Calculation of YTM

MEANING OF DEBT

- **Debt** means a sum of money due by one party to another. Most businesses need a mix of debt and equity to run their operations. This is called the capital structure of that firm/ company.
- **Debt capital consists of mainly bonds and debentures**.
- **The holder of debt capital does not receive a share of ownership** of the company when they provide funds to the firm but he becomes a creditor to the firm.
- In return for loaning this money, bondholders have a right to certain guaranteed payments during the life of the bond.

TERMS ASSOCIATED WITH BONDS

Face Value: Also known as the par value and stated on the face of the bond. It represents the amount borrowed by the firm, which it promises to repay after a specified period.

Coupon rate: A bond carries a specific rate of interest, which is also called as the coupon rate.

Maturity: A bond is issued for a specified period. It is to be repaid on maturity.

Redemption Value: The value, which the bondholder gets on maturity, is called the redemption value. A bond is generally issued at a discount (less than par value) and redeemed at par.

Market Value: A bond may be traded on a stock exchange. Market value is the price at which the bond is usually bought or sold in the market. Market value may be different from the par value or the redemption value.

TYPES OF BONDS

Fixed rate bonds have a coupon that remains constant throughout the life of the bond

Floating rate notes (FRNS, floaters) have a variable coupon that is linked to a reference rate of interest, such as LIBOR

Zero-coupon bonds pay no regular interest. They are issued at a discount to par value. The bondholder receives the full principal amount on the redemption date.

High-yield bonds (also called junk bonds ) are bonds that are rated below investment grade by the credit rating agencies. As these bonds are riskier than investment grade bonds, investors expect to earn a higher yield.

Convertible bonds give option to the bondholder to exchange a bond to a number of shares of the issuer's common stock.

Inflation-indexed bonds in which the principal amount and the interest payments are indexed to inflation.

Asset backed securities are bonds whose interest and principal payments are backed by underlying cash flows from other assets.

Subordinated bonds are those that have a lower priority than other bonds of the issuer in case of liquidation

Perpetual bonds are also often called perpetuities or 'Perps' or ‘console bonds’. They have no maturity date.

Bearer bond is an official certificate issued without a named holder. In other words, **the person who has the paper certificate can claim the value of the bond**. Often, they are registered by a number to prevent counterfeiting, but may be traded like cash. Bearer bonds are very risky because they can be lost or stolen.

Government bond, also called Treasury bond, is issued by a national government and is not exposed to default risk

VALUATION OF BONDS

the value of any security can be defined as the present value of these future cash flows.

There are two types of payments in general to the bond holder i.e. coupon (regular payment of the interest) and receives the face value on the maturity of the bond.

Therefore, the intrinsic value or the present value of a bond is

$$V = \frac{F}{(1+kd)^n} + \sum_{t=1}^{n} \frac{I}{(1+kd)^t}$$

where, V Intrinsic value of the bond
I = Annual Interest payable on the bond
F = Redeemable value of the bond
n = Maturity period of the bond
kd = Cost of Capital

Que: A bond, whose par value is Rs 1,000, 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?**

CALCULATION OF VALUE WITH SEMI-ANNUAL INTEREST

A bond, whose par value is 10000, bears a coupon rate of 10 per cent payable semi-annually and has a maturity period of 3 years. The required rate of return on bond is 8 per cent. What is the value of this 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.

Current yield = Coupon interest/current market price

Ex: If a bond of face value ₹10000, carrying a coupon interest rate of 8 per cent, is quoted in the market at Rs 9,000, then the current yield of the bond is?

Rate of Return

The rate of return takes into account the capital gain or loss along with the coupon earned.

Ex: if A bought a Rs 1000, 6%, 5-year bond at Rs 1020 and after one year sold it for Rs 1040.

Then, rate of return will be (coupon income + capital gain/ Loss)/ Purchase Price or investment = (60 + (1040-1020))/ 1020 = 80/1020 = 7.84%

Whereas CY will be 60/1020 = 5.88%

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 market price/ purchase price.

Ex: Consider a 1000 par value bond, whose current market price is Rs 850 and coupon rate of 8 per cent and has the maturity period of 9 years. What would be the rate of return that an investor earns if he purchases the bond and holds until maturity?

Solution

If kd is the yield to maturity then,

Current Market Price = Coupon (PVIFA, kd%, t) + FV (PVIF, kd%, t)

850 = 80 (PVIFA, kd%, 9 yrs) + 1000 (PVIF, kd%, 9 yrs)

To calculate the value of kd, we will assume two values of YTM 12% & 10%:

= 80 (PVIFA, 12%, 9) + 1,000 (PVIF,12%, 9)

= 80 x 5.328 + 1,000 x (0.361)

= 426.26 + 361 = **787.26**

At kd% = 10% the present value of the bond will be

= 80 (PVIFA, 10%, 9) + 1,000 (PVIF, 10%, 9)

= 80 x 5.759 + 1000 x 0.424

= 884.72

kd = Lower DR + Difference B/w 2 DRs x (PV of Lower DR - CMP)/Absolute Diff b/w PV

DR→ Discount Rate, CMP → current market value

= 10 + (12 - 10) x (884.72 - 850)/ (884.72 – 787.26)

= 10 + 2 x 34.72/97.46

= 10 + 2 x 0.356 = 10 + 0.712 = 10.71%

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: Bank purchased 4-year bond with face value of Rs 100, coupon 12% and required rate of return 12%. Calculate the present value of the bond.

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: Bank purchased 3-year bond with face value of Rs 100, coupon 9% and required rate of return 11%. Calculate the present value of the bond.

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: Bank purchased 3-year bond with face value of Rs 100, coupon 12% and required rate of return 9%. Calculate the present value of the bond.

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

Que: Bank purchased 3-year bond with face value of Rs 100, 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.

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

Que: Bank purchased 3-year bond with face value of Rs 100, 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.

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

➔ ROR > Coupon Rate →Value of bond < Par Value

➔ ROR < Coupon Rate →Value of bond > Par Value

7. For a given difference between YTM and coupon rate of the bonds, the longer the term to maturity, the greater will be the change in price with a change in YTM, It is because, in the case of long maturity bonds, a change in YTM is cumulatively applied to the entire series of coupon payments and the principal payment is discounted at the new rate for the entire number of years to maturity.

Que: Bank has two bonds having face value of Rs 100 and coupon of 12%. Residual maturity is 4 years and 6 years. If YTM is increased by 1%, what will be the change in the price of these bonds?

8. Given the maturity, the change in bond price will be greater, with a decrease 📉 in the bond's YTM than the change in bond price with an equal increase 📈 in the bond's YTM. That is, for equal sized increases and decreases in the YTM, price movements are not symmetrical.

Que: Bank purchased 3-year bond with face value of Rs 100, coupon 10% and if there is 1% change in the YTM i.e. 1% increase or decrease in YTM in reference to coupon rate. Calculate the increase or decrease in the value of the YTM.

9. For any given change in YTM, the percentage% price changes.

In case of bonds of a high coupon rate change will be smaller than in the case of bonds of a low coupon rate, other things remaining the same.

Que: Bank has two bonds having face value of Rs 100 and coupon of 12% and 10%. Residual maturity is 3 years. If YTM is increased by 1%, what will be the change in the price of these bonds? Assume YTM to be 12%

Bond A – with coupon of 12%

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

= 12 x 2.40 + 100 x 0.712 = 100

Bond B – with coupon of 10%

Value of B = 10(PVIFA, 12%, 3) + 100(PVIF, 12%, 3)

= 10 x 2.40 + 100 x 0.712 = 95.2

Value of Bond on change of YTM to 13%

Bond A – with coupon of 12%, ROR = 13%

Value of A = 12(PVIFA, 13%, 3) + 100(PVIF, 13%, 3)

= 12 x 2.36 + 100 x 0.693 = 97.62 (change in price is 100-97.62/100 %= 2.38%)

Bond B – with coupon of 10%, ROR = 13%

Value of B = 10(PVIFA, 13%, 3) + 100(PVIF, 13%, 3)

= 10 x 2.36 + 100 x 0.693 = 92.90 (change in price is 95.2-92.90/95.2 %= 2.42%)

10. A %change in the YTM affects the bonds with a higher YTM more than it does bonds with a lower YTM.

Que: Bank has two bonds, one having face value of Rs 100 and coupon of 12% and its rate of return is 10% and other bond with par value of Rs 100 coupon rate is 12% and rate of return is 15%. Both bonds have maturity of 5 years. It there is increase in rate of return by 20% in value in both bonds. Calculate the market value.

Position before increase in YTM:

Value of Bond 1 = 12(PVIFA, 10%, 5) + 100(PVIF, 10%, 5)

=12 x 3.79 + 100 x 0.621 = 107.58

Value of Bond 2 = 12(PVIFA, 15%, 5) + 100(PVIF, 15%, 5)

=12 x 3.352 + 100 x 0.497 = 89.92

Position after increase in YTM:

Value of Bond 1 @YTM 12% = 12(PVIFA, 12%, 5) + 100(PVIF, 12%, 5)

=12 x 3.604 + 100 x 0.567 = 100

Value of Bond 2 @YTM 18% = 12(PVIFA, 18%, 5) + 100(PVIF, 18%, 5)

=12 x 3.127 + 100 x 0.437 = 81.22

%change Bond 1 = (107.58 – 100 /107.58 = 7.04 %)

%change Bond 2 = (89.92 – 81.22 /89.92 = 9.67 %)

DURATION OF BOND

- All the aspects of valuation of bonds, the underlying assumption is that the **periodic interest is reinvested at the rate prevailing in the market**.
- When the interest rate in the market increases, the market price of the bond comes down but the holder of the bond gains on the reinvestment of his periodic interest receipts and vice versa.
- Duration is that holding period at the end of which the holder of the bond is not affected by the interest rate risk. Duration is expressed in years.

The concept was first introduced by Macaulay and thus, is called by his name as the Macaulay Duration.

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

PROPERTIES

a) Duration is **less than the term to maturity**
b) Bond's duration will be equal to its term to maturity if and only if it is a **zero-coupon bond**
c) The **duration of perpetual bond** is equal to (1 + r) /r, where r= current yield of the bond
d) Duration and YTM are inversely related
e) **Larger the coupon rate**, smaller the duration of a bond
f) **An increase in the frequency of coupon payments** decreases the duration, while a decrease in frequency of coupons increases it.
g) **Duration of a bond declines** as the bond approaches maturity.

Que: Bank ABC held a bond with face value of Rs 100, coupon rate 8% payable half-yearly and maturity after 3 years and YTM is 6%. Calculate the Duration of the bond.

A	B. Cash flow	C. Present value factor	D. CF x PVF	A x D
1	8	0.94	7.55	7.55
2	8	0.89	7.12	14.24
3	8	0.84	6.72	20.15

4	8	0.79	6.34	25.35
5	108	0.75	80.70	403.52
			108.42	**470.80**

Duration = 470.80/ 108.42 = 4.34 years

Modified Duration = duration/ (1 + r)

r = YTM/n, n is number of compounding periods in a year

= 4.34/ (1 + 0.06/1) = 4.34/ (1.06) = 4.094 years

%change in Value of the Bond if duration is given

= MD x numerical change in the stated yield

BOND PRICE VOLATILITY

- The sensitivity of the bond price to changes in the interest rates is called 'Bond Volatility'.
- Bond prices and YTM are inversely related.
- The extent of change in the bond prices for a change in YTM measures the interest rate risk of a bond, the interest rate risk is a function of the interest rate elasticity. Interest rate elasticity (IE) can be defined as:

IE = % change in price for bond in period t / % change in yield to maturity for bond

- Interest rate elasticity is **always a negative number**, due to the inverse relationship between YTM and bond prices.

- Bond price elasticity can also be computed with the help of following mathematical formula:

IE=D x YTM/(1 + YTM)

- The duration and interest rate elasticity of a bond are directly related.

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 the bond after change in ROR will be:

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

= 100 x 4.968 + 1000 x 0.404 = 900.76

IE = % change in price for bond in period t / % change in yield to maturity for bond

= (1000 – 900.76/1000 x 100)/ (10 – 12)

= -9.924/2 = -4.962%