

Risk and Return

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Chapter Overview

- Bond returns
- Equity returns
- Portfolio returns
- Concept of risk
- Measurement of Risk
- Portfolio risk

Motivation for Investment

- An investor makes an investment to earn a return.
- The quantum of return depends on the amount of risk taken.
- If no risk is taken, then the risk-free return can only be earned.
- The motivation behind any investment is the expected return.

IRR (Yield)

An investment means cash out flow at a point of time. This investment will, in turn, provide returns by way of cash in flows in future. Internal rate of return (IRR) or yield is that discount rate which equates the present value of cash out flows with the present value of cash in flows.

$$\frac{C_1}{(1+r)}$$

IRR (Yield)

Suppose we invest an amount I at time 0 and receive cash in flows of $C_1, C_2, C_3, \dots, C_n$ at annual periods $t_1, t_2, t_3, \dots, t_n$. If r be the IRR expressed as percent per annum, then

$$I = C_1/(1+r) + C_2/(1+r)^2 + \dots + C_n/(1+r)^n$$

By solving the above equation by MS Excel, we can obtain the value of r .

IRR (Yield)-Example

Suppose we make an investment of Rs.10,000 and expect to receive Rs.300 every year for the next five years, then we can calculate the Internal rate of return (IRR) or the yield of the investment as follows.

$$10000 = 300/(1+r) + 300/(1+r)^2 + 300/(1+r)^3 + 300/(1+r)^4 + 300/(1+r)^5$$

Solving the above equation, we get $r = 15.24\%$
So, the internal rate of return (IRR) or the yield is 15.24% per annum.

Bonds

Bonds are financial instruments that are issued by a borrower to take debt on a long-term basis from lenders. Bonds are of two types –

- 1) Pure discount or Zero-coupon bonds
- 2) Coupon bonds.

Zero-coupon Bonds

- Investors in pure discount bonds receive a single payment at a specified future date.
- The single payment is the face value of the bond and the bond is sold at a price that reflects the desired yield from the bond at that point of time.

Returns from Zero-coupon Bonds

Suppose the face value of a bond is Rs.100 and is for n years and currently sold at P . Let the annual yield be r . The pricing convention is to use semiannual compounding so that the yield of this type of bond is comparable with coupon bonds that usually pay interest semi annually.

The present value of the zero-coupon bond is

$$P = 100/(1+r/2)^n$$

Returns from Zero-coupon Bonds

Suppose a two-year zero-coupon bond is selling at Rs.85, then the return from the bond can be determined as follows:

$$\text{Rs.85} = 100 / (1 + r/2)^2$$

Solving we get the yield, $r = 8.30$ per cent per annum.

Coupon Bonds

- The coupon bonds usually pay interest semiannually in addition to principal amount on maturity. The coupon rate is the annual interest rate.
- In this case we calculate the Yield to Maturity (YTM), which is the yield achieved if the bond is held till maturity.

Returns from Coupon Bonds

Suppose a 12 per cent per annum 2-year bond is selling at Rs.90. The cash flows from the bond are as follows:

<u>Time</u>	<u>Amount</u>
0.5 year	Rs.6
1 year	Rs.6
1.5 years	Rs.6
2 years	Rs.6 + Rs.100 = Rs.106

So, the present value of the bond is

$$90 = 6/(1+r) + 6/(1+r)^2 + 6/(1+r)^3 + 106/(1+r)^4$$

Solving we get the YTM, $r = 18.2\%$.

Returns from Coupon Bonds

- Often the bonds are not held till maturity and may be sold at a specified price before maturity.
- Then we can calculate the Holding period yield using the selling price.

Returns from Equity Investments

- The return from investment in equity capital of a company arises from two sources – dividends paid by the company and capital gain or loss.
- Capital gain takes place if investor can sell equity shares at a price greater than buying price.
- Capital loss is incurred if selling price is lower than buying price.
- Total return = Dividend income + Capital gain (or loss)

Returns from Equity Investments

Suppose an investor buys the equity shares of a company at Rs.90 each (the face value of the equity shares is Rs.10). The company pays 20 per cent dividend and the investor sells the shares at Rs.97 each at the end of one year. Then the total return is

$$\begin{aligned}\text{Total return} &= \text{Dividend income} + \text{Capital gain} \\ &= 0.2 \times \text{Rs.10} + \text{Rs.}(97 - 90) \\ &= \text{Rs.9}\end{aligned}$$

Returns from Equity Investments

The dividend yield is calculated as:

$$\text{Dividend yield} = D(t+1) / P_t$$

where P_t is the buying price of equity shares at time t and $D(t+1)$ is the amount of dividend to be received in the next year.

Returns from Equity Investments

The capital gains yield is calculated as:

$$\text{Capital gains yield} = [P(t+1) - P_t] / P_t$$

The total yield in percentage is the sum of the dividend yield and the capital gains yield. This can be expressed as:

$$\text{Yield} = [\text{Dividend} + (\text{Selling Price} - \text{Buying Price})] / \text{Buying Price}$$

$$\sum_{i=1}^n \frac{D_i}{(1+r)^i} + \frac{P_n}{(1+r)^n}$$

Returns from Equity Investments

- If equity shares are held for more than one year, then the yield or the IRR is calculated.
- Suppose P_0 is the current buying price (time t_0), $D_1, D_2, \dots, D_n$ are the dividends received at times $t = 1, 2, \dots, n$ years and P_n is the selling price of the shares at the end of n years.
- The present values of the investment and returns can be equated as follows:
- $P_0 = D_1/(1+r) + \dots + D_n/(1+r)^n + P_n/(1+r)^n$
- Solving the equation, we can calculate r , which is the yield from the equity investment.

Portfolio Returns

- A portfolio of assets implies that the investor has invested in more than one stock, bond or other assets.
- The expected return on a portfolio of investments is the weighted combination of expected returns on individual assets. The portfolio weights are the percentages of total portfolio value invested in each of the assets in the portfolio.

- This can be expressed as

$$E(R_p) = \omega_1 * E(R_1) + \omega_2 * E(R_2) + \dots + \omega_n * E(R_n)$$

where $E(R_p)$ is the expected return from the portfolio of assets and $E(R_i)$ represents the expected return from the i th asset and ω_i is the weight of the i th asset in the portfolio.

Portfolio Returns

Suppose an investor invests Rs.50,000 in a equity and expects to earn a return of 15 per cent over a particular period, and invests Rs.150,000 in a bond and expects to earn a return of 10 per cent over the same period. Then the portfolio weights are calculated as follows.

$$\begin{aligned}\text{Value of the portfolio} &= \text{Rs.50,000} + \text{Rs.150,000} \\ &= \text{Rs.200,000}\end{aligned}$$

$$\text{Portfolio weight of the investment in equity} = 0.25$$

$$\text{Portfolio weight of the investment in bonds} = 0.75$$

$$\begin{aligned}\text{Expected Portfolio return} &= 0.25 \times 0.15 + 0.75 \times 0.10 \\ &= 11.25 \text{ per cent}\end{aligned}$$

Concept of Risk

The term risk means uncertainty of outcome.

For example, the investment in shares is risky meaning that there is no certainty about the actual return or there is no fixed return or the return is not perfectly predictable.

Concept of Risk

Why does the actual return in shares differ from the expected return? This is because the company performs better or worse than expected. Why does that happen?

There could be many reasons like:

- 1) RBI and banks reduce the interest rates.
- 2) There was Kargil war and the Government levied a new surcharge on corporate income tax.
- 3) GDP of India grew by 8 per cent (much higher than expected).
- 4) Ten working days were lost by labor strikes.
- 5) The company's products sold much better than expected.
- 6) The CEO of the Company was changed.

Concept of Risk

We observe that there are various sources of risk - some are known and some may be unknown. Some of the above events like the ones numbered (1) to (3), affect all the companies in India while the events numbered (4) to (6) affect only the specific company.

These two types of events have different implications on the performance of companies. The risk in return due to the first type of events is called the **systematic risk** and the risk in return due to the second type of events is known as the **unsystematic risk**.

Systematic and Unsystematic Risks

➤ Systematic Risk

This refers to that portion of total variability in return caused by factors affecting the prices of all securities.

➤ Unsystematic Risk

Unsystematic risk is that portion of total risk that is specific to a company.

Systematic and Unsystematic Risks

- Unsystematic risk can be of two types – business risk and financial risk.
- Business risk refers to uncertainties in the operating environment of the business like efficiencies in producing and selling activities, business cycle, additional pollution control measures etc.
- Financial risk refers to risks in the financing of the company. It is due to debt financing. A company with no debt does not have any financial risk. The risks in debt financing are that the cost of debts may increase or the company may be wound up if the interest is not paid or the principal amount is not repaid in time.

Measurement of Risk

- Risk is the possibility that actual return will deviate from expected return. More the deviation, more is the risk.
- So, the measurement of deviation of actual return from expected return can be the measurement of risk.
- If there are many possibilities of actual return, then the variance or the standard deviation of possible returns can be a measure of the risk

Measurement of Risk

Suppose an investor has invested in the equity shares of a company for one year and expects the following returns from the investment under different assumptions about the state of the economy and the company. He or she has also estimated the probability of those returns as shown below.

Possible Return	Probability
25	10 %
20	20 %
15	40 %
10	20 %
5	10 %

Measurement of Risk

- The expected return = $0.25 \times 0.10 + 0.20 \times 0.20 + 0.15 \times 0.40 + 0.10 \times 0.20 + 0.05 \times 0.10 = 15\%$
- The variance, $\sigma^2 = (0.25 - 0.15)^2 \times 0.10 + (0.20 - 0.15)^2 \times 0.20 + (0.15 - 0.15)^2 \times 0.40 + (0.10 - 0.15)^2 \times 0.20 + (0.05 - 0.15)^2 \times 0.10 = 0.0022$
- The standard deviation, $\sigma = 4.69 \%$

Diversification and Portfolio Risk

- Diversification implies that an investor has invested in more than one security or asset.
- He has built a portfolio of assets.
- He can create a portfolio of a number of equity shares or bonds or equity shares and bonds or a combination of many assets including shares, bonds, real estate etc.

Diversification and Portfolio Risk

- The benefit of diversification is that the variance of a portfolio of randomly selected two stocks is less than the variance of randomly selected one stock.
- As we increase the number of randomly selected stocks in the portfolio, the portfolio variance decreases. This is the main benefit of diversification.

Diversification and Portfolio Risk

It is observed that as we keep on increasing the number of securities in the portfolio, the portfolio variance almost stops declining beyond a specified number of securities and **also, the rate of decline of the portfolio variance reduces as the number of securities in the portfolio increases.**

Diversification and Portfolio Risk

- A relatively large portfolio essentially eliminates all the unsystematic risk and retains only the systematic risk.
- The investor of a diversified portfolio has to cope with the systematic risk and earns risk premium for retaining that amount of risk.

Capital Asset Pricing Model (CAPM)

According to the CAPM, there is a linear relationship between the risk premium of an asset and the risk premium of market. This can be expressed in the form of an equation as:

$$(R_s - R_f) = \beta_s (R_m - R_f)$$

$$\sigma_p^2 = \sum_{j=1}^n \sum_{i=1}^n \omega_i \omega_j P_{ij} \sigma_i \sigma_j$$

Capital Asset Pricing Model (CAPM)

R_s = Expected rate of return of the security

R_m = Expected rate of return of the market

R_f = Risk free rate of return

β_s = Beta coefficient of the security.

Security Market Line (SML)

CAPM can be expressed as:

$$R_s = R_f + \beta_s (R_m - R_f)$$

This line represented by the above equation is called the Security Market Line (SML).

Security Market Line (SML)



Calculation of β of a security

$$\beta_s = \text{Cov}(s,m) / \sigma_m^2 = \rho(s,m) * \sigma_s / \sigma_m$$

β_s = beta of the security

σ_s = standard deviation of return of the security

σ_m = standard derivation of return of the market

$\rho(s,m)$ = coefficient of correlation between
returns of the security and the market

$\text{Cov}(s,m)$ = co-variance of returns of the security
and the market

Portfolio Beta

The portfolio beta is the weighted average of the betas of the individual securities.

$$\beta_p = \sum \omega_i * \beta_i \quad \text{over all "n" securities.}$$

Portfolio Beta

β_p = portfolio beta

n = number of securities in the portfolio

ω_i = the percent of the value of total portfolio invested in security i

β_i = betas of the individual securities
[$i = 1, 2, \dots, n$]

Portfolio Beta

Suppose a portfolio contains two stocks with beta of 0.8 and 1.4. The total value of the portfolio is Rs.100,000 and the investments in the two securities are 40 per cent and 60 per cent respectively.

$$\omega_1 = 0.4, \omega_2 = 0.6, n = 2,$$

$$\beta_1 = 0.8 \text{ and } \beta_2 = 1.4$$

$$\text{Portfolio beta, } \beta_p = \omega_1 \beta_1 + \omega_2 \beta_2$$

$$= 0.4 \times 0.8 + 0.6 \times 1.4 = 1.16$$

Multiple Choice Question-1

A diversified portfolio has three stocks and two bonds in the proportion of 25 per cent, 15 per cent, 20 per cent, 25 per cent and 15 per cent respectively. The annualized returns on the securities are 20 per cent, 22 per cent, 16 per cent, 12 per cent and 11 per cent respectively. What is the return on the portfolio?

- a) 15.20 %
- b) 16.15 %
- c) 13.10 %

Multiple Choice Question-1

Ans. (b)

Solution:

The portfolio return

$$\begin{aligned} &= 0.25 \times 0.20 + 0.15 \times 0.22 + 0.20 \times 0.16 \\ &+ 0.25 \times 0.12 + 0.15 \times 0.11 \\ &= 16.15 \% \end{aligned}$$

Multiple Choice Question-2

You want to spread investment risks on two stocks. In which of the following cases there will be largest reduction in risk?

- a) The shares are perfectly negatively correlated
- b) The shares are perfectly positively correlated
- c) The shares are not all correlated.

Multiple Choice Question-2

Ans. (a)

Solution:

If the shares have negative coefficient of correlation, the combined variance will be least.

Multiple Choice Question-3

Which of the following investments is likely to provide the highest return?

- a) Investment in 91-day Treasury bills
- b) Investment in a AAA rated Municipal bond
- c) Investment in a AA rated corporate bond

Multiple Choice Question-3

Ans. (c)

Solution:

The AA rated corporate bond will be most risky.

So, the risk premium will be the highest.

Multiple Choice Question-4

A company's beta has doubled. Will the return on investment in the equity of that company double?

- a) Yes
- b) No

Multiple Choice Question-4

Ans. (b)

Solution:

If β doubles, then risk premium (= return – risk free rate) will double. The return will not double.

Multiple Choice Question-5

The risk-free rate is 8 %. The expected risk premium on a stock index portfolio is 6 %.

Which stock out of the following is over-valued?

	<u>Expected Return</u>	<u>Beta</u>
a) Stock A -	16.2 %	1.2
b) Stock B -	12.4 %	0.9
c) Stock C -	16.4 %	1.4

Multiple Choice Question-5

Ans. (b)

Solution : As per the CAPM,

Executed return in Stock A = $8 \% + 1.2 * 6 \% = 15.2 \%$

Expected return in Stock B = $8 \% + 0.9 * 6 \% = 13.4 \%$

Expected return in Stock C = $8 \% + 1.4 * 6 \% = 16.4 \%$

So, Stock A is under valued,

Stock B is over valued,

Stock C is correctly priced