# PORTFOLIO MANAGEMENT

## Calculation related to Individual Security

Holding Period Return (HPR): -

$$\text{HPR} = \frac{\text{Dividend} + \text{Change in price}}{\text{Pricie at the beginning}}$$

| **Return of a Security** | |
|---|---|
| When Past data is given | $\text{Average Return}, \overline{X} = \frac{\sum X}{n}$ |
| When probability is given | $E(X) = \sum_{i=1}^{n} P_i X_i$ |
| Under Arbitrage Pricing Theory | $E(R) = R_f + \lambda_1\beta_1 + \lambda_2\beta_2 + \lambda_3\beta_3 + \cdots \lambda_n\beta_n$<br>Where,<br>$\lambda_1, \lambda_2, \ldots \lambda_n = Average\ Risk\ premium\ for\ different\ factor$<br>$\beta_1, \beta_2, \ldots \beta_n = Sensitivity\ to\ each\ different\ factors$ |

| **Risk on Security / Standard Deviation /σ :** | |
|---|---|
| When Past data is given | $\sigma_s = \sqrt{\frac{\sum(x_i - \overline{X})^2}{n}}$ or $\sigma_s = \sqrt{\frac{\sum x_i^2}{n} - \overline{X}^2}$ |
| When probability is given | $\sigma_s = \sqrt{\sum P_i (X_i - \overline{X})^2}$ |

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| Variance of Security | $\sigma_s^2$ |
| Co-efficient of Variation (C.V): | $C.V = \frac{\sigma}{\overline{X}} \times 100$ |

| | |
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| Beta of security | $\beta_S = \dfrac{\text{Covariance between Secuirty's Return \& Market's Return}}{\text{Variance of Market Return}}$<br><br>$\beta_S = \dfrac{\text{COV(Secuity \& Market Return)}}{\sigma_m^2}$<br><br>$\text{COV(Secuity \& Market Return)} = \frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{n}$ or $= \frac{\sum x_i y_i}{n} - \bar{x}\bar{y}$<br><br>Where, x is security and y is market.<br><br>Covariance between Security's Return & Market's Return = $r_{sm} \,.\, \sigma_s \,.\, \sigma_m$ |
| | $\beta_S = r_{sm} \dfrac{\sigma_s}{\sigma_m}$ |
| Regression method | $Y = \alpha + \beta_S X$<br>Where,<br>Y is dependent variable<br>X is independent variable<br>$\alpha$ is constant<br>$\beta_S$ is beta of security<br><br>$\beta_S = \dfrac{n\sum x_i y_i - \sum x_i \times \sum y_i}{n\sum x_i^2 - (\sum x_i)^2}$ |

## Calculation related to Portfolio

| Return on Portfolio ($R_p$) | |
|---|---|
| When Past data is given | $R_p = W_x R_x + W_y R_y$ |
| When probability is given | $R_p = W_x E_x + W_y E_y$ |
| $W_x + W_y = 1$ | |

| | |
|---|---|
| Beta of Portfolio $\beta_P$ | $\beta_P = \beta_x W_x + \beta_y W_y$ |

| Risk of portfolio / Standard Deviation of Portfolio |
|---|
| $$\sigma_{xy} = \sqrt{\sigma_x^2 . w_x^2 + \sigma_y^2 . w_y^2 + 2\,\sigma_x . \sigma_y . w_x . w_y . r_{xy}}$$ $\sigma_x =$ S.D of security X<br>$\sigma_y =$ S.D of security Y<br>$w_x =$ weight of Security X<br>$w_y =$ weight of Security Y |
| Co-efficient of correlation<br>$$r = r_{xy} = \frac{\text{Covariance Between x \& y}}{\sigma_x \times \sigma_y}$$ Where,<br>Covariance Between X & Y $= \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{n}$ or $= \frac{\sum x_i y_i}{n} - \bar{x}\bar{y}$<br>$\sigma_x = \sqrt{\frac{\sum(x_i - \bar{X})^2}{n}}$ $\sigma_y = \sqrt{\frac{\sum(y_i - \bar{y})^2}{n}}$<br>$$r = \frac{n\sum x_i y_i - \sum x_i \times \sum y_i}{\sqrt{[n\sum x_i^2 - (\sum x_i)^2] \times [n\sum y_i^2 - (\sum y_i)^2]}}$$ |

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| $$\text{Coefficient of Determination} = r^2$$ This gives the percentage of variation in the security's return i.e., explained by the variation of the market index return.<br>Systematic Risk = Variance of security return × Co-efficient of determination of security<br>$$\text{Systematic Risk} = \sigma_s^2 . r^2$$ |
| $$\text{Coefficient of Non-Determination} = 1 - r^2$$ Unsystematic Risk = Variance of security return × Co-efficient of non-determination of security<br>$$\text{Unsystematic Risk} = \sigma_s^2 . (1 - r^2)$$ |

| | |
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| **Characteristic Line:** $R_S = \alpha + \beta_S X$ | |
| **Security Market Line:** Required Return $= R_f + \beta.(R_m - R_f)$ | |

| **Relationship among Systematic, Unsystematic & Total Risk** | |
|---|---|
| Systematic Risk (Uncontrolled Risk): - This risk is beyond the control of management and cannot be ignored i.e., it applies to all company in the market. E.g., Interest rate, inflation rate, taxation policy etc.<br>Unsystematic Risk (Controllable Risk): - This risk can be minimized or avoided by the management. E.g., Business Risk, Financial Risk etc. | |
| For a security | Total Risk$(\sigma_S^2)$ = Systematic Risk $(\beta_S^2 . \sigma_m^2)$ + Unsystematic Risk |
| For a portfolio of securities | Total Risk$(\sigma_P^2)$ = Systematic Risk $(\beta_P^2 . \sigma_m^2)$ + Unsystematic Risk |

| | |
|---|---|
| Standard deviation of three securities $= \sigma_{xyz}$ | $\sqrt{\sigma_x^2.w_x^2 + \sigma_y^2.w_y^2 + \sigma_z^2.w_z^2 + 2\,\sigma_x.\sigma_y.w_x.w_y.r_{xy} + 2\,\sigma_y.\sigma_z.w_y.w_z.r_{yz} + 2\,\sigma_x.\sigma_z.w_x.w_z.r_{xz}}$ |
| Standard deviation of four securities $= \sigma_{abcd}$ | $\sqrt{\sigma_a^2.w_a^2 + \sigma_b^2.w_b^2 + \sigma_c^2.w_c^2 + \sigma_d^2.w_d^2 + 2\,\sigma_a.\sigma_b.w_a.w_b.r_{ab} + 2\,\sigma_b.\sigma_c.w_b.w_c.r_{bc} + 2\,\sigma_c.\sigma_d.w_c.w_d.r_{cd} + 2\,\sigma_a.\sigma_d.w_a.w_d.r_{ad}}$ |
| Markowitz's Portfolio Variance | $\sigma_A^2.w_A^2 + \sigma_B^2.w_B^2 + \sigma_C^2.w_C^2 + 2\,w_A.w_B.\mathrm{Cov}(A,B) + 2\,w_B.w_C.\mathrm{Cov}(B,C) + 2\,w_A.w_C.\mathrm{Cov}(A,C)$ |

| **Optimum weights** | |
|---|---|
| When -1< $r_{xy}$ > +1<br>Excluding $r_{xy} = 0$ | $W_x = \dfrac{\sigma_y^2 - \mathrm{Cov}(x,y)}{\sigma_x^2 + \sigma_y^2 - 2\,.\mathrm{Cov}(x,y)}$<br>$W_y = 1 - W_x$ |
| When $r_{xy} = -1$<br>i.e., x & y are perfectly negatively correlated | $W_x = \dfrac{\sigma_y}{\sigma_x + \sigma_y}$<br>$W_y = 1 - W_x$ |

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| CAPM (Capital Asset Pricing Model) | |
|---|---|
| For Security | Expected Return E(x) = $E(x) = R_f + \beta_S(R_m - R_f)$ |
| For Portfolio | Expected Return E(x) = $E(x) = R_f + \beta_P(R_m - R_f)$ |

Note:

- ✓ Market beta is always assumed to be 1.
- ✓ Market beta is a benchmark against which we can compare beta for different securities and portfolio.
- ✓ Standard Deviation & Beta of risk-free security is assumed to be zero unless otherwise specified.

**Decision Based on CAPM**

| Case | Strategy | Decision |
|---|---|---|
| Estimated Return < CAPM Return | Sell | Overvalued |
| Estimated Return > CAPM Return | Buy | Undervalued |
| Estimated Return = CAPM Return | Ignore | Correctly Valued |

Note: Estimate return can be actual return or it can be calculated through holding period return.

**Rewards to Volatility Ratio**

| | |
|---|---|
| Sharpe's Ratio | $\text{Sharpe's Ratio} = \frac{R_s - R_f}{\sigma_p}$ |
| Treynor's Ratio | $\text{Treynor's Ratio} = \frac{R_s - R_f}{\beta_p}$ |

Where,

$$R_s = Return\ on\ Secuirty$$

$$R_f = Risk\ free\ Return$$

$$\sigma_p = Standard\ Deviation\ of\ fund$$

$$\beta_p = Beta\ of\ fund$$

| Sharpe's Optimal Portfolio | |
|---|---|
| Sharpe's Ratio | $$C_i = \frac{\sigma_y^2 \sum_{i=1}^{n} \frac{(R_i - R_f) \times \beta_i}{\sigma_{ei}^2}}{1 + \sigma_m^2 \sum_{i=1}^{n} \frac{\beta_i^2}{\sigma_{ei}^2}}$$ |

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