Security Analysis

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Bond - debt instrument

Bond Issuer - Borrower $\xrightarrow{\text{BOND}}$ Bond Investor

Bond Investor $\xrightarrow{\text{Money}}$ Bond Issuer

Valuation / pricing of a Bond

Ex: 3 yrs Corporate Bond with a f. value of ₹100 and an annual Coupon of 10% - The risk free rate is 5% and the appropriate risk premium is 4%.

$YTM = r_f + \text{risk premium}$

$= 5\% + 4\% = 9\%$

$$\left.\begin{array}{lll} 10 & 10/1.09 & = 9.17 \\ 10 & 10/(1.09)^2 & = 8.42 \\ 110 & 10/(1.09)^3 & = 84.94 \end{array}\right\} \quad \underline{102.53}$$

Consider a Bond that pays an annual coupon of 5% and that has 3 years remaining until maturity. Assume the term structure of interest rate is flat at 6% → YTM

-> what is the price of the Bond?

-> If the int rate remains unchanged at 6% what shall be the price one year from now?

#

Year	CF	PV
1	5	$5/1.06$
2	5	$5/(1.06)^2$
3	105	$105/(1.06)^3$
		97.33

After a year

Y_1	5	$5/1.06$
Y_2	105	$\frac{105}{(1.06)^2}$
		98.17

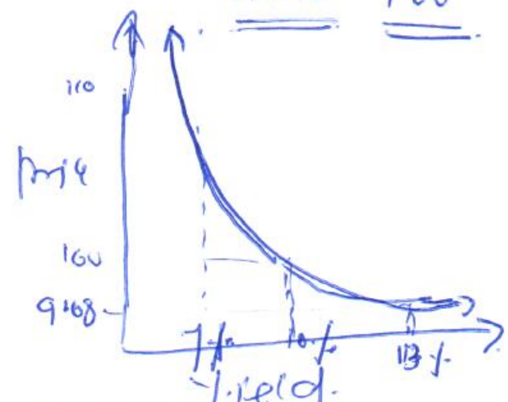
② What is the price of a ₹100 bond 4 year to maturity. 10% Annual coupon trading at a YTM of

(a) 7% (b) 10% (c) 13%

#

Scenario (A)

Year	CF	PV@7%	@10%	@13
1	10	$\frac{10}{1.07}$ 9.35	9.09	8.85
2	10	$\frac{10}{1.07^2}$ 8.73	8.26	7.83
3	10	$\frac{10}{1.07^3}$ 8.16	7.51	6.93
4	110	$\frac{110}{1.07^4}$ 83.92	75.13	67.47
		110.16	100	91.08



Bond valuation

- → Bond Terminology
- → Types of Bonds
- → Valuation
- → YTM
- → Interest Rate Risk
  - → Duration
  - → Convexity
- → Term Structure - spot Rates
- → Forward Rates
- → Convertible Bonds

Face value ₹100.
Coupon rate = 12% paid semi annually.
YTM = 10% – ~~duration~~ Maturity – 5 yrs.

Step I Step cash flows

→ → one period = 6 months

Period	CF	PV of CF	
1 – 10	6	PVIFA(10, 5%) = 7.72	= 46.33
10	100	PVIF(10, 5%) = 0.614	= 61.40
			107.73

If the yield is 13%

1 – 10	6	PVIFA (10, 6.5%)	7.19	= 43.13
10	100	PVIF (10, 6.5%)	0.53	53.30
				96.43

Clean price / Dirty price

Y_0 Y_1 Y_2 Y_3

price?? 10 10 110

$$\frac{10}{1.08} + \frac{10}{1.08^2} + \frac{110}{1.08^3} = \boxed{105.15}$$

Y_0 $Y_{0.5}$ $Y_{1.5}$ $Y_{2.5}$

price?? 10 10 110

price

$$\frac{10}{1.08^{0.5}} + \frac{10}{1.08^{1.5}} + \frac{110}{1.08^{2.5}}$$

OR

$$= 1.08^{0.5}\left[\frac{10}{1.08} + \frac{10}{1.08^2} + \frac{110}{1.08^3}\right]$$

$$= 1.039 \times 105.15 = 109.25$$ – Dirty Price

Clean price = Dirty price – Accrued interest

$$= 109.25 - \frac{6}{12} \times 10$$

$$= \boxed{104.25}$$

(A) at which transaction take place

#3 A Bond with the following features is brought on June 1 2014. 4

Face value - ₹ 100

Coupon = 10%

Settlement Date - June 1 2014.

Coupon Date - March 1, Sep 1

Yield - 8% (Annualised)

Maturity - March, 2017

(Q i) Clean ?
ii) Dirty price ?

#

March'14		Sep'14	Mar'15	Sep'15	Mar'16	Sep'16	March 17
0	??	5	5	5	5	5	105
3 months	June 14						

∴ Price of the Bond as on 1st March 2014 @ 8% YTM

$= 5\, PVIFA(4\%, 6) + 100\, PVIF(4\%, 6)$

$= 105.24$

Price as on June 1, 2014

$= 105.24 \times 1.04^{0.5}$

$= \underline{107.32}$ Dirty price

Clean = Dirty price − Accrued Interest

$= 107.32 - \cancel{205}\ 5 \times 3/6 \times$

$= 107.32 - 2.5 = \underline{104.82}$

Computation of YTM, current yield

(1) Rs 1000 Bond paying 10% annual coupon has 3 year left for maturity.

Its price is ₹ 920. (1) Computed YTM?
(2) current yield?

#. Approach 1 Trial and Error approach

(13% Assumed)

	CF	PV of CF @13%	PV @14%
Y_1	100	88.50	87.72
Y	100	78.31	76.95

Applying interpolation

13% ⟷ 14%

929.17 ↑ 907.14

$x = 13.42\%$

Approach 2 YTM (approx) = $\dfrac{\text{Coupon} + \dfrac{\text{Final redemption price} - \text{Market price}}{n}}{\dfrac{\text{Final redemption price} + \text{Market price}}{2}}$

$$YTM = \frac{\cancel{C + (F-P)}}{} = \frac{C + \frac{F-P}{n}}{\frac{F+P}{2}} = \frac{C + \left(\frac{F-P}{n}\right)}{\left(\frac{F+P}{2}\right)}$$

$$= \frac{100 + \frac{(1000-920)}{3}}{\left(\frac{1000+920}{2}\right)} = 13.19\%$$

140

128.67

Current yield $= \dfrac{\text{Coupon}}{\text{Market price}} = \dfrac{100}{920} = 10.87\%$

Ex: A 9% 5 year Bond is issued in the market for ₹ 90. It will get redeemed at ₹ 105 (5% premium). Compute post tax YTM [Take marginal rate = 30%, Capital Gain Tax = 10% (No indexation)]

#

$$YTM = \frac{C + \frac{F+P}{n}}{\left(\frac{F+P}{2}\right)} \qquad \frac{C^* + \frac{F^* - P}{n}}{\left(\frac{F^* + P}{2}\right)}$$

(1) Tax adjusted

$C^* = C(1-T) = 9(1-0.3)$

₹ 6.3

$F^* = F - T(F-P) = \cancel{105} = 105 - 10\%(105-90)$ ₹

⑥

$$YTM = \frac{C^{x} + \frac{F - P}{n}}{\frac{F + P}{2}} = \frac{6.3 + \left(\frac{103.5 - 90}{5}\right)}{\left(\frac{103.5 + 90}{2}\right)}$$

$= 9.3\%$

Mr A has decided to apply the following discount rate (Based on Credit Rating)

	Discount rate	
AAA	T-Bill rate + 3% spread	= 12%
AA	AAA + 2%	= 12% + 2 = 14%
A	AAA + 3%	= 12% + 3 = 15%

5 y. AA Rated bond is selling at ₹ 1025.86

The Coupon rate is 15%

364 day T Bill rate = 9%.

Compute → Intrinsic value of the Bond.

→ YTM Current yield → $\frac{150}{1025.86} = \boxed{14.62\%}$

\# Should Mr A invest?

Computation of intrinsic value

(b) Step 1

Year	CF	PV @ 14%	
1	150	150/1.14	= 131.58
2	150	$150/(1.14)^2$	= 115.42
3	150	$150/(1.14)^3$	101.25
4	150	$150/(1.14)^4$	88.81
5	1150	$150/(1.14)^5$	597.22
			₹ 1034.33

\# Mr A should invest, because bond is underpriced

(c)

(a) Current YTM Computation

$$YTM\ C + \frac{(F - P)}{n} \quad .150 + \frac{1000 - 1025.86}{5} = 14.3\%$$

7

A portfolio Manger purchases ₹ 20mm par value of a 5 year Bond that pays 10% annual coupon.
What is the realised return if bond is held till maturity and coupons are reinvested at 8%?

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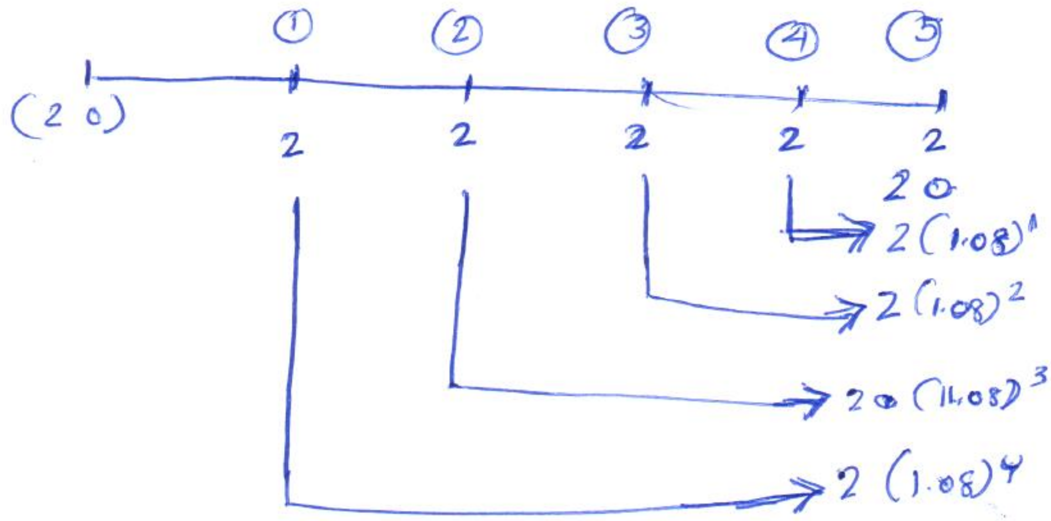

Final amount.

$$= 2\ FVIFA(8\%, 5) + 20$$

$$= 2\left[\frac{1.08^5}{1.08} - \frac{1}{1.08}\right] + 20$$

$$= 2 \times 5.867 + 20 = ₹11.733 + 20 = \underline{31.733}$$

Realised return

$$= 20 \cdot (1+r)^5 = 31.733$$

$$r = \underline{9.67\%}$$

Important Types:

(a) Callable Bond
(b) Putable Bond
(c) Floating Rate Bond
(d) Convertible Bond

Callable Bonds

Yield to Call (YTC)

A 9% 5 year Bond has the following call structure.

→ Not callable for the first 3 years ~~₹ 104~~

→ Callable at the end of 3 years for ₹ 104.

→ First call par at the end of fourth year.

Price of the Bond = ₹ 120.

Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	
−120	9	9	(9+104)			YTC $= \frac{9+\frac{(104-120)}{3}}{\frac{104+120}{2}} = 3.27\%$
−120	9	9	9	109		First call at par $= \frac{9+\frac{100-120}{4}}{(100+120)/2} = 3.57\%$
−120	9	9	9	9	109	YTM

Interest Rate Risk

Face value = ₹ 100

Coupon rate : 10%

Maturity = 5 years

Basically YTM = 5%

→ Compute the price at 5.1%, 4.9% YTMs

#

Year	C.F.	$\boxed{PV @ 5.1\%}$		$\boxed{PV @ 4.9\%}$
1–5	10	10/(1.051) 10 × (4.3175)	= ₹ 43.175	10 × 4.3295 = 43.295
5	100	$\frac{100}{(1.051)^2}$ 100 × 0.7798	= ₹ 77.98 ₹ 121.155	100 × 7835 = 78.35
				121.645

Observation: when interest rate ↑ 10 points, my price has come ↓ 0.50 paisa.

Interest Rate ~~₹ 100~~ Risk

Face value - ₹ 100.
Coupon Rate - 10%
maturity - 5 years
Presently ytm = 5%

#

Year	CF	PV(CF) @ 5% ytm		n x PV (CF)
1	10	10/1.05	= 9.52	9.52
2	10	10/(1.05)^2	9.07	18.14.
3	10	10/(1.05)^3	8.64	25.92.
4	10	10/(1.05)^4	8.23	32.92.
5	110	10/(1.05)^5	7.84 + 78.4	431.20
			121.70	517.70

Price of the Bond

Macaulay duration = $\frac{517.70}{121.70}$ = $\boxed{4.25}$

Modified duration = $\frac{4.25}{1+r} = \frac{4.25}{1.05} = \boxed{4.05}$

$\boxed{\% \Delta \text{ Price} = \Delta Y \times \text{Duration}}$

5% to 5.1%

= 0.1% × 4.05

= 0.405%

Initial price = 121.70

price at would be = 121.70 − (0.405% × 121.70)

= 121.7 − 0.50

= 121.2

Compute the modified duration to the following Bond (10)

Face value = ₹ 100 Coupon rate = 12% (annual) Yield 10%.

maturity - 5 years.

Also estimate the price of the Bond when the yield is

(a) 10.1 %

(b) 9.9 %.

#

Year	CF	PV CF @10%		n.x PV CF.
1	12	12/1.10	10.91	10.91
2	12	12/(1.10)^2	9.911	19.82
3	12	12/(1.10)^3	9.011	27.03
4	12	12/(1.10)^4	8.20	32.80
5	112.	112/(1.10)^5	69.55	347.75
			107.38	438.31

Macaulay duration

$$= \frac{\sum n \times PV(CF)}{\sum PV(CF)} = \frac{438.31}{107.38}$$

$$= 4.07 \text{ YEARS}$$

modified duration $= \frac{\text{Macaulay duration}}{1+r} = \frac{4.07}{1.1} = 3.7$ years

% Δ price = Duration x change in yield

= 3.7 x 0.1%

= 0.37%

@ ytm 10.1% Initial price = 107.58 − 0.37% of 107.58.

= 107.58 − 0.3980.

= 107.18 ₹ ↓

@ ytm 9.9 % = 107.58 + 0.3980

= 107.98 ↑.

Portfolio duration.

Bond	Duration	value	Duration x value
A	2	100	200 (2x100)
B	4	200	800 (4x200)
C	6	50	300 (6x50)
		350	1300

Portfolio duration = 1300/350 = 3.71

Another Example.

Bond	Duration	value	∇ Y	% △ Bond value x Bond value
A	2	100	0.5% ↓	2 x 0.5% x 100 = 1 ↑
B	4	200	1% ↓	4 x 1% x 200 = 8 ↑
C	6	50	1.5% ↓	6 x 1.5% x 50 = 4.5 ↑
		350		13.5 ↑

Total ~~value~~ yield increase = 350 + 13.50 = ₹363.50

% △ portfolio change = 1350/350 %

Duration & Convexity

Compute the duration and convexity of the following Bond

Face value = ₹100 maturity 5 yrs.

Annual coupon = 12%. YTM 10%.

Also calculate the Bond price if the yield 8

(a) go up by 1%

(b) come down by 1%

Year	CF	PV (CF) @10% YTM	Duration (n x PV of CF)	Cn(n+1) PV
1	12	10.91	10.91	21.82
2	12	9.91 (2x9.91)	19.82	59.46
3	12	9.01 (3x9.01)	27.03	108.12
4	12	8.20	32.80	164.00
5	112	69.55 (5x69.55)	347.76 ~~69.55~~	207.50
		107.58	438.32	244.0

Macaulay duration

$= \frac{\Sigma n \times PV}{\Sigma PV}$

$= \frac{438.32}{107.58} = 4.07$

Calculate modified duration

4.07 3.7

Convexity $= \cancel{\Sigma n f} \; \dfrac{\dfrac{\Sigma n(n+1) PV}{\Sigma PV}}{(1+r)^2}$

$= \dfrac{\left(\dfrac{2440}{107.88}\right)}{1+1^2} = \underline{18.74}$

$\boxed{\text{Price effect} = \text{Duration effect} + \text{Convexity effect}}$

$= \% \Delta \text{ price} = (-)\text{Duration} \times \Delta \text{ yield} + \text{Convexity val.} \times \Delta y^2$

Ans (a)

$= -3.7 \times 1\% + 18.74 \times (1\%)^2 \quad (18.74 \times 0.01 \times 1\%)$

$= -3.7\% + 0.1874\%$

$= \underline{-3.5126\%}$

Case (b)

$= -3.7 \times -1\% + 18.74 \times (1\%)^2$

$= 3.74\% + 0.1874\%$

$= \underline{3.9274\%}$

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3 yrs Zero Coupon Bond FV 100
Currently trading at ₹92

Y_0	Y_1	Y_2	Y_3
(-92)	-	-	100

$92 = \dfrac{100}{(1+r)^3}$

$r = \sqrt[3]{\dfrac{100}{92}} - 1$

$= 2.82\%$

Three year Spot Rate = 2.82%

2 year Zero Coupon bond FV 100
trading at 98

$98 = \dfrac{100}{(1+r)^2}$

$r = \sqrt[2]{\dfrac{100}{98}} - 1$

$= 2.60\%$

2 year spot Rate 2.60

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1 year Coupon bond FV 100
C. Price 98

$r = \dfrac{100}{98} - 1$

$= 2.04\%$

Find the value of ₹100 12% annual coupon bond with a maturity of 5 yrs given the following spot rate

S_1 10%
S_2 10.25%
S_3 10.5%
S_4 10.75%
S_5 11%

Solution

year	CF	PV(CF)
1	12	$12/1.1 = 10.91$
2	12	$12/(1.025)^2 = 9.87$
3	12	$12/(1.05)^3 = 8.89$
4	12	$12(1.075)^4 = 7.98$
5	112.	$12(1.11)^5 = 66.42$
		104.07

Computation of YTM

$$\frac{C + \frac{F-P}{n}}{\frac{F+P}{2}}$$

$$= \frac{12 + \left(\frac{100-104.67}{5}\right)}{\frac{100+104.67}{2}}$$

$$= \frac{11.2}{102} = 10.98\%$$

YTM for the 6 month and 12 month T. bill is 4.6% and 5% respectively.
Information w.r.t other treasury bond are being offered as follow.

Maturity	YTM( )
1.5 Years	5.4%
2 Years	5.8%
2.5 Years	6.4%
3 Years	7%

Compute the 1.5 Years, 2yrs, 2.5 yrs 3 yrs spot rate

value of 1.5 Year T Bond ₹100

$$= \frac{2.7}{(1.023)} + \frac{2.7}{(1.025)^2} + \frac{102.7}{(1+x)^3}$$

$= 2.7\% = S_1$ $2 \times 2.7 = 5.4$ annualised.

value of 2 year T Bond ₹100

$$= \frac{2.9}{(1.023)} + \frac{2.9}{(1.025)^2} + \frac{2.9}{(1.0273)^3} + \frac{102.90}{(1+x)^4} = 2.91\%$$

Likewise for $Y_{0.5}$ Y_1 $Y_{1.5}$ Y_2

Spot Rates / Fwd Rates

Yrs	1	2	3	4	5
Spot Rates	5%	5.8%	6.4%	7%	7.2%

Compute (i) 1 yr Fwd rate 1 yr from now
ii) 1 yr Fwd rate 2 yrs from now
iii) 2 yrs Fwd rate 3 years from now

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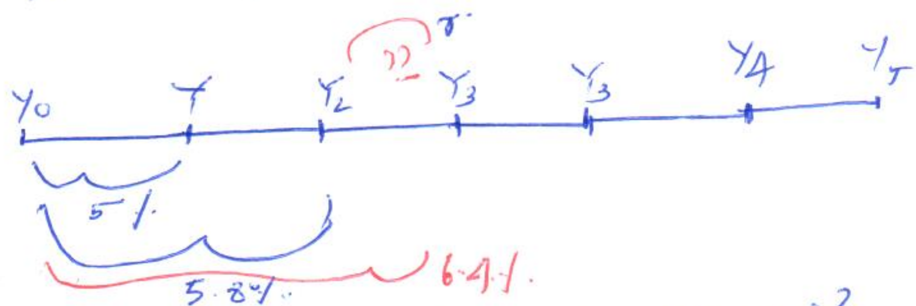


(1)

$$100\,(1.05)(1+r) = 100\,(1.058)^2$$

$$(1+r) = \frac{(1.058)^2}{1.05} = 1.6660$$

$$= r = \underline{\underline{6.60\%}}$$

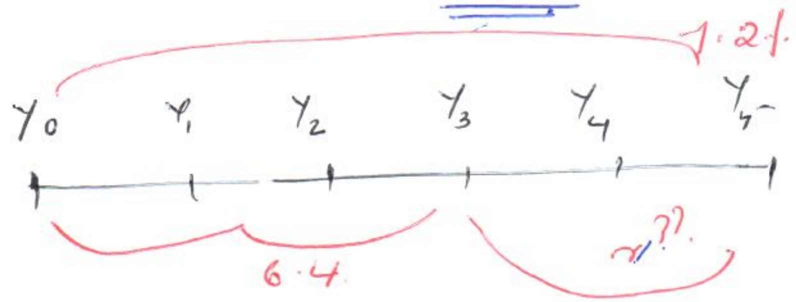
(ii)

$$100\,(1.058)^2(1+r) = 100\,(1.064)^3$$

$$1+r = \frac{(1.064)^3}{(1.058)^2} = 1.0761$$

$$r = \underline{\underline{7.61\%}}$$

(iii)



Alternatively

$$= 100\,(1.64)^3 + (1+r)^2 = 100\,(1.072)^5$$

$3 \times 64 + 2 \times z = 5 \times 7.2$

$$1 + r^2 = \frac{(1.072)^5}{(1.64)^3}$$

$r = \underline{8.4\%}$

$$1+r^2 = 8.41\%$$

Calculate the Forward Rates from the Following Spot Rates

Face value	Coupon Rate	Maturity	Current price
10,0000	0 %	1	91,000
10,0000	10.5 %	2	99,000
10,0000	11 %	3	99,500
10,0000	11.5 %	4.	99,900

#

price of 1 year Bond $= 91000 = \dfrac{1,00,000}{(1+S_1)}$

$S_1 = \dfrac{1,00,000}{91000} = 9.89\%$

Price of 2 year Bond : $99,000 = \dfrac{10500}{1.0989} + \dfrac{110500}{\cancel{(1+S_2)}^2}$

$\cancel{S_2} = \dfrac{}{(1+S_1)(1+F_2)}$

$(1.0989)(1+F_2)$

$= 12.42\%$

Price of 3 year Bond $= 99,500 = \dfrac{11000}{(1+S_1)}\ \dfrac{11000}{1.09869 \times (1.242)}\ \dfrac{111000}{1.0989\ (1.242)(1+f)}$

$= \cancel{12.49\%}\ \ 11.5\%$

$3_r F = 12.78\%$

Convertible Bonds: Informations w.r.t 8.5 %
Fully Convertible ~~debenture~~ Bonds issued by ABC Ltd @ ₹1000

Net price ₹ 900.

Conversion Ratio 30.

Straight value of the Bond ₹ 700

Net price of the Share ₹ 25

Expected Dividend ₹ 1

Conversion Value (Stock value of the Bond) = Conversion Ratio × Share price

$= 30 \times 25$

$= ₹\ 750$

Market Conversion price (Conversion parity price) $= \dfrac{\text{price of the Bond}}{\text{Conversion Ratio}} = \dfrac{900}{30} = 30\ ₹$

Conversion Premium % $= \boxed{\dfrac{900 - 750}{750} = 20\%}$ or $\boxed{\dfrac{30 - 25}{25} = 20\%}$

Conversion premium (₹) per share $= ₹\ 30 - ₹\ 25 = ₹\ 5$

Floor value $= \text{Max}\left[\text{Conversion value, Straight value}\right]$

$= \text{Max}\ [750,\ 700]$

$= 750$

P.

% Downside $= \dfrac{900 - 700}{700} = \dfrac{200}{700} = 28.7\%$

Premium Pay back Period or Differential Income $=$

$= 85 - 30 = 55\ ₹$

Premium Pay back Period $= \dfrac{150\ (900 - 750)}{₹\ 55 \text{ Extra Income}} = 2.73 \text{ years}$

Floating Rate Note / Floater

Bonds Refunding :-

→ Refund the old issue with the proceeds from the new issue

Cash outflow / Less: Tax benefit on the premium → The old issue would get bought back at a $\boxed{\text{Premium}}$.

→ The new issue could be at a premium or at a discount or at par } Cash inflow

→ Immediate Recognition of Tax benefits on unamortised discount / premium on the old issue.

	old issue	New issue
→ Interest outgo		
(−) Tax benefit on the above.		
(∓) Tax benefits on prem / discount amortised		

#

M/s Transindia Ltd is contemplating calling ₹ 3 crore of 10 year, ₹1000 bond issued 5 years ago with a coupon rate of 14%. The Bonds have a call price of ₹ 1015 and initially collected proceeds of ₹ 2.91 Crores due to a discount of ₹ 30 per bond. The initial floating cost was ₹ 3,60,000. The Company intends to sell ₹ 3 crore of 12% coupon rate, 5 years bond to raise funds for retiring the old bonds. It proposes to sell the new bonds at their par value of ₹ 1000. The estimated floatation cost is ₹ 2,00,000. The Company is paying 40% Tax. The new bonds shall be issued 2 month before retiring the old bonds to avoid any market

Solution

Initial cash out flow / In flow.

→ purchase of old Bonds.
1015 × 30,000 = (3,04,50,000)

→ Issuance of New Bonds
1000 × 30,000 = 3,00,00,000

→ Tax Benefit on premium paid for the old Bonds.
4,50,000 × 40% = 1,80,000

→ Floatation cost of New Bonds = (2,00,000)

→ Tax benefit w.r.t unamortised
(a) discount $\frac{5}{10}$ × 9,00,000 × 0.40 1,80,000
(b) floatation cost - $5/10$ × 3,60,000 × 40% 72,000.

→ Interest on the Overlapping period.
$\left[\begin{array}{c}(14\% + 2/12 \times 3,00,00,000) \\ \text{Tax saving benefits } 40\% \\ 14 \ (1 - 0.4)\end{array}\right]$ (4,20,000)

(−) 6,38,000

Second part

Annual Interest cost Savings

old Bond

Interest 14% of 3,00,00,000 = 42,00,000
Less: Tax Benefits on Interest 40%. (16,80,000)
Less: Tax Benefits on amortised discount 9,00,000 × $1/10$ × 40% (36,000)
floatation cost 360000/10 × 40% (14,400)
~~New B.~~

24,69,600

New Bond:

Interest → 12% of 3,00,00,000	36,00,000
Tax saving benefits on Interest	(14,40,000)
Floatation cost tax benefit 2,00,000 @ 1/5 × 40%	(16,000)
	21,44,000

= 24,69,600 − 21,44,000

Net Interest saving = 3,25,600/- (Per year)

NPV for Bond Refunding:

PV of annuity of cash savings every year for 5 years.

(12% − 40% tax benefit = 7.2%)

3 25,600 × PVIAF(5, ~~12%~~ 7.2) =

= 3 25,600 × 4.0783 = 13,27,834.

Less: initial cash flow − 6,38,000

₹ 6,89,834