Required to:

- Calculate the risk of XYZ's short-term investment portfolio relative to that of the market;
- Whether XYZ should change the composition of its portfolio.

Answer

(i) Computation of Beta of Portfolio

Investment	No. of shares	Market Price	Market Value	Dividend Yield	Dividend	Composition	β	Weighted β
I.	60,000	4.29	2,57,400	19.50%	50,193	0.2339	1.16	0.27
II.	80,000	2.92	2,33,600	24.00%	56,064	0.2123	2.28	0.48
III.	1,00,000	2.17	2,17,000	17.50%	37,975	0.1972	0.90	0.18
IV.	1,25,000	3.14	3,92,500	26.00%	1,02,050	0.3566	1.50	0.53
			11,00,500		2,46,282	1.0000		1.46

$$\text{Return of the Port Folio} = \frac{2,46,282}{11,00,500} = 0.2238$$

$$\text{Beta of Port Folio} = 1.46$$

Market Risk implicit

$$0.2238 = 0.11 + \beta \times (0.19 - 0.11)$$

$$\text{Or, } 0.08 \beta + 0.11 = 0.2238$$

$$\beta = \frac{0.2238 - 0.11}{0.08} = 1.42$$

Market β implicit is 1.42 while the port folio β is 1.46. Thus the portfolio is marginally risky compared to the market.

- (ii) The decision regarding change of composition may be taken by comparing the dividend yield (given) and the expected return as per CAPM as follows:

Expected return R_s as per CAPM is:

$$R_s = I_{RF} + (R_M - I_{RF}) \cdot b$$

$$\begin{aligned} \text{For investment I } R_s &= I_{RF} + (R_M - I_{RF}) \cdot b \\ &= .11 + (.19 - .11) 1.16 \\ &= 20.28\% \end{aligned}$$

$$\text{For investment II, } R_s = .11 + (.19 - .11) 2.28 = 29.24\%$$

$$\begin{aligned} \text{For investment III, } R_s &= .11 + (.19 - .11) .90 \\ &= 18.20\% \end{aligned}$$

$$\begin{aligned} \text{For investment IV, } R_s &= .11 + (.19 - .11) 1.50 \\ &= 23\% \end{aligned}$$

Comparison of dividend yield with the expected return R_s shows that the dividend yields of investment I, II and III are less than the corresponding R_s . So, these investments are over-priced and should be sold by the investor. However, in case of investment IV, the dividend yield is more than the corresponding R_s , so, XYZ Ltd. should increase its proportion.

Question 31

A company has a choice of investments between several different equity oriented mutual funds. The company has an amount of ₹1 crore to invest. The details of the mutual funds are as follows:

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Mutual Fund	Beta
A	1.6
B	1.0
C	0.9
D	2.0
E	0.6

Required:

- If the company invests 20% of its investment in the first two mutual funds and an equal amount in the mutual funds C, D and E, what is the beta of the portfolio?
- If the company invests 15% of its investment in C, 15% in A, 10% in E and the balance in equal amount in the other two mutual funds, what is the beta of the portfolio?
- If the expected return of market portfolio is 12% at a beta factor of 1.0, what will be the portfolios expected return in both the situations given above?

Answer

With 20% investment in each MF Portfolio Beta is the weighted average of the Betas of various securities calculated as below:

(i)

Investment	Beta (β)	Investment (₹ Lacs)	Weighted Investment
A	1.6	20	32
B	1.0	20	20
C	0.9	20	18
D	2.0	20	40
E	0.6	<u>20</u>	<u>12</u>
		<u>100</u>	<u>122</u>
Weighted Beta (β) = 1.22			

(ii) With varied percentages of investments portfolio beta is calculated as follows:

Investment	Beta (β)	Investment (₹ Lacs)	Weighted Investment
A	1.6	15	24

B	1.0	30	30
C	0.9	15	13.5
D	2.0	30	60
E	0.6	<u>10</u>	<u>6</u>
		<u>100</u>	<u>133.5</u>
Weighted Beta (β) = 1.335			

(iii) Expected return of the portfolio with pattern of investment as in case (i)

= $12\% \times 1.22$ i.e. 14.64%

Expected Return with pattern of investment as in case (ii) = $12\% \times 1.335$ i.e., 16.02%.

Question 32

Your client is holding the following securities:

Particulars of Securities	Cost	Dividends/Interest	Market price	Beta
	₹	₹	₹	
Equity Shares:				
Gold Ltd.	10,000	1,725	9,800	0.6
Silver Ltd.	15,000	1,000	16,200	0.8
Bronze Ltd.	14,000	700	20,000	0.6
GOI Bonds	36,000	3,600	34,500	1.0

Average return of the portfolio is 15.7%, calculate:

(i) Expected rate of return in each, using the Capital Asset Pricing Model (CAPM).

(ii) Risk free rate of return.

Answer

Particulars of Securities	Cost ₹	Dividend	Capital gain
Gold Ltd.	10,000	1,725	- 200
Silver Ltd.	15,000	1,000	1,200
Bronz Ltd.	14,000	700	6,000
GOI Bonds	<u>36,000</u>	<u>3,600</u>	<u>- 1,500</u>
Total	<u>75,000</u>	<u>7,025</u>	<u>5,500</u>

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Expected rate of return on market portfolio

$$\frac{\text{Dividend Earned} + \text{Capital appreciation}}{\text{Initial investment}} \times 100$$
$$= \frac{\text{₹ } 7,025 + \text{₹ } 5,500}{\text{₹ } 75,000} \times 100 = 16.7\%$$

Risk free return

$$\text{Average of Betas} = \frac{0.6 + 0.8 + 0.6 + 1.0}{4}$$

$$\text{Average of Betas} = 0.75$$

Average return = Risk free return + Average Betas (Expected return – Risk free return)

$$15.7 = \text{Risk free return} + 0.75 (16.7 - \text{Risk free return})$$

$$\text{Risk free return} = 12.7\%$$

Expected Rate of Return for each security is

$$\text{Rate of Return} = R_f + B (R_m - R_f)$$

$$\text{Gold Ltd.} = 12.7 + .6 (16.7 - 12.7) = 15.10\%$$

$$\text{Silver Ltd.} = 12.7 + .8 (16.7 - 12.7) = 15.90\%$$

$$\text{Bronz Ltd.} = 12.7 + .6 (16.7 - 12.7) = 15.10\%$$

$$\text{GOI Bonds} = 12.7 + 1.0 (16.7 - 12.7) = 16.70\%$$

Question 33

A holds the following portfolio:

Share/Bond	Beta	Initial Price	Dividends	Market Price at end of year
		₹	₹	₹
Epsilon Ltd.	0.8	25	2	50
Sigma Ltd.	0.7	35	2	60
Omega Ltd.	0.5	45	2	135
GOI Bonds	0.99	1,000	140	1,005

Calculate:

- (i) The expected rate of return on his portfolio using Capital Asset Pricing Method (CAPM)
- (ii) The average return of his portfolio.

Risk-free return is 14%.

Answer

- (i) Expected rate of return

	Total Investments	Dividends	Capital Gains
Epsilon Ltd.	25	2	25
Sigma Ltd.	35	2	25
Omega Ltd.	45	2	90
GOI Bonds	<u>1,000</u>	<u>140</u>	<u>5</u>
	<u>1,105</u>	<u>146</u>	<u>145</u>

$$\text{Expected Return on market portfolio} = \frac{146 + 145}{1105} = 26.33\%$$

$$\text{CAPME}(R_p) = R_F + \beta [E(R_M) - R_F]$$

Epsilon Ltd	$14 + 0.8 [26.33 - 14] =$	$14 + 9.86$	$= 23.86\%$
Sigma Ltd.	$14 + 0.7 [26.33 - 14] =$	$14 + 8.63$	$= 22.63\%$
Omega Ltd.	$14 + 0.5 [26.33 - 14] =$	$14 + 6.17$	$= 20.17\%$
GOI Bonds	$14 + 0.99 [26.33 - 14] =$	$14 + 12.21$	$= 26.21\%$

- (ii) Average Return of Portfolio

$$\frac{23.86 + 22.63 + 20.17 + 26.21}{4} = \frac{92.87}{4} = 23.22\%$$

$$\text{Alternatively } \frac{0.8 + 0.7 + 0.5 + 0.99}{4} = \frac{2.99}{4} = 0.7475$$

$$14 + 0.7475(26.33 - 14)$$

$$14 + 9.22 = 23.22\%$$

Question 34

Your client is holding the following securities:

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Particulars of Securities	Cost ₹	Dividends ₹	Market Price ₹	BETA
Equity Shares:				
Co. X	8,000	800	8,200	0.8
Co. Y	10,000	800	10,500	0.7
Co. Z	16,000	800	22,000	0.5
PSU Bonds	34,000	3,400	32,300	1.0

Assuming a Risk-free rate of 15%, calculate:

- Expected rate of return in each, using the Capital Asset Pricing Model (CAPM).
- Average return of the portfolio.

Answer

Calculation of expected return on market portfolio (R_m)

Investment	Cost (₹)	Dividends (₹)	Capital Gains (₹)
Shares X	8,000	800	200
Shares Y	10,000	800	500
Shares Z	16,000	800	6,000
PSU Bonds	<u>34,000</u>	<u>3,400</u>	<u>-1,700</u>
	<u>68,000</u>	<u>5,800</u>	<u>5,000</u>

$$R_m = \frac{5,800 + 5,000}{68,000} \times 100 = 15.88\%$$

Calculation of expected rate of return on individual security:

Security

Shares X	$15 + 0.8 (15.88 - 15.0)$	$= 15.70\%$
Shares Y	$15 + 0.7 (15.88 - 15.0)$	$= 15.62\%$
Shares Z	$15 + 0.5 (15.88 - 15.0)$	$= 15.44\%$
PSU Bonds	$15 + 1.0 (15.88 - 15.0)$	$= 15.88\%$

Calculation of the Average Return of the Portfolio:

$$= \frac{15.70 + 15.62 + 15.44 + 15.88}{4} = 15.66\%.$$

Question 35

An investor is holding 1,000 shares of Fatlass Company. Presently the rate of dividend being paid by the company is ₹ 2 per share and the share is being sold at ₹ 25 per share in the market. However, several factors are likely to change during the course of the year as indicated below:

	Existing	Revised
Risk free rate	12%	10%
Market risk premium	6%	4%
Beta value	1.4	1.25
Expected growth rate	5%	9%

In view of the above factors whether the investor should buy, hold or sell the shares? And why?

Answer

On the basis of existing and revised factors, rate of return and price of share is to be calculated.

Existing rate of return

$$= R_f + \text{Beta} (R_m - R_f)$$

$$= 12\% + 1.4 (6\%) = 20.4\%$$

Revised rate of return

$$= 10\% + 1.25 (4\%) = 15\%$$

Price of share (original)

$$P_0 = \frac{D(1+g)}{K_e - g} = \frac{2(1.05)}{.204 - .05} = \frac{2.10}{.154} = \text{Rs. } 13.63$$

Price of share (Revised)

$$P_0 = \frac{2(1.09)}{.15 - .09} = \frac{2.18}{.06} = \text{Rs. } 36.33$$

In case of existing market price of ₹ 25 per share, rate of return (20.4%) and possible equilibrium price of share at ₹ 13.63, this share needs to be sold because the share is overpriced (₹ 25 – 13.63) by ₹ 11.37. However, under the changed scenario where growth of

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dividend has been revised at 9% and the return though decreased at 15% but the possible price of share is to be at ₹ 36.33 and therefore, in order to expect price appreciation to ₹ 36.33 the investor should hold the shares, if other things remain the same.

Question 36

An investor has two portfolios known to be on minimum variance set for a population of three securities A, B and C having below mentioned weights:

	WA	WB	WC
Portfolio X	0.30	0.40	0.30
Portfolio Y	0.20	0.50	0.30

It is supposed that there are no restrictions on short sales.

- What would be the weight for each stock for a portfolio constructed by investing ₹ 5,000 in portfolio X and ₹ 3,000 in portfolio Y?
- Suppose the investor invests ₹ 4,000 out of ₹ 8,000 in security A. How he will allocate the balance between security B and C to ensure that his portfolio is on minimum variance set?

Answer

- Investment committed to each security would be:-

	<u>A</u> (₹)	<u>B</u> (₹)	<u>C</u> (₹)	<u>Total</u> (₹)
Portfolio X	1,500	2,000	1,500	5,000
Portfolio Y	<u>600</u>	<u>1,500</u>	<u>900</u>	<u>3,000</u>
Combined Portfolio	<u>2,100</u>	<u>3,500</u>	<u>2,400</u>	<u>8,000</u>
\ Stock weights	0.26	0.44	0.30	

- The equation of critical line takes the following form:-

$$WB = a + bWA$$

Substituting the values of WA & WB from portfolio X and Y in above equation, we get

$$0.40 = a + 0.30b, \text{ and}$$

$$0.50 = a + 0.20b$$

Solving above equation we obtain the slope and intercept, $a = 0.70$ and $b = -1$ and thus, the critical line is

$$WB = 0.70 - WA$$

If half of the funds is invested in security A then,

$$WB = 0.70 - 0.50 = 0.20$$

$$\text{Since } WA + WB + WC = 1$$

$$WC = 1 - 0.50 - 0.20 = 0.30$$

$$\begin{aligned} \backslash \text{ Allocation of funds to security B} &= 0.20 \times 8,000 = ₹ 1,600, \text{ and} \\ \text{Security C} &= 0.30 \times 8,000 = ₹ 2,400 \end{aligned}$$

Question 37

X Co., Ltd., invested on 1.4.2009 in certain equity shares as below:

Name of Co.	No. of shares	Cost (₹)
M Ltd.	1,000 (₹100 each)	2,00,000
N Ltd.	500 (₹10 each)	1,50,000

In September, 2009, 10% dividend was paid out by M Ltd. and in October, 2009, 30% dividend paid out by N Ltd. On 31.3.2010 market quotations showed a value of ₹220 and ₹290 per share for M Ltd. and N Ltd. respectively.

On 1.4.2010, investment advisors indicate (a) that the dividends from M Ltd. and N Ltd. for the year ending 31.3.2011 are likely to be 20% and 35%, respectively and (b) that the probabilities of market quotations on 31.3.2011 are as below:

Probability factor	Price/share of M Ltd.	Price/share of N Ltd.
0.2	220	290
0.5	250	310
0.3	280	330

You are required to:

- Calculate the average return from the portfolio for the year ended 31.3.2010;*
- Calculate the expected average return from the portfolio for the year 2010-11; and*
- Advise X Co. Ltd., of the comparative risk in the two investments by calculating the standard deviation in each case.*

Answer

Calculation of return on portfolio for 2009-10	(Calculation in ₹ / share)		
	M	N	
Dividend received during the year	10	3	
Capital gain/loss by 31.03.10			

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Market value by 31.03.10	220	290	
Cost of investment	200	300	
Gain/loss	20	(-)10	
Yield	30	(-)7	
Cost	200	300	
% return	15%	(-)2.33%	
Weight in the portfolio	57	43	7.55%
Weighted average return			
Calculation of estimated return for 2010-11			
Expected dividend	20	3.5	
Capital gain by 31.03.11			
(220x0.2) + (250x0.5) + (280x0.3) – 220 = (253-220)	33	-	
(290x0.2) + (310x0.5) + (330x0.3) – 290 = (312 – 290)	-	22	
Yield	53	25.5	
*Market Value 01.04.10	220	290	
% return	24.09%	8.79%	
*Weight in portfolio (1,000x220): (500x290)	60.3	39.7	
Weighted average (Expected) return			18.02%
(*The market value on 31.03.10 is used as the base for calculating yield for 10-11)			

Calculation of Standard Deviation

M Ltd.

Exp. market value	Exp. gain	Exp. div.	Exp Yield (1)	Prob. Factor (2)	(1) X(2)	Dev. ($P_M - \bar{P}_M$)	Square of dev. (3)	(2) X (3)
220	0	20	20	0.2	4	-33	1089	217.80
250	30	20	50	0.5	25	-3	9	4.50
280	60	20	80	0.3	24	27	729	218.70
					53			$\sigma^2_M = 441.00$

Standard Deviation (σ_M)

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N Ltd.

Exp. market value	Exp. gain	Exp. div.	Exp Yield (1)	Prob. Factor (2)	(1) X (2)	Dev. $(P_N - \bar{P}_N)$	Square of dev. (3)	(2) X (3)
290	0	3.5	3.5	0.2	0.7	-22	484	96.80
310	20	3.5	23.5	0.5	11.75	-2	4	2.00
330	40	3.5	43.5	0.3	13.05	18	324	97.20
					25.5			$\sigma^2_N = 196.00$

Standard Deviation (σ_N)

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Share of company M Ltd. is more risky as the S.D. is more than company N Ltd.

Question 38

An investor holds two stocks A and B. An analyst prepared ex-ante probability distribution for the possible economic scenarios and the conditional returns for two stocks and the market index as shown below:

Economic scenario	Probability	Conditional Returns %		
		A	B	Market
Growth	0.40	25	20	18
Stagnation	0.30	10	15	13
Recession	0.30	-5	-8	-3

The risk free rate during the next year is expected to be around 11%. Determine whether the investor should liquidate his holdings in stocks A and B or on the contrary make fresh investments in them. CAPM assumptions are holding true.

Answer

$$\text{Expected Return on stock A} = E(A) = \sum_{i=G,S,R} P_i A_i$$

(G,S & R, denotes Growth, Stagnation and Recession)

$$(0.40)(25) + 0.30(10) + 0.30(-5) = 11.5\%$$

Expected Return on 'B'

$$(0.40 \times 20) + (0.30 \times 15) + 0.30 \times (-8) = 10.1\%$$

Expected Return on Market index

$$(0.40 \times 18) + (0.30 \times 13) + 0.30 \times (-3) = 10.2\%$$

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Variance of Market index

$$(18 - 10.2)^2 (0.40) + (13 - 10.2)^2 (0.30) + (-3 - 10.2)^2 (0.30) \\ = 24.34 + 2.35 + 52.27 = 78.96\%$$

Covariance of stock A and Market Index M

$$\text{Cov. (AM)} = \sum_{i=G,S,R} (A_i - E(A)) [M_i - E(M)] P$$

$$(25 - 11.5) (18 - 10.2)(0.40) + (10 - 11.5) (13 - 10.2) (0.30) + (-5 - 11.5) (-3 - 10.2)(0.30) \\ = 42.12 + (-1.26) + 65.34 = 106.20$$

Covariance of stock B and Market index M

$$(20 - 10.1) (18 - 10.2)(0.40) + (15 - 10.1)(13 - 10.2)(0.30) + (-8 - 10.1)(-3 - 10.2)(0.30) = 30.89 + 4.12 + 71.67 = 106.68$$

$$\text{Beta for stock A} = \frac{\text{CoV(AM)}}{\text{VAR(M)}} = \frac{106.20}{78.96} = 1.345$$

$$\text{Beta for Stock B} = \frac{\text{CoV(BM)}}{\text{VarM}} = \frac{106.68}{78.96} = 1.351$$

Required Return for A

$$R(A) = R_f + \beta (M - R_f)$$

$$11\% + 1.345(10.2 - 11)\% = 9.924\%$$

Required Return for B

$$11\% + 1.351 (10.2 - 11)\% = 9.92\%$$

Alpha for Stock A

$$E(A) - R(A) \text{ i.e. } 11.5\% - 9.924\% = 1.576\%$$

Alpha for Stock B

$$E(B) - R(B) \text{ i.e. } 10.1\% - 9.92\% = 0.18\%$$

Since stock A and B both have positive Alpha, therefore, they are UNDERPRICED. The investor should make fresh investment in them.

Question 39

Ramesh wants to invest in stock market. He has got the following information about individual securities:

Security	Expected Return	Beta	σ^2_{ci}
A	15	1.5	40
B	12	2	20
C	10	2.5	30
D	09	1	10
E	08	1.2	20
F	14	1.5	30

Market index variance is 10 percent and the risk free rate of return is 7%. What should be the optimum portfolio assuming no short sales?

Answer

Securities need to be ranked on the basis of excess return to beta ratio from highest to the lowest.

Security	R_i	b_i	$R_i - R_f$	$\frac{R_i - R_f}{b_i}$
A	15	1.5	8	5.33
B	12	2	5	2.5
C	10	2.5	3	1.2
D	9	1	2	2
E	8	1.2	1	0.83
F	14	1.5	7	4.67

Ranked Table:

Security	$R_i - R_f$	b_i	S^2_{ei}	$\frac{(R_i - R_f) \times b_i}{S^2_{ei}}$	$\frac{\sum_{e=i}^N (R_i - R_f) \times b_i}{S^2_{ei}}$	$\frac{b_i^2}{S^2_{ei}}$	$\frac{\sum_{e=i}^N b_i^2}{S^2_{ei}}$	C_i
A	8	1.5	40	0.30	0.30	0.056	0.056	1.923
F	7	1.5	30	0.35	0.65	0.075	0.131	2.814
B	5	2	20	0.50	1.15	0.20	0.331	2.668
D	2	1	10	0.20	1.35	0.10	0.431	2.542
C	3	2.5	30	0.25	1.60	0.208	0.639	2.165
E	1	1.2	20	0.06	1.66	0.072	0.711	2.047

$$CA = 10 \times 0.30 / [1 + (10 \times 0.056)] = 1.923$$

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$$CF = 10 \times 0.65 / [1 + (10 \times 0.131)] = 2.814$$

$$CB = 10 \times 1.15 / [1 + (10 \times 0.331)] = 2.668$$

$$CD = 10 \times 1.35 / [1 + (10 \times 0.431)] = 2.542$$

$$CC = 10 \times 1.60 / [1 + (10 \times 0.639)] = 2.165$$

$$CE = 10 \times 1.66 / [1 + (10 \times 0.7111)] = 2.047$$

Cut off point is 2.814

$$Z_i = \frac{\beta_i}{\sigma_{ei}^2} \left[\frac{(R_i - R_f)}{\beta_i} - C \right]$$

$$Z_A = \frac{1.5}{40} (5.33 - 2.814) = 0.09435$$

$$Z_F = \frac{1.5}{30} (4.67 - 2.814) = 0.0928$$

$$X_A = 0.09435 / [0.09435 + 0.0928] = 50.41\%$$

$$X_F = 0.0928 / [0.09435 + 0.0928] = 49.59\%$$

Funds to be invested in security A & F are 50.41% and 49.59% respectively.

Question 40

Mr. Tamarind intends to invest in equity shares of a company the value of which depends upon various parameters as mentioned below:

Factor	Beta	Expected value in%	Actual value in %
GNP	1.20	7.70	7.70
Inflation	1.75	5.50	7.00
Interest rate	1.30	7.75	9.00
Stock market index	1.70	10.00	12.00
Industrial production	1.00	7.00	7.50

If the risk free rate of interest be 9.25%, how much is the return of the share under Arbitrage Pricing Theory?

Answer**Return of the stock under APT**

<i>Factor</i>	<i>Actual value in %</i>	<i>Expected value in %</i>	<i>Difference</i>	<i>Beta</i>	<i>Diff. x Beta</i>
GNP	7.70	7.70	0.00	1.20	0.00
Inflation	7.00	5.50	1.50	1.75	2.63
Interest rate	9.00	7.75	1.25	1.30	1.63
Stock index	12.00	10.00	2.00	1.70	3.40
Ind. Production	7.50	7.00	0.50	1.00	<u>0.50</u>
					8.16
Risk free rate in %					<u>9.25</u>
Return under APT					<u>17.41</u>

EXERCISES**Question 1**

Mr. Sunil Mukherjee has estimated probable under different macroeconomic conditions for the following three stocks:

<i>Stock</i>	<i>Current price (₹)</i>	<i>Rates of return(%) during different macroeconomic scenarios</i>		
		<i>Recession</i>	<i>Moderate growth</i>	<i>Boom</i>
Him Ice Ltd	12	-12	15	35
Kalahari Biotech	18	20	12	-5
Puma Softech	60	18	20	15

Mr. Sunil Mukherjee is exploring if it is possible to make any arbitrage profits from the above information. Using the given information you are required to construct an arbitrage portfolio and show the payoffs under the different economic scenarios.

(Answer: Construction of an arbitrage portfolio requires formation of a zero investment portfolio. If we short sell two stocks each of the Him Ice Ltd and Kalahari Biotech one stock of Puma Softech can be purchased and this portfolio will qualify as zero investment portfolio.)

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Question 2

Assume that you have half your money invested in T, the media company, and the other half invested in U, the consumer product giant. The expected returns and standard deviations on the two investments are summarized below:

	T	U
Expected Return	14%	18%
Standard Deviation	25%	40%

Estimate the variance of the portfolio as a function of the correlation coefficient (Start with -1 and increase the correlation to $+1$ in 0.2 increments).

(Answer: For Correlation of -0.8 the variance will be 156.25 and other variances can be calculated accordingly)

Question 3

Suppose Mr. X in a world where there are only two assets, gold and stocks. He is interested in investing his money in one, the other or both assets. Consequently he collects the following data on the returns on the two assets over the last six years.

	Gold	Stock Market
Average return	8%	20%
Standard deviation	25%	22%
Correlation	-	0.4

- (a) Mr. X is constrained to pick just one, which one he would choose?
- (b) Mr. Y, a friend of Mr. X argues that this is wrong. He says that Mr. X is ignoring the big payoffs that he can get on gold. How would Mr. X go about alleviating his concern?
- (c) How would a portfolio composed of equal proportions in gold and stocks do in terms of mean and variance?
- (d) Mr. X came to know that GPEC (a cartel of gold-producing countries) is going to vary the amount of gold it produces with stock prices in the country. (GPEC will produce less gold when stock markets are up and more when it is down.) What effect will this have on his portfolios? Explain.

(Answer: (a) Gold **(b)** The average return on gold is much less than that on the stock market. **(c)** 14% and 167.25 **(d)** The optimal amount to invest in gold would drop.)