CALCULATION OF YTM

MEANING OF BOND

It is a financial instrument whereby the **issuer of the bond raises capital or funds at a certain cost for a certain time period** and **pays back the principal amount on maturity of the bond**.

TERMS ASSOCIATED WITH BONDS

FACE VALUE : It signifies the **predetermined nominal amount of a bond**. It indicates the **sum that the issuer commits to repay** to the bondholder upon reaching maturity.

COUPON RATE: It refers to the **interest rate paid on a bond**, expressed as a percentage of the bond's face value.

MATURITY : It is the date when the bond's **principal amount becomes due and payable to the bondholder**.

REDEMPTION VALUE: It is the amount that the issuer of a **bond agrees to repay to the bondholder** when the bond reaches its maturity date.

MARKET VALUE : The market value of a bond is the price at which it is **commonly bought or sold in the market.**

DIFFERENT TYPES OF BONDS

FIXED-RATE BONDS

When the **coupon rate on a bond remains the same** through the course of the investment, it is called Fixed-rate bonds.

FLOATING RATE BONDS

When the **coupon rate on a bond keeps fluctuating** during the course of an investment, it is called a floating rate bond.

ZERO-COUPON BONDS

- These are a type of bond that does **not pay periodic interest or coupon payments to the bondholder**.
- They are issued at a **discounted price below their face value** and provide a **return to investors** through the difference between the purchase price and the redemption value at maturity.

PUTTABLE BOND

When the **investor has a right to sell their bond** and get their money back **before the maturity date**, such type of bond is called a Puttable bond.

CALLABLE BOND

When the **issuer of the bond** calls out his right to **redeem the bond even before it reaches its maturity** is called a Callable Bond.

PERPETUAL BONDS

A perpetual bond is a bond with **no maturity date that is not redeemable** but pays a steady stream of interest forever.

BEARER BOND

A bearer bond is an **official certificate** that is issued **without a designated holder**. This means that whoever possesses the physical paper certificate can claim ownership and receive the value of the bond.

VALUATION OF BONDS

- Bond valuation is the process of determining **the fair price, or value, of a bond.**
- Bond valuation involves calculating the **present value of a bond's future interest payments—as well as its face value** which refers to the bond's value once it matures.

$$\text{Value of Bond} = C\ X\ \frac{1-\frac{1}{(1+i)^n}}{i} + \frac{M}{(1+i)^n}$$

- C= Coupon payment
- i =The rate of return demanded by investors
- n = Number of payments until maturity

Que: A bond, whose par value is Rs 1,0000, bears a coupon rate of 12 per cent and has a maturity period of 3 years. The required rate of return on the bond is 10 per cent. **What is the value of this bond?**

Solution

- C= 1200
- i =10 %=0.10
- n = 3 years

Method 1

Value of Bond=$C\ X\ \frac{1-\frac{1}{(1+i)^n}}{i}+\frac{M}{(1+i)^n}$

Method 2

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond= 1200 X PVIFA (10%, 3) +10000 X PVIF (10%,3)

Value of Bond= 1200 X 2.486+10000X 0.751 =2983+7510=10492

No. of years	Payments(X)	PVIF $1/(1+i)^n$ (Y)			P .V(X*Y)
1	1200	$\frac{1}{(1+0.10)^1}$	$\frac{1}{1.10}$	0.909	1090
2	1200	$\frac{1}{(1+0.10)^2}$	$\frac{1}{1.21}$	0.826	991
3	1200+10000	$\frac{1}{(1+0.10)^3}$	$\frac{1}{1.33}$	0.751	8411
Total	13600		PVIFA	2.486	10492

CALCULATION OF VALUE WITH SEMI-ANNUAL INTEREST

A bond, whose par value is 100000, bears a coupon rate of 10 per cent per annum payable semi-annually and has a maturity

period of 4 years. The required rate of return on bond is 8 per cent per annum . What is the value of this bond?

Solution

Method 1

Value of Bond=$C\ X\ \frac{1-\frac{1}{(1+i)^n}}{i}+\frac{M}{(1+i)^n}$,

YIELD

A bond's yield represents the **return an investor can expect to receive from holding the bond.**

CURRENT YIELD ON BOND

It measures the **rate of return earned on a bond** if it is **purchased at its current market price** and if the coupon interest is received on face value.

$$\textbf{Current yield} = \frac{\text{Coupon interest}}{\text{current market price}} \times 100$$

Ex: If a bond of face value ₹10000, carrying a coupon interest rate of 10 per cent, is quoted in the market **at Rs 12,000, then the current yield of the bond is?**

Solution

$$\textbf{Current yield} = \frac{\text{Coupon interest}}{\text{current market price}} \times 100,$$

YIELD-TO-MATURITY OF BOND

- It **is rate of return earned by the investor** who **purchases a bond and holds it till maturity.**
- YTM is the **discount rate or rate of return**, which **equals the present value of cash flows** to the current price/ purchase price.

Ex: Consider a 10000-par value bond, whose current market price is Rs 9000 and coupon rate of 10 per cent and has a maturity period of 10 years. What would be the rate of return that an investor earns if he purchases the bond and holds it until maturity?

$$YTM = \frac{Annual\ interest + \frac{Redemable\ value - purchase\ price}{Life\ of\ bond}}{\frac{Redemable\ value + purchase\ price}{2}} X100$$

Theorems of Bond Value

1. When the required rate of return is equal to the coupon rate, the value of the bond is equal to its par value.

Que: XYZ ltd company purchased 4-year bond with face value of Rs 1000, coupon 12% and required rate of return 12%. Calculate the present value of the bond.

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond = 12(PVIFA, 12%, 4) + 1000(PVIF, 12%, 4)

Value of Bond= 120 X 3.0373+1000X 0.6355, =365+635= 1000

2. When the required rate of return (kd) is greater than the coupon rate, the value of the bond is less than its par value.

Que: XYZ ltd company purchased 3-year bond with face value of Rs 1000, coupon 9% and required rate of return 11%. Calculate the present value of the bond.

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond = 90 (PVIFA, 11%, 3) + 1000(PVIF, 11%, 3)

Value of Bond= 90 X 2.4437+1000X 0.7311, =220+731= 951

3. When the required rate of return is less than the coupon rate, the value of the bond is greater than its par value.

Que: XYZ ltd company purchased 3-year bond with face value of Rs 1000, coupon 12% and required rate of return 9%. Calculate the present value of the bond.

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond = 120(PVIFA, 9%, 3) + 1000(PVIF, 9%, 3)

Value of Bond= 120 X 2.531+1000X 0.772, =303+772= 1075

4. When the required rate of return (kd) is greater than the coupon rate, the discount on the bond declines as maturity approaches.

Que: XYZ ltd company purchased a 3-year bond with a face value of Rs 1000, coupon 10% and required rate of return 12%. Calculate the present value of the bond and also calculate the PV of bond after 1 year.

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond = 100(PVIFA, 12%, 3) + 1000(PVIF, 12%, 3)

Value of Bond = 100(2.401) + 1000(0.711) =240 + 711 = 951

Value of Bond After 1 year

Value of Bond = 100(PVIFA, 12%, 2) + 1000(PVIF, 12%, 2)

Value of Bond = 100(1.690) + 1000(0.797) = 169 + 797 = 966

5. When the required rate of return (kd) is less than the coupon rate, the premium on the bond declines as maturity approaches.

Que: XYZ ltd purchased 3-year bond with face value of Rs 1000, coupon 10% and required rate of return 8%. Calculate the present value of the bond and also calculate the PV of bond after 1 year.

Que: XYZ ltd purchased 3-year bond with face value of Rs 1000, coupon 10% and required rate of return 8%. Calculate the

present value of the bond and also calculate the PV of bond after 1 year.

Value of Bond= Annual Interest X PVIFA (YTM, n) +F X PVIF (YTM, n)

Value of Bond = 100(PVIFA, 8%, 3) + 1000(PVIF, 8%, 3)

Value of Bond = 100(2.577) + 1000(0.793), =258+ 793 = 1051

Value of Bond After 1 year

Value of Bond = 100(PVIFA, 8%, 2) + 1000(PVIF, 8%, 2)

Value of Bond = 100(1.783) + 1000(0.857), = 178 + 857 = 1035

6. A bond price is inversely related to its yield to maturity.

Example

Suppose there is a bond with a **face value of Rs 1,000**, a **coupon rate of 5%,** and a **maturity of 5 years**. The bond pays annual coupon payments, and the prevailing **market interest rate is 5%.**

When the market **interest rate is equal to the coupon rate (5%),** the bond is said to be **trading at par**, meaning its **price is equal to its face value (Rs 1,000)**. In this case, the bond's yield to **maturity (YTM) is also 5%,**

If the Yield to Maturity Decreases

Suppose the prevailing **interest rate decreases to 3%.** As a result, the bond's yield to **maturity decreases below its coupon rate of 5%.** In this scenario, the bond **becomes more attractive to investors** because it offers a higher coupon payment compared to the prevailing interest rate.

Bond prices will increase. Investors are **willing to pay a premium to purchase the bond**, driving its price above face value.

If the Yield to Maturity Increases

Now, consider the opposite scenario where the **prevailing interest rate increases to 6%.** In this case, the bond's **yield to maturity would increase** above **its coupon rate of 5%.** The bond becomes **less attractive to investors** as the **coupon payment is lower than the prevailing interest rate.**

To make the bond more attractive at the higher yield, its **price will decrease**. Investors are willing to **pay less for the bond,** resulting in a price below the face value.

DURATION OF BOND

- Since Macaulay was the one who first suggested the idea**, it is known as the Macaulay Duration.**
- **Bond duration is the length of time** it takes for an **investor to receive their money back from a bond investment**.

$$Duration = \frac{\Sigma pvT}{\Sigma pv}$$

PROPERTIES

- The **duration of a bond** is typically **shorter than its term to maturity**.
- The **duration of a bond equals its term to maturity** only in the case of a **zero-coupon bond.**
- There is an **inverse relationship** between the **lifetime (or term to maturity)** and the **Yield to Maturity (YTM) of a bond**.
- Increasing the **coupon frequency** reduces the duration, while decreasing the coupon frequency increases the duration.
- As a bond approaches its maturity date, its duration decreases.

Que: Bank ABC held a bond with a face value of Rs 10000, coupon rate 8% payable yearly and maturity after 5 years and YTM is 6%. Calculate the Duration of the bond.

A	Cash inflow	Present value factor	Present value of cash inflow	Present value X Time

		$1/(1+r)^n$	(P.V.F X cash inflow)	
1	800	0.9433	754	754
2	800	0.8899	711	1422
3	800	0.8395	671	2013
4	800	0.7919	633	2532
5	10800	0.7470	8067	40335
			10836	**47056**

$$\boldsymbol{Duration = \frac{\Sigma pvT}{\Sigma pv} = \frac{47056}{10836}}$$ **=4.53 years**

MODIFIED DURATION

It refers to **its sensitivity to changes in interest rates**, considering both the bond's Macaulay duration and its yield to maturity.

$$\boldsymbol{Modified\ duration = \frac{Duration}{1 + r}}$$

Que: Bank ABC held a bond with face value of Rs 10000, coupon rate 8% payable yearly and maturity after 5 years and YTM is 6%. Calculate the Duration of the bond.

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			10836	**47056**

$$Duration = \frac{\Sigma pvT}{\Sigma pv} = \frac{47056}{10836} = 4.53 \text{ years}$$

$$Modified\ duration = \frac{Duration}{1 + r} = \frac{4.53}{1.06} = 4.27$$

BOND PRICE VOLATILITY

- It refers to the **degree of fluctuation or variation** in the **price of a bond** in response to changes in **market conditions, particularly interest rates**.
- **High volatility** indicates that the **bond's price is more sensitive to interest rate movements**, while low volatility suggests a relatively stable bond price.

$$IE = \frac{\%\ \text{change in price for bond in period t}}{\%\ \text{change in yield to maturity for bond}}$$

Que: Bank XYZ has a 10%, 8-year bond with par value of Rs 1000. The market rate changes from 10% to 12%. Calculate the interest rate elasticity of the bond.

Value of Bond= 100 (PVIFA, 10%, 8) + 1000 (PVIF, 10%, 8) =1000

Value of Bond= 100 (PVIFA, 12%, 8) + 1000 (PVIF, 12%, 8)

Value of Bond= 100 (4.96) + 1000 (0.40) =496+400=896

Change in price=1000-896=104, $= \frac{104}{1000} X100 = 10.4\%$

IE=$\frac{\textbf{\% change in price for bond in period t}}{\textbf{\% change in yield to maturity for bond}}, = \frac{10.4\%}{2\%} = 5.2\ \%$

Explanation

In this case, the Interest Elasticity is 5.2%. This means that for every 1% change in the bond's yield to maturity, the bond's price would be expected to change by approximately 5.2%.

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