equaliFi ACADEMY

CTM

CERTIFICATE IN INTEGRATED TREASURY MANAGEMENT

Session 4- Fixed Income Portfolio Management

Bond Valuation

❑ OUTLINE

- Definition of Bond and Bond valuation
- Features of Bond
- Types of Bonds
- Reasons for Issuing Bonds
- Risk in Bonds
- Measuring Bond Yield
- Bond pricing theorems

Definition of 'Bond’

- A debt investment in which an investor loans money to an entity (corporate or governmental) that borrows the funds for a defined period of time at a fixed interest rate.

- Bonds are used by companies, municipalities, states and foreign governments to finance a variety of projects and activities.

Definition of 'Bond Valuation'

A technique for determining the fair value of a particular bond. Bond valuation includes calculating the present value of the bond's future interest payments, also known as its cash flow, and the bond's value upon maturity, also known as its face value or par value.

Definitions

- Par or Face Value –
- The amount of money that is paid to the bondholders at maturity. For most bonds this amount is $1,000. It also generally represents the amount of money borrowed by the bond issuer.
- Coupon Rate –
- The coupon rate, which is generally fixed, determines the periodic coupon or interest payments. It is expressed as a percentage of the bond's face value. It also represents the interest cost of the bond to the issue

FEATURES OF BONDS

- A Sealed agreement
- Repayment of principles
- Specified time period
- Interest payment
- Call

TYPES OF BONDS

- Government Bonds
- Municipal Bonds
- Corporate Bonds
- Zero-Coupon Bonds

REASONS FOR ISSUING BOND

- Reduce the cost of capital
- Effective Tax saving
- Widen the sources of funds
- Preserve and control

RISK IN BONDS

- Interest rate risk
- Default risk
- Marketability Risk
- Callability Risk
- Reinvestment Risk

MEASURING BOND YIELD

- Current Yield
- Yield To Maturity
- Yield To Call
- Realized Yield To Maturity

CURRENT YIELD

- The current Yield relates the annual coupon interest to the market price. It is expressed as: Annual interest Current Yield = Price

EXAMPLE

- The Current Yield of a 10 Year, 12 % coupon Bond with a Par value of Rs.1000 and selling for Rs.950. what is current yield.

  120 Current yield = 950 = 12.63

YIELD TO MATURITY

- When you purchase a bond, you are not quoted a promised rate of return. Using the information on Bond price, maturity date, and coupon payments, you figure out the rate of return offered by the bond over its life

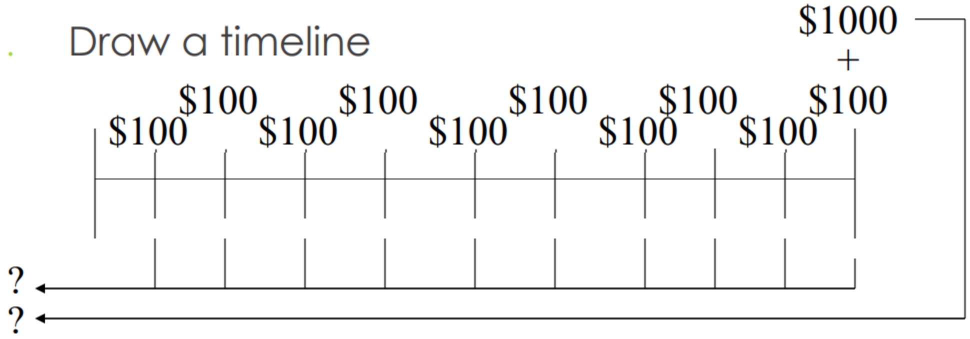
Formula

- C C C M
- P = (1+r) + (1+r)2 + (1+r)n + (1+r)n

Example

- Assume Hunter buys a 10-year bond from the KLM corporation on January 1, 2003. The bond has a face value of $1000 and pays an annual 10% coupon. The current market rate of return is 12%. Calculate the price of this bond today.

1. Draw a timeline



Example

2. First, find the value of the coupon stream

□ Remember to follow the same approach you use in time value of money calculations.

□ You can find the PV of a cash flow stream

□ PV = $100/(1+.12)1 + $100/(1+.12)2 + $100/(1+.12)3 + $100/(1+.12)4 + $100/(1+.12)5 + $100/(1+.12)6 + $100/(1+.12)7 + $100/(1+.12)8 + $100/(1+.12)9+ $100/(1+.12)10

□ Or, you can find the PV of an annuity

□ PVA = $100 * {[1-(1+.12)-10]/.12} □ PV = $565.02

Example

3.Find the PV of the face value

- PV = CFt / (1+r)t
- PV = $1000/ (1+.12)10
- PV = $321.97 4. Add the two values together to get the total PV
- $565.02 + $321.97 = $886.99

YIELD TO CALL

- Some bonds carry a call feature that entitles the issuer to call(buy back) the bond prior to the stated maturity date in accordance with a call schedule for such bonds.

Realized Return

This is the return that the investor actually realized from holding a bond. Using time value of money concepts, you are solving for the required rate of return instead of the value of the bond.

Example

- A purchased a bond for $800 5-years ago and he sold the bond today for $1200. The bond paid an annual $100 coupon. What is his realized rate of return? n
- $PV = S\ [CFt / (1+r)t\ ]\ t=0$
- $\$800 = [\$100/(1+r) + \$100/(1+r)2 + \$100/(1+r)3 + \$100/(1+r)4 + \$100/(1+r)5\ ] + [\$1200/(1+r)5\ ]$
- To solve, you need use a “trail and error” approach. You plug in numbers until you find the rate of return that solves the equation.
- The realized rate of return on this bond is 19.31%.

Example

This is much easier to find using a financial calculator:

- n = 5 PV = -800 FV = 1200 PMT = 100 i = ?, this is the realized rate of return on this bond

- Note that if the payments had been semiannual, n=10, PV=-800, FV=1200, PMT=50, i=?=9.47%. Thus, the realized return would have been 2 * 9.47% = 18.94%.

BOND PRICING THEOREMS

- **THEOREM 1:**

Bond prices move inversely to interest rate changes.

When $y\uparrow \Rightarrow \mathbf{P}\downarrow$

When $y\downarrow \Rightarrow \mathbf{P}\uparrow$

Proof:

- C = Rs.20p.a., F = Rs.100, N = 1.5 years, y = 10% p.a.
- Price of the bond = ?
- From bond valuation model:
- P = 10/(1+0.05) + 10/(1+0.05)2 + 110/(1+0.05)3
- P = Rs.113.616
- Assume that interest rates rise and let y = 20% p.a.
- With higher interest rates, the price of the bond falls:
- P = Rs.100.00

THEOREM 2:

- The longer the maturity of the bond, the more sensitive it is to changes in interest rates.
  Proof:
- Original annual YTM 10% for all bonds

	BOND-A	BOND-B	BOND-C
TERM TO MATURITY	3 yrs	6 yrs	9 yrs
Annual Coupon	Rs.10	Rs.10	Rs.10
Current price	Rs.100	Rs.100	Rs.100

Assume that interest rates fall by 2%, so that YTM becomes 8%.

	BOND-A	BOND-B	BOND-C
TERM TO MATURITY	3 yrs	6 yrs	9 yrs
▶ Current price	Rs.105.24	Rs.109.38	Rs.112.66
▶ Price sensitivity (in£)	+Rs.5.24	+Rs.9.38	+ Rs.12.66

A 2% fall in YTM causes a higher price increase (+ Rs.12.66) for the 9 year bond.

Assume that interest rates increase by 2%, so that YTM becomes 12%.

	Bond A	Bond B	Bond C
Term to maturity	3 yrs	6 yrs	9 yrs
Current price	Rs.95.08	Rs.91.62	Rs.89.17
Price sensitivity(in Rs.)	- Rs.4.92	- Rs.8.38	- Rs.10.83

A 2% increase in YTM causes a higher price fall (- Rs.12.66) for the 9 year bond.

THEOREM 3:

The price changes resulting from equal absolute increases in YTM are not symmetrical.

Proof:

	Bond A	**Bond B**	**Bond C**
Price changes (in Rs.)			
YTM falls by 2%	+Rs.5.24	+ Rs.9.38	+ Rs.12.66
YTM rises by 2	- Rs.4.92	- Rs.8.38	- Rs.10.83

For any given maturity, a x% decrease in YTM causes a **price rise that is larger** than the price loss resulting from an equal x% increase in YTM.

THEOREM 4:

- The lower a bond’s coupon, the more sensitive its price will be to given changes in interest rates.

Proof: Assume annual YTM 10% for all bonds

	Bond A	Bond B	Bond C	Z C B
Term to maturity 3 years				
Annual Coupon	Rs.30	Rs. 15	Rs. 5	Rs. 0
Current price	Rs.150.76	Rs.112.69	RS.87.31	Rs.74.62

Assume that interest rates increase by 2%, so that YTM becomes 12%.

	Bond A	Bond B	Bond C	Z C B
Term to maturity3 years				
Annual Coupon	Rs.30RS.	15Rs.	5Rs.	0
Current price	Rs.144.26	Rs.107.38	Rs.82.79	RS.70.50

The change in the price of the bond as percentage of the +initial price is:

	Bond A	Bond B	Bond C	Zero Coupon Bond
Annual Coupon	Rs.30	Rs.15	Rs.5	Rs.0
% Change in Price	- 4.31%	- 4.71%	-5.18%	-5.52%

Bonds

- Bonds and debentures are terms used interchangeably
- Both represent long term fixed income securities
- The cash flow stream (in form of interest and principal) as well as the time horizon (i.e. the date of maturity) are well specified and fixed
- Bond returns can be calculated in various ways
  - Coupon rate
  - Current yield
  - Spot interest rate
  - Yield to maturity (YTM)
  - Yield to call (YTC)
  - Realized YTM

Coupon Rate

- It is the nominal rate of interest that is fixed and is printed on the bond certificate
- It is calculated on the face value of the bond
- It is the rate at which interest is paid by the company to the bondholder
- It is payable by the company at periodical intervals of time till maturity

- Example:
  - A bond has a face value of Rs 1000 with an interest rate of 12% p.a.
  - It means that Rs 120 will be paid by the company on an annual basis to the bond holder till maturity

Current yield

- The current market price of the bond in the secondary market may differ from its face value (i.e. it may be currently selling at a discount or at a premium)
- Current yield relates the annual interest receivable on a bond to its current market price

$$\textbf{Current yield} = \frac{\textbf{Annual interest}}{\textbf{Current market price}} * 100$$

- It thus measures the annual return accruing to a bondholder who purchases the bond from the secondary market and sells it before maturity presumably at a price at which he bought the bond
- Example:
  - A bond has a face value of Rs 1000 and a coupon rate of 12%. It is currently selling for Rs 800.
  - The current yield = $\frac{120}{800} * 100 = 15\%$
- Current yield > coupon rate : when bond is selling at a discount
- Current yield < coupon rate : when bond is selling at a premium

- **Zero coupon bond or Deep discount bond** is a special type of bond which does not pay annual interest
- Rather such bonds are issued at a discount to be redeemed at par
- The return comes in form of the difference between the issue price and the maturity value
- Spot interest rate is the return on deep discount bonds when expressed in % terms on an annual basis
- Mathematically it is that rate of discount which makes the present value of the single cash inflow to the investor (on redemption of bond, no interest being payable annually) equal to the cost of the bond

- Example:
  - A zero coupon bond has a face value of Rs 1000 and maturity period of five years. If the issue price of the bond is Rs 519.37, what is the spot interest rate?
  - It is that rate of interest which makes the PV of 1000 = 519.37
  - $519.37 = \frac{1000}{(1+i)^5}$
  - $i = 0.14$ or 14%

Yield to Maturity

- It is the rate of return that an investor is expected to earn on an annualized basis expressed in % terms from a bond purchased at the current market price and held till maturity
- It is the internal rate of return earned on a bond if held till maturity
- YTM is that rate of discount (r) which makes the present value of cash inflows from the bond (in form of interest and redemption value) equal to the cash outflow on purchase of the bond

  i.e. **MP = I * PVAF (r%, n) + RV * PVF (r%, n)**

- **Approximate YTM** may be calculated as follows:

$$\textbf{YTM} = \frac{\textbf{I + (RV – MP) / N}}{\textbf{(RV + MP) / 2}}$$

where,

I: Annual interest

RV: Redemption value

MP: Market price

N: Number of years remaining to maturity

- Interpolation may be then be done to arrive at the exact value of YTM

Example

A bond of face value Rs 1000 and a coupon rate of 15% is currently available at Rs 900. Five years remain to maturity and bond is redeemable at par. Calculate YTM.

- MP = 900
- RV = 1000
- I = 15% of Rs 1000 = 150
- N = 5

$$YTM = \frac{I + (RV - MP) / N}{(RV + MP) / 2} = \frac{150 + (1000 - 900) / 5}{(1000 + 900) / 2} = 0.1789 \text{ or } 17.89\%$$

Thus actual YTM would lie between 17% and 19%, which can be arrived at through interpolation

Yield to Call (YTO)

- Some bonds may be redeemable before their full maturity at the option of the issuer or the investor
- In such cases, two yields are calculated:
  - YTM (assuming that the bond will be redeemed only at the end of full maturity period)
  - YTC (assuming that the bond will be redeemed at a call date before maturity)

- YTC is computed on the assumption that the bond's cash inflows are terminated at the call date with redemption of the bond at the specific call price
- Thus, YTC is that rate of discount which makes the present value of cash inflows till call equal to the current market price of the bond
- Same method as YTM would be used except for 'N' now being years remaining to call.

- If **YTC > YTM**, it would be advantageous to the investor to exercise the redemption option at the call date
- If **YTM > YTC**, it would be better to hold the bond till final maturity

Realized YTM

- The calculation of YTM assumes that cash flows received through the life of the bond are being reinvested at a rate equal to YTM
- However, the reinvestment rate may differ over time. In such cases, Realized YTM is a more appropriate measure

Example

- A Rs 1000 par value bond carrying a coupon rate of 15% maturing after 5 years is being considered. The present market price of this bond is Rs 850. The reinvestment rate applicable to future cash flows is 16%. Calculate realised YTM.

	0	1	2	3	4	5
Investment	850					
Annual interest		150	150	150	150	150
Reinvestment period @ 16%		4	3	2	1	0
FV of these CFs		271.5	234	202.5	174	150
Maturity value						1000

Total FVs = 271.5 + 234 + 202.5 + 174 + 150 + 1000 = 2032

For calculating Realized YTM,

$MP\ (1+r)^5 = 2032$

$850\ (1+r)^5 = 2032$

$r = 0.19$ or 19%

Bond Prices

- **Intrinsic value of bond** is equal to the present values of all future cash flows discounted at the required rate of return

$$P_o = I * PVAF\ (r\%, n) + RV * PVF\ (r\%, n)$$

where

P_o : Present value of the bond today

I : Annual interest payments

RV : Redemption value

r : required rate of return

n : number of years

Example

A bond has a face value of Rs 1000 and was issued five years ago at a coupon rate of 10%. The bond had a maturity period of 10 years. If the current market interest rate is 14%, what should be the PV of the bond?

- I = 1000 * 10% = 100
- n = 5
- RV = 1000
- r = 14%

$$P\left[\frac{1-(1+r)^{-n}}{r}\right]$$

$P = Periodic\ Payment$
$r = rate\ per\ period$
$n = number\ of\ periods$

P_o = I * PVAF (r%, n) + RV * PVF (r%, n)

= 100 * PVAF (14%, 5) + 1000 * PVF (14%, 5)
= Rs 862.71

$$PV\ Factor = \frac{1}{(1+r)^n}$$

$r = rate\ of\ return$
$n = number\ of\ periods$

Example

If in the above question, interest is payable semi-annually, what would be the intrinsic value of the bond?

- I = 1000 * 10% * ½ = 50
- n = 5 * 2 = 10
- RV = 1000
- r = 14% * ½ = 7%

$$P_o = I * PVAF\ (r\%, n) + RV * PVF\ (r\%, n)$$

$$= 50 * PVAF\ (7\%, 10) + 1000 * PVF\ (7\%, 10)$$

$$= Rs\ 859.48$$

Exercise 1

An investor is considering the purchase of a bond currently selling for Rs 878.50. The bond has four years to maturity, a face value of Rs 1000 and a coupon rate of 8%. The appropriate discount rate for investments of similar risk is 10%.

- Calculate the YTM of the bond.
- Based on the calculation, should the investor purchase the bond?

Exercise 2

- An investor recently purchased a bond with Rs 1000 face value, 10% coupon rate and six years to maturity. The bond makes annual interest payments. The investor paid Rs 1032.50 for the bond.
  - What is the YTM of the bond?
  - If the bond can be called two years from now at a price of Rs 1080, what is its YTC?
  - Would such a call be advantageous for the investor?

Exercise 3

A company issues a deep discount bond of the face value of Rs 5000 at an issue price of Rs 3550. The maturity period of the bond is 7 years.

Determine the spot interest rate of the bond.

Exercise 4

A bond of Rs 1000 was issued five years ago at a coupon rate of 6%. The bond had a maturity period of 10 years to be redeemable at par. The market interest rate currently is 10%. Determine the value of the bond.

Exercise 5

A 20 year, 10% coupon rate bond has Rs 1000 face value. The market rate of interest is 8%. Compute the intrinsic value of this bond if it has five years remaining to maturity. Assume that interest is paid

1. annually
2. semi annually
3. quarterly

Exercise 6

A Rs 1000 par value bond carrying a coupon rate of 10% maturing after 5 years is being considered. The present market price of this bond is Rs 900. The reinvestment rate applicable to future cash flows is 12%. Calculate realized YTM.

Bond Pricing

- Bonds are issued at a fixed rate of interest payable on the face value which is referred to as ***COUPON RATE***
  - At the time of issue, coupon rate is representative of the then prevailing market interest rate
  - However, subsequent changes in the market interest rates may have its affect on the bond prices
- ***If market interest rate rises above the coupon rate***
  - The existing bonds would start providing lower return
  - Thus becoming unattractive
  - Thus the price of the bond would fall below its face value i.e. the bond would start selling at a discount
- ***If market interest rate falls below the coupon rate***
  - The existing bonds would start providing relatively higher return
  - Thus becoming very attractive
  - Thus the price of the bond would rise above its face value i.e. the bond would start selling at a premium
- ***Long maturity bonds***
  - A change in interest rate structure would result in a relatively large price change in a long maturity bond

Bond Risks

Risk is the possibility of variation in returns

The actual returns realized from investing in bond may vary from what was expected on account of:

- Default or delay on part of the issuer to pay interest or principal
- Change in market interest rates

Thus there are two broad sources of risk associated with bonds:

- Default risk
- Interest rate risk

Default Risk

- It refers to the possibility that a company may fail to pay the interest or principal on stipulated dates
- Poor financial performance of the company may lead to such default
- Credit rating of debt securities is a mechanism adopted for assessing the credit risk involved
- Credit rating process involves:
  - Qualitative assessment of company's business and management
  - Quantitative assessment of company's financial performance
  - Specific features of the bond being issued
- Credit rating is an **opinion** of the credit rating agency regarding the relative ability of issuer of debt to fulfill the debt obligations in respect of interest and repayment

Interest rate risk

- It refers to variation in returns of bond because of a change in market interest rates
- Interest rate risk is composed of two risks:
  - Reinvestment risk
  - Price risk
- **Reinvestment risk**
  - An investor in bonds receives interest annually or semi-annually
  - He reinvests it each year at the then prevailing interest rate. Thus interest is earned on the interest received from the bonds each year
  - If the market interest rate moves up, the investor would be able to reinvest the annual interest received from the bond at a higher rate than expected. Thus he would gain from the reinvestment activity
  - When the market interest rates moves down, the investor would be able to reinvest the interest only at a lower rate than expected. Thus he would lose on reinvestment activity
- **Price risk**
  - The price of the bond is inversely related to changes in market interest rate
  - If the market interest rate moves up, bond price may decline below its face value. Thus the investor would suffer a loss while selling the bond
  - If the market interest rate goes down, the existing bonds may start selling at a premium. Thus the investor would gain from sale of such bond

Microsoft PowerPoint - [CTM__Session 3]

Interest rate risk

- **When the market interest rate rises**
  - Investor can reinvest the interest at a higher rate, thus gaining from reinvestment
  - However the future bond price would decline, thus losing on sale of the bond
  - If the gain on reinvestment > loss on sale of bond: **Net Gain**
  - If the gain on reinvestment < loss on sale of bond: **Net loss**

- **When the market interest rate falls**
  - Investor can reinvest the interest at a lower rate, thus losing from reinvestment
  - However the future bond price would rise, thus gaining on sale of the bond
  - If the loss on reinvestment > gain on sale of bond: **Net loss**
  - If the loss on reinvestment < gain on sale of bond: **Net gain**

Thus, reinvestment risk and price risk are inversely related. Together they constitute interest rate risk

Bond duration

When considering the reinvestment risk and price risk, loss in one may be exactly compensated for by the gain in the other, thus completely eliminating the interest rate risk

This particular holding period at which the interest rate risk disappears is referred to as **Bond Duration**

Bond duration is calculated as the weighted average measure of the bond's life

$$d = \left[\frac{1I_1}{(1+k)^1} + \frac{2I_2}{(1+k)^2} + \frac{3I_3}{(1+k)^3} + \ldots\ldots + \frac{nI_n + RV_n}{(1+k)^n} \right] / P_0$$

Example

- A bond with face value of Rs 100 with 12% coupon rate issued 3 years ago is redeemable after 5 years from now at a premium of 5%. The interest rate prevailing in the market currently is 14%. Calculate bond duration.

Year	Cash flow	PVF(14%)	PV	PV * Year
1	12	0.8772	10.5264	10.5264
2	12	0.7695	9.234	18.468
3	12	0.675	8.1	24.3
4	12	0.5921	7.1052	28.4208
5	12	0.5194	6.2328	31.164
5	105	0.5194	54.537	272.685
			95.7354	**386.0402**

- d = 386.0402 / 95.7354 = 4.03 years

Exercise 7

A new bond with face value Rs 100 is issued at a coupon rate of 15% and maturity period of 5 years. It is redeemable at par. Calculate the bond duration

Exercise 8

An investor has a 14% debenture with face value Rs 100 that matures at par in 15 years. The debenture is callable in 5 years at Rs 114. It is currently selling for Rs 105. Calculate:

- YTM
- YTC
- Current yield

Exercise 9

A person owns a Rs 1000 face value bond with 5 years to maturity. The bond makes annual interest payments of Rs 80. The bond is currently priced at Rs 960. Given that the market interest rate is 10%, should the investor hold or sell the bond?

Exercise 10

A bond pays interest annually and sells for Rs 835. It has 6 years remaining to maturity and a par value of Rs 1000. What is the coupon rate if it is promised a YTM of 12%?

Thank You