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P R I S T I N E

Portfolio Management

- Risk Aversion
- Assumptions of Markowitz model
- Expected return and Standard deviation
- Covariance
- Components of portfolio standard deviation
- Efficient Frontier
- Optimal Portfolio

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Risk Aversion

- Risk Aversion simply means that investors prefer lesser risk.
- **Assumptions of Markowitz Model**
 - Investors are risk averse and try to minimise the risk and maximise return.
 - Investors look at each investment opportunity as a probability distribution of expected returns.
 - Investors are rational and behave in a manner as to maximise their utility with a given level of income or money.
 - Investors make investment decisions considering only the risk and return of the investment.
 - Investors measure risk as variance of returns.

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Expected return and Standard deviation

Individual Security:

- Expected return of a single security is measured by multiplying the probability of achieving a return with the quantum of the return. The various return are summed to arrive at the security return.

$$E(R) = P_1R_1 + P_2R_2 + P_3R_3 + \dots + P_nR_n$$

- Variance(Standard deviation) of a single security

$$\text{Variance} = \sigma^2 = \sum P_i [R_i - E(R)]^2$$

- TWO ASSET PORTFOLIO:

$$E(R_p) = w_A E(R_A) + (1-w_A) E(R_B)$$

$$\text{Variance } (w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2 w_A w_B \sigma_A \sigma_B \rho_{AB})$$

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- **Covariance:** measure the extent to which two change together.

$$\rho_{X,Y} = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y} = \frac{E((X - \mu_X)(Y - \mu_Y))}{\sigma_X \sigma_Y}$$

- **Correlation:** measures the strength of the linear relationship between two variables.
 - It is a better measure than Covariance as it is easier to interpret. It varies from +1 to -1.
 - <1, variances of returns of a portfolio is less than a weighted average of the individual variances of the portfolio securities.
 - The lower the correlation between 2 securities the greater the diversification benefits.

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Components of portfolio standard deviation

- Portfolio Variance is calculated using the below formula:
- For two-asset portfolio:
$$\text{Var}(w_A k_A + w_B k_B) = w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2 w_A w_B \sigma_A \sigma_B \rho_{AB}$$
- where,
 - ρ_{AB} is correlation coefficient between A and B.
 - w_A, w_B are weights of the asset A and B.
- If $\rho = 1$
$$\text{Var}(w_A k_A + w_B k_B) = (w_A \sigma_A + w_B \sigma_B)^2$$
- If $\rho < 1$
$$\text{Var}(w_A k_A + w_B k_B) < (w_A \sigma_A + w_B \sigma_B)^2$$
- So there is a risk reduction from holding a portfolio of assets if assets do not move in perfect unison.

Importance of Correlation

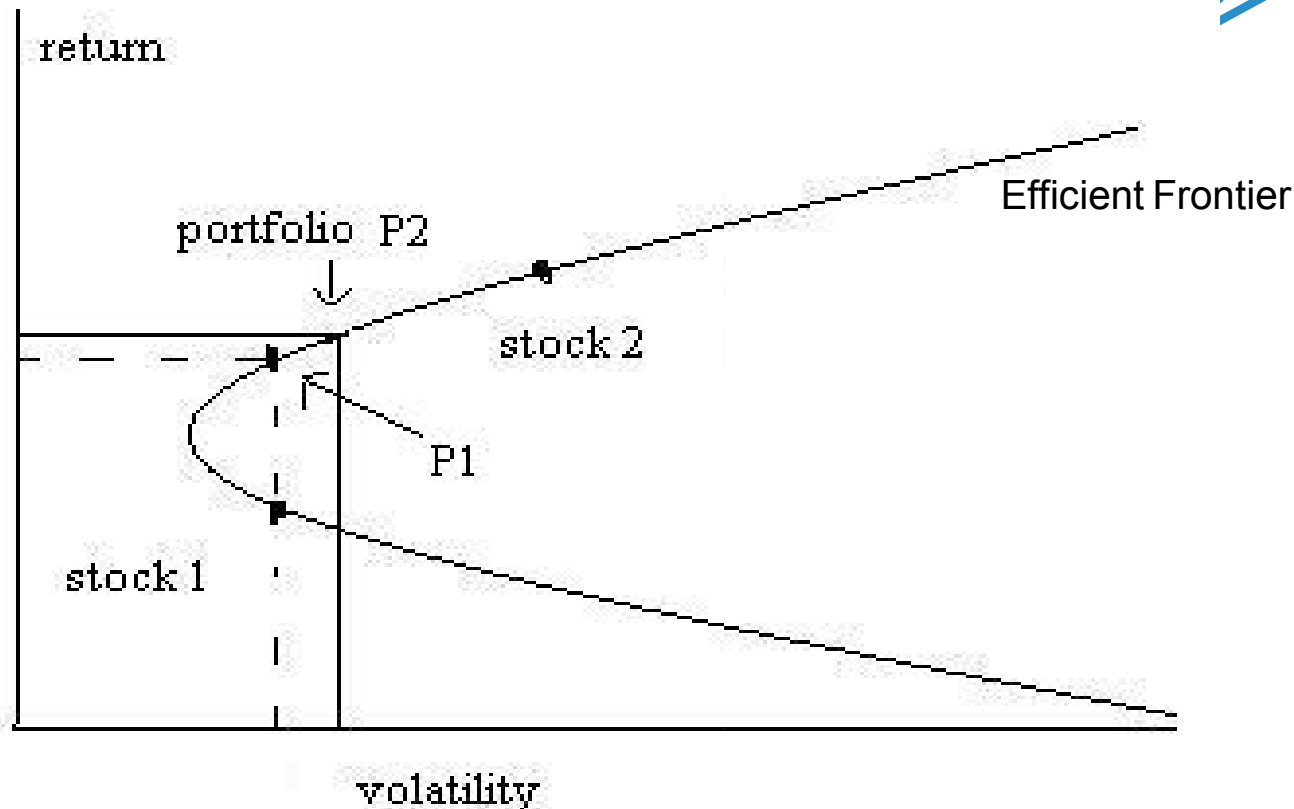
- $E(R_A) = 10\%$, $\sigma_A = 20\%$, $E(R_B) = 10\%$, $\sigma_B = 20\%$
- Assume the weights to be 50 % for A & B
- Calculate portfolio returns when
 - Case 1 : $\rho_{AB} = 1$,
 - Case 2 : $\rho_{AB} = 0$,
 - Case 3 : $\rho_{AB} = -1$
- Expected return = $10\% * 0.5 + 10\% * 0.5 = 10\%$ (in all three cases)
- Variance
 - Case 1 : $(0.5^2) * (0.2^2) + (0.5^2) * (0.2^2) + 2 * 0.5 * 0.5 * 0.2 * 0.2 * 1 = 0.04$
 - Case 2 : $(0.5^2) * (0.2^2) + (0.5^2) * (0.2^2) + 2 * 0.5 * 0.5 * 0.2 * 0.2 * 0 = 0.02$
 - Case 3 : $(0.5^2) * (0.2^2) + (0.5^2) * (0.2^2) + 2 * 0.5 * 0.5 * 0.2 * 0.2 * -1 = 0.00$



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- Efficient Frontier refers to the set of portfolios which will give the highest return for each level of risk.



Optimal Portfolio

- Optimal Portfolio is most preferred portfolio of all the possible options.
- Optimal portfolio varies from investor to investor because a risk averse investor will prefer a portfolio with lower risk and thus a lower return whereas a risk taking investor will prefer a portfolio with higher risk and commensurately higher return.
- Combining this concept with the Efficient frontier:
 - Optimal portfolio for each investor is the point where his indifference curve is a tangent to the Efficient Frontier.

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