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MFP-4 CURRENCY AND DEBT MARKETS

Bond Mathematics and Derivatives

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MFP-4
Currency and Debt Markets

Block

4

BOND MATHEMATICS AND DERIVATIVES

COURSE DESIGN AND DEVELOPMENT COMMITTEE

Prof. M.S. Narasimhan
Indian Institute of Management
Bangalore

Prof. G. Balasubramanian
Institute for Financial Management
and Research
Chennai

Mr. Raghu Iyer
Derivatives Consultant
Mumbai

Mr. Amitabh Chakraborty
Managing Director and
Chief Investment Officer
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Mumbai

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School of Management Studies
IGNOU, New Delhi

Prof. K. Ravi Sankar
School of Management Studies
IGNOU, New Delhi

Dr. Kamal Vagrecha
School of Management Studies
IGNOU, New Delhi

PRINT PRODUCTION

Mr. K.G. Sasi Kumar
Assistant Registrar (Publication)
School of Management Studies
IGNOU, New Delhi

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BLOCK 4 BOND MATHEMATICS AND DERIVATIVES

Normally a bond has three intrinsic characteristics – face value, coupon payment and maturity date. These characteristics remain attached to the bond through out its lifetime. They do not change. But there are two more characteristics of a bond that keep changing – one is its price and the other is its yield. Accepting interest rate risk is a normal part of investing and it can be an important source of profitability and shareholder value. However, excessive interest rate risk can pose a significant threat to earnings and capital base. Changes in interest rates affect earnings. The management of Interest Rate Risk should be one of the critical components of market risk management in an investor's portfolio. How interest rate risk can be managed through various derivative products is explained in this block.

Unit 13 explains in detail the valuation of different types of bonds such as par bond,discount bond and premium bond. It also explains with illustration calculation of duration and modified durations.

Unit 14 elaborates the sources of interest rate risk and its impact on earnings. It also explains measurement of interest rate risk and the various risk mitigation techniques.

Unit 15 focuses on interest rate futures and explains the trading, clearing and settlement practices. It also covers concepts such as conversion factor, deliverable bonds etc and highlights the benefits to the various segments such as banks, insurance companies, primary deals and retail investors etc.

Unit 16 explains in detail the various interest rate derivative products such as caps, collars, floors, interest rate swaps and forward rate agreements and how they can be used to hedge interest rate risk. It also covers credit derivatives such as credit default swaps and total return swaps.


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UNIT 13 BOND VALUATION AND CONVENTIONS

Objectives

After studying this unit, you should be able to:

- understand market conventions in debt market;
- appreciate valuation methodology for par bond, discount bond and premium bond; and
- discuss concept and calculation of duration and modifical duration.

Structure

13.1 INTRODUCTION

Bonds are instruments that promise the holder certain cash flows; Government securities, and corporate bonds are some examples of bonds. A bond promises a fixed lump sum amount on a pre-determined day in future. The fixed lump sum amount is called the face value of the bond. The pre-determined date on which the face value is paid is termed the maturity date. The time period up to the maturity date is term to maturity. Besides the face value, the bond also promises periodic payments until the maturity date. These periodic payments are called coupon payments. These coupon payments are usually calculated as some fixed percentage, called the coupon rate, of face value.

Interest Rates on instruments can be set in different ways. When we discuss a money market or debt instrument we think of an instrument carrying a fixed rate of interest. Hence, debt instruments are also referred to as fixed income instruments. In an instrument carrying a fixed rate, the interest rate or the coupon rate is fixed at the time of issue for the entire tenor of the instrument. Since, normally an instrument is issued for a par value and coupon is fixed, the periodical income (par value * coupon * amount invested) is same for the tenor of the investment. So the return for an investor holding a fixed rate instrument till maturity is fixed. However, during the tenor of the instrument the value (or market price) of the instrument will vary depending on the then prevailing interest rate in the market. If the market interest rate is higher than the coupon, the investors will

pay less than par value for buying the security such that they get market return on the security. On the other hand, if the market value is lower than the coupon the security will attract a premium above the par value. Thus, if the market interest rate goes up the value/price of a fixed rate instrument will decrease if the market interest rate goes down the value/price of a fixed rate instrument will increase.On the other hand, in the case of an instrument carrying a floating rate of interest, the interest earned on the instrument may change from time to time during the tenor of the instrument. Usually in the case of a floating rate instrument, the interest rate is linked to a reference or a benchmark rate which is determined at pre determined periodic intervals e.g., daily, semi-annually, annually etc. The dates at which the reference rate is determined are known as the coupon reset dates. The reference/benchmark rate is usually a market determined one e.g., NSE Overnight MIBOR (the overnight call rate), the 364-day Treasury bill cut-off rate etc. Obviously the return to the investor over the tenor of the instrument will be variable. In view of this, the price volatility in the case of a floating rate instrument will be much less than that in the case of a fixed rate instrument of the same tenor. This is because of the fact that in the case of the floating rate instrument the coupon rate will get aligned to the market interest rate at every reset date.

13.2 SIMPLE AND COMPOUND INTEREST

The simple rate of interest as the name suggests is simple to understand as well as to calculate. The formula for a simple interest is as follows: Interest Amount = Principal × Interest Rate × Time e.g., A deposit of Rs. 100 at a simple interest rate of 7% p.a. will earn Rs. 7 over a period of 1 year.

On the other hand in the case of a compounded rate of interest, interest is paid on the principal value as well as the interest earned during the previous interest periods depending on the compounding frequency.

Example A fixed deposit of Rs.100 at a rate of 7% for a period of 1 year with the interest compounded quarterly. The interest computation in this case will be as follows:

First quarter interest:
$100 \times 7\% \times (3/12) = \text{Rs. } 1.75$

Second quarter interest:
$[100 \times 7\% \times (3/12)] + [1.75 \times 7\% \times (3/12)]$ or $101.75 \times 7\% \times (3/12) = \text{Rs. } 1.78$

Third quarter interest:
$[100 \times 7\% \times (3/12)] + [(1.75 + 1.78) \times 7\% \times 3/12]$ or $103.53 \times 7\% \times (3/12) = \text{Rs. } 1.81$

Fourth quarter interest
$[100 \times 7\% \times (3/12)] + [(1.75 + 1.78+1.81) \times 7\% \times 3/12]$ or $105.34 \times 7\% \times (3/12) = \text{Rs. } 1.84$

Total Interest = 1.75 + 1.78 + 1.81 + 1.84 = Rs. 7.18 as against Rs. 7 in case of simple interest. Thus the effective rate of interest is 7.18% in this case.

The effective rate of interest on an instrument which carries a compounded rate of interest can be computed as follows:

Effective Rate of Interest = [1+i/f]^f – 1

i = nominal rate of interest on the instrument
f= compounding frequency.

Thus, a compounded rate of interest gives a higher yield than under the simple rate of interest for the same interest rate. The compounding frequency in case of instruments usually is quarterly or semi-annual, though there are instruments where the interest is compounded daily.

13.3 YIELD

Yield is a measure of the overall return to the investor on his/ her investment. Yield on an investment can be computed in different ways, some of which are given below:

- **Nominal Yield**

This is the annual interest rate specified on the security, irrespective of its actual price or the rate at which the security has been purchased. This is also known as 'coupon'.

- **Current Yield**

This is the effective yield an investor earns keeping in mind the current market price of the security. This is calculated as follows: Current Yield =((Coupon)/(Current Market Price)) × 100

- **Yield To Maturity**

[YTM] This means the yield on the security if it is held till redemption. This can be interpreted as the average compounded rate of return on the security if the same is bought at the current market price and held until it matures and the face value is repaid. YTM is a discount rate that equates the present value of all cash flows to the present market price of the security. Future cash flows include the interest and the capital gain/ loss. This is calculated as per the following formula:

$$P = \{ (C/(1+y)) + (C/(1+y)^2) + (C/(1+y)^3) + \ldots\ldots + ((C+A)/(1+y)^n) \}$$

Where P is the market price at which the security is traded C is Coupon

A is face value

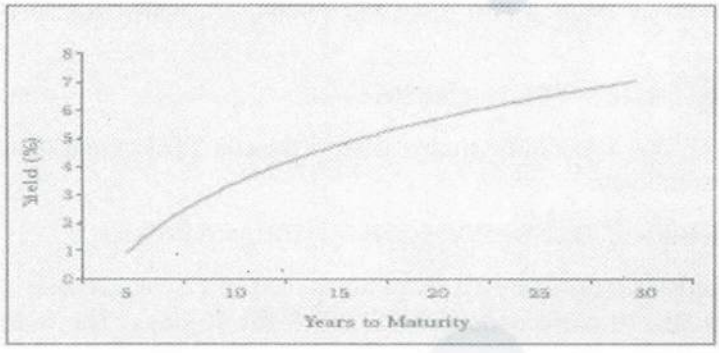
Y is the discount rate at which the cash flows are discounted.

Y is worked out through trial and error until the equation tallies on both the sides incidentally, is the YTM.

- **Yield curve**

Yield curve, also known as term structure of interest rates, is the representation of zero coupon yields of a series of maturities at a point of time. It is constructed by plotting the yields against the respective maturity periods of benchmark fixed-income securities. The yield curve is a measure of market's expectations of future interest rates, given the current market conditions. Securities issued by the Government are considered risk-free, and as such, their yields are often used as the benchmarks for fixed-income securities with the same maturities.

Representation of a Normal Yield



The difference between short and long ends of the yield curve (spread) determines the shape of the curve which is an important indicator of the expected performance of the economy and inflation. Since, the government securities yield curve represents the

risk-free interest rates, it is used for pricing other instruments of various maturities. The yield curve has informational value to bond issuers for pricing as well as timing of their issue depending on the expected performance of the economy. Investors can also use the curve in choosing the right tenor of investment. For overseas investors, expected performance of different countries could be compared by looking at the respective yield curves to make investment decisions.

Most other interest rates are measured on the basis of the government securities yield curve, *viz.*, credit curve and swap curve. Similarly pricing of other financial instrument uses the government securities yield curve in some form or the other. Thus, the yield curve acts as a kind of public good that is used constantly by participants in the financial system.

13.4 PREMIUM AND DISCOUNT

When the rate at which the security is quoted is above its par value i.e., above 100 (normally the security prices are expressed with par value = 100) the security is said to be at premium. Conversely when the security is quoted below par i.e., below 100 it is said to be at discount.

There is an inverse relationship between the price and the yield to maturity (YTM). When the security is at premium, the price is above par, and thus high. The YTM in this case will be lower than the coupon rate. Conversely the YTM would be higher when the security is at discount. In other words, when the security is at premium the premium the investor pays more than the face value and thus his return is lower; on the other hand the investor pays less than the face value and gets higher return.

The deep discount bond is a security the price of which is at a fairly high discount and the period of the security is also fairly longer. The investor pays very low and gets substantial terminal value (redemption value).

- **Front-end and Rear-end**

Generally, when one refers to a yield or YTM on an instrument one implies the yield till redemption and this means. However, in case of discounted instruments the yield referred could be on a front ended or a rear ended basis. When the yield is on a rear-ended basis then it is same as the YTM. However when the yield is quoted on a front ended basis then the YTM will be higher than the front end yield. The following example will illustrate the difference.

Example

A 90-day Commercial Paper (CP) is trading at 7%. CP yield is usually quoted o a rear-end basis and hence is the YTM. The price of the CP, hence will be computed as follows:

Price = (100) / (1+(7% × 90/365) = 98.3033

Similarly if a 91 -day day T-bill is traded at 98.59 then its YTM or rear-ended yield will be computed as follows:

Yield on the T-Bill = [(100 – 98.59)/98.59] × [365/91] = 5.74%.

However, in a BRDS transaction the yields are quoted on a front end basis. For example Bank A lends Rs. 10 crore under BRDS at 7% for 90 days. The interest amount computation will be as follows:

Interest Due: 10,00,00,000/- × 7% × (90/365) = Rs. 17,26,027/-

Bank A has to pay the principal value of the transaction less the interest on the day of the transaction and will receive Rs. 10 crore after 90 days.

Thus, Bank A pays (10,00,00,000/- 17,26,027/-) = Rs. 9,82,73,973/-

And receives Rs.10,00,00,000/- after 90 days.

Thus, effective yield or YTM or rear-ended yield for Bank A will be

[(10,00,00,000/- 9,82,73,973/-)/(9,82,73,973/-)] × [365/90] = 7.12%.

13.5 DAY COUNT CONVENTIONS

The market uses quite a few conventions for calculation of the number of days that has elapsed between two dates. It is interesting to note that these conventions were designed prior to the emergence of sophisticated calculating devices and the main objectives were to reduce the math in complicated formulae and to bring about standards such that the prices quoted are correctly understood by all. The conventions are still needed even though calculating functions are readily available even in hand-held devices. The conventions used are as follows:

- **A/360 (Actual by 360)**

In this method, the actual number of days elapsed between the two dates is divided by 360, i.e., the year is assumed to have 360 days.

- **A/365 (Actual by 365)**

In this method, the actual number of days elapsed between the two dates is divided by 365, i.e., the year is assumed to have 365 days.

- **A/A (Actual by Actual)**

In this method, the actual number of days elapsed between the two dates is divided by the actual days in the year. If the year is a leap year AND the 29th of February is included between the two dates, then 366 is used in the denominator, else 365 is used. Using this method, accrued interest is 3.8356

- **30/360 (30 by 360 – American)**

This is how this convention is used in the US. Break up the earlier date as D(1)/M(1)/Y(1) and the later date as D(2)/M(2)/Y(2). If D(1) is 31, change D(1) to 30. If D(2) is 31 AND D(1) is 30, change D(2) to 30. The days elapsed is calculated as Y(2)-Y(1)*360+M(2)-M(1)*30+D(2)-D(1)

- **30/360 (30 by 360 – European)**

This is the variation of the above convention outside of the United States. Break up the earlier date as D(1)/M(1)/Y(1) and the later date as D(2)/M(2)/Y(2). If D(1) is 31, change D(1) to 30. If D(2) is 31, change D(2) to 30. The days elapsed is calculated as Y(2)-Y(1)*360+M(2)-M(1)*30+D(2)-D(1)

Importance of market conventions: Prices quoted in the market are driven by conventions. If three dealers in the market were to use different conventions such as 30/360, actual/365 or say 30/365 the prices of securities will vary and this will make trades difficult. Conventions have an important role to play in smoothening the market practices. Another convention is that all prices are quoted for YTM irrespective of the fact that one may buy the security and sell it the very next day though the security may have a residual maturity of 10 years. Here again YTM is adopted as the basis for arriving at a price on an uniform basis and smoothens the market quotes.

As an illustration, consider a 5 year 8% bond of face value Rs. 1,000, with half-yearly coupon payments. Here the coupon rate is 8 % and the coupon payments are every half-year. Each coupon payment is, therefore, half of 8% of 1000, which is Rs.40. Accordingly, this bond promises Rs. 40 every half-year for 5 years – resulting in ten coupon payments. Along with the last coupon payment at the end of five years, there is also a payment of Rs. 1,000, the face value on the maturity date. Therefore, the cash flows are –

40,40,40,40,40,40,40,40,40,1040

You can notice that there are three important characteristics to a bond – *face value, fixed coupon* rate and *maturity date*. There can be deviations to these characteristics. There can be bonds without any coupon payments but only one lump sum payment on the maturity date. They are called zero coupon bonds. There can be coupon payments. But they need not be necessarily fixed. The coupon rate can be determined at the time of coupon payment, by linking the rate to some external indicator like inflation rate or a reference interest rate. Such bonds are called floating rate bonds.Some bonds may not have any maturity date. They may be promises to keep paying some fixed amount forever. Such bonds are perpetuities.

There can be bonds, which do not promise any lump sum payment towards the end. They do not have any face value. They just promise a series of coupon payments. There can be combination of these deviations in different ways, leading to plethora of hybrid instruments. But normally a bond has three intrinsic characteristics – face value, coupon payment and maturity date. These characteristics remain attached to the bond through out its lifetime. They do not change.But there are two more characteristics of a bond that keep changing – one is its price and the other is its yield.

The price of the bond is the price at which it is traded. It is not necessary that a bond is traded at its face value. A bond with a face value Rs.100 need not be traded at Rs.100. It can be traded for an amount less than Rs.100, say Rs.98.50 or at an amount greater than Rs.100, say Rs.102. If it is traded below face value, it is said to be traded at discount. If it is traded above face value, it is said to be traded at premium.

The value at which a bond is traded is the mutually agreed value of the bond; agreed by both the buyer and the seller. How or why do they agree for such a value is the question. To understand this question and its answer, we have to understand the concept of yield of a bond. Yield, in its simplest terms, means the rate of return.

An 8% bond of face value Rs.100 gives the bondholder Rs.8 every year. If the bond is purchased at Rs.100 and if it is giving Rs.8 every year, then the rate of return on the bond is 8%. However, if the bond is purchased at Rs.99 and not at Rs.100, then the return has to be calculated on Rs.99. Since Rs.8 is received on an investment of Rs.99, the rate of return is (8/99)*100 = 8.08%.But in this case, we are not taking into account the difference in the values received at different points of time. While Rs.99 is invested today, Rs.8 is received after one year, two years, three years and so on. . To take such differences into account, we need to use the present values of cash flows.

The rate of return on a bond is thus that rate of return, which equals the present value of all cash inflows on the bond to its price.This rate of return is called yield-to-maturity (YTM) of the bond. When we refer to yield of a bond, we usually refer to its YTM.

Illustration

Find the yield of a 5 year 8% bond of face value Rs.100 purchased at Rs.99.The coupon payment is Rs.8. The term to maturity is 5 years. The face value and the price are Rs.100 and Rs.99 respectively. By inputting the values to the four parameters - Pmt = 8, Nper = 5, FV = 100, and PV = -99 to the Rate function of Excel, we get the rate to be 8.25%.See the negative sign to PV vis-à-vis the positive sign to Pmt and FV.

YTM or yield, as it is called, is nothing but the IRR we have seen in the case of project evaluation. As in the case of IRR, here also it is assumed that this rate does not change through the life of bond, which may not be realistic. Another assumption made is that the bond is held till maturity and is not sold in between. This is also not realistic. However this assumption does not alter the yield-to-maturity concept.

Yield, as we have seen, is derived as that rate that equals present values of all cash inflows and outflows. What does it signify? It is the rate of return expected by the buyer of a bond. The buyer is willing to pay a price (cash outflow) for a series of coupon payments plus face value (cash inflows). She expects to get a rate of return on her investment, which is nothing but the price she is paying for the bond. Yield can be understood to be the expected rate of return. Since all characteristics of the bond - term to maturity, coupon payments and face value - are fixed and pre-determined, it depends mainly on the price.

13.6 BOND VALUATION

From the concept of yield, it is easy to infer that price is nothing but the present value of all future cash inflows discounted at the expected rate of return, which is nothing but the yield-to-maturity or yield.

Illustration

Find the value of a 3-year 8% bond of face value Rs.100, if coupon payments are made every half-year. Assume that the prevailing interest rate on similar bonds is 9%.

We should always keep in mind the difference between coupon rate and expected rate of return. Coupon rate is tagged to the bond. It is generally fixed and does not change over the life of the bond. On the other hand, expected rate of return depends on market realities and perceptions. It is market determined and keeps changing. Prevailing interest rate in the market on similar bonds becomes the expected return for any particular bond.For the bond under consideration, the coupon payments are every half-year at the rate of 8% per annum, which means Rs.4 every half year. Thus the cash flows are –

4,4,4,4,4,104

The appropriate discounting rate is the prevailing interest rate on a similar bond, which is 9% per annum. As the coupon payments are made every half-year, the interest rate is half of 9%, which is 4.5%. There are in all six coupon payments.We can use the PV function as we have the values for all the parameters – Rate = 4.5%, Nper = 6, Pmt = 4; and FV = 100. The present value turns out to be Rs.97.42. We can see that the bond in the illustration 1.8.2 is traded at discount. The reason is obvious. A bond that has a coupon rate of 8% has an expected rate of return of 9%. Since the coupon rate is less than the expected rate of return, price has to be lower to compensate the investor for the difference in expected rate of return and the coupon payments the bond gives. The bond is traded at discount. As a natural corollary, we can say that a bond gets traded at a premium if the prevailing interest rate is less than the coupon rate. Thus,

A bond is traded at discount if the prevailing interest rate is greater than the coupon rate. A bond is traded at premium if the prevailing interest rate is less than the coupon rate **(1.8.1)**

From the two illustrations, we can see that price and yield are two sides of the same coin. Given price, yield can be determined. And given yield, price can be calculated. Yield is nothing but the expected rate of return. It is typically market determined. What are the factors that drive the yield is a different question, which we will not attempt to answer.

Will there be only one yield in the market? The answer is no. Yield for a 5-year bond may not be equal to the yield for an 8-year bond. Typically, yields are different for bonds of different terms to maturity. Based on the market forces that drive them, yields change. Prices change along with yields.

Change in the price of a bond has a great significance to its holder. She gains if prices go up and loses if prices go down. Prices themselves depend on yields. So changes in yields (which are nothing but the prevailing interest rates) affect bondholder. She has to keep re-assessing the value of the bonds she holds.

Thus the value of a bond depends on its yield. It also depends on term to maturity. Let us see the relationship price has with yield and term to maturity - one after the other.

Price goes up when yield goes down
Price goes down when yield goes up **(1.8.2)**

It is expected. When yield, which is nothing but the rate that can be expected in the market, goes up, the buyer will not be interested in paying the same price. She will be willing to pay a lesser price, bringing down the value of the bond. In a similar way, when interest rates go down, the seller will not be interested in receiving the same price. She will be willing to receive a higher price, pushing up the value of the bond.

Illustration

What is the price of a 6-year 8% bond with face value Rs.100 if yield on a similar bond in the market is 8.5%? What will happen to the price if yield goes up by 0.5% to 9%? What will happen if yield goes down by 0.5% to 8%?

We have Pmt = Rs.8, Nper = 6, FV = Rs.100 and Rate = 8.5% Using PV function, we can get the price equal to Rs.97.72.

Now we can change Rate to 9% and obtain price to be Rs.95.51. We can see that as the interest rate goes up from 8.5% to 9%, price comes down from Rs.97.72 to Rs.95.51. a fall of Rs.2.21.

Now suppose instead of rising by 0.5% the interest rate falls by 0.5% to become 8%.

What is the price when yield is 8%? Without any calculation, we can tell the price is Rs.100 (why?).

As interest rate falls from 8.5% to 8%, the price increases from Rs.97.72 to Rs.100, a rise of Rs.2.28.

From the illustration , we can clearly see that the fall and rise in price are not the same for an equal rise and fall in yield. It leads to another interesting observation on the relationship between price and yield.

The fall in the price of a bond for a given rise in the yield is *less* than the rise in the price of a bond for exactly same fall in the yield

Now we will look at the relationship between the price of a bond and its term to maturity. Let us first state the relationship and then discuss its rationale.

As term to maturity decreases, the premium or discount on a bond decreases at an increasing rate

We can make one obvious observation about the price of a bond on the maturity date. On that day, price is equal to face value; there is no premium or discount. On any day prior to the maturity date, the bond is sold at a premium if coupon rate is higher than YTM and is sold at discount if coupon rate is lower than YTM.

The quantum of premium or discount depends on YTM to a great extent. It also depends on how far the maturity date is. Farther the maturity date, greater the quantum of

premium or discount. It decreases as it approaches the maturity date. The rate of decrease increases as the maturity date approaches.

Illustrations 1.8.4 and 1.8.5 serve as examples to understand the relationship between price and term to maturity of a bond. Table 1.8.1 summarizes the observation clearly. The quantum of premium or discount decreases. The decreases are higher as term to maturity approaches.

Illustration 1.8.4

Consider a bond maturing in 3 years with face value Rs.100 and coupon rate 6%. What is its price today if prevailing interest rate is 8%. Assuming that the interest rate remains same, what is the price of the bond after 1 year, after 2 years and after 3 years.

Let us first find the price at the end of three years. At the end of three years, term to maturity is zero. The present value of cash flows is value of cash flows themselves. Therefore, the bond is sold at par – no discount and no premium.

Now let us find the price of the bond at the end of two years. This means that term to maturity is one year. We can use the function PV. The values to be provided are Pmt = 6, FV = 100, Nper = 1 and Rate = 8%. We get the price as Rs.98.15. The bond is sold at discount of Rs.1.85. Similarly, after one year, when term to maturity is two years, we get the price of the bond to be Rs.96.43. The bond is sold at discount of Rs.3.57. As on today, when the term to maturity is 3, the price is Rs.94.85. The discount is Rs.5.15.

A summary of the results is provided in Table 13.1.

Table 13.1 : Term to Maturity and Premium / Discount

(Amount in rupees)

Term to Maturity	*Yield = 4%*		*Yield = 8%*	
	Premium	*Decrease in Premium*	*Discount*	*Decrease in Discount*
3	5.15	5.55		
2	3.57	1.58	3.77	1.78
1	1.85	1.72	1.92	1.85
0	0.00	1.85	0.00	1.92

Illustration 1.8.5

Solve the bond problem in 1.8.4 with the assumption that the interest rate is 4%.

The price of the bond on the maturity date (when term to maturity is 0) is its face value i.e., Rs.100.

When the term to maturity is 1, the price can be obtained as Rs.101.92. It is sold at a premium of Rs.1.92.

When the term to maturity is 2, the price becomes Rs.103.77. The premium increases to Rs.3.77.

The term to maturity today is 3. The price today would be 105.55, quoted at a premium of Rs.5.55.

A summary of these results is presented in Table 13.1.

Table 13.1, we can observe that when yield is 4%, the premium on bond decreases from Rs.5.15 to Rs.3.57 to Rs.1.85 to Re.0 as term to maturity decreases from 3 years to 2 years, to 1 year to 0 years.

However, the difference in decreases in premium from 3 years to 2 years is Rs.1.58. This difference increases to Rs.1.72 between 2 years and 1 year. It further increases to Rs.1.85 between 1 year and 0 year.

Similarly, when yield is 8%, the discount on bond decreases from Rs.5.55 to Rs.3.77 to Rs.1.92 and 0 as time to maturity decreases from 3 to 2 to 1 to 0 years. However, the amount of decrease in discount increases from Rs.1.78 to Rs.1.85 to Rs.1.92.

Before we go further on interest rate changes and risks associated with such changes, let us look at one specific type of bond called zero coupon bond (ZCB). Normally, bonds have two types of cash flows – coupon payments and face value. In the case of ZCBs, there are no coupon payments. There is only one lumpsum payment, the face value, towards the end of term to maturity.

Illustration 1.8.6

Find the price of 7-year zero coupon bond of face value Rs.100 if interest rate is 8%. Compare the price of this bond with a similar bond paying coupons at the rate of 7%.

The price of a zero coupon bond is the present value of Rs.100 received after 7 years, discounted at 8%. By supplying values to parameters Rate = 8%, Nper = 7 and FV = 100 to PV function, we get the price of the ZCB as Rs. 58.35.

If the bond has coupons paid at the rate of 7%, there are yearly payments of Rs.7 for 7 years. In addition to the values supplied to Rate, Nper and FV, supply the value of 7 to the parameter Pmt. We get the price of the coupon paying bond as 94.79.

You can see that the price of the zero coupon bond is less – in fact far less – than a similar coupon bond. It is understandable as there is only cash flow in the case of a ZCB, which is its face value, and that too at the end of the term to maturity.

Illustration 1.8.7

For the bonds in 1.8.6 calculate prices if interest rates goes up to 8.5%. Find out the percent change in the price of zero coupon and coupon bond for the same change in interest rate from 8% to 8.5%.

Using PV function, we can calculate the prices when yield is 8.5%.

The price of the ZCB is Rs.56.49. The price of 7% coupon bond is Rs.92.32.

Table 13.2 presents prices, decrease in prices and per cent decreases for both zero coupon and coupon bonds for the two interest rates 8% and 8.5%.

Table 13.2 : Impact of Interest Rate Change on ZCB and Coupon Bond

	Interest Rate	*Price*	*Decrease in price*	*% Decrease*
Zero Coupon	8%	58.35		
	8.5%	56.49	1.86	3.18
Coupon	8%	94.79		
	8.5%	92.32	2.47	2.61

It can be seen from illustration 1.8.7, and more specifically from Table 13.2, that % decrease in the price of a zero coupon bond for a given % increase in the interest rate is higher than the corresponding % decrease in the price of a coupon bond for the same % increase in the interest rate.

This observation leads to two questions. First. Is holding a zero coupon bond more risky than holding a coupon bond? Second. If so, how much risky? We will try to answer these questions in the next section on interest rate risk.

13.7 DURATION

We have seen that the value of a bond decreases as interest rate increases. But an increase in interest rates has an advantage too. The coupon payments the investor receives can be re-invested at higher rate.

Similarly, when the interest rates fall, the value of the bond increases. But the coupons can be re-invested at lower interest rates.

Thus, there are two risks associated with changes in interest rate. The value of the bond decreases when interest rates rise. But the decrease is off set to some extent because there is a possibility of earning higher returns by re-investing the coupon receipts at a higher rate of interest. When interest rates fall, returns on re-investment of coupon receipts also fall. But they are off set to a great extent by the increase in the value of the bond due to decrease in interest rates.

This understanding answers the two questions raised in the previous section. In the case of ZCB, there are no coupon payments to off set the loss due to reduction in the value of a bond when prices go up. So they are more sensitive to interest rate changes compared to coupon bonds. Thus holding a ZCB is more risky than holding a coupon bond.

The statement is qualitative and answers the first question – compared to a coupon bond, whether ZCB is risky or not. To answer the second question – how much riskier it is, we require a quantitative measure of risk; to be specific interest rate risk.

For deriving such a measure, let us first look at two extreme situations – a cash flow of Rs.100 today and a cash flow of Rs.100 after three years. A cash flow of Rs.100 today carries no interest rate risk at all. While cash flow of Rs.100 after three years carries the risk of interest rate changes for three years. Now compare this with cash flow of Rs.100 after five years, which carries the risk for another two years. It is natural to conclude that a bond that has cash flows at farther time points carry greater risk.

Not all real life cases are extreme cases like above. It is not easy to assess how farther cash flows are in the case of bonds that have different cash flows at different points of time. In such cases, it is useful to find some sort of average time point at which all cash flows are received. The average should be able to indicate how far the cash flows are from today on an average.

For example, consider the cash flows – 8, 8, 8, 8 and 108. There are five cash flows, at the end of years 1,2,3,4, and 5. The simplest average is average of these five years, which is three. But we cannot say that all cash flows, on an average, are received at the end of third year. In fact by that time only Rs.24 is received and Rs.116 is still due. So simple average does not work. One needs to look at weighted average with suitable weights.

Since, there is a larger cash flow towards the end and smaller cash flows at the beginning, probably cash flows themselves can serve as suitable weights.

Thus, the years 1,2,3,4 and 5 can be averaged with weights as 8,8,8,8 and 108, the cash flows received in the corresponding years. Are cash flows appropriate weights? Weights have to be comparable in all respects. Cash flows are all rupees and are comparable in units. But their values across years are not same.

To make values comparable across years, we have to find their present values as it is more appropriate to use present values of the cash flows as weights and not just the cash flows.

So, the weights are present values of the cash flows 8,8,8,8 and 108.

The average time point at which the cash flows can be considered to have been received therefore, is

$$\frac{1 * PV(8) + 2 * PV(8) + 3 * PV(8) + 4 * PV(8) + 5 * PV(108)}{PV(8) + PV(8) + PV(8) + PV(8) + PV(108)}$$

Assuming a discounting rate of 5%, we can find that the average period is 4.35 years.

This average point at which the cash flows are received is called the duration of the bond. Thus we can formally define duration as

$$D = \sum t_i PV(C_i) / \sum PV(C_i)$$

where t_i are the time periods and C_i are the corresponding cash flows. Incidentally, denominator is the price of the bond.

There are some quick observations about duration.

1) Duration is measured in terms of years and months.
2) Duration of any coupon bond is less than or equal to its term to maturity.
3) Duration of a zero coupon bond is its term to maturity.

In addition to the above, we can make some more observations about duration.

1) Higher the duration, more risky the bond; it is a measure of riskiness.
2) Duration serves as a measure of sensitivity of bond's price to variations in yield.
3) Matching durations of assets and liabilities helps in immunizing a portfolio.

Illustration 1.9.1

Which bond carries the lowest interest rate risk (a) 30-Sep-2011 8% (half-yearly) Rs.100 bond (b) 31-Dec-2013 5% Rs.100 bond, and (c) 30-Jun-2012 Rs.100 bond if the prevailing interest rates on similar bonds are 9%, 10% and 9.5% as on June 15, 2006.

Duration for the three bonds can be calculated using the duration formula. But calculation of duration using the formula is little tedious. There is an excel function Duration. It gives duration of a bond with face value Rs.100 after taking inputs to the following parameters:

Settlement (day on which duration is calculated), Maturity (day of maturity of the bond), Coupon (coupon rate), Yld (yield), Frequency (no. of times coupon is paid) and Basis (type of day count).

Settlement date is same for all three bonds and so the input to the parameter Settlement is same, which is 15-Jun-2006. Values to other parameters are different for the three different bonds.

a) Maturity = 30-Sep-2011; Coupon = 8%; Yld = 9%, Frequency = 2 The duration of the bond is 4.32.
b) Maturity = 31-Dec-2013; Coupon = 5%; Yld = 10%; Frequency = 1 The duration of the bond is 6.08
c) Since it is ZCB, its duration is term to maturity itself, which is 6 years 15 days, approximately equaling 6.04.

Since, bond (a) has the least duration it carries the least interest rate risk.

Duration of a portfolio is a weighted average of durations of individual assets in the portfolio; with weights being proportional investments in individual assets.

Illustration 1.9.2

Find the duration of a portfolio comprising bonds (a), (b) and (c) mentioned in 1.9.1 with 30% investment in (a), 40% investment in (b) and 30% investment in (c).

Durations of bonds (a), (b) and (c) are 4.32, 6.08 and 6.04 years.

The weights are 0.3, 0.4 and 0.3, proportions of investments in (a), (b) and (c).

The duration of the portfolio is the weighted average of durations, with weights as proportions of investments. Thus duration of the portfolio is

$4.32 * 0.3 + 6.08 * 0.4 + 6.04 * 0.3 = 5.54$ years

Duration is very useful in immunizing a portfolio. Immunizing means neutralizing the affects of interest rate changes on both assets and liabilities. A bond portfolio can be said to be immunized if it is not very much affected by changes in interest rates. Illustration 1.9.3 helps in understanding the concept of immunization as also the process of immunizing a portfolio, with the help of duration.

Illustration 1.9.3

A portfolio manager has only one cash outflow to make from her portfolio – an amount equal to Rs.10,00,000 to be paid after two years. She has two choices – a bond that matures after one year and the other that matures after three years. There is only one cash flow of Rs.1070 at the end of one year for the 1-year bond. In the case of 3-year bond there are three coupon payments of Rs. 80 and a payment of Rs.1000 at the end of three years. Assuming an yield of 10%, construct an immunized portfolio that meets the Rs.10,00,000 requirement at the end of two years.

The manager can invest all her funds in 1- year bond. She can invest the proceeds of the bond received after one year in a bond that has 1- year maturity. In doing so, she faces reinvestment risk. If interest rates were to decline after 1 year, the funds realised from the first bond have to be reinvested at lower rates of interest.

Alternately, the funds manager can invest in 3-year bonds and sell them at market price after 2 years. The manager in this case faces the price risk. If interest rates were to go up at the time of selling the bond, its price would fall.

Both the strategies - investing in 1-year bond and 3-year bond - entail risks - either reinvestment risk or price risk. Whereas reinvestment risk occurs when interest rates fall, price risk occurs when interest rates rise. As the two risks are caused by interest rate movements in opposite directions, it would be possible to construct a portfolio of these two bonds in such a way that the affects are nullified. It is achieved by constructing the portfolio in such a way that its duration is equal to 2 years.

There is a single cash inflow of Rs.1070 at the end of one year in case of 1-year bond. Its duration, naturally, is 1 year. In the case of 3-year bond, there are annual payments of Rs.80 for 3 years and a payment of Rs.1000 at the end of 3 years. Duration of the 3-year bond can be calculated to be 2.78 years (how?)

We have to now find the proportion of investment to be made in these two bonds. If w_1 and w_2 are proportions invested in 1-year and 3-year bonds, then

$$w_1 + w_2 = 1$$
$$w_1 * 1 + w_2 * 2.78 = 2$$

The first equation states that sum of weights is 1. The second equation stipulates that the duration of the portfolio is 2 years. We can get the proportional investments in the

two bonds by solving the above two equations. From the first equation we can get w_1 to be equal to 1 - w_2. Substituting this value of w_1 in the second equation we get

$$1 - w_2 + 2.78 * w_2 = 2$$

$$1.78\ w_2 = 1$$

$$w_2 = 1 / 1.78 = 0.5618$$

Substituting this value of w_2 in first equation, we get

$$w_1 = 1 - 0.5618 = 0.4382$$

For immunization, the portfolio manager has to invest 56.18% in 3-year bond and 43.82% in 1-year bond. As the yield is 10%, the amount to be invested today to get a cash flow of Rs.10,00,000 after 2 years is obtained as $10,00,000 / 1.1^2$, which equals Rs. 8,26,446.

Using the percentages worked out above one can calculate the investments into 1-year and 3-year bonds to be Rs.3,62,149 (8,26,446 * 0.4382) and Rs.4,64,297 (8,26,446 * 0.5618) respectively.

At 10% yield, the prices of 1-year and 3-year bonds can be worked out to be Rs.972.73 and Rs.950.25. At these prices, the number of 1-year and 3-year bonds purchased would be 372 (3,62,149 / 972.73) and 489 (4,64,297 / 950.25).

All the three possible scenarios regarding yield – decreases, remains same, increases - are considered. Table 13.3 illustrates portfolio immunization if yield at the end of one year – decreases to 9%, remains at 10% and increases to 11%. In all the three cases, you can see that the aggregate portfolio is more or less same as Rs.10,00,000. The portfolio has been constructed with the two objectives - it gives a cash flow of Rs.10,00,000 and it is immunized.

Table 13.3 Immunization of a Portfolio : A Scenario Analysis

(Amount in rupees)

	Yield at the end of one year (y)		
	9%	10%	11%
Value of 372 1-year bonds at the end of 2 years			
Value at the end of 2 years after reinvesting proceeds of 1-year bonds at the end of one year = (1,070 * 372 * (1 + y))	4,33,864	4,37,844	4,41,824
Value of 489 3-year bonds at the end of 2 years			
Value from reinvesting coupons received at the end of first year = (80 * 489 * (1 + y)	42,641	43,032	43,423
Value of coupons received at the end of 2 years = (80 * 489)	39,120	39,120	39,120
Sale proceeds at the end of 2 years = (1,080 * 489 / (1 + y))	4,84,514	4,80,109	4,75,784
Aggregate portfolio value at the end of 2 years	10,00,138	10,00,105	10,00,151

When yield increases, the portfolio's losses owing to the selling of the 3-year bonds at a discount after 2 years is offset by the gains from reinvesting the maturing 1-year bonds and first year coupons of the 3-year bonds at the higher rate. Similarly when the yield falls, the loss from reinvesting the 1-year bonds and first year coupons on the 3-year bonds at a lower rate is offset by selling the 3-year bonds after two years at a premium. Thus, the portfolio is immunized from the effect of movements in interest rates in the future.

13.8 MODIFIED DURATION

We know that the price of a bond depends on the yield and we also know the formula linking price and yield:

$$P = c / (1 + y) + c / (1 + y)^2 + \ldots\ldots + (c + FV) / (1 + y)^n$$

Rate of change of price P with respect to yield, y can be obtained as derivative of the price-yield function.

$$dP / dy = - c / (1 + y)^2 - 2c / (1 + y)^3 + \ldots\ldots - n (c + FV) / (1 + y)^{(n+1)}$$

$$= [-1/(1+y)] [c / (1 + y) + 2c / (1 + y)^2 + \ldots\ldots + n (c + FV) / (1 + y)^n]$$

$$= [-1/(1+y)] D$$

where D is duration. We have already seen that duration is the weighted average of time points at which there are cash flows, weights being present values of cash flows themselves. We have also seen that duration is a measure of riskiness; greater the duration, riskier the bond.

In the above expression, rate of change dP/dy is equal to duration divided by (1+y). We call this term as modified duration. Modified duration gives rate of change of price with respect to yield. We know that dP/dy is rate of change of price with respect to yield. It gives sensitivity of bond's price to small changes in yield. So modified duration measures the rate of change in price for a small change in yield.

We have to note a few important points before we proceed with further discussion.

1) Duration divided by (1+y) is called modified duration (MD), where y is the yield for the appropriate period. For a bond paying coupons every quarter, appropriate y is yield divided by 4.

   $MD = D / (1 + y)$ (2.7.1)

2) Modified duration is the rate of change of P with respect to y i.e., $MD = dP/dy$ (2.7.2)

3. From 2, we can get

   $\Delta P = - MD * \Delta y$ (2.7.3)

   The formula gives the change in price for a small change in yield. The negative sign is to indicate the opposite directions of movement of price and yield.

4) If Äy gives the change in yield in basis points, we get the change in price by multiplying it by modified duration.

5) The rate of change of price for a small change in yield is not uniform. It is different for different levels of yield. So MD has to be calculated whenever there is change in yield.

6) Modified duration as a rate of change is valid only for small changes in yield.

Illustration 2.7.1

Consider a half-yearly 7% Rs.100 bond maturing on Dec 31, 2015. Let expected yield on a similar bond be 7.5% on March 31, 2006. What is the possible impact on the value of the bond if the expected yield goes up by (a) 5 (b) 10 (c) 15 and (d) 20 basis points?

The price of the bond as on March 31, 2006 can be obtained using Excel function PRICE. The inputs to parameters are : Settlement = 31/03/2006; Maturity = 31/12/2005; Rate = 7%; Yld = 7.5%; Redemption = Rs.100; Frequency = 2. It is Rs.96.57.

We can calculate price of the bond for different yields like 7.55, 7.6, 7.65 and 7.7 and then find the changes in the price. The results are tabulated in table 2.71. Columns 3 and 4 of the table give prices and changes in prices, respectively.

However, we know that modified duration gives the relationship between price and yield for small changes in yield. Therefore, it is possible to use modified duration for finding the impact of yield changes on price.

We can use the Excel function MDURATION for which we have to provide inputs to parameters : Settlement = 31/03/2006; Maturity = 31/12/2015; Coupon = 7%; Frequency = 2 and Yld = 7.5%. Modified duration as 6.79.

Changes in prices obtained by the formula -

$$\Delta P = - MD * \Delta y$$

are presented in column 5 of the Table 13.4.

Table 13.4 : Change in price for change in yield

Case	*bp*	*Price (P)*	*P*	*MD * bp*
a	5	96.24	0.33	0.34
b	10	95.90	0.67	0.68
c	15	95.57	1.00	1.02
d	20	95.24	1.32	1.36

From the illustration 2.7.1 and more specifically from Table 13.4, it can be clearly seen that the changes in price for small changes in yield like 5 or 10 basis points (Column 4) is closer to the calculations obtained using modified duration concept (Column 5) compared to slightly higher changes like 15 and 20 basis points.

While seeing the properties of bond prices, we have seen that fall in the price of a bond for a given rise in the yield is less than the rise in the price of the bond for the same fall in the bond's yield (1.8.3). This property can be clearly seen from Column 4. For similar increases in yields (5 bp each time), the change in price is not uniform.

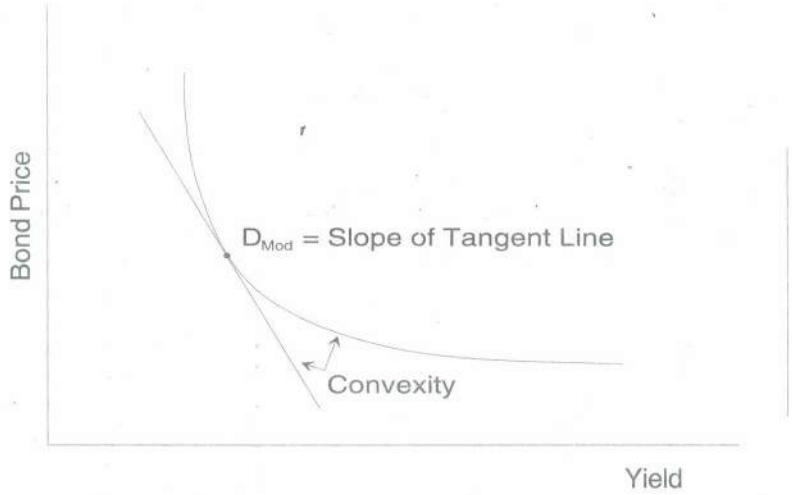
However, calculations using modified duration (Column 5), do not capture this relationship between price and yield. The changes are uniform according to this method. That is because, modified duration, as first order derivative captures the rate of change but not rate of change of rate of change, which is captured by second order derivative.

Bond's price as a function of yield is a decreasing function, but decreasing at a decreasing rate. This property of bond's price is called convexity and can be measured by second order derivative.

Rates of change captured by modified duration are valid for only small changes in yield; this limitation has to be kept in mind while using it.

13.9 CONVEXITY

Calculation of change in price for change in yields based on duration works only for small changes in prices. This is because the relationship between bond price and yield is not strictly linear i.e., the unit change in price of the bond is not proportionate to unit change in yield. Over large variations in prices, the relationship is curvilinear i.e., the change in bond price is either less than or more than proportionate to the change in yields. This is measured by a concept called convexity, which is the change in duration of a bond per unit change in the price of the bond.



Valuation of Straight coupon bond

Bond price is equal to sum of all the discounted cash flows of coupons plus the discounted face value. To calculate the price or value of a bond, we have to discount its expected cash flow to the present by using the appropriate discount rate. The cash flow of a bond consists of coupon payments till maturity plus the par value at the time of maturity.

Bond value = Present value of all coupon + Present value of par value

Important Points

1) Present value of coupons: Is a concept similar to present value of ordinary annuities, so for this part we use the present value annuities formula that is

$$= C/r\ [1 - 1/(1+r)^N]$$

$$= C * PVIFA(r,N)$$

2) Present value of Par value: For this we use simple present value formula that is

$$= FV/(1+r)^N$$

Here we use M in place of FV.

So it is $M/(1+r)^N$, which is also equal to

$$M * PVIF(r,N)$$

$$P = C * PVIFA(r,N) + M * PVIF(r,N)$$

Where P = Bond value or Bond price
C = the annual coupon payment
r = the rate of return of the bond or yield
M = Face value of the bond

Example1.2: The issue date is 12 September, 2007 and maturity date is 12 September, 2022. The face value of the bond is Rs.1000, coupon rate is 10% per annum paid semiannually and yield to maturity is 9%. What is the price of the bond at the issue date?

Solution:

M = Rs.1000; c = 10%
r = 9%; N = 15 * 2 = 30

C = M * c/2 (Coupon is paid semiannually)
= 1000 * 0.05
= Rs.50

$$P = C * PVIFA(r,N) + M * PVIF(r,N)$$

$$= C * \frac{1}{r} \left[1 - \frac{1}{(1+r)^N}\right] + M * \frac{1}{(1+r)^N}$$

$$= 50 * \frac{1}{0.045} \left[1 - \frac{1}{(1 + 0.045)^{30}}\right] + 1000 * \frac{1}{(1 + 0.045)^{30}}$$

$$= 814.44 + 267.00$$

$$= \text{Rs.}1081.44$$

Valuation of Zero Coupon Bond

A zero coupon bond is a debt security that are not paid any interest amount during the life of the bond. Bonds are issued at discount and at the end of the maturity investor will sell it at face value. The difference between the price at which holder buys the bond and the face value is return for the holders.

The value of the zero coupon bond is calculated by following formula:

$$P = \frac{M}{(1 + r)^N}$$

$$= M * PVIF(r,N)$$

Example1.3: The face value of the zero coupon bond is Rs.1000, yield is 8% per annum paid semiannually and time to maturity is 6 years. What should be the price of this bond?

Solution

$$M = 1000, r = 8\%,$$
$$N = 6 * 2 = 12$$
$$P = M * PVIF(r,N)$$
$$= M * \frac{1}{(1 + r)^N}$$
$$P = \frac{1000}{(1 + 0.04)^{12}}$$
$$= \text{Rs. } 624.597$$

Premium, Par and Discount Bond

Premium Bond

A bond is said to be premium bond when its price is greater than its face value. This will occur when the coupon rate is greater than the required rate of return. For example: A bond has issued with a face value of Rs.1000 selling for Rs.1100 would be considered as a premium bond and bond is sell at a premium of Rs.100.

Example 1.4: The issue date is 28-Dec-2007 and maturity date is 28-Dec-2012. The face value of the bond is Rs.1000, coupon rate is 12% per annum paid semiannually and yield to maturity is 10%. What is the price of the bond at the issue date?

Solution

M = Rs.1000; c = 12%
r = 10%; N = 5 * 2 = 10
C = M * c/2 (Coupon is paid semiannually)
= 1000 * 0.06
= Rs.60

$$P = C * PVIFA(r,N) + M * PVIF(r,N)$$

$$= C * \frac{1}{r}\left[1 - \frac{1}{(1+r)^N}\right] + M * \frac{1}{(1+r)^N}$$

$$= 60 * \frac{1}{0.05}\left[1 - \frac{1}{(1+0.05)^{10}}\right] + 1000 * \frac{1}{(1+0.05)^{10}}$$

$$= 463.30 + 613.91$$

$$= Rs.1,077.21$$

Here, we see that when coupon rate is higher than required yield than bond price is more than its face value. We can say that bond is selling at a premium of Rs.77.21.

Discount Bond

A bond is said to be a Discount bond when its price is less than its face value. This will occur when the coupon rate is less than the required rate of return. For example: A bond with a face value of Rs.1000 is selling for Rs. 900 would be considered as a discount bond and the discount is Rs.100.

Solution

M = Rs.1000; c = 12%
r = 14%; N = 5 * 2 = 10
C = M * c/2 (Coupon is paid semiannually)
= 1000 * 0.06
= Rs.60

$$P = C * PVIFA(r,N) + M * PVIF(r,N)$$

$$= C * \frac{1}{r}\left[1 - \frac{1}{(1+r)^N}\right] + M * \frac{1}{(1+r)^N}$$

$$= 60 * \frac{1}{0.07}\left[1 - \frac{1}{(1+0.07)^{10}}\right] + 1000 * \frac{1}{(1+0.07)^{10}}$$

$$= 421.41 + 508.35$$

$$= Rs.929.76$$

So here, we see that when coupon rate is less than the required rate of return than the bond is selling at a discount.

Important Points

1) The price of the Discount bond will gradually increases with the change of time if yield remains unchanged.

Recall the Example 1.5

As we see in the example 1.4 that when coupon rate is 12% and yield is 10% then the bond is sell at premium. Now we see what happens when the coupon is same as 12% but required rate of return (Yield) is 14%.

Years to Maturity	Number of Period	Bond Price
5	10	929.76
4	8	940.29
3	6	952.33
2	4	966.13
1	2	981.92

In the above table we see that at the issue date (28-Dec-2007) when time to maturity of the bond is 5 years or 10 periods, the bond price is Rs.929.76. Gradually as the time decreases (From 5 years to 4 years, 4 years to 3 years or so on), you see the price of the bond is increases and it go up towards the face value.

So in this case it is just opposite of Premium bond. In case of premium bond the bond price decreases with the time whereas in case of Discount bond the price increases with the decline of time. Hence in both the cases the bond price converges to face value at the time to maturity.

Par Bond

A bond is said to be a Par bond when its price is equal to its face value. This will occur when the coupon rate is equal to the required rate of return. A bond with a face value of Rs.1000 is selling for Rs.1000 would be considered as a par bond.

Example 1.6:. Now let us see the bond price when the coupon is same as 12% but required rate of return (Yield) is also equal to 12%.

Solution

M = Rs.1000; c = 12%

r = 12%; $N = 5 * 2 = 10$

$C = M * c/2$ (Coupon is paid semiannually)

$= 1000 * 0.06$

$=$ Rs.60

$$P = C * PVIFA(r,N) + M * PVIF(r,N)$$

$$= C * \frac{1}{r}\left[1 - \frac{1}{(1+r)^N}\right] + M * \frac{1}{(1+r)^N}$$

$$= 60 * \frac{1}{0.06}\left[1 - \frac{1}{(1+0.06)^{10}}\right] + 1000 * \frac{1}{(1+0.06)^{10}}$$

$$= 441.61 + 558.39$$

$$=$$ Rs.1000

So here we see that when coupon rate is equal to the required rate of return than the bond is selling at Par.

Conclusion

1) If r < c then a bond will sell above par value of the bond and such a bond is known as a premium bond.
2) If r > c then a bond will sell below par value of the bond and such a bond is known as a Discount bond.
3) If r = c then a bond will sell equal to par value and such a bond is known as a Par bond.

13.10 SUMMARY

Yield is a measure of the overall return to the investor on his/ her investment. Price of a bond goes up when yield goes down and price goes down when yield goes up A bond is traded at discount if the prevailing interest rate is greater than the coupon rate and is traded at premium if the prevailing interest rate is less than the coupon rate. The fall in the price of a bond for a given rise in the yield is *less* than the rise in the price of a bond for exactly same fall in the yield. Duration is measured in terms of years and months. Duration of any coupon bond is less than or equal to its term to maturity. Duration of a zero coupon bond is its term to maturity.

13.11 SELF ASSESSMENT QUESTIONS

1) What is meant by day count convention?
2) What is duration?
3) How modified duration is calculated?
4) What is convexity?
5) How the value of par bond is calculated?
6) Choose the correct answer (answer marked as ****)
   1) What is the price of a 8%, 5-year annual coupon bond if investors require a 6% return?
      a) Rs.913.35
      b) Rs.1023.87
      c) Rs.1084.25***
      d) Rs.1106.12
   2) What is the required return on a 4-year annual coupon bond that pays a 7% coupon if the bond is selling for Rs.904.90
      a) 7%
      b) 12%
      c) 10%***
      d) 9%
   3) What is the price of a 10-year zero coupon bond if the investor requires a 9% return?
      a) Rs.564.13
      b) Rs.1000.00
      c) Rs.455.55
      d) 385.54***

4) What is the Yield to Maturity (YTM) on a 5-year zero coupon bond that sells for Rs.497.18?

   a) 15%***

   b) 12%.

   c) 8.4%

   d) 7.1%

5) What is the price of a perpetuity that pays a 10% coupon if investors demand a 7% return?

   a) Rs.1009.16

   b) Rs.1090.65

   c) Rs.1183.42

   d) Rs.1428.47***

13.12 FURTHER READINGS

1) Moorad Choudhry, *An Introduction to Bond Markets, 3rd Edition.*

2) Miles Livingston, *Bonds and Bond Derivatives, 2nd Edition.*

3) Stephen J. Antczak, Douglas J. Lucas, Frank J. Fabozzi, Leveraged Finance: Concepts, Methods, and Trading of High-Yield Bonds, Loans, and Derivatives.

4) Moorad Choudhry ert W. Kolb, Ricardo J. Rodriguez, Analysing and Interpreting the Yield Curve.

5) Sharon Saltzgiver Wright, *Getting Started in Bonds, 2nd Edition.*

6) Frank J, Professional Perspectives on Fixed Income Portfolio Management, Volume 4.

7) RBI Publication, *A primer on Government Securities Market.*

UNIT 14 INTEREST RATE RISK MANAGEMENT

Objectives

After studying this unit, you should be able to:

- define the concepts of internal rate risk;
- discuss the process of measurement of interest rate risk; and
- describe the different Techniques of managing interest rate risk.

Structure

14.1 INTRODUCTION

The Oxford Dictionary of Word Origin states the following on risk: "We know well enough what the immediate source of word risk was. The English borrowed French *risqué* in the 17th century. That in turn came from Italian *rischo*, which was based on the Latin verb *rischare* meaning 'to run into danger'. Beyond that, though, we get into uncertain territory. According to one theory it was a nautical term, referring to ships that ran the risk of sailing too close to dangerous rocky coasts. Evidence that supports this idea includes Greek *rhiza* meaning a cliff and the Latin verb *resecare* meaning 'to cut of short' (a rocky cliff being land that has been 'cut off short'), both of which have been claimed as the source of *rischare*.

Risk is an event or injury that can cause damage to an institution's income and/or reputation. It is like energy that cannot be created or destroyed but can only be passed on or managed. There is a direct relationship between risk and reward and the quest for

profit maximization has given rise to accelerated risk taking for enhanced rewards. Whatever be the type of risk, the impact is primarily financial. Ultimately risk manifests in the form of loss of income and reputation. The existence and quantum of risk associated with each transaction cannot be ascertained with certainty. Whatever models have been developed for risk management, are primarily on the basis of observed occurrences of the past, which may or may not be repeated in future. Risk is inherent to business. Since, it cannot be eliminated, it has to be managed.

14.2 CHARACTERISTICS OF RISK

Financial Risk has to be differentiated from loss. Normally, the risks involved in business are fairly known. The risk is probabilistic and generic. Risks in financial markets are events that are likely to happen. The uncertainty is more in respect of time of risk and its impact. There is nothing that can be completely failing or succeeding one hundred percent. There is always a chance element reflected in probability. The risk is generic. Risks are ascertainable, although not always quantifiable. Risk has a direct relationship with return, i.e., higher the risk higher the return and *vice, versa*. Precisely because of this, risks are needed for the conduct of business. The types of risks discussed below are interrelated; they are collectively exhaustive but not mutually exclusive.

14.3 INTEREST RATE RISK

Risk is defined as an event having adverse impact on profitability and/or reputation due to several distinct sources of uncertainty. Interest rate risk occurs due to movements in interest rates. This risk is the possibility that assets or liabilities have to be re-priced on account of changes in the market rates and its impact on the income of the bank. Such situations arise when rates fall or rise, fixed interest rates become variable after maturity or after fixed period or variable interest rates become fixed between two revision dates.

Interest rate risk is the exposure of a bank's financial condition to adverse movements in interest rates. Accepting this risk is a normal part of banking and can be an important source of profitability and shareholder value. However, excessive interest rate risk can pose a significant threat to a bank's earnings and capital base. Changes in interest rates affect a bank's earnings by changing its net interest income and the level of other interest sensitive income and operating expenses. Changes in interest rates also affect the underlying value of the bank's assets, liabilities and off-balance sheet instruments because the present value of future cash flows (and in some cases, the cash flows themselves) change when interest rates change.

The management of Interest Rate Risk should be one of the critical components of market risk management in an investor's portfolio. Deregulation of interest rates has exposed investors to the adverse impacts of interest rate risk. The Net Interest Income (NII) or Net Interest Margin (NIM) of investors is dependent on the movements of interest rates. Any mismatches in the cash flows (fixed assets or liabilities) or repricing dates (floating assets or liabilities), expose investor's NII or NIM to variations. The earning of assets and the cost of liabilities are now closely related to market interest rate volatility.

- It should be remembered that the period between two revisions for interest rates on assets and liabilities are not uniform or constant. Instances of this kind as well as market- driven and regulations-driven changes give rise to interest rate risk. The components of the risk are:
    - basis (change in the basis points in market quotes),
    - yield (change/shift in the yield),

- price (change in pricing policy methodology or price itself),
- reinvestment (impact of interest rate changes on income from re-invested interest),
- embedded option (impact of prepaid loan or pre-mature withdrawal of deposit on earnings) and
- gap (the difference between rate sensitive assets and rate sensitive liabilities)

To manage the interest rate risk it would be useful to distribute various products on the basis of their expected interest flows, as illustrated below:

Expected Interest	Contracted	Contracted but with embedded options	Un-contracted
Fixed	Term loans	Bonds with put or call Option	Guarantees
Variable	Asset based securities LIBOR/MIBOR based loans	Structured products PLR based loans with prepayment options	Insurance claims Certain derivative products

14.4 MEASUREMENT OF INTEREST RATE RISK

a) **Sources of Interest Rate Risk**

Repricing risk

As financial intermediaries, banks encounter interest rate risk in several ways. The primary and most often discussed form of interest rate risk arises from timing differences in the maturity (for fixed rate) and repricing (for floating rate) of bank assets, liabilities and off-balance-sheet (OBS) positions. While such repricing mismatches are fundamental to the business of banking, they can expose a bank's income and underlying economic value to unanticipated fluctuations as interest rates vary. For instance, a bank that funded a long-term fixed rate loan with a short-term deposit could face a decline in both the future income arising from the position and its underlying value if interest rates increase. These declines arise because the cash flows on the loan are fixed over its lifetime, while the interest paid on the funding is variable, and increases after the short-term deposit matures.

Yield curve risk

Repricing mismatches can also expose a bank to changes in the slope and shape of the yield curve. Yield curve risk arises when unanticipated shifts of the yield curve have adverse effects on a bank's income or underlying economic value. For instance, the underlying economic value of a long position in 10-year government bonds hedged by a short position in 5-year government notes could decline sharply if the yield curve steepens, even if the position is hedged against parallel movements in the yield curve.

Basis risk

Another important source of interest rate risk (commonly referred to as basis risk) arises from imperfect correlation in the adjustment of the rates earned and paid on different instruments with otherwise similar repricing characteristics. When interest rates change, these differences can give rise to unexpected changes in the cash flows and earnings spread between assets, liabilities and OBS instruments of similar maturities or repricing frequencies. For example, a strategy of funding a one year loan that reprices

monthly based on the one month U.S. Treasury Bill rate, with a one-year deposit that reprices monthly based on one month Libor, exposes the institution to the risk that the spread between the two index rates may change unexpectedly.

Optionality

An additional and increasingly important source of interest rate risk arises from the options embedded in many assets, liabilities and OBS portfolios. Formally, an option provides the holder the right, but not the obligation, to buy, sell, or in some manner alter the cash flow of an instrument or financial contract. Options may be stand alone instruments such as exchange-traded options and over-the-counter (OTC) contracts, or they may be embedded within otherwise standard instruments. While banks use exchange traded and OTC-options in both trading and non-trading accounts, instruments with embedded options are generally most important in non-trading activities. They include various types of bonds and notes with call or put provisions, loans which give borrowers the right to prepay balances, and various types of non-maturity deposit instruments which give depositors the right to withdraw funds at any time, often without any penalties. If not adequately managed, the asymmetrical payoff characteristics of instruments with optionality features can pose significant risk particularly to those who sell them, since the options held, both explicit and embedded, are generally exercised to the advantage of the holder and the disadvantage of the seller. Moreover, an increasing array of options can involve significant leverage which can magnify the influences (both negative and positive) of option positions on the financial condition of the firm.

b) Effects of Interest Rate Risk

Earnings perspective: In the earnings perspective, the focus of analysis is the impact of changes in interest rates on accrual or reported earnings. This is the traditional approach to interest rate risk assessment taken by many banks. Variation in earnings is an important focal point for interest rate risk analysis because reduced earnings or outright losses can threaten the financial stability of an institution by undermining its capital adequacy and by reducing market confidence.

In this regard, the component of earnings that has traditionally received the most attention is net interest income (i.e., the difference between total interest income and total interest expense). This focus reflects both the importance of net interest income in banks' overall earnings and its direct and easily understood link to changes in interest rates.

Economic value perspective: Variation in market interest rates can also affect the economic value of a bank's assets, liabilities and OBS positions. Thus, the sensitivity of a bank's economic value to fluctuations in interest rates is a particularly important consideration of shareholders, management and supervisors alike. The economic value of an instrument represents an assessment of the present value of its expected net cash flows, discounted to reflect market rates. By extension, the economic value of a bank can be viewed as the present value of bank's expected net cash flows, defined as the expected cash flows on assets minus the expected cash flows on liabilities plus the expected net cash flows on OBS positions. In this sense, the economic value perspective reflects one view of the sensitivity of the net worth of the bank to fluctuations in interest rates.

Repricing Schedules

The simplest techniques for measuring interest rate risk exposure begin with a maturity/repricing schedule that distributes interest-sensitive assets, liabilities and off balance sheet positions into a certain number of predefined time bands according to their maturity (if fixed rate) or time remaining to their next repricing (if floating rate). Those assets and liabilities lacking definitive repricing intervals (e.g. sight deposits or savings accounts)

or actual maturities that could vary from contractual maturities (e.g. mortgages with an option for early repayment) are assigned to repricing time bands according to the judgement and past experience of the bank.

14.5 GAP ANALYSIS

Simple maturity/repricing schedules can be used to generate simple indicators of the interest rate risk sensitivity of both earnings and economic value to changing interest rates. When this approach is used to assess the interest rate risk of current earnings, it is typically referred to as gap analysis. Gap analysis was one of the first methods developed to measure a bank's interest rate risk exposure, and continues to be widely used by banks. To evaluate earnings exposure, interest rate sensitive liabilities in each time band are subtracted from the corresponding interest rate sensitive assets to produce a repricing "gap" for that time band. This gap can be multiplied by an assumed change in interest rates to yield an approximation of the change in net interest income that would result from such an interest rate movement. The size of the interest rate movement used in the analysis can be based on a variety of factors, including historical experience, simulation of potential future interest rate movements, and the judgment of bank management.

A negative, or liability-sensitive, gap occurs when liabilities exceed assets (including off-balance sheet positions) in a given time band. This means that an increase in market interest rates could cause a decline in net interest income. Conversely, a positive, or asset-sensitive, gap implies that the bank's net interest income could decline as a result of a decrease in the level of interest rates.

Activity 1

1) What is gap analysis?

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.....

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2) What is simulation approach?

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Although gap analysis is a very commonly used approach to assessing interest rate risk exposure, it has a number of shortcomings. First, gap analysis does not take account of variation in the characteristics of different positions within a time band. In particular, all positions within a given time band are assumed to mature or reprice simultaneously, a simplification that is likely to have greater impact on the precision of the estimates as the degree of aggregation within a time band increases. Moreover, gap analysis ignores differences in spreads between interest rates that could arise as the level of market interest rates changes (basis risk). In addition, it does not take into account any changes in the timing of payments that might occur as a result of changes in the interest rate environment. Thus, it fails to account for differences in the sensitivity of income that may arise from option-related positions. For these reasons, gap analysis provides only a rough approximation to the actual change in net interest income which would result from the chosen change in the pattern of interest rates. Finally, most gap analyses fail to

capture variability in non-interest revenue and expenses, a potentially important source of risk to current income.

A typical gap statement would divide time into buckets of different time periods. These buckets represent the values of maturing and repricing of assets and liabilities. The gap statement works out the differences between maturing/repricing rate of sensitive assets and liabilities. The gap is translated into an income impact by the simple formula of change in net interest income (NII) equaling the gap multiplied by the assumed change in interest rates. It can also be indicated as Δ NII, where

Δ NII = Change in Interest Rate X (Gap)

A gap statement based risk analysis and its impact on NII has certain inadequacies. The repricing assumes at the same percentage although in reality the interest changes in assets/liabilities across the balance sheet are not uniformly the same. The inability to drill down to have different interest rate variations creates difficulties. Further, the inability to drill down refers to the gap statement having pre-defined buckets and gaps being constructed or computed on these predefined buckets. Were a bucket of one month to register a gap of say Rs. 100 crore, the bank would not be able to grasp from this gap statement as to whether the gap is over one day (with the remaining 29 days having a balanced profile) or it is spread over four weeks. Same case may happen on liabilities side as well. Depending on the maturity within a range of 1 to 30 days in one month bucket, the NII would be impacted. This reality does not get reflected in the gap statement or repricing thereof. There is also a possibility that rates exhibit a lag effect (interest on deposits and loans do not change simultaneously). A gap statement however does not have the capability to model these technicalities.

14.6 SIMULATION APPROACH

In some sense, simulation techniques can be seen as an extension and refinement of the simple analysis based on maturity/repricing schedules. However, simulation approaches typically involve a more detailed breakdown of various categories of on- and offbalance sheet positions, so that specific assumptions about the interest and principal payments and non-interest income and expense arising from each type of position can be incorporated. In addition, simulation techniques can incorporate more varied and refined changes in the interest rate environment, ranging from changes in the slope and shape of the yield curve to interest rate scenarios derived from Monte Carlo simulations.

In static simulations, the cash flows arising solely from the bank's current on- and off-balance sheet positions are assessed. For assessing the exposure of earnings, simulations estimating the cash flows and resulting earnings streams over a specific period are conducted based on one or more assumed interest rate scenarios. Typically, although not always, these simulations entail relatively straightforward shifts or tilts of the yield curve or changes of spreads between different interest rates. When the resulting cash flows are simulated over the entire expected lives of the bank's holdings and discounted back to their present values, an estimate of the change in the bank's economic value can be calculated.

In a dynamic simulation approach, the simulation builds in more detailed assumptions about the future course of interest rates and the expected changes in a bank's business activity over that time. For instance, the simulation could involve assumptions about a bank's strategy for changing administered interest rates (on savings deposits, for example), about the behaviour of the bank's customers (e.g. withdrawals from sight and savings deposits) and/or about the future stream of business (new loans or other transactions) that the bank will encounter. Such simulations use these assumptions about future activities and reinvestment strategies to project expected cash flows and estimate dynamic earnings

and economic value outcomes. These more sophisticated techniques allow for dynamic interaction of payments stream and interest rates, and better capture the effect of embedded or explicit options.

14.7 DURATION AND INTEREST RATE RISK

Duration is a measure of the interest rate sensitivity of an instrument/product. It is defined as the weighted average time to maturity with the weights being the present values of the respective cash flows. Though this concept was originally meant for trading portfolio of bonds/debentures of banks, it has now been extended to the entire balance sheet. The duration of any bond or portfolio is, as was mentioned earlier, an indicator of its rate sensitivity. Duration is a source of interest rate risk. Duration (D) is expressed in years. If interest rates increase 1%, present value of cash flows decrease about D%. This gives rise to a risk of loss/gain in value (assets, liabilities, surplus) due to random interest rate shifts. Both liability and asset cash flows have durations. They react similarly to interest rate changes. If duration for assets and liabilities are equal, the surplus will not be subjected to interest rate risk from the liabilities (or their supporting assets). More specifically, the percentage change in price is equal to the modified duration times the change in interest rate. Numerically, it is indicated below.

Change in Price/Price = - Duration/ (1+Yield) X Change in yields or

Percentage change in price = - Modified duration X change in rates, where modified duration is given as Duration/ (1+yield).

The duration concept is called Macaulay's Duration after Frederick Macaulay, the man to discover the significance of this measure for interest rate sensitivity. Modified Duration is often referred to as Mod. Duration.

The Duration of equity essentially measures the impact of a percentage change in interest rates on the value of equity. Here, equity is defined as the difference between assets and liabilities. The excess of assets over liabilities is reflected as for equity. an example, if the Duration of equity of a bank is 10 years, then an adverse change in interest rate of 1 % would reduce the value of the bank's equity by approximately 10% and a 10% change would almost wipe out the bank's equity. The Duration of equity is the difference between the Duration of assets and that of liabilities. The Duration of the total portfolio of assets is the weighted sum of the Duration of individual assets with the weights being the market values.

The market value of equity is computed as the difference between the market value of assets and liabilities. As gap is an approximate indicator of NII at risk; Duration too has its shortcomings as an indicator of the bank's equity at risk (its validity is best for small changes in interest rates). Most banks now prefer to arrive at the market value of equity at risk by computing the market value of equity at different interest rates and, hence arrive at the impact arising out of variation in interest rates.

The sensitivity of a bank's economic value to fluctuations in interest rates is a particularly important consideration of shareholders, management and supervisors alike. The economic value of an instrument represents an assessment of the present value of its expected net cash flows, discounted to reflect market rates. By extension, the economic value of a bank can be viewed as the present value of bank's expected "net cash flows, defined as the expected cash flows on assets minus the expected cash flows on liabilities plus the expected net cash flows on a balance sheet position. In this sense, the economic value perspective reflects one view of the sensitivity of the net worth of the bank to fluctuations in interest rates.

Since, the economic value perspective considers the potential impact of interest rate changes on the present value of all future cash flows, it provides a more comprehensive

view of the potential long-term effects of changes in interest rates than is offered by the earnings perspective. This comprehensive view is important since changes in near-term earnings - the typical focus of the earnings perspective - may not provide an accurate indication of the impact of interest rate movements on the bank's overall position.

Measures for interest rate risk focus on the two areas that a bank should be concerned about: its short-term profitability (through Gap and NII at risk) and its long-term viabiiity or economic capital (through duration and market value of equity at risk). While the first is usually the immediate area of concern to bank management, the second attracts considerable attention from the regulatory authorities.

It is important to note, however, that duration changes as the coupons are paid to the bondholder. As the bondholder receives a coupon payment, the amount of the cash flow is no longer on the timeline, which means it is no longer counted as a future cash flow that goes towards repaying the bondholder. Duration increases immediately on the day a coupon is paid, but throughout the life of the bond, the duration is continually decreasing as time to the bond's maturity decreases.

Duration will decrease as time moves closer to maturity, but duration will increase momentarily on the day a coupon is paid and removed from the series of future cash flows-all this occurs until duration, as it does for a zero-coupon bond, eventually converges with the bond's maturity.

Besides the movement of time and the payment of coupons, there are other factors that affect a bond's duration: the coupon rate and its yield. Bonds with high coupon rates and in turn high yields will tend to have lower durations than bonds that pay low coupon rates, or offer a low yield. When a bond pays a higher coupon rate, or has a high yield, the holder of the security receives repayment for the security at a faster rate.

The computation of duration is done as under,

Bond	India Government
Coupon	7.50% Yield to Maturity (YTM) 7.50%
Maturity	March 2008
Price	Rs. 100

Coupon Date	*Term years (t)*	*Amount in Rs.*	*Present Value(PV)*	*PV*t*
01-Sept. 2003	0.50	3.75	3.61	1.82
01-March 2004	1.00	3.75	3.48	3.48
01-Sept. 2004	1.50	3.75	3.36	5.05
01-March 2005	2.00	3.75	3.24	6.47
01-Sept. 2005	2.50	3.75	3.12	7.81
01-March 2006	3.00	3.75	3.01	9.03
01-Sept. 2006	3.50	3.75	2.90	10.15
01-March 2007	4.00	3.75	2.79	11.18
01-Sept. 2007	4.50	3.75	2.69	12.13
01-March 2008	5.00	103.75	71.78	359.11

Sum of PV*t = Rs. 426.23
Bond price = Rs. 100

$$\text{Macaulay Duration} = \frac{\text{Sum of PV*t}}{\text{Bond Price}} = \frac{426.23}{100.00} = 4.26 \text{ years}$$

14.8 MODIFIED DURATION AMD INTEREST RATE RISK

Modified duration is an extension of Macaulay duration and is a useful measure of the sensitivity of a bond's prices (the present value of the cash flows to interest rate movements. Modified duration is a measure of the price sensitivity of a bond to interest rate movements. It accounts for changing interest rates. Because the interest rates affect yield, fluctuating interest rates will affect duration. Modified formula shows how much the duration changes for each percentage change in yield. For bonds without any embedded features, bond price and interest rate move in opposite directions. There is an inverse relationship between modified duration and an approximate one-percentage change in yield. As the modified duration shows how a bond's duration changes in relation to interest rate movements, the formula is appropriate for investors wishing to measure the volatility of a particular bond.

Modified duration follows the concept that interest rates and bond prices move in opposite directions. This formula is used to determine the effect a 100 basis point (1%) change in interest rates will have on the price of a bond Modified duration t is calculated as shown below:

$$\text{Modified Duration} = \frac{\text{Macaulay Duration}}{(1+y/n)}$$

Where

y = yield to maturity, and

n = number of discounting periods in year (2 for semi-annually paid bonds)

The Dmod (modified duration) from the earlier example would be worked out as under:

Dmod = 1 * 4.26 / (1 + .075/2) = 4.106 years

Modified duration indicates the percentage change in the price of a bond for a given change in yield. The percentage change applies to the price of the bond including accrued interest. In the section showing a bond's price as the present value of its cash flows, the bond shown was priced initially at par (100), when the YTM was 7.5%, with Macaulay duration of 4.26 years.

Assume that the bond was re-priced for an increase and decrease in rates of 2.5% (i.e., =/- 2.50%) A change in the yield of +/- 2.5% should result in a % change in the price of the bond. The computation of the same is as under:

% Price Change = -1 * Modified Duration * Yield Change
= -/+1* (4.106)*0.025
= -/+ 4.106 * .025
= +/- 0.10265
= (+/- 10.265 %).

Since, the bond was initially priced at par, the estimated prices are $110.27 at 5.00% and $89.74 at 10.00%. In reality, there may be certain variation in the estimated change in the bond price due to the convexity of the bond, which must be included in the price change calculation when the yield change is large. However, modified duration is still a good indication of the potential price volatility of a bond.

14.9 CONVEXITY

The previous percentage price change calculation was not fully accurate because it did not recognize the convexity of the bond. Convexity is a measure of the amount of

"whip" in the bond's price yield curve and is so named because of the convex shape of the curve. Because of the shape of the price yield curve, for a given change in yield down or up, the gain in price for a drop in yield will be greater than the fall in price due to an equal rise in yields. This slight "upside capture, downside protection" is what convexity accounts for. Mathematically Dmod is the first derivative of price with respect to yield and convexity is the second (or convexity is the first derivative of modified duration) derivative of price with respect to yield. An easier way to think of it is that convexity is the rate of change of duration with yield, and accounts for the fact that as the yield decreases, the slope of the price — yield curve and duration, will increase. Similarly, as the yield increases, the slope of the curve will decrease, as will the duration. By using convexity in the yield change calculation, a much closer approximation is achieved.

Using Convexity (C) and Dmod

% Price Chg. =. -1 * D mod * Yield Chg. + C/2 * Yield Chg * Yield Chg

Using the previous example, convexity can be calculated and it results in the expected price change being:

Coupon Date	*Term— years (t)*	*Amount in Rs.*	*Present Value(PV)*	*PV*t*(t+1)*
01-Sept. 2003	0.50	3.75	3.61	2.7
01-March 2004	1.00	3.75	3.48	7.0
01-Sept. 2004	1.50	3.75	3.36	12.6
01-March 2005	2.00	3.75	3.24	19.4
01-Sept. 2005	2.50	3.75	3.12	27.4
01-March 2006	3.00	3.75	3.01	36.1
01-Sept. 2006	3.50	3.75	2.90	45.7
01-March 2007	4.00	3.75	2.79	55.9
01-Sept. 2007	4.50	3.75	2.69	66.8
01-March 2008	5.00	103.75	71.78	2155.6

$$\text{Convexity} = \frac{PV*t*(t+1)}{\text{Bond Price}} = \frac{2429.3}{100.00} = 24.29$$

% Price change = -1 * D mod * Yield Chg. + C/2 * Yield Chg * Yield Chg
= -1*4.106* (0.025+ 12.30)*(0.025)* (1.025)
= Rs. 111.02 at 5.00% and Rs. 90.49 at 10.00%

14.10 ASSET LIABILITY MANAGEMENT

ALM refers to the management of a portfolio of assets and liabilities in order to maximize profitability and stockholders' earnings over long term, consistent with safety and liquidity considerations. ALM addresses to the responsibility of managing the acquisition and allocation of funds to ensure adequate liquidity, maximum profitability and minimizing risks. It includes reviewing recent past performance of exposures as an indicator to take up future activities. It involves the assessment of the funding strategies, as consideration is required to be given to, both liquidity and return. Such exercise calls for monitoring the distribution of assets and liabilities in terms of volume, rates and mix. The review of budgets and earnings is generally the tool used for this purpose.

a) **Spread Management:** Spread or margin, known differently as interest spread or interest margin or net interest spread/margin or net interest income refers to the difference

between interest earned on deployment and interest paid on the acquisition of financial resources. Spread maximization strategy involves:

- Reducing exposure to cyclical rates and stabilizing earnings over the long term.
- Predicting rate changes and planning for such eventualities.
- Co-ordinating rate structure.

b) **Gap Management:** Gap refers to the difference between assets and liabilities that can be impacted due to the change in the interest rates. Such assets/liabilities are referred to as rate sensitive assets (RSA) and rate sensitive liabilities (RSL) respectively. For the gap management purpose, the assets and liabilities are distributed over different time bands/buckets calling for,

- Identifying and matching assets and liabilities over different time bands.
- Optimizing the earnings over a complete economic cycle without moving to an extreme position during any one phase.
- Building a mechanism to expand and contract assets/liabilities in response to rate cycle phases.

c) **Interest Sensitivity Analysis:** This analysis is an extrapolation of gap management strategy. It concerns with the analysis of the impact of interest changes on the bank's spread/margin and resultant overall earnings. The strategy includes,

- Separating fixed and variable interest rate components of balance sheet.
- Listing assumptions regarding rate, volume and mix of the projected portfolio.
- Making alternative assumptions on rise and fall in interest rates.
- Testing the impact of assumed changes in the volume and composition of the portfolio against both, rising and falling interest rate scenarios.

ALM need to be proactive and be commensurate with the business cycle. Consideration has to be given to holding long-term or short-term assets/liabilities with fixed and variable interest rates. Addressing these issues should facilitate better interest sensitivity analysis as also spread and gap management. An illustrative response process is given in the following table,

Gap Position	*Change in Interest Rate*	*Change in Interest Income*	*Change in Interest Expenses*	*Change in Net Interest Income*
POSITIVE	/\	/\	> ++ /\	INCREASE
POSITIVE	\/	\/	> ++ \/	DECREASE
NEGATIVE	/\	/\	< — /\	DECREASE
NEGATIVE	\/	\/	< — \/	INCREASE
ZERO	/\	/\	== /\	NEUTRAL
ZERO	\/	\/	== \/	NEUTRAL

Sign	Signifies
Abbreviations used:	
/\	Rise
\/	Fall
++	Positive, i.e., RSA > RSL
—	Negative, i.e., RSA < RSL
==	Equality, i.e., RSA = RSL
RSA	**R**ate **S**ensitive **A**ssets
RSL	**R**ate **S**ensitive **L**iabilities

Pre-requisites for ALM

For ensuring that ALM process is undertaken successfully, each investor has to recognize the happenings in the market place. These could be

- **Volatility of interest rates:** With the market driven economies, the forces operating the market decide the interest rate structure. Volatile interest rates extend opportunities as also create threats for ALM. The possible profits or losses are huge compared to static and passive market conditions.
- **Changing asset composition:** Similarly, asset composition also needs to change in tune with the changes in the economy, interest rates, priorities of the owners, etc.

14.11 INVESTMENT POLICY

An Investment policy is a set of broad statements that describe the objectives, responsibilities, characteristics and limits on investment portfolio. It is the foundation on which portfolio planning and strategies are based. The portfolio strategy describes how the investment policy is to be implemented given the current and expected market conditions. The policy normally addresses to the issues like purpose, organizational responsibilities, composition of portfolio, acceptable tolerance levels, decision-making processes, etc. A typical Investment policy would have the following contents,

1) Statement of purpose: It can include optimizing income generated from investment consistent with stated liquidity and quality standards regulatory set by the industry/ bank and complying with regulatory requirements.
2) Assignment of responsibilities: The tasks for Board of Directors, chief executive, Investment committee, its members individually, reporting arrangements and like are the part of this section. The role assigned to concurrent/statutory and management audit individually is specified as a part of the assignment of responsibilities.
3) Listing of acceptable investment, their composition as percentage to total investment, pricing ranges and desired maturity patterns.
4) Specification of investment under non-statutory category, minimum credit rating levels, approved credit rating agencies, etc.
5) Guidelines for trading on Investments, monitoring of trading operations and the like.
6) Physical security of paper and authorizations thereto.
7) Accounting procedures including year-end processes like mark to market.
8) Procedures to handle deviations from the policy.

14.12 INTEREST RATE SENSITIVITY POLICY

Interest rate risk refers to the potential impact on Net Interest margin/income or/and market value of equity caused by unexpected changes in interest rates. The risk arises from holding assets and liabilities with different principal amounts and maturity dates/re-pricing dates.

An asset or liability is termed as rate sensitive within a time band if,

1) It represents an interim/partial or final cash flow.
2) The interest rate resets/re-prices during the interval.
3) Regulatory/monetary or government authorities change the interest rates.
4) Assets or liabilities are withdrawn before stated maturity.

A positive gap (RSA>RSL) is desirable when the yield curve is shifting from flat position to negative or humped shape. The interest strategies in relation to business cycle are illustrated below,

Rate sensitivity arises primarily from the impact of future interest changes on the bank's future earnings. It depends on volume, diversity/composition of assets/liabilities and interest pricing. Since banks do not have the benefit of significant amount of fixed rate liabilities or assets, they are exposed to interest rate risk. The broad parameters of Interest Rate Sensitivity Policy are generally as follows:

1) **Purpose of the Policy:** The prime purpose of the policy is evaluating the management of assets and liabilities, their maturity pattern and composition in the context of interest pricing. Such exercise entails visualizing liquidity needs with attendant costs as also initiation of remedial actions.

Phases → ↓ Strategies	Recovery	Prosperity	Recession	Depression
Assets side	Increase RSA Avoid fixed rate loans	Encourage fixed rates to lock in higher yield	Encourage fixed rate loans	Sell fixed rate loans and investments to book profits Increase RSA in anticipation of higher rate when recovery begins
Liabilities side	Encourage fixed rate sources	Encourage short term sources Avoid high cost fixed rate sources	Raise short term sources of funds	Borrow long term at fixed rates
Recommended Gap Position	Positive RSA>RSL	Negative RSA<RSL	Negative RSA<RSL	Positive RSA>RSL

2) **Policy Prescriptions:** There is nothing like an ideal RSA: RSL ratio although desired situations have been narrated aforesaid. The assumptions underlying the prescription need to be documented as a part of the policy. ALCO is required to assess their validity at the planning stage. Accuracy of assumptions is also to be examined by the ALCO at the monitoring stage.

3) **Formats and Procedure for reporting**: Normally, regulatory authorities in each country provide the proformae for such reporting. Individual banks can and do modify these formats. Vertically, rate sensitive assets and liabilities are reflected. The time bands like overnight, one month, one to three months, three to six months, etc. are specified horizontally so as to work out the gaps in each time band as also on a cumulative basis.

4) **ALCO:** The composition of ALCO and the tasks assigned to each member of ALCO are detailed as part of the policy.

5) **Remedial Measures:** The policy has to provide possible corrective measures in adverse gap situations. These include expanding unfixed rate lending, shortening the maturities of investments, use of interest rate swaps, development of sources for fee based or non-interest income and the like.

While developing such policy, it must be recognized that merely keeping a balanced gap position i.e., equating RSA and RSL would not render the bank immune to interest rate risk. Such contention is erroneous because of the following.

- Gap structure is arrived at a given point of time whereas the risk is assessed on a futuristic interest rate structure.
- Impact of interest rate changes is not uniform across all loans and investments.
- Visualizing the bank's strategy to go in for interest swaps is not facilitated by gap structure alone.
- Re-pricable loans and investments may roll over at rates significantly different than current rates.
- Rate sensitivity report may show a balanced position in 1-3 months time band. However, if most of the assets are due re-pricing in the first 45 days, interest rate risk continues to be significant.

14.13 STRESS TESTING

Stress-testing techniques fall into two general categories: sensitivity tests and scenario tests. Sensitivity tests assess the impact of large movements in financial variables on portfolio values without specifying the reasons for such movements. A typical example might be a 100 basis point increase across the yield curve or a 10% decline in stock market indexes. These tests can be run relatively quickly and are commonly used as a first approximation of the portfolio impact of a financial market move. However, the analysis lacks historical and economic content, which can limit its usefulness for longer-term risk-management decisions. Scenario tests are constructed either within the context of a specific portfolio or in the light of historical events common across portfolios. In a stylized version of the specific portfolio approach, risk managers identify a portfolio's key financial drivers and then formulate scenarios in which these drivers are stressed beyond standard VaR (Value-at-Risk) levels. For the event-driven approach, stress scenarios are based on plausible but unlikely events, and the analysis addresses how these events might affect the risk factors relevant to a portfolio. Commonly used events for historical scenarios are the large US $ stock market declines of October 1987, the Asian financial crisis of 1997, the financial market fluctuations surrounding the Russian default of 1998, and financial market developments following the September 11, 2001, terrorist attacks in the United States.

The choice of portfolio-based or event-based scenarios depends on several factors, including the relevance of historical events to the portfolio and the firm resources available for conducting the exercise. Historical scenarios are developed more fully since they reflect an actual stressed market environment that can be studied in great detail, thereby requiring fewer judgments by risk managers. Since such events may not be relevant to a specific portfolio, hypothetical scenarios that are directly relevant can be crafted, but only at the cost of a more labor-intensive and judgmental process. Hybrid scenarios are commonly used, where risk managers construct scenarios that are informed by historical market movements that may not be linked to a specific event. Historical events also can provide information for calibrating movements in other market factors, such as firm credit quality and market liquidity. More generally, risk managers always face a trade-off between scenario realism and comprehensibility; i.e., more fully developed scenarios generate results that are more difficult to interpret. Stress testing is an appealing risk-

management tool because it provides risk managers with additional information on possible portfolio losses arising from extreme, although plausible, scenarios. In addition, stress scenarios can often be an effective communication tool within the banks and to outside parties, such as supervisors and investors.

14.14 INTEREST RATE RISK – SOME MISCONCEPTIONS

There are primarily four myths about risk management. They need to be addressed while setting up the risk organization.

Myth 1: Risk is Bad

Investors are faced by uncertainty whenever they make a decision, but some of that uncertainty can be measured, thus becoming "risk," and through this measurement investors can position themselves to make better decisions. Safety, public policy and insurance professionals continue to see "risk" primarily as a negative, something to be avoided, reduced or shifted. As against this a broader view of risk prevails in the financial and market segments. Such an approach could confuse those who study the discipline. Second, the more restricted view vitiates responses to risk situations. It forms an artificial blinder that constrains the perspective. In the process, the ever-increasing ability to measure risk comes to naught. That risk and uncertainty are important stimulants for life. Uncertainty, far from being a symptom of imperfection, is in fact a natural property of economics, indeed, probably of all life systems. Uncertainty is the name of the game in the service economies and bankers can hardly avoid it.

Risk is a balancing act in which the investors balance the expected rewards of their actions against the perceived costs of failure. Risk always involves a potential reward, whether real or imagined, tangible or intangible. Precisely this is why bankers make decisions involving risk. To deny the reward element is to distort any subsequent decision. It must be acknowledged that not everyone relishes risk and uncertainty. Risk management framework thus becomes "a discipline for dealing with uncertainty," an acknowledgment that both risk and uncertainty are creative stimulants in all walks of life and are all pervasive. Taking risk is the defining element in human existence. Investors should therefore relish, not avoid it; balance, not eliminate it.

Myth 2: The Goal is to Benefit Shareholders

One of the most damaging current thoughts on risk management is that its primary purpose is to serve shareholders, to increase share prices. In the rush to worship the share value, one should not become shortsighted, loosing touch with the longer-term principles that support survival. If the focus is narrow "shareholder value," how does one apply risk management to nonprofits, mutual companies or governmental organizations?

Risk management's most important role is becoming the mechanism that corrects erratic steering, bringing the vessel back on a principled course. The proper course is to serve all stakeholders, from employees and customers, to suppliers, investors, lenders, regulators, and the community at large. A focus on any one set of stakeholders inevitably does injustice to others. The risk management function has a positive obligation to assess and respond to risks and to develop and maintain a continuing two-way dialogue with every stakeholder group.

Risk management, like general management, must serve all stakeholders, not just shareholders. It follows that the single biggest responsibility of the risk management function is intelligent communication with all these groups.

Myth 3: Risk Management is the Responsibility of Specialists

Over the years, numerous pillars of risk management specialization have been erected on the assumption that each specialty is derived from long experience and the classification is exclusive such that outsiders cannot appreciate, leave alone practice the trade. This trend is seen in credit, safety and health, financial derivatives, security, insurance, contingency planning, auditing and contractual and regulatory management. The recent move to strategic, integrated, enterprise, or holistic risk management is recognition that the separation of risk function is not effective.

Allowing the specialists to ply their separate trades does not work. That is one reason why there is a new exclusive Chief Risk Officer (CRO). This person reports to both the Chief Executive and the Board and coordinates the work of other risk specialists. Implicit in the CRO movement is the assumption that risk management is no longer the sole province of specialists. It is now the responsibility of each and every person in the organization. The new goal is to build a culture of risk understanding so that informed decisions may be made at every level, every day

Myth 4: Risk Can be Transferred

There is no such thing as risk transfer; there is only risk sharing. Risk is created by decisions of individuals or organizations. The potential rewards and penalties accrue to that decision maker. Risk remains their responsibility. Some risk may be shared. An entrepreneur shares both reward and loss with investors who buy stock. Some risk may be diversified. A trader sells a derivative. An insurance buyer shares risk with an insurance company, a pooling of funds given to a fiduciary in return for dispensing them under certain circumstances with certain conditions. Yet most of the risk remains with the original decision maker, and the sharing actually creates a new risk, that the counterparty may be unable to meet its obligations.

One of the misunderstandings is that insurance actually solves a risk problem. It does not. It simply provides the possibility of some sharing, some spreading of the risk.

Activity 2

1) What is convesity?

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2) What is stress testing?

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14.15 SUMMARY

Risk is defined as an event having adverse impact on profitability and/or reputation due to several distinct sources of uncertainty. Interest rate risk occurs due to movements in interest rates. The components of the risk are: basis (change in the basis points in market quotes), yield (change/shift in the yield), price (change in pricing policy methodology or price itself), reinvestment (impact of interest rate changes on income from re-invested interest), embedded option (impact of prepaid loan or pre-mature

withdrawal of deposit on earnings) and gap (the difference between rate sensitive assets and rate sensitive liabilities). Interest Sensitivity Analysis is an extrapolation of gap management strategy and concerns with the analysis of the impact of interest changes on the bank's spread/margin and resultant overall earnings.

14.16 SELF ASSESSMENT QUESTIONS

1) What is meant by interest rate risk?
2) What are the components of interest rate risk?
3) What is gap analysis?
4) What is stress testing?
5) What is an investment policy?
6) Choose the most appropriate answer from the given option(Answers marked as ***)

   1) Which of the following is true?
      a) Gap refers to the difference between assets and liabilities that can be impacted due to the change in the interest rates***
      b) Gap refers to the difference between profit earned on sale of securities and interest collected on securities
      c) Gap refers to the excess of interest paid over the price of security
      d) Gap refers to difference between security selling and buying price
   2) Which of the following is an example of basis risk
      a) Asset is priced at fixed rate and liability at floating rate
      b) Both asset and liabilities are priced at floating rates***
      c) Asset is priced at floating rate and liability at fixed rate
      d) All the above
   3) If gap position is positive ,.....
      a) NII increases****
      b) NII decreases
      c) NII remains static
      d) None of the above
   4) Spread or margin, refers to the difference between .....on deployment and ..... on the acquisition of financial resources.
      a) Interest earned and interest paid****
      b) Profit earned and losses made
      c) Sale price and purchase price
      d) Premium and discount
   5) .....is a measure of the interest rate sensitivity of an instrument/ product. It is defined as the weighted average time to maturity with the weights being the present values of the respective cash flows
      a) Yield
      b) Duration***
      c) Gap
      d) Spread

14.17 FURTHER READINGS

1) Moorad Choudhry, *An Introduction to Bond Markets,* 3rd Edition.

2) Miles Livingston, *Bonds and Bond Derivatives,* 2nd Edition.

3) Stephen J. Antczak, Douglas J. Lucas, Frank J. Fabozzi, *Leveraged Finance: Concepts, Methods, and Trading of High-Yield Bonds, Loans, and Derivatives.*

4) Moorad Choudhry, *Analysing and Interpreting the Yield Curve.*

5) Sharon Saltzgiver Wright, *Getting Started in Bonds,* 2nd Edition.

6) Frank J. Fabozzi, *Professional Perspectives on Fixed Income Portfolio Management,* Volume 4.

7) *A primer on Government Securities Market* -RBI Publication.

UNIT 15 INTEREST RATE FUTURES

Objectives

After studying this unit, you would be able to:

- understand the meaning and mechanics of interest rate futures;
- discuss the meaning of conversion factor invoice and cheapest to deliver bond;
- hedging strategies using interest rate futures; and
- investment strategies.

Stucture

15.1 INTRODUCTION

Interest Rate Futures (IRF) is one of the most innovative financial instruments to have been engineered in 1970's.Interest Rate Futures refers to a contractual agreement to buy or sell an underlying interest bearing instrument at a specified future date, at a price, implied by its specific interest rate that is determined today. In a typical IRF, the underlying asset is usually a Treasury-bill, longer-dated Government Security (G-Sec), a Zero-coupon bond, or other such interest bearing securities. They can be short term (less than one year) money market instruments or long term (more than a year) debt market securities.

The reforms initiated in the fixed income securities markets in India resulted in volatility of interest rates since 1991. This exposed the financial statements of large number of corporate and banks to severe interest rate risk and mismatch in asset-liability management. A few basis points fluctuation in interest rate can lead to substantial erosion

in value of investment as well as adversely impact the profit of participating intermediaries. Hence, a need was felt for the introduction of derivative products to hedge interest rate risks.

15.2 SALIENT FEATURES OF INTEREST RATE FUTURES (IRF)

Interest Rate future is a contractual obligation for the contract holder to purchase or sell a bond on a specified date at a predetermined price. An IRF can be bought in a futures exchange market and the prices and dates are determined at the time the future is purchased.IRF contracts are standardized, and are overseen by regulatory agencies that ensures consistency.IRFs offer considerable liquidity with least impact cost and large volumes, due to wider participation. This ensures lower transaction costs. Pricing of product is transparent and uniform. IRFs allow a large number of various stake holders to participate through online electronic trading systems, leading to efficient price discovery. It allows hedgers to efficiently transfer risk to speculators and arbitragers. Exchange traded IRF provides credit guarantee of the clearing house and hence eliminates counter party risk thereby increasing the capital efficiency of the market participants.

15.3 GLOBAL MARKET FOR IRF

Interest rate futures contracts were first traded on October 20, 1975, in the Chicago Board of Trade. In the US, short-term interest rate futures like 9-day T-Bill and 3 month Eurodollar time deposits are more popular for actively traded short-term interest rate futures. Long-term interest rate futures include the 10-year Treasury note futures contract, the Treasury bond futures contract etc. Some of the underlying assets maturing in the short-term, for which Interest Rate Futures are traded world over include:

- 9 months Euro-Dollar
- 90 days T-Bills
- 1 month LIBOR
- 3 month Euro Yen SIMEX, Singapore
- 3 month Euro Dollar LIFFE, UK
- 3 month KLIBOR, MME
- 3 month HIBOR, Hong Kong Future Exchange

Some of the underlying assets maturing in the long-term, for which Interest Rate Futures are traded worldover include:

- T-Bonds (15 years) CBOT
- T-Notes (10 years) CBOT
- T-Notes (5 years) CBOT)
- Japanese Government Bonds (10 years)
- UK Government Bonds
- Australian Government Bonds

Global markets trade futures on two underlying - one at the long end (maturity of 10 years or more) and another at the short end (maturity up to one year) of the yield curve. The futures on the long end of the yield curve are called the Long Bond Futures and futures at the short end of the yield curve are called the T-Bill Futures and Reference Rate Futures. Some markets do trade futures on underlying with multiple maturities say

of 2 years and 5 years as well, but volumes in these products speak for their poor receptivity by market participants. In other words, most of the volumes in the global markets are concentrated on derivatives with one underlying at the long end and one underlying at the short end of the yield curve. In global markets, underlying for the long bond futures is a notional coupon bearing bond. These contracts are generally physically settled but some markets do have cash settled products. For instance, Singapore trades 5 years gilt futures, which are cash settled. Chicago Board of Trade (CBOT) also trades futures on the 10 year Municipal Bond Index, which is also a cash settled product. Methodology of the physically settled products is beyond the scope of this work. The simple thing to understand here is that there are concepts like basket of deliverable bonds, conversion factors, cheapest to deliver bond, delivery month etc. Price quote for long bond futures is the clean price of the notional bond, across the markets.On the short end of the yield curve, global markets have two kinds of products – T-Bill futures and reference rate futures. T-Bill futures are essentially the futures on the notional T Bills, which are physically settled. But, reference rate futures are the futures on reference rates like London Inter-bank Offer Rates (LIBOR) and are cash settled. Over a period of time, these reference rate futures have rendered the T-Bill futures out of fashion. Possible reasons for this phenomenon are that they are easy to comprehend, have very wide participation from across the globe and are cash settled. The success of reference rate futures may be measured by the volumes they command in the international markets. Indeed, all major markets across the globe trade them. For instance, Japan trades futures on the Japan inter-bank offer rates (JIBOR), Singapore trades futures on Singapore inter-bank offer rates (SIBOR), Hong Kong trades futures on Hong Kong inter-bank offer rates (HIBOR).

Interest Rate Futures assume significant position in Global Exchange Traded Futures markets. As per Bank for International Settlements (BIS) 2008 data, Interest Rate Futures contribute 90% of the total volume, about 75% of total contracts outstanding, and nearly 50% of the total turnover of the markets. They are actively traded on CME Group, European markets (Liffe and Eurex), South American markets (BM&F and MexDer), and Asian markets (Tokyo and Korea). Of them, CME Group accounts for nearly 50% share in terms of number of contracts traded and notional value

Exchange Traded Interest Rate Futures

Exchange-wise	*2,008*	*2007*	*2006*	*2008*	*2007*	*2006*
Exchange	*Volume Traded (Number of Contracts in millions)*			*Notional Value (USD billions)*		
SHORT-TERM INTEREST RATE FUTURES						
Chicago Mercantile Exchange (CME Group)	598	623	503	598,906	625,694	505,340
Liffe	342	353	296	437,880	435,533	341,274
BM&FBOVESPA	167	221	178	7,887	9,983	7,385
MexDer	62	223	267	549	2,032	26,564
Tokyo Financial Exchange	22	38	31	NA	NA	NA
LONG-TERM INTEREST RATE FUTURES						
CME Group	615	710	512	164,693	159,156	NA
Eurex	589	692	654	94,735	102,896	92,905
Australian SE	39	52	45	3,244	4,378	3,414
Liffe	26	29	23	4,804	5,832	4,357
Korea Exchange	16	14	10	1,529	1,567	1,181

Region-wise	2,008	2007	2006	2008	2007	2006
Exchange	Number of Contracts (in millions)			Turnover (USD billions)		
World	2583	3,077	2,621	1,392,798	1,433,767	1,169,300
North America	1,296	1,582	1,327	774,439	801,680	667,386
Europe	983	1,101	988	543,902	538,134	427,979
Asia and Pacific	114	150	129	63,812	81,498	65,713
Other Markets	190	243	178	10,646	12,455	8,222

15.4 INTEREST RATE FUTURES IN INDIA

Interest rate risk affects not only the financial sector, but also the corporate and household sectors. Banks, insurance companies, primary dealers and provident funds bear a major portion of the interest rate risk on account of their exposure to government securities. As such these entities need a credible institutional hedging mechanism. Today, with a large stock of household financial savings on the assets side and an increasing quantum of housing loans on the liabilities side, interest rate risk is becoming increasingly important for the household sector as well. Moreover, because of the Fisher effect, interest rate products are the primary instruments available to hedge inflation risk which is typically the single most important macroeconomic risk faced by the household sector. In this context, therefore, it is important that the financial system provides the household sector greater access to interest rate risk management tools through Exchange-Traded interest rate derivatives. It is against this background,Interest Rate Futures was introduced in in India in 2003.

Activity 1

1) Explain the salient features of an IRF.

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2) Explain the benefits of IRF for a bank.

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15.5 BENEFITS OF EXCHANGE TRADED INTEREST RATE DERIVATIVES

Interest rate futures, a derivative instrument with linear pay-offs, provide benefits typical to any Exchange. Traded product, such as:

- **Standardization:** Through standardization, the Exchanges offer market participants a mechanism for gauging the utility and effectiveness of different positions and strategies.
- **Transparency:** Transparency, efficiency and accessibility is accentuated through online real time dissemination of prices available for all to see and daily mark-to-market discipline.

- **Counter-party Risk:** The credit guarantee of the clearing house eliminates counter party risk thereby increasing the capital efficiency of the market participants.

15.6 INTEREST RATE FUTURES PERFORMANCE

In 1999, the Reserve Bank of India introduced Over-the-Counter (OTC) interest rate derivatives, such as Interest Rate Swaps (IRS) and Forward Rate Agreements (FRA). With the successful experience, particularly with the IRS, National Stock Exchange (NSE) introduced, in 2003, exchange-traded interest rate futures (IRF) contracts. However, due to a variety of reasons, the IRF failed to attract a critical mass of participants and transactions. In June 2003, exchange-traded IRF was launched with the following three types of contracts for maturities up to 1 year on the NSE.

- Futures on 10-year notional GoI security with 6% coupon rate.
- Futures on 10-year notional zero-coupon GoI security.
- Futures on 91-day Treasury bill.

The volumes in the Interest Rate Futures launched in 2003 did not increase due to the following reasons:

- The use of a ZCYC for determining the settlement and daily MTM price, as anecdotal feedback from market participants seemed to indicate, resulted in large errors between zero coupon yields and underlying bond yields leading to large basis risk between the IRF and the underlying. In other words, it meant that the linear regression for the best fit resulted in statistically significant number of outliers.
- The prohibition on banks taking trading positions in the IRF contracts deprived the market of an active set of participants who could have provided the much needed liquidity in its early stages.

In late 2003, an attempt to improve the product design was made by SEBI in consultation with RBI and the Fixed Income Money Market and Derivative Association of India (FIMMDA). Accordingly, in January 2004, SEBI dispensed with the ZCYC and permitted introduction of IRF contracts based on a basket of GoI securities incorporating the following important features:

- The IRF contract was to continue to be cash-settled.
- The IRF contract on a 10-year coupon bearing notional bond was to be priced on the basis of the average 'Yield to Maturity' (YTM) of a basket comprising at least three most liquid bonds with maturity between 9 and 11 years.
- The price of the futures contract was to be quoted and traded as 100 minus the YTM of the basket.
- In the event that bonds comprising the basket become illiquid during the life of the contract, reconstitution of the basket shall be attempted, failing which the YTM of the basket shall be determined from the YTMs of the remaining bonds. In case 2 out of the 3 bonds comprising the basket become illiquid, polled yields shall be used.
- NSE commenced the trading in interest Rate Futures on Aug 31, 2009 with a first day turnover of Rs. 2.67 billion rupees .BSE, MCX-SX and the newly –formed United Stock Exchange are waiting in the wings for regulatory go ahead for the formal launch of Interest Rate Futures.

Interest Rate Futures (IRF) are standardized exchange traded derivatives. They are highly liquid, low cost products that enable fund managers to effectively and efficiently manage a fixed income investment portfolio. Interest Rate Futures (IRF) contracts can act as a substitute for the government securities market with one major distinction: In

the G-sec market, a cash transaction demands immediate payment and delivery where as a futures contract provides for the delivery of the cash security at a specified date in the future. IRF allows the buyer and seller to agree upon the price today but defer delivery of the instrument and its payment until a future date. Both buyer and seller must abide by the futures contract's specifications of the exchange. The standardization of financial futures allows market participants to offset their obligations to make or take delivery by simply executing an offsetting trade to cover the existing position or by actual physical delivery. The futures contract will track the price of its underlying G sec security. Since, futures are not coupon bearing instruments, they do not have yields. Trading activity is conducted in a liquid and competitive market. Price negotiation creates a market where the bids and offers are publicly disseminated and transparent.

Generally, interest rate futures contracts will be traded using a price index, which is derived by subtracting the futures' interest rate from 100.00. For instance, an interest rate of 5.00 percent translates to an index price of 95.00 (100.00 – 5.00 = 95.00). Given this price index construction, if interest rates rise, the price of the contract falls and vice versa. Therefore, to profit from declining interest rates, you would buy the futures contract (go long); to profit from a rise in interest rates, you would sell the contract (go short). In either case, if your view turns out to be correct, you will be able to liquidate or offset your original position and realize a gain. If you are wrong, your trade will result in a loss.

15.7 PRODUCT FEATURES OF IRF

Name: 10-Year Notional Coupon-bearing Government of India (GoI) Security Futures

- **Underlying**

  10-Year Notional Coupon-bearing GoI security

- **Coupon**

  The notional coupon would be 7% with semi-annual compounding.

- **Trading Hours**

  The Trading Hours would be from 9 a.m. to 5.00 p.m on all working days from Monday to Friday.

- **Size of the Contract**

  The Contract Size would be Rs. 2 lakh.

- **Quotation**

  The Quotation would be similar to the quoted price of the GoI security. The day count convention for interest payments would be on the basis of a 360-day year,consisting of 12 months of 30 days each and half yearly coupon payment.

- **Tenor of the Contract**

  The maximum maturity of the contract would be 12 months.

- **Available Contracts**

  The Contract Cycle would consist of four fixed quarterly contracts for entire year expiring in March, June, September and December.

- **Daily Settlement Price**

  The Daily Settlement Price would be the closing price of the 10-year Notional Coupon-bearing GoI security futures contract on the trading day. (Closing price = Weighted Average price of the futures for last half an hour). In the absence of last half an hour trading the theoretical price, to be determined by the exchanges,would be considered as Daily Settlement Price. The exchanges will be required to disclose the model/methodology used for arriving at the theoretical price.

- **Settlement Mechanism**

  The contract would be settled by physical delivery of deliverable grade securities using the electronic book entry system of the existing Depositories (NSDL and CDSL) and Public Debt Office (PDO) of the RBI. The delivery of the deliverable grade securities shall take place from the first business day of the delivery month till the last business day of the delivery month. The owner of a short position in an expiring futures contract shall hold the right to decide when to initiate delivery. However, the short position holder shall have to give intimation, to the Clearing Corporation, of his intention to deliver two business days prior to the actual delivery date.

- **Deliverable Grade Securities**

  GoI securities maturing at least 7.5 years but not more than 15 years from the first day of the delivery month with a minimum total outstanding stock of Rs 10,000 crore.

- **Conversion Factor**

  The Conversion Factor for deliverable grade security would be equal to the price of the deliverable security (per rupee of the principal), on the first day (calendar day) of the delivery month, to yield 7% with semiannual compounding. For deliveries into 10-Year Notional Coupon-bearing GoI security futures, the deliverable security's remaining term to maturity shall be calculated in complete three-month quarters, always rounded down to the nearest quarter. If, after rounding, the deliverable security lasts for an exact number of 6-month periods,the first coupon shall be assumed to be paid after 6 months. If, after rounding, the deliverable security does not last for an exact number of 6-month periods (i.e. there are an extra 3 months), the first coupon would be assumed to be paid after 3months and accrued interest would be subtracted.

- **Invoice Price**

  Invoice Price of the respective deliverable grade security would be the futures settlement price times a conversion factor plus accrued interest.

- **Last Trading Day**

  Seventh business day preceeding the last business day of the delivery month.

- **Last Delivery Day**

  Last business day of the delivery month.

- **Initial Margin**

  Initial Margin requirement shall be based on a worst case loss of a portfolio of an individual client across various scenarios of price changes. The various scenarios of price changes would be so computed so as to cover a more than 99% VaR over a one day horizon. In order to achieve this, the price scan range may initially be fixed at 3.5 standard deviation4. The initial margin so computed would be subject to a minimum of 2.33% of the value of the futures contract on the first day of trading in 10-year Notional Coupon-bearing GoI security futures and 1.6% of the value of the futures contract thereafter. The initial margin shall be deducted from the liquid net worth of the clearing member on an online, real time basis. One tailed standard normal variate corresponding to 99 % confidence interval is 2.33. However, simulation on the historical data showed that 99 % of data could be covered only with 3.5 times standard deviation.

- **Extreme Loss Margin**

  Extreme loss margin of 0.3% of the value of the gross open positions of the futures contract shall be deducted from the liquid assets of the clearing member on an on line, real time basis.

- **Calendar Spread Margin**

  Interest rate futures position at one maturity hedged by an offsetting position at a different maturity would be treated as a calendar spread. The calendar spread margin shall be at a value of Rs.2000/- per month of spread. The benefit for a calendar spread would continue till expiry of the near month contract.

15.8 INTEREST RATE FUTURES ANALYTICS

The underlying asset for the Interest Rate Futures contract to be traded on Indian exchanges is based on the 10-year notional coupon bearing Government of India Security. The notional coupon would be 7% with semi-annual compounding. The lot size is Rs. 2,00,000. Though, the Interest Rate Futures prices are quoted in terms of this hypothetical bond, the owner of a short position in the expiring futures contract can choose to deliver any treasury bond that is maturing at least 7.5 years but not more than 15 years from the first day of the delivery month with a minimum total outstanding stock of Rs 10,000 Crores.

Conversion Factor

The underlying bonds within the prior mentioned tenor - which are eligible for delivery trade at different prices. Because of the variation in bond prices, the interest rate futures contracts specify a Conversion Factor that is announced by the exchange.

> The Conversion Factor for deliverable grade security would be equal to the price of the deliverable security (per rupee of the principal), on the first day (calendar day) of the delivery month, to yield 7% with semi-annual compounding.

For deliveries into 10-Year Notional Coupon-bearing Government of India Security Futures, the deliverable security's remaining term to maturity shall be calculated in complete three-month quarters, always rounded down to the nearest quarter. If, after rounding, the deliverable security lasts for an exact number of 6-month periods, the first coupon shall be assumed to be paid after 6 months. If, after rounding, the deliverable security does not last for an exact number of 6-month periods (i.e. there are an extra 3 months), the first coupon would be assumed to be paid after 3 months and accrued interest would be subtracted.

Example 1

Consider the GS CG6.05%2019 bond with 10 years and two months to maturity. For the purposes of calculating the conversion factor, the *bond is assumed to have exactly 10 years to maturity*. The first coupon payment is assumed to be made after six months. Coupon payments are then assumed to be made at six-month intervals until the end of 20 years when the principal payment is made. Assume that the face value is Rs. 100. When the discount rate is 7% per annum with semi-annual compounding (or 3.50% per six months), then the value of the bond is calculated as follows:

$$\sum_{i=1}^{20} \frac{3.025}{(1.035)^i} + \frac{100}{(1.035)^{20}} = \text{Rs.}93.249.$$

Dividing by the face value of the bond gives us a conversion factor of 0.93249. Following are the calculations for the above pricing.

Semi-Annual Coupon Payment	*Cash Flow (Rs)*	*Discount Factor*	*Discounted Cash Flow (Rs)*
1	3.0250	1.035000	2.92271
2	3.0250	1.071225	2.82387
3	3.0250	1.108718	2.72838
4	3.0250	1.147523	2.63611
5	3.0250	1.187686	2.54697
6	3.0250	1.229255	2.46084
7	3.0250	1.272279	2.37762
8	3.0250	1.316809	2.29722
9	3.0250	1.362897	2.21954
10	3.0250	1.410599	2.14448
11	3.0250	1.459970	2.07196
12	3.0250	1.511069	2.00189
13	3.0250	1.563956	1.93420
14	3.0250	1.618695	1.86879
15	3.0250	1.675349	1.80559
16	3.0250	1.733986	1.74454
17	3.0250	1.794676	1.68554
18	3.0250	1.857489	1.62854
19	3.0250	1.922501	1.57347
20	3.0250	1.989789	1.52026
20	100.0000	1.989789	50.25659
	Present Value of Bond		**93.24911**

Example 2

On 1st November 2009, consider the GS CG8.39%2018 bond with 9 years and four months to maturity. For the purposes of calculating the conversion factor, the *bond is assumed to have exactly 9 years and 3 months to maturity*. In such circumstances, it should be assumed that the first coupon would be paid after 3 months and the accrued interest should be subtracted.

Thus, discounting all payments back to a point in time, 3 months from today, at 7% per annum (compounded semi-annually) gives a value as follows:

$$\sum_{i=1}^{18} \frac{4.195}{(1.035)^i} + \frac{100}{(1.035)^{20}} = \text{Rs.}109.1668$$

Following are the cash flow computations. It may be noted that the coupon payment "0" corresponds to the point in time after 3 months when the next coupon payment is due. The discounted value of future cash flows is valued at Rs. 109.1668 for a date 3 months from today (i.e., 1st November 2009)

Semi-Annual Coupon Payment	*Cash Flow (Rs)*	*Discount Factor*	*Discounted Cash Flow*
1	4.195	1.035000	4.05314
2	4.195	1.071225	3.91608
3	4.195	1.108718	3.78365
4	4.195	1.147523	3.65570
5	4.195	1.187686	3.53208
6	4.195	1.229255	3.41264
7	4.195	1.272279	3.29723
8	4.195	1.316809	3.18573
9	4.195	1.362897	3.07800
10	4.195	1.410599	2.97391
11	4.195	1.459970	2.87335
12	4.195	1.511069	2.77618
13	4.195	1.563956	2.68230
14	4.195	1.618695	2.59159
15	4.195	1.675349	2.50396
16	4.195	1.733986	2.41928
17	4.195	1.794676	2.33747
18	4.195	1.857489	2.25842
18	100.000	1.857489	53.83611
Value of Bond 3 months from Today			**109.16683**

The interest rate for a 3 month period is v1.035 – 1, or 1.7349%. This is calculated based on the formula:

$$r = \sqrt{(1+R)} - 1 \ldots \text{Equation 7.1}$$

Equation 7.1

where
R is the 6 month interest rate
r is the 3 month interest rate

Hence, discounting back to the present date gives the bond's value as follows:

$$\frac{109.16683}{1.017349} = \text{Rs. } 107.3051$$

Subtracting the accrued interest of 8.39/4 = 2.0975, this becomes Rs. 105.2076. Thus, the conversion factor is therefore 1.052076.

In both the above examples, we have analyzed the method to calculate the conversion factor.

Activity 2

1) Explain the product features of IRF.

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2) Explain with illustration calculation of conversion factors.

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15.9 PRICING OF INTEREST RATE FUTURES

At the time of delivery period, It is up to the short position holder in Interest Rate Futures to decide which Government Security to deliver. Therefore, he/she identifies the Cheapest-to-Deliver (CTD) bond. This is done by computing the cost of delivery for each deliverable bond as follows:

Cost = (Quoted Price + Accrued Interest) - (Quoted Futures Price X Conversion Factor + Accrued Interest).....Equation 7.2

Equation 7.2

This cost of delivery should be the least for the security to be considered for delivery.

It may be noted that the quotation for bonds is given by:

Cash Price = Quoted Price of Bond + Accrued Interest since last Coupon Date.....Equation 7.3

Equation 7.3

The theoretical value of an Interest Rate Futures contract is calculated using the following formula:

$$F_0 = (S_0 - I)e^{rt} \quad \text{.....Equation 7.4}$$

Equation 7.4

Where

F_0 Interest Rate Futures contract price

S_0 Price of an asset underlying the Interest Rate Futures contract

I Present value of coupons during the life of the futures contract

r Risk free interest rate per annum (continuously compounded)

t Tenor of futures contract (time to maturity)

The assumption underlying an interest rate futures contract is that both the *Cheapest-to-Deliver (CTD)* bond and the Delivery date are known. Then the relationship of the futures price to the spot price can be determined.

Steps for Calculation of Interest Rate Futures Price

The stepwise calculation of futures price is as follows:

1) Calculate the cash price of the cheapest-to-deliver bond from the quoted price.

2) Calculate the cash futures price from the cash bond price using the above equation.

3) Calculate the quoted futures price from the cash futures price.

4) Divide the quoted futures price by the conversion factor.

When a particular bond is delivered, a parameter known as its *"Conversion Factor"* defines the price received by the party with the short position. The quoted price applicable for delivery is the product of the conversion factor and the quoted futures price.

Example

Assume that for an Interest Rate Futures contract with underlying as a notional 10-year Central Government Security, the cheapest to deliver bond is a 14% coupon bond with a conversion factor of 1.37. Delivery will take place after 280 days. The term structure is flat and the rate of interest is 10% per annum. Assume that the current quoted bond price is Rs. 120 with semi-annual coupon payment. The previous coupon date was 45 days ago, the next coupon date will be 137 days from the present date, and the next to next coupon date will be in 320 days from the present.

A diagrammatic representation is as follows:

We need to compute the following:

I) The cash price of the bond.
II) The present value of next coupon payment to be received.
III) The futures price of the bond, calculated from the cash price.
IV) The quoted future price from cash futures price.
V) The quoted futures price.

Solution:

I) Given the current quoted bond price of Rs. 120, the cash price would be the quoted inclusive of the accrued interest, (*refer to equation 7.3*) Cash price = 120 + [45/(45+137) X 7] = Rs. 121.7308

II) The present value of the coupon payment of Rs. 7 to be received after 137 days (0.3753 year) is, $= 7e^{-0.3753 \times 0.10}$ = Rs. 6.7421

III) The futures contract lasts for 280 days (= 0.7671 year). Thus, the cash futures price of a 14% bond would therefore be (*as per Equation 7.4*): $(121.7308 - 6.7421)e^{0.7671 \times .1}$ = Rs. 124.1566

IV) At the point of delivery, the accrued interest would be for 143 days. This has to be deducted from the cash futures price to calculate the quoted futures price, 124.1566 - 7 X [143/(143+40)] = Rs. 118.6866

V) The contract is based on a standard notional 7% Government Security, and 1.37 standard bonds are considered to be equivalent to each 14% bond, as 1.37 is the conversion factor. Therefore, the quoted futures price is calculated as follows:

$$\frac{118.6866}{1.37} = \text{Rs. } 86.6326 = \text{Quoted Futures Price}$$

Thus, from the price of the bond and having details about the coupon payment schedule, as well as the conversion factor, we have calculated the value of the futures contract.

15.10 DETERMINATION OF CHEAPEST TO DELIVER BOND

Following is the methodology to calculate the Cheapest-to-Deliver bond.

The seller may choose the bond to deliver from the bonds eligible for delivery. The factors which affect the bond yield include the bond price, the coupon, and the time until maturity. Therefore, bonds with coupons of 6% may not yield exactly 6%, but may be

more or less than that. Five percent bonds yielding 6% necessarily sell for less than par, while 7% bonds yielding 6% sell for more than par. The conversion factor makes all bonds equally attractive for delivery only when the bonds under consideration yield 7% (which is the notional coupon 10-year GoI, based on which futures contract trade). If they yield more or less than 7%, one bond will have the *lowest adjusted price*, and hence be *cheapest to deliver*.

Since the party with the short position receives the amount based on,
(Quoted Futures Price X Conversion factor) + Accrued Interest

The short position holder's cost of purchasing the bond is:
Quoted price of bond + Accrued Interest

Therefore, the cheapest to deliver bond is the one for which:
(Quoted price of bond) - (Quoted Futures price X Conversion Factor)
is the minimum as discussed earlier.

Example:

The short position holder in the Interest Rate Futures has decided to make delivery against his outstanding position. Thus, he is trying to choose between the following 3 bonds (as given below):

Bond	*Quoted Price of Bond*	*Conversion Factor*
1	98.50	1.0182
2	134.50	1.4088
3	128.75	1.3485

Given a quoted futures price of 93.25, the cost of delivering each of the bonds is:

Bond	1:	98.50	-	(93.25×1.0182)	=	3.55
Bond	2:	134.50	-	(93.25×1.4088)	=	3.12
Bond	3:	128.75	-	(93.25×1.3485)	=	3.00

The cheapest to deliver security is Bond 3

15.11 INVESTMENT STRATEGIES USING INTEREST RATE FUTURES

Speculation

Speculation involves the attempt to profit over the short term from fluctuating prices. A speculator is a person who consciously seeks to take risk hoping to profit from subsequent price movements. For example, he/she may take a view that interest rates will soften after six months and buy government securities today in the hope that he can sell the securities after six months at a higher price. If the interest rate softens six months down the line as predicted by him, he/she can make a profit. If it does not, he has to forego the profit potential and may even incur a loss.

Arbitrage

Arbitrage involves simultaneously buying and selling the same asset in two different markets at two different prices in order to exploit pricing inefficiencies across markets and earn riskless profit.

Example: A security with a known price in the future, must today trade at that price discounted at the risk free rate.

a) Where the discounted future price is *higher* than today's price:

- The arbitrageur agrees to deliver the security on the future date and simultaneously buys it today with borrowed money.
- On the delivery date, the arbitrageur hands over the underlying, and receives the agreed price.
- He/she then repays the lender the borrowed amount plus interest.
- He/she difference between the agreed price and the amount owed is the arbitrage profit.

b) Where the discounted future price is *lower* than today's price:

- The arbitrageur agrees to pay for the security on the future date and simultaneously sells the underlying today;
- He/she then takes delivery of the underlying and pays the agreed price using the sale price.
- The difference between the sale price and the agreed price is the arbitrage profit.
- Hedging through futures.

Hedging interest rate risks with interest rate futures

Hedging means taking an opposite position to what one has in cash market. The rationale for taking this opposite position is to set off any gain or loss one incurs in cash market against loss or gain in futures markets.

Interest rate futures can be used to protect against an increase in interest rates as well as a decline in interest rates. By selling interest rate futures, also known as short hedging, an investor can protect himself against an increase in interest rates; and by buying interest rate futures, also known as long hedging, an investor can protect himself against a decline in interest rates.

For example, assume an investor expects a cash inflow after six months and plans to invest the same in long-term bonds. He is worried that interest rates may fall and his investment would yield low. He wishes to hedge against this unfavorable movement in interest rate. He can hedge this risk by buying bonds in the futures market today.Similarly, an investor expects a cash outflow after six months on account of scheduled repayment and plan to borrow. He is worried that interest rates may rise and his borrowing cost would rise. He wishes to hedge against this unfavorable movement in interest rate. He can hedge this risk by selling bonds in the futures market today.

The pay off without hedging for both the (expected) positions are given below.

Hedging mechanics

Expected position in cash market	Risk to be hedged	Position to be taken in Futures markets
Borrowing funds	Rise in interest rate	Short / sell the future
Lending funds	Fall in interest rate	Long / buy the future

Example I

On June 6, 2009, the treasurer of a corporate comes to know about a funds requirement of Rs.10 million on Sep 15, 2009, for a 3-month period. A bank has also agreed to provide the loan of Rs.10 million for a 3-month MIBOR rate prevailing on Sep 15, 2009. Since the firm is concerned about an increase in the MIBOR rate, it decides to go short on Sep IRF (money market) contract to protect itself from any increase in the interest rate between June 6 and Sep 15.

The risk of an increase in interest rates can be hedged by selling interest rate futures.

The corporate enters into ten contracts because the size of one IRF money markets is assumed to be of Rs.1 million. Assume that on June 6, the Sep IRF 91 T Bill future is at 92.86 and the implied three-month repo is 7.14%, and the 3-month MIBOR therefore in Sep is 7.14%. Since MIBOR rates are always quoted for one year, 7.14% implies 7.14% per annum. Assume the tick size is 25.

> The firm can lock a 3-month 91 days T Bills future rate of 7.14% and thus limit its borrowing cost to:
> = Rs10, 000,000 X (7.14/100) X 3/12
> = Rs.178, 500

To limit the borrowing cost, the firm will have to sell 10 Sep 91 days T Bill futures contract on June 6, because if the interest rates rise, the price of the contract will go down and the firm can settle the contract by purchasing it at a lower price and thereby gaining in the futures market.

Case I

The 3-month MIBOR rises to 8.5% by Sep 15 (thus the Sep futures will be priced at 91.5, since the Money market IRF is quoted as 100 – MIBOR) Interest Expense = (Principal) × (Annual Rate) × 3/12 = Rs. 10,000,000 × 8.5% × 3/12 = Rs. 212,500 Less: Futures Gain = (Price Change) × (25/BP) × 10 = (92.86 – 91.5)*0.25*10,000,000

100

= Rs. 34000
Net borrowing cost = Rs. (212,500 - 34,000)
= Rs. 178,500

Case II

The 3-month MIBOR falls to 6.5% by March 15 Interest Expense = (Principal) × (Annual Rate) × 3/12 = Rs.100, 00,000 × 6.5% X 3/12 = Rs162, 500
Add: Futures Loss = (Price Change) × (25/BP) X 10 = (92.86-93.5)*0.25*10,000,000

100

= (92.86 – 93.5) × 100 × 25 × 10 = Rs.16, 000
Net borrowing cost = Rs. (162,500 + 16,000) = Rs. 178,500

In both the above cases, the corporate has locked its cost of borrowing at Rs. 178, 500. In the first case, a rise in interest expenses is compensated by a gain on the short futures position.

Connect between Cash and Futures Markets: G-Sec markets

The 'connect' between the two markets throughout the contract period and also forces convergence between the cash and futures markets, at settlement. In case of discrepancy in prices between the cash market and derivatives market like futures, cash-futures arbitrage, deriving from the 'law of one price' will quickly align the prices in the two markets. Specifically, if futures are expensive relative to the cash market, i.e., if the actual Repo rate is less than the implied Repo rate, arbitrageurs will go long the G-Sec in the cash market by financing it in the Repo market at the actual Repo rate and short the futures contract, thus realizing the arbitrage gain, being the difference between the implied Repo rate and actual Repo rate. On the other hand, if the futures are cheap relative to the cash market, i.e., if the actual Repo rate is more than the implied Repo

rate, arbitrageurs will short the cash market by borrowing the GoI security, for a period exactly matching the tenor/maturity of the futures contract, in the Repo market for delivery into short sale, investing the sale proceeds at the actual Repo rate and go long the bond futures, thereby realizing the arbitrage gain, being the difference between actual Repo rate and implied Repo rate!

In either case, such arbitrage-driven trades will inevitably settle at expiration of the contracts by physical delivery with risk-free arbitrage profits being realized.

Calendar Spread

Traders can assume long and short position in the near-month and far-month futures contracts, based on expectations of movement of the spread differential between interest rates across different tenors. Spread positions are eligible for lower margins, due to spread benefit.

Interest rate futures position at one maturity hedged by an offsetting position at a different maturity would be treated as a calendar spread. The calendar spread margin shall be at a value of Rs. 2000 per month of spread. The benefit for a calendar spread would continue till expiry of the near month contract.

15.12 HEDGING – EXAMPLES

Hedging refers to taking opposite position in futures markets, as compared to the position taken in the cash market. The rationale for taking opposite position in futures market is to set off any loss (or gain) incurred in cash market against gain (or loss) in futures markets, respectively. Futures contracts are linear derivatives: the pay-off is a straight line. When a long position is taken in futures market, because of a short position in the cash market, it is referred to as a long hedge. When a short position is taken in futures market, because of a long position in the cash market, it is referred to as a short hedge.

For example, assume an investor is expecting a cash inflow after six months, and plans to invest the same in long-term bonds. He is worried that interest rates may fall and his investment would yield lower returns. He wishes to hedge against any unfavorable movement in interest rates. He can hedge this risk by buying bonds in the futures market today.

Similarly, a corporate expecting cash outflow after six months on account of scheduled repayment plans to borrow funds in future. But the Chief Financial Officer (CFO) is worried that interest rates may increase – thereby inflating the borrowing cost. The Corporate can hedge against this unfavorable movement in interest rate by selling bonds in the futures market today. This is because, if interest rates increase, then the bond futures yield rate would increase, thereby, decreasing the futures price of bond. Thus, the corporate would obtain profit in futures, compensating for the loss against borrowing funds in the open market.

Example: Corporate Borrowing Long-Term Debt for Infrastructure Expenses

XYZ Company Limited is a well-established infrastructure development company. It has won a contract for building the sea-link between Mumbai and Navi Mumbai. The total cost of the project is approximately Rs. 4,000 Crores, 50% of which is funded using debt over a period spanning the duration of the project – estimated to be 4 years. The loan is syndicated through 2 banks and 4 financial institutions.

In the first tranche of the entire debt structure, XYZ is planning to borrow Rs. 500 Crores, which it plans to repay in 10 years. The interest on the first tranche is payable quarterly based on a major Public Sector Bank's Prime Lending Rate (PLR) prevailing on the interest payment date. The interest payment is commencing on 1st January 2010.

The loan has been sanctioned and first tranche issued on 1st October 2009, when the PLR is 11%.

XYZ is exposed to risk of increase in interest rates (which increase PLR). If inflation increases, then there is likelihood that the Central Bank may increase interest rates, leading to increase in the PLR. This may lead to higher interest rate cash outflow. XYZ decides to hedge using Interest Rate Futures.

1) On 1st October 2009, the December 2009 futures contract on the 10-year Notional 7% coupon-bearing Government Security is trading at Rs. 114, effectively indicating a yield rate of 6.30%.
2) XYZ decides to hedge by taking short position in the Dec 2009 futures contract. The rationale for shorting the futures contract is as follows:
   a) When the interest rate increases, then the yield rate for the underlying G-Sec also increases. This effectively decreases the price of the bond, leading to corresponding decrease in price of the futures contract.
   b) Thus, when XYZ shorts the futures contract, it is protected against any impending increase in the interest rate.
3) The number of lots of the futures contracts should be equivalent to the debt component considered for the duration of hedge. As XYZ increases the loan exposure over the tenor of the project, it needs to increase the hedge exposure, to mitigate against interest rate risk.

Loss due to higher interest rate cash outflow, compensated by, profit from short-hedge position in futures

Example: Bank Investments in G-Secs

ABC Bank Limited is one of the top five public sector banks in India, in terms of deposit mobilization. ABC has invested 30% of its Deposits in SLR securities, well beyond the requirements specified by the Central Bank for investment in SLR securities. 20% of these SLR investment deposits are classified as Held to Maturity (HTM), and balance is classified as Available for Sale (AFS) and Held for Trade (HFT). For the latter two categories of HFT and AFS, ABC Bank has a risk of increase in interest rates, leading to increase in yield rates, eventually resulting in decrease in asset value of investments in Government Securities.

ABC decides to leverage using Interest Rate Futures, for mitigating the risk of decline in asset value of its SLR securities.

On 10th November 2009,

- The yield rate of the 10-year benchmark Indian Government Security, 6.09% GS2019, was trading at 7.13%. The security is priced at Rs. 106.54.
- March 2009 futures contract on the 10-year Notional 7% coupon-bearing Government Security is trading at Rs. 105.32, effectively indicating a yield rate of 7.19%.
- ABC Bank Limited decides to hedge its exposure to SLR securities by taking a short position in March 2009 interest rate futures.

On 1st January 2010,

- Expectedly, the yield rate of the 10-year benchmark Indian Government Security, 6.09% GS2019, has increased to 8.56%. The security price has decreased to Rs. 104.39.
- March 2010 futures contract on the 10-year Notional 7% coupon-bearing Government Security is trading at Rs. 104.56, effectively indicating a yield rate of 8.59%.
- ABC Bank Limited unwinds the short hedge position by buying the futures contract.

Thus, the long position in the cash market was effectively hedged by taking a short futures position.

Market	10th Nov 2009	1st Jan 2010
Cash Market	Buy G-Sec	Sell the G-Sec
Futures Market	Short Futures	Square off hedge Position

Example: Corporate Issuing Bonds with Embedded Put Options at Fixed Rate of Interest

PQR Auto Limited is recognized for innovation and engineering excellence in the automotive industry. For funding its capacity expansion, PQR decides to source funds by issuing bonds, with an option for investors to redeem the bonds after a lock-in of 1 year. The coupon for the bonds has been fixed at a rate of 8.96%. PQR has excellent credit rating of AAA from two independent rating agencies, for issue of these corporate bonds with embedded options.

After 6 months of having issued the bonds, the General Manager - Finance and Treasury has observed that the interest rates in India has increased, due to fast growth of Indian economy. The bank rate which was under 5% has surged by over 100 basis points, due to high inflation rate. Even the PLR has increased by 150 basis points. Banks have commenced increasing the deposit rates. The GM is worried that when the bonds are due for puttability option for optional redemption by investors, there would be a huge demand for funds. This may pose an asset liability mismatch for PQR. In such circumstance, PQR may be forced to redeem the bonds issued at coupon of 8.96% and reissue new bonds at a higher coupon rate.

Thus, in order to mitigate risk against increase in interest rates, leading to redemptions, the corporate decides to hedge using interest rate futures. By taking a short position in interest rate futures, the corporate can effectively ensure that increase in interest rates would lead to decrease in bond prices, thereby, protecting PQR against the interest rate differential between the coupon of already issued bonds at 8.96% and the coupon of the new bonds to be issued.

Example: Retail Investor who has invested in long-term Infrastructure Bonds at benchmark floating interest

Mr. TMN has invested Rs. 3,00,000 of his retirement savings in Infrastructure bonds issued by a leading Financial Institution in India. The bonds provide returns to Mr. TMN based on a floating rate benchmark that is reset in the beginning of every quarter. The latest benchmark is 9.36%.

With the credit crisis slowing the economy, the central bank has been decreasing the repo and reverse repo rates. Thus, the floating interest rate benchmark has also been decreasing, negating the expected returns for Mr. TMN.

Mr. TMN decides to hedge his risk using interest rate futures. He can take a long position in interest rate futures contract, so that when interest rate decreases, the yield

rate of bonds also decrease. This results in corresponding increase in the bond prices. The bond futures prices also increase in tandem, thereby, enabling hedge profit for Mr. TMN.

15.13 RISK MANAGEMENT

a) **Transaction Settlement Guarantee**

The Clearing Corporation of the Exchange or any designated Clearing House will act as a central counterparty to all trades and performs full novation. A robust risk management system needs to not only impose margins on the members of the Clearing Corporation but also enforce collection of margins from the clients.

b) **Portfolio Based Margining**

The Standard Portfolio Analysis of Risk (SPAN) methodology shall be adopted to take an integrated view of the risk involved in the portfolio of each individual client comprising his positions in futures contracts across different maturities. The client-wise margins would be grossed across various clients at the Trading / Clearing Member level.The proprietary positions of the Trading / Clearing Member would be treated as that of a client.

c) **Real-Time Computation of Worst Case Scenario Basis**

The computation of worst loss scenario would have two components:

1) Valuation of the portfolio under the various scenarios of price changes.
2) These scenario contract values would be applied to the actual portfolio positions to compute the portfolio values and the initial margin.

The exchanges shall update the scenario contract values at least 6 times in the day, which may be carried out by taking the closing price of the previous day at the start of trading and the prices at 11:00 a.m., 12:30 p.m., 2:00 p.m., 3.30 p.m. and at the end of the trading session.The latest available scenario contract values would be applied to member/client portfolios on a real time basis.

d) **Minimum Liquid Networth**

Initial margin and the extreme loss margin shall be deducted from the liquid assets of the clearing member. The clearing member's liquid net worth, after adjusting for the initial margin and extreme loss margin requirements must be at least Rs. 50 Lakhs at all points in time. The minimum liquid Networth shall be treated as a capital cushion for days of unforeseen market volatility.

e) **Liquid Assets**

The liquid assets are to be provided separately and maintained with the Clearing Corporation. However, the permissible liquid assets, the applicable haircuts and minimum cash equivalent norms would be mutatis mutandis applicable from the equity/currency derivatives segment.

f) **Mark-to-Market (MTM) Settlement**

1) The MTM gains and losses shall be settled in cash before the start of trading on T+1 day.
2) If MTM obligations are not collected before start of the next day's trading, the Clearing Corporation shall collect correspondingly higher initial margin to cover the

potential for losses over the time elapsed in the collection of margins. The daily closing price of interest rate futures contract for mark to market settlement would be calculated on the basis of the last half an hour weighted average price of the futures contract.

3) In the absence of trading in the last half an hour the theoretical price would be taken. The eligible exchanges shall define the methodology for calculating the 'theoretical price' at the time of making an application for approval of the interest rate futures contract to SEBI.

g) **Monitoring of collection of clients margin by members by the Exchange**

1) The client margins (initial margin, extreme loss margin, calendar spread margin and mark to market settlements) have to be compulsorily collected and reported to the Exchange by the members.

2) The Exchange shall also conduct regular inspections to ensure margin collection from clients, and impose stringent penalty on default.

h) **Safeguarding Client Interests**

The client's money is to be held in trust for client purpose only. The following process is required to be adopted for segregating the client's money *vis-à-vis* the clearing member's money:

a) At the time of opening a position, the member should indicate whether it is a client or proprietary position.

b) Margins across the various clients of a member should be collected on a gross basis and should not be netted off.

c) When a position is closed, the member should indicate whether it was a client or his own position which is being closed.

d) In the case of default, the margins paid on the proprietary position would only be used by the Clearing Corporation for realizing its dues from the member.

15.14 BENEFITS OF IRF TO USERS

Interest Rate Futures (IRF) enable Banks and Primary Dealers to mitigate risk, improve process efficiency and increase their bottomline. Following are some of the scenarios, when IRF can benefit Banks and Primary Dealers:

1) Manage "Yield Curve Risk", when banks are exposed to assets and liabilities across different tenors.

   Example: Short-term interest rates may be lower than long-term interest rates

2) Mitigate "Basis Risk", when yield on assets and costs on liabilities are based on different benchmarks. Example: Asset returns may be based on MIBOR, whereas, liabilities, may be based on fixed interest rate.

3) Hedge against "Repricing Risk", related to volatility of cash flows, due to revaluation of assets and liabilities over a period of time.

   Example: When the returns on an asset are based on floating interest rates.

4) Effective and efficient hedge against decrease in interest rates impacting fixed rate cash outflows.

   Example: Recently, many banks have exposure to fixed deposits at higher interest rate cash flows, while lending rates are decreasing.

5) Protect against devaluation of SLR securities (G-Sec) inventory (held under AFS and HFT categories) due to sudden spike in bond yield rates (and consequent decrease in bond prices).

6) Investment by banks in Corporate Bonds (and other non-SLR securities) expose banks to volatility in interest-rate spreads.

7) Mitigate overall risk due to volatility in interest rates associated with Asset-Liability mismatch, across different tenors.

8) Exposure to embedded options in structured products can lead to "Option Risk", due to varying "Optionality". For example "Puttability" of mortgage (home) loans, by borrowers, due to home-loan refinancing in lower interest rate regime.

9) Improve the financial performance, by increasing the "Yield on Fund Advances" ratio, thereby, decreasing the "Breakeven Yield Ratio" for the bank, resulting in increase in "Net Interest Income".

10) Decrease the sensitivity of returns on bank assets and liabilities, due to volatility in interest rates.

11) Banks have lower entry and exit costs by using IRF, as compared to Interest Rate Swaps (IRS).

12) IRF pricing is directly dependent on the widely accepted Government of India Securities, unlike IRS which may even be trading at a discount to G-Sec. This leads to better price discovery and high liquidity.

13) Organized markets provide clearing and settlement through exchange clearing houses, – no counterparty default risk – thereby ensuring safety for banks, leading to decrease in risk capital allocation for hedged assets. This also leads to better "Capital Adequacy Ratio" (CAR) for banks.

14) Lower lot sizes of IRF, as compared to lot size of Rs. 25 Crores in IRS, can provide an excellent avenue for banks to earn service income.

15) Banks can also mitigate risk against default by retail and corporate borrowers, by effectively hedging against increase in interest rates. This can enable banks to pass on the hedge benefit to the borrowers – through packaged debt products.

16) According to RBI guidelines, Primary Dealers are expected to adhere to annual minimum bidding for dated securities, with a minimum success ratio and commitment to underwrite the shortfall (gap) between the subscribed accepted amount and the notified amount. Interest Rate Futures can be used to minimize risk due to volatility of interest rates, in spite of meeting their commitment.

17) Primary dealers also need to achieve annual turnover of not less than five times of the average month-end stocks during the year in dated securities and ten times in Treasury Bills, within which outright transactions should be three and six times respectively. While fulfilling these obligations, it is possible to hedge using Interest Rate Futures.

18) With increasing Government borrowings, the pressure on Primary Dealers to adhere to regulatory requirements is enormous. Interest Rate Futures aid in minimizing the Securities portfolio risk.

Benefits to Mutual Funds

Fund managers, FI and FII can immensely benefit from IRF. Following are some of the major benefits to these participants:

1) Investors can diversify their portfolio, by taking positions in Interest Rate Futures (IRF). Since, G-Sec and bonds usually have lower volatility as compared to other asset classes, including equity, commodity and currency, IRF can be an excellent avenue to increase the risk adjusted returns (Sharpe Ratio)

2) Money Market Funds and Debt Funds are usually susceptible to volatility in interest rates. Hedging using IRF can mitigate this risk.

3) IRF can provide another avenue for improving investment income, by arbitrage between cash and futures markets of the debt segment, as well as through spread trading strategies.

4) Better price discovery and high liquidity due to trading in IRF on exchange-trading platform – organized markets – with clearing-house providing counterparty guarantee to trades.

5) Arbitrage opportunities between different interest-bearing instruments across different geographies (countries), provides alignment of Indian interest rate markets with global markets. This also provides opportunity for FII to leverage on such arbitrage/spread trading opportunities.

6) Improving the NAV of Money Market and Debt Market Funds using Interest Rate Futures.

7) Innovative Mutual Fund Debt Products using Interest Rate Futures.

8) Optimizing Portfolio Returns.

9) Value-added services for Clients using Interest Rate Futures.

10) Increasing the absolute performance of a portfolio on a risk adjusted basis (improved Jensen's measure and decreased drawdown as compared to unmanaged portfolios); superior risk adjusted returns (Sharpe Ratio) using Interest Rate Futures.

Benefits to Insurance Companies

1) Insurance companies having exposure to Government Securities and Corporate Debt can leverage on Interest Rate Futures, for mitigation against volatility of interest rate bearing assets and liabilities.

2) Increase the return on investments in Interest bearing securities, thereby minimizing the "Actuarial Risk" for the Insurance Company.

3) Innovative Insurance Products using Interest Rate Futures can be structured. For example, Unit Linked Insurance Plans for investment in Government Securities with a hedge cover for protecting against interest rate risk.

4) Asset Liability Management can be improved using Interest Rate Futures.

5) Leveraging Interest Rate Futures for increasing return on investments and decreasing the insurance claims ratio in Home Loan Sector.

6) Optimizing Portfolio Returns.

Benefits to Corporates

Corporates need to identify, measure and mitigate risk pertaining to interest rate volatility. Interest Rate Futures (IRF) provide the mechanism to manage risk at strategic and operational level, pertaining to volatility in interest rates. Following are some of benefits to corporate, by hedging using IRF:

1) Corporates having debt exposure can mitigate risk against volatility in interest rates, by using IRF.

   Example: Debt linked to floating rate cash outflows can impact future financial performance, due to adverse movement (increase) in interest rates.

2) Smaller lot size in IRF enables better interest rate risk management by SME and MSME.

3) Hedging using IRF provides lower entry and exit costs as compared to Interest Rate Swaps (IRS).

4) Better management of interest-rate cash outflow towards funding working capital expenses (short-term debt).

5) Improve the credit rating for corporate by enhancing the "debt-service coverage" ratio and the "interest coverage" ratio (improved leverage), by better risk management using IRF.

6) Optimizing the cost of capital to company, leading to optimal "debt-equity" ratio, based on interest rate risk management using IRF.

7) Implementation of efficient processes and systems for improving credit terms for clients, based on improved interest rate risk management.

8) Improve the "Enterprise Value" to "EBIDTA" ratio, by better management of interest rate risk.

9) Sophisticated management of debt and interest rate cash outflows, can lead to effective use of debt as a tax-shield.

10) Corporate issuing bonds with "embedded options" (callability and puttability), can better manage risk against volatility in interest rates, leading to the exercise of the option by borrowers.

Benefits to Brokers, Foreign Institutional Investors and Retail Investors

1) Excellent opportunity for brokers to generate alternate source of income, by providing brokerage service to clients, High Networth Individuals (HNI), corporate, etc.

2) Focus on proprietary and client trading by debt market brokers, who had previously lost on income due to commencement of the "NDS OM" system.

3) Improved and easy access to retail and corporate customers, who are already trading through the broker-members, in other asset classes such as equity and commodity.

4) Wealth Management advisory services can be provided by brokers to their existing and new clients.

5) Individuals, who have borrowed personal and home loans, are usually subject to volatility in interest rates. IRF can be used to mitigate risk of interest rate volatility.

6) Decrease in cost of loans, due to hedging using IRF, can effectively decrease the "refinancing cost". Instead of the borrower switching the mortgage (home) loan from one lender to another (which can entail cost), the retail borrower can hedge using IRF.

7) The prospect of pre-payment of home loans (in a decreasing interest rate scenario) may entail additional cost to the borrower. Instead of pre-payment of loan, the borrower can effectively hedge using IRF and at the same time, leverage on the interest rate cash outflow, to obtain tax-shield under Indian Income Tax Act, 1961 (within the specified limits).

8) FIIs investing in the cash markets of the Indian debt market segment (within the prescribed limits as stipulated by regulator), can mitigate risk using IRF against fluctuation in the value of their investments.

9) Improved career opportunities and profit making avenue for jobbers, traders and dealers.

10) IRF can provide another avenue for improving investment income, by arbitrage between cash and futures markets of the debt segment, as well as through spread trading strategies.

15.15 SUMMARY

Interest Rate Futures (IRF) are standardized exchange traded derivatives. They are highly liquid, low cost products that enable fund managers to effectively and efficiently

manage a fixed income investment portfolio. Interest Rate Futures (IRF) contracts can act as a substitute for the government securities market with one major distinction: In the G-sec market, a cash transaction demands immediate payment and delivery where as a futures contract provides for the delivery of the cash security at a specified date in the future.IRF allows the buyer and seller to agree upon the price today but defer delivery of the instrument and its payment until a future date. Both buyer and seller must abide by the futures contract's specifications of the exchange. The standardization of financial futures allows market participants to offset their obligations to make or take delivery by simply executing an offsetting trade to cover the existing position or by actual physical delivery. The futures contract will track the price of its underlying G sec security. Since futures are not coupon bearing instruments, they do not have yields. Trading activity is conducted in a liquid and competitive market. Price negotiation creates a market where the bids and offers are publicly disseminated and transparent. The Conversion Factor for a bond is equal to the value of the bond per Rupee of Principal on the first day of the delivery month on the assumption that the interest rate for all maturities equals 7% per annum (with semi-annual compounding).

15.16 SELF ASSESSMENT QUESTIONS

1) What is meant by IRF?
2) What is 'Cheapest to Deliver Bond'
3) What is meant by conversion factor?
4) What is invoice price?
5) What is the notional value of an IRF contract?
6) Choose the most appropriate answer from the options given below: (Answers are marked as ***)
   1) Interest rate futures contracts were first traded on October 20, 1975, in the.....
      a) Chicago Board of Trade****
      b) London International Futures Exchange
      c) Newyork Stock Exchange
      d) Philadelphia Stock Exchange
   2) ..... involves simultaneously buying and selling the same asset in two different markets at two different prices in order to exploit pricing inefficiencies across markets and earn riskless profits
      a) Arbitrage****
      b) Speculation
      c) Spread trading
      d) Hedging
   3) ..... 0.3% of the value of the gross open positions of the IRF contract will be deducted from the liquid assets of the clearing member on an on line, real time basis.
      a) Extreme loss margin***
      b) Volatility magin
      c) Initial margin
      d) Span Margin

4) The Conversion Factor for a bond is equal to the value of the bond per Rupee of Principal on the first day of the delivery month on the assumption that the interest rate for all maturities equals ..... per annum (with semi-annual compounding).

   a) 7%

   b) 8%

   c) 9*

   d) 10*

5) Deliverable Grade Securities are GoI securities maturing at least ..... years but not more than 15 years from the first day of the delivery month with a minimum total outstanding stock of Rs 10,000 crore.

   a) 5 years

   b) 7.5 years****

   c) 10 years

   d) 12 years

15.17 FURTHER READINGS

1) Moorad Choudhry, *An Introduction to Bond Markets,* 3rd Edition.

2) Miles Livingston, *Bonds and Bond Derivatives,* 2nd Edition.

3) Stephen J. Antczak, Douglas J. Lucas, Frank J. Fabozzi, *Leveraged Finance: Concepts, Methods, and Trading of High-Yield Bonds, Loans, and Derivatives.*

4) Moorad Choudhry, *Analysing and Interpreting the Yield Curve.*

5) Sharon Saltzgiver Wright, Getting Started in Bonds, 2nd Edition.

6) Frank J. Fabozzi (Editor), *Professional Perspectives on Fixed Income Portfolio Management,* Volume 4.

7) *A primer on Government Securities Market* – RBI Publication.

UNIT 16 INTEREST RATE DERIVATIVES

Objectives

After studying this unit, you should be able to:

- understand the meaning and Mechanics of Interest rate caps,floors and collars;
- explain the meaning .mechanics and application of Forward Rate Agreement;
- appreciate the meaning and mechanics of Interest Rate Swaps and its uses; and
- discuss the rate of credit derivatives in managing credit default risks.

Structure

16.1 INTRODUCTION

Over-the-counter (OTC) derivatives have come to play an important role in the financial systems the world over. These instruments allow users to unbundle risks and allocate them to investors most willing and able to assume them. This has brought substantial benefits to the commercial community in facilitating hedging and have enabled the financial institutions to offer a progressively wider range of services and greater efficiency in the intermediation process as well as to exploit market imperfections and other trading opportunities for their own gain. The factors generally attributed as the major driving force behind growth of financial derivatives are: (a) increased volatility in asset prices in financial markets, (b) increased integration of national financial markets with the international markets, (c) marked improvement in communication facilities and sharp decline in their costs, (d) development of more sophisticated risk management tools, providing economic agents a wider choice of risk management strategies, and (e) innovations in derivatives markets which optimally combine the risks and returns over a large number of financial assets leading to higher returns, reduced risk as well as transaction costs as compared to individual financial assets.

In order to manage and control interest rate risks as also to further deepen the money market, OTC rupee derivatives in the form of Forward Rate Agreements (FRAs)/ Interest Rate Swaps (IRS) were introduced in India in July 1999. These derivatives

enable banks, primary dealers (PDs) and all-India financial institutions (FIs) to hedge interest rate risk for their own balance sheet management and for market-making purposes. Banks/PDs/FIs can undertake different types of plain vanilla FRAs/IRS. Swaps having explicit/implicit option features such as caps/floors/collars are permitted now.

16.2 BENCHMARK INTEREST RATES

Before we study the various types on interest rate derivatives, it is necessary to understand the most commonly used bench mark rates in interest rate derivative contacts which are indicated below:

MIBOR (Mumbai Inter Bank Offered Rate) is the interest rate at which banks can borrow funds, in marketable size, from other banks in the Indian interbank market. The Mumbai Interbank Offered Rate (MIBOR) is calculated everyday by the National Stock Exchange of India (NSEIL) as a weighted average of lending rates of a group of banks, on funds lent to first-class borrowers. The MIBOR rate is used as a bench mark rate for majority of deals struck for Interest Rate Swaps, Forward Rate Agreements, Floating Rate Debentures and Term Deposits.

MIFOR (Mumbai Inter Bank Forward Rate) is a rate that Indian banks and other derivative market participants uses as a benchmark for setting prices and MIFOR is a mix of the London Interbank Offer Rate (LIBOR) and a forward premium derived from Indian forex markets and is complied by Thompson Reauters and FIMMDA.

LIBOR (London Inter Bank Offered Rate) stands for London InterBank Offered Rate and is a composite of the rates of interest at which banks borrow funds of a sizeable amount from other bank in the London market. LIBOR is the most widely used "benchmark" or reference rate for short term interest rates and is compiled by the BBA (British Bankers Association) in conjunction with Thomson Reuters and released to the market shortly after 11.00am London time each day. LIBOR is produced for ten currencies with 15 maturities, giving an indication of the average rate at which a bank can obtain unsecured funding for a given period in a given currency

16.3 INTEREST RATE CAPS, FLOORS AND COLLARS

Interest Rate Floor

Interest Rate Floor is a over the counter product. It is basically an agreement to receive payments at a rate below the strike price. This rate would be a floor rate below which if the reference rate falls, the investor would continue to receive interest payments.The purchase of a Floor option will allow the investor (the depositor) to fix a minimum interest rate for one or more future money market investments (deposits), thus protecting him against falling interest rates .The Floor agreement covers an agreed principal and an agreed series of interest periods between the buyer and seller.This will be against a payment of a premium that will be paid in advance. The buyer of the Floor option agreement will guarantee a minimum of an agreed interest rate from the seller. At the start of each agreed interest period, the agreed Floor rate is compared with the money market interest rate applicable (e.g., LIBOR). If the MMR is lower then Floor agreed rate,the seller will pay the difference to the buyer (Client) at the end of the interest period. If MMR is higher than Floor agreed rate, no settlement takes place. The investor or the depositor, therefore will benefit entirely from a favorable move in interest rate.It can be arranged for a series of interest rates receivable in the future (e.g., from deposits). It exclusively relates to an interest rate difference to be settled and is separate from underlying principal transaction.

An Example of Interest Rate Floor

The following table illustrates a 3-year, USD 200 MM notional floor with 6-month Libor as its index rate, struck at 5.5%. The exhibit shows what the floor's payments would be under a hypothetical interest rate scenario.

Libor Rate	*Margin*	*Without Floor*	*Settlement under Floor*	*Result with Floor*	*Result W/ fixed rate*
3.5%	0.25%	3.25%	1.25%	3.80%	4.75%
4.5%	0.25%	4.25%	0.25%	3.80%	4.75%
5.5%	0.25%	5.25%	N.a	4.55%	4.75%
6.5%	0.25%	6.25%	N.a	5.55%	4.75%
7.5%	0.25%	7.25%	N.a	6.55%	4.75%
8%	0.25%	7.25%	N.a	7.05%	4.75%

Payments made under a hypothetical interest rate scenario by a 3-year USD 200MM notional floor linked to 6-month USD Libor with strike rate of 5.5%. Values for the index rate are 6.75%, 5.25%, 6.25%, 4.50%, 5.00%, 6.75%. These result in payments of USD 0MM, USD .25MM, USD 0MM, USD 1MM, USD.5MM, and USD 0MM.

Floor Risks and Benefits

The investor buys the Floor to protect himself against an unfavorable rate movements, premium is paid in advance. If rates movements fails to materialize, investor can see that paid premium as a loss. However he can take full advantage of it in case of favorable interest rate movement.Also, it allows the investor to secure a minimum to interest rate income of future money market deposits. A Floor Option agreement is a customized product. Effective Date, Expiry Date, the agreed rate and frequency of interest rate payment/ receipts can be tailored subject to investor requirements . The cost of Buying a Floor are limited, so no further costs or commissions are involved. Also a Floor agreement is separate from client underlying transaction or deposit .

Interest Rate Cap

A Cap is an interest rate option agreement in which the buyer of the option, with the intention of locking himself to a ceiling of interest cost for his borrowing, reserve the right to receive the different in interest rate on a notional principal in case the interest rate on the underlying borrowing goes higher than the ceiling he has chosen at pre-agreed periodical intervals for a given time maturity.The purchase of a Cap will allow the borrower to fix a maximum interest rate for one or more future money market loans (short-term or roll-over loans) thus protecting it against rising interest rates. It is basically an option contract between two parties regarding interest rate and the agreement covers an agreed principal and an agreed series of interest periods. The buyer of the Cap option agreement will guarantee a maximum of an agreed interest rate from the seller against payment of a premium that will be paid in advance.At the start of each agreed interest period, the agreed Cap rate is compared with the interest rate applicable at that time (e.g., Libor). If the interest rate is higher then CAP agreed rate,the seller will pay the difference to the buyer (Client) at the end of the interest period. If interest rate is lower then CAP agreed rate, no settlement takes place. The cap can be arranged for a series of interest rates payable in the future (e.g., on short-term or roll-over loans) and relates to an interest rate difference to be settled and is separate from underlying principal transaction.

Hedging through Caps

Example: X Company has issued a bond for Rs.100crore at a floating rate of 6M MIBOR + 50 basis points with interest payable at half yearly intervals and the maturity of the

bond is 5 years. Currently, the 6M MIBOR is 7%..The company has invested the money at a fixed rate of 8% and wants to ensure a spread of 0.5% during the 5 year period.The company runs an interest rate risk in case the 6M MIBOR goes up beyond 7% after every six months during the five year period.To hedge the interest rate risk, the company can buy a cap of, say, 7%..In the above structure, if the 6M MIBOR moves beyond 7%, the company will be compensated by the seller of the cap. However, if the 6M MIBOR falls below 7%, the company may choose not to exercise the option and hence need not pay the seller the difference.This is the major difference between FRA (Forward Rate Agreement) and IRS (Interest Rate Swaps) and CAPS.

Cap Risks and Benefits

The borrower buys the Cap to protect himself / herself against an unfavorable rate movements, premium is paid in advance. If rates movements fails to materialize, borrower can see that paid premium as a loss. However borrower can take full advantage of it in case of favorable interest rate movement. A Cap Option agreement is a customized product. Effective Date, Expiry Date, the Cap agreed rate and frequency of interest rate payment/ receipts can be tailored subject to borrowers requirements. In addition, it can be arranged for fixed or variable principal sum (to be arranged in advance).The cost of Buying a Cap are limited, so no further costs or commissions are involved. Also Cap agreement is separate from client underlying loan.

Interest Rate Collar

An Interest Rate Collar is a combination of an interest rate cap and an interest rate floor. The buyer of the collar purchases the cap that places a ceiling on the interest rate he will pay, and sells the floor to obtain a premium to pay for all or part of the cap. The collar transaction limits interest rate payments by the buyer of the collar to a range bounded by the strike rates of the cap and floor. If the floating rate rises above the cap strike, the collar contract provides for payments from the seller of the collar to the buyer for the difference between the floating rate and the cap strike. If the floating rate falls below the floor strike, the collar buyer pays the collar seller the difference between the floor strike and the floating rate. The collar premium charged by the seller depends upon the market's assessment of the probability that rates will move through the cap or floor level over the time horizon of the transaction. In other words, if the yield curve is upward sloping, a shorter term (two years vs. five years) and/or a higher cap strike (7.0% vs. 6.0%) or a higher floor strike (5.0% vs. 4.0%) will result in a lower collar premium.The collar premium takes the form of an up front premium that is usually expressed in basis points as a percentage of the notional principal amount. Many collar buyers purchase zero cost or zero premium collars. In a zero cost collar, the price paid for the cap equals the price received for the floor, and no net premium is exchanged. Parties to an interest rate collar take on potential credit exposure to one another. The collar buyer is exposed to the seller for payments over the cap strike. The collar seller is exposed to the buyer for payments under the floor strike.

Application:

Liability Management

Situation 1:	The borrower is willing to give up protection, but wants to minimize the cost. The borrower is willing to give up some of the benefit of a decline in rates for cheaper cost protection against rising rates.
Solution:	The borrower purchases an interest rate collar (buys the cap and sells the floor). Buying the cap provides protection from rising rates and selling the floor cheapens the cost of purchasing the cap. However, selling the floor requires the borrower to give up some of the benefit of a decline in rates.

Situation 1:	An investor holding a floating rate note feels floating interest rates will remain unchanged or decline and wants to enhance the yield on the note.
Solution:	The investor sells an interest rate collar (sells the cap and buys the floor). The investor collects the collar premium and benefits if rates drop below the floor level. However, if floating rates rise through the cap level the investor's yield will decline.

16.4 FORWARD RATE AGREEMENT(FRA)

FRA is a forward contract on interest rate. It is a contract for exchange of payments based on fixed interest rate and floating interest rate. The payments are based on a notional principal and has two legs, the fixed leg and the floating leg. As per the agreement, the two parties to the contract agree to settle between them the interest differential on a notional principal on a future settlement date for a specified future period. Performance in an FRA is limited to the interest rate differential on a given notional principal. Since the agreement is only to settle the interest rate differential, credit risk with the counter party is minimal.They are OTC contracts and easy to customize. They are linear derivatives like futures and interest rate swaps.

Illustration: A company sells a FRA as per the following terms:

Notional principal	INR 230 million
Company to receive	5% fixed
Company to pay	3 month NSE MIBOR
Term of FRA	3 * 6
Tenor of FRA	90 days

On settlement date 3 month NSE MIBOR is 5.5%

In this case , the payment to be made/received by the company is calculated as follows: Company has to make a payment netting out the differences in interest rates since the floating rate is more than the fixed interest rate.

$230 * (5.50 - 5.00) * 90/365 = 0.2835616$ million

FRA Conventions

FRA is denoted as 3 vs 6, 6 vs 9 etc. 6 vs 9 denotes seeking protection for a three month borrowing or lending commitment starting 6 months from today.Prices are quoted two ways. The customer would buy at the higher of the two rates and sell at the lower rate.Borrowers buy FRA to lock themselves at a fixed rate whereas lenders sell to lock in a fixed rate on their lending.

A **Forward Rate Agreement** (FRA) is a cash-settled forward contract on a short-term loan. For example, a 2 × 5 FRA is a 2-month forward on a 3-month loan. The interest rate on the loan, called the FRA rate, is set when the contract is first entered into.Because FRAs are cash settled, no loan is ever actually extended. Instead, contracts settle with a single cash payment made on the first day of the underlying loan, which is called the settlement date. The formula for the payment is

$$\text{notional} \frac{(\text{reference rate} - \text{FRA rate})\ \text{days}/\text{basis}}{1 + (\text{reference rate})\ \text{days}/\text{basis}}$$

where

- notional is the notional amount of the loan,
- the reference rate is typically a bench mark rate like MIBOR or LIBOR,

- days is the number of days the loan is for, and
- basis is the day count basis applicable to money market transactions in the currency of the loan-usually either 360 or 365 days.

Consider an example. A 4 ×10 USD 20 MM FRA is transacted with an FRA rate of 3.4%. The four month forward period starts on the spot date and extends to the settlement date. Typically, the spot date is two business days after the trade date. Two business days before the settlement date is the fixing date. This is the date on which the value of the reference rate is determined. For this FRA, the reference rate is 6-month USD Libor. Suppose 6-month Libor is 3.7% on the fixing date. The USD money market uses a 360 day basis. On the settlement date, the borrower (the party that is long the FRA) receives from the lender (the party that is short the FRA) the amount

$$20\text{mm}\,\frac{(.037-.034)\,\text{days}/360}{1+(.037)\,\text{days}/360}$$

$$= 20\text{MM} \;\; *0.001508/0.52138 \;=\; 20 * 0.002892 = 0.057846$$

16.5 INTEREST RATE SWAPS (IRS)

An interest rate swap is an agreement between two parties to pay each other interest on a notional principal amount, calculated on two different bases, or a stated period of time.The agreed amount is called the "notional amount", and since it is not a loan or investment, the principal amount is not exchanged initially or repaid at maturity. Interest payment streams are exchanged according to predetermined rules and are based upon the underlying notional amount.A swap is a custom tailored bilateral agreement in which cash flows determined by applying a prearranged formula on a notional principal. The first publicized interest rate swap was completed in August 1982 and involved a US$ 300 million, seven-year fixed rate Eurobond issue by Deutsche Bank wherein the fixed interest rate was swapped into floating rate. Interest rate swaps are presently available in all major currencies. . Following the first swap transaction in the early 1980s interest rate swaps have become one of the most commonly used instruments in the world of financial risk management by bank and corporate treasurers in managing the interest rate risks arising from both assets and liabilities. The popularity of swaps is attributable to the simplicity and flexibility of the product ; swaps provide a simple and effective tool for users to change their risk profile to a form that suits their individual needs. Swaps are generally of the following types:

- *Interest Rate Swap*: Where cash flows at a fixed rate of interest are exchanged for those referenced to a floating rate.
- *Currency Swap*: Where cash flows in one currency are exchanged for cash flows in another currency.
- *Basis Swaps*: Where cash flows on both the legs of the swap are referenced to different floating rates.

An interest rate swap is a contractual agreement to exchange a series of cash flows. One leg of cash flow is based on a fixed interest rate and the other leg is based on a floating interest rate over a period of time. There is no exchange of principal. The size of the swap is referred to as the notional amount and is the basis for calculating the cash flows. Example of such swaps in the Indian market are:

- Overnight Index Swaps (OIS) – Fixed v/s NSE Overnight MIBOR Index
- Mumbai Inter-bank Forward Offer Rate (MIFOR) Swap – Fixed V/s Implied INR yield derived from the USD/INR premium and the relevant USD LIBOR for that tenor, usually 6 months.

- INBMK Swap – Fixed v/s 1 year INBMK rate – The 1 year INBMK rate is derived from the rate on the benchmark Indian Government of India securities

A Basis swap is an Interest Rate Swap where both legs are based on a floating rate. A basis swap involves a regular exchange of cash flows, both of which are based on floating interest rates. Most swaps are based on payment of a fixed rate against a floating rate say LIBOR. In the basis swap both legs are calculated on floating rates. For example

- 6 months USD LIBOR against 3 months USD LIBOR
- 6 month JPY LIBOR against 6 month USD LIBOR
- 6 month MIFOR against 6 Month USD LIBOR

A Basis Swap is most commonly used when liabilities are tied to one floating rate index and financial assets are tied to another floating index and this mismatch can be hedged via a basis swap Swaps can be used to create either synthetic fixed or floating rate liabilities or assets or to hedge against adverse movements or to reduce the funding cost by exploiting the comparative advantage that each counterparty has in the fixed / floating rate markets.In the Indian market Banks are allowed to run a book on swaps which have an Indian Rupee leg. Banks can offer swaps, which do not have an Indian Rupee leg, to their customers but have to cover these with an overseas bank on a back-to-back basis.

Pricing an interest rate swap

An interest rate swap is simply an exchange of a fixed rate bond for a floating rate bond or *vice versa.* Hence the first step in pricing an IRS consists in finding the present values of the cash flows of these two bonds. The net present value of the cash flows of these two bonds should be equal to start with. It is easy to compute the present value of the fixed rate leg as risk free zero rates for various maturities are easily available from say government securities yield curve. It is not so easy to compute the present value of floating leg payments as one does not know what the rates are likely to be in future. Hence using the zero rates, an implied forward yield curve is developed and these rates are used to discount the floating leg payments. The present values of fixed and floating legs thus obtained are equated and the rate that makes them equal is computed. This rate will be base rate for pricing the swap on which mark up may be made to offer it to the market. A brief note on computation of zero or spot yields and the implied forward yields is furnished below .(The Yield to Maturity or YTM has a drawback in that it assumes that future cash flows will be invested at the same rate "y" - the YTM itself, which is a wrong assumption for no one knows what the interest rates are likely to be in future.If we are able to eliminate the intermediary cash flows by some means, then there will be no reinvestment risk and hence the assumption of same rate for future periods can also be done away with. This may be achieved by arriving at the Zero rates (also known as Spot Rate) by a mathematical process known as Boot Strapping. This process eliminates intermediary cash flows and hence the wrong assumption of the same rate for reinvestment as well.

The first step in pricing an IRIS consists of determining the present values of cash flows of two payments. The present value of fixed leg can be calculated as risk free zero rates for various maturities involved. For floating leg part, since present value of floating rates cannot be calculated without knowing the actual rates, an implied forward yield curve is developed using zero rates and these rates are developed. This rate will be the base rate for pricing the swap. The zero rate or spot rate is arrived at through bootstrapping.

Illustration of Overnight Index Swap: Let us say Paradise Bank has entered into an OIS on a notional principal of Rs.10 crores and has agreed to receive MIBOR overnight floating rate for a fixed payment of 8% on the notional principal. The swap was entered

into on 1 April, 2009 and was to commence on 2 April, 2009 and run for a period of 7 days. The amount payable by Paradise Bank on the floating rate will be calculated on the notional principal everyday at the respective MIBOR rate and will be compounded on a daily basis as shown below. (Pleasenote the rate for Saturday and Sunday are the same as the market is closed on Sundays). The fixed leg interest payment is worked in the normal way for 7 days at 8% and the difference between the two is the amount Paradise Bank has to pay or receive on maturity. It may be noted that the interest payments are not exchanged on a daily basis but are exchanged only on maturity.

Dates	*Notional Principal*	*Mibor*	*ACC.INT*
2.4.2009	10,00,00 000	7.75%	21232
3.4.2009	10,00,21,232	8.15%	22333
4.4.2009	10,00,43,565	8.12%	22256
5.4.2009	10,00,66,041	7.95%	21795
6-4-09 (Holiday)			
7.4.2009	10,00,87,836	7.98%	43764
8.4.2009	10,01,31,600	8.15%	22358
		Total of floating LEG	Rs. 153738
Interest on fixed LEG = 10CR × 0.08 × 7/365 = 153424			
Paradise Bank to receive 153738 - 153424 = INR 314 (net)			

Types of interest rate swaps

- **A Plain Vanilla Swap:** This is the simplest form of Interest rate swaps where a fixed rate is exchanged for a floating rate or *vice versa* on a given notional principal at pre-agreed intervals during the life of the contract.
- **A Basis Swap:** In a floating to floating swap, it is possible to exchange the floating rates based on different benchmark rates. For example, we may agree to exchange 3m Mibor for 91 days T Bills rate. Such a swap is called a Basis Swap.
- **An Amortising swap:** As the name suggests, swaps that provide for reduction in notional principal amount corresponding to the amortisation of a loan, are called amortising swaps.
- **Step-up Swap:** This is the opposite of an amortising swap. In this variety the notional principal increases as per a pre-agreed schedule.
- **Extendable Swap:** When one of the counter parties has the right to extend the maturity of the swap beyond its original life, the swap is said to be an extendable swap.
- **Delayed start swaps/Deferred swaps/forward swaps:** When it is agreed between the counter parties that the swap will come into effect on a future date, it is termed as a delayed start swap or deferred swap or a forward swap.
- **Differential Swaps:** Interest rate swaps which are structured in such a way that one leg of the swap provides for payment of interest at a rate pertaining to a currency other than the currency of the underlying principal amount. The other leg provides for payment of interest at the rate and currency of the underlying principal. For example, a corporate can choose to enter into a differential swap by which it could bind itself to pay 3m USD Libor on a principal of Rs. 100 crores and receive 12% fixed in the Indian currency. The interest on both the legs will be computed on the notional principal of Rs. 100 crores. The swap is thus a combination of currency and plain interest rate swaps. There is no currency risk in this arrangement.

RBI guidelines on IRS

Scheduled commercial banks (excluding Regional Rural Banks), Primary Dealers and all India Financial Institutions are free to undertake IRS as a product for their own balance sheet management for market making.They may also offer these products to corporates for hedging their own balance sheet exposures.Participants should ensure adequate infrastructure and risk management systems before venturing into market making activities. The Bench Mark rate should necessarily evolve on its own in the market and require market acceptance.The parties are free to use any domestic money or debt market rate as benchmark rateprovided the methodology of computing the rate is objective, transparent and mutually acceptable. There is no restriction on the minimum or maximum size of notional principal amounts. Size norms are to emerge in the market with the development of the market.There is no restriction on the tenor as well.Banks, Financial Institutions and Primary Dealers are required to maintain capital for FRAs and IRS.Transactions for hedging and market making purposes should be recorded separately.Positions on account of market making activities should be marked to market at leastat fortnightly intervals. Transactions entered into for hedging purposes should be accounted for on accrual basis.Participants could consider using ISDA standard documentation with suitable modifications for transactions in FRAs and IRS.Participants are required to report their operations in FRAs and IRS on a fortnightly basis to Monetary Policy Department of RBI.Capital adequacy for banks and financial institutions for undertaking FRAs and IRS transactions shall be calculated as follows:The notional principal should be multiplied by a conversion as follows:

For original maturities less than a year -	0.5%
Between one year and < 2years	1.00%
For each additional year	1.00%

The product thus obtained shall be assigned a risk weightage at 20% for banks and financial institutions and 100% for others (other than government). Presently required capital adequacy is 9% on the resultant sum.

Interesrt Rate Swap: Example

Company 'A' enjoys highest credit rating and is able to raise floating rate Dollar funds at LIBOR + 25 basis point. This company can issue fixed rate bonds in US Dollars at 9% for 5 years. The company wishes to raise floating rate Dollar funds cheaper than market rate at which the company can raise i.e., less than LIBOR + 25 basis point.

Company 'B' who is a low rated borrower is able to raise floating rate Dollar loan at LIBOR + 50 basis point. This company can issue fixed rate bonds in US Dollars at 10% for 5 years. The Company wishes to raise fixed rate Dollar funds cheaper than the market rate at which the company can raise Dollar funds i.e., less than 10%.

Each party borrows in the market in which it enjoys relative advantage i.e., initially Company 'A' issues fixed rate bonds and Company 'B' raised floating rate loans. Both Company 'A' and 'B' agrees to swap their interest rate obligations. A agrees to pay LIBOR to B against fixed interest rate payment of 9.25% by B to A. As a result the Company A saves 0.50% and Company B 0.25%.

	Outflow	Inflow	Net Cost	Net Saving
Company 'A'	9%	9.25%		
Company 'B'	LIBOR 9.25%	 LIBOR	LIBOR-0.25%	0.50%
	LIBOR+0.50		9.75%	0.25%

Activity 1

1) Explain with illustration how a corporate can hedge its interest rate risk through FRA.

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2) Explain interest rate swap with an example.

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16.6 CREDIT DERIVATIVES

Credit derivatives are globally used risk management instruments that are traditionally employed by lenders to transfer the credit risk of an underlying asset to another party. The credit derivative market is worth 8.2 trillion USD worldwide. A credit derivative is an individually negotiated over-the-counter transaction or a note-structure, between two parties one of which can be referred to as the buyer of protection and the other as the seller of protection,in which the value of at least one of the obligations is based on performance by a third party ('Reference entity') or parties under specified debt obligations or on the change in credit worthiness of the Reference entity,which obligations are often but not necessarily triggered by the occurrence of a specified credit event or events.Credit events include bankruptcy, insolvency, merger, price decline, a downgrade in rating, etc, of the underlying asset/issuer.

Credit derivative can be defined as arrangements that allow one party (protection buyer or originator) to transfer, for a premium, the defined credit risk, or all the credit risk, computed with reference to a notional value, of a reference asset or assets, which it may or may not own, to one or more other parties (the protection sellers).Credit derivatives are over the counter financial contracts.A credit derivative contract is typically settled on the happening of the agreed credit event in any of the following ways:

Physical delivery: The protection seller pays the protection buyer an agreed consideration or par value of the underlying asset in exchange for the underlying asset (or a variety of assets) ('deliverable obligation').

Cash settlement: The protection seller pays the protection buyer an agreed consideration/par value less the recovery value, if any, of the deliverable obligation.Credit derivatives particularly find favour with FI's and banks to move the risk underlying their credit assets off their balance-sheet thereby reducing their exposure to a particular sector/investor and increase lending activities while adhering to capital adequacy norms.

The origin of credit derivatives can be traced back to the securitization of mortgaged-back market of 1980s. In securitisation, the credit risk was hedged only by eliminating the credit product from the books of credit provider altogether. The credit derivative, in the present form, was formally launched by Merrill Lynch in 1991. In 1992 credit derivative emerged openly in the market, ISDA (International Swaps and Derivatives Association) first used the term "credit derivative" to describe a new type of over - the – counter contract.The product menu in the credit derivatives market is changing periodically , but there are four major instruments that make up the bulk of the trading volume today:

Credit Default Swaps, Total Return Swaps, Credit Default Options and Credit Linked Notes,

16.7 CREDIT DEFAULT SWAPS

The credit default swaps (CDS) have grown rapidly in the credit risk market since their introduction in the early 1990s. It is believed that current usage is but a small fraction of what it will ultimately represent in the credit risk markets. In particular, the CDS market will become as central to the management of credit risk as the interest rate swap market is to the management of market risk. Credit Default Swap (CDS) is a bilateral derivative contract on one or more reference assets in which the protection buyer pays a fee through the life of the contract in return for a contingent payment by the protection seller following a credit event (e.g., failure to pay, credit rating downgrade, etc.) of the reference entities.

In a Credit Default Swap (CDS), one party agrees to pay another party periodic fixed payments in exchange for receiving "credit event protection", in the form of a payment, in the event that a third party or its obligations are subject to one or more pre-agreed adverse credit events over a pre-agreed time period. Typical credit events include bankruptcy, failure to pay, obligation acceleration, restructuring, and repudiation/ moratorium.

It is the CDS market's convention to refer to the party that makes the periodic payments for credit event protection as the Protection Buyer. Conversely, the party that provides the credit event protection is referred to as the Protection Seller. The third party and the specific obligation, if any, on which credit event protection is concurrently bought and sold are referred to as the Reference Entity and Reference Obligation, respectively.

In most instances, the Protection Buyer makes quarterly payments to the Protection Seller. The periodic payment is typically expressed in annualized basis points of a transaction's notional amount. In the instance that no pre-specified credit event occurs during the life of the transaction, the Protection Seller receives the periodic payment in compensation for assuming the credit risk on the Reference Entity/Obligation. Conversely, in the instance that any one of the credit events occurs during the life of the transaction, the Protection Buyer will receive a compensating payment.

The form of the compensation will depend on whether the terms of a particular CDS calls for a physical or cash settlement. In a physically settled transaction, the buyer of protection would deliver the reference obligation (or an obligation of equal or higher payment priority) to the Protection Seller and receive the face value of the Reference Obligation.

Alternatively, in cash settled transaction, the Protection Seller makes a cash payment to the Protection Buyer based on a formula that the two parties agree upon at the inception of the contract. Generally, the formula specifies that the Protection Seller pays the Protection Buyer the difference between par and the then prevailing market value of a Reference Obligation following one of the specified credit events. In some cases, the cash payment is a fixed amount decided at the inception of the contract.

16.8 TOTAL RETURN SWAP

Another very important credit derivative prevailing in the international market is total rate of return swap.

A total rate of return swap tries to transfer the total volatility in the rate of return on a credit asset to the protection seller. In a total rate of return swap, the protection buyer agrees to transfer, periodically and throughout the term of the contract, the actual return

from a reference asset, to the protection seller, and the latter, in return, agrees to transfer returns calculated at a certain spread over a base rate.

For example, if the base rate were LIBOR and the agreed spread is 60 bps, a typical total rate of return swap would be, the protection buyer will swap the actual proceeds from a reference assets to protection seller against LIBOR + 60 bps. If there is any appreciation the market value of the reference obligation, the protection buyer will transfer that as well to the protection seller; if there is any depreciation, the protection seller will pay for the same. The swapping of appreciation/depreciation in market value is done to ensure that the total return of the protection buyer, which includes such appreciation/ depreciation, is swapped with the protection seller.A similar example can be taken into study where a bank is the protection buyer and a financial institution or an investor is a protection seller.

- Bank "B" invests in an unsecured bonds of X at a fixed coupon of 6.5%.
- Bank "B" get into a total rate of return swap with investor "I", agreeing to receive LIBOR + bps for the exchange of actual returns of X.
- In terms of the swap Bank "B" will keep transferring periodically the actual coupon plus/minus any changes in the market value of the bond.
- Investor "I" will periodically pay LIBOR + 100 bps.
- Bank "B" who is technically invested in X bonds in reality neither has neither exposure in X bonds nor exposure in the returns from it.
- Investor "I" on the other hand is exposed to X bonds and its returns.
- In other words bank "B" has hedged his position in X bonds to investor "I".

There are number of significant differences between a credit default swap and total rate of return swap.Unlike a credit derivative swap, there pay – offs in a total rate of return swaps are not based on any event of default. The parties exchange the relative cash flows on a regular basis. Here, the credit event leads to termination of swap.However if during the tenure of a total rate of return swap, a defined credit event takes place , the swap will be terminated and the protection seller will make compensatory payments to the extent of the difference between the last settled market value and the current market value of the defaulted obligation. Thus, whereas in the credit default swap, the payoff by the protection seller is merely contingent upon a credit event, the payoff in the case of total rate of return swap is both ongoing and contingent upon credit event. No fixed premium is received by the protection seller in case of a total rate of return swap. The premium is inherent in the difference between the actual returns from the underlying obligation and the spread over LIBOR.Credit default swap seeks insurance only against specified credit default swaps; a total rate of return swap seeks to transfer the total risk of volatility in return, including interest rate risk, to the counterparty. Therefore, there risks hedged in a total rate of return swaps are comprehensive.The protection seller in case of a total rate of return swap is also referred to as total receiver and the protection buyer is similarly called total return payer. The impact of a credit default swap is to transfer the volatility of inflow or market values on account of certain specified events, which are listed in "credit events". There is no transfer of any risk unless the credit events take place.As against this, a total rate of return swap synthetically replaces the entire cash flows from a reference asset for an agreed spread on a risk free or reference rate.Technically, if the credit events in a credit default swap were listed so widely that any change in the cash flows or market value of the reference obligation were to be covered thereby, there will be no difference between a credit default swap and a total rate of return swap. So, a total rate of return swap has the most comprehensive implicit listing of all those events which have any bearing on the cash flows from a reference asset.

Activity 2

1) What is a credit default swap?

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2) What is the difference between credit default swap and total return swap?

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16.9 CREDIT LINKED NOTES

Credit-Linked Note (CLN) market is one of the fastest growing areas in the credit derivatives sector. The origin of credit linked notes lies in several contingent coupons or contingent principal bonds that emerged around early 1990's. Yet another bond type that emerged was variable principal bonds where the principal repayable on the maturity was variable based on certain contingencies. Synthetic equity deals make use of similar instruments. In the field of credit derivative, the word "credit linked note" is now well accepted and generally understood.Credit linked notes have given a completely new window to credit derivative. Credit derivative being a commodity in the capital markets could not have been thought of, in absence of credit linked notes.Credit linked notes are investments products. They are not a new type of credit derivative difference from credit default swap or total rate of return swap, but rather a method of implanting a credit default swap or total rate of return swap in an investment product. Thus credit linked notes make it possible for credit derivative to be mounted on capital market vehicles and carry them into the capital market. While both credit default swap and total rate of return swap by themselves are bilateral OTC products, Credit linked notes make credit derivatives a capital market product.

Unlike credit swaps, credit-linked notes are funded balance sheet assets that offer synthetic credit exposure to a reference entity in a structure designed to resemble a synthetic corporate bond or loan. Credit-linked notes are frequently issued by special purpose vehicles for the purpose of a capital market transaction, a special purpose vehicle is a trust or a corporation specially formed for this purpose and constituted as a bankruptcy remote entity (bankruptcy remote entity is one which one cannot enter into any other business to have an obligations, cannot issue liabilities, cannot burden itself with expenses that allow the right to take it to bankruptcy and denies a voluntary winding up or merger option to the equity holders).

Special purpose vehicle hold some form of collateral securities financed through the issuance of notes or certificates to the investor. The investor receives a coupon and par redemption, provided there has been no credit event of the reference entity. The vehicle enters into a credit swap with a third party in which it sells default protection in return for a premium that subsidises the coupon to compensate the investor for the reference entity default risk.

The investor assumes credit risk of both the Reference Entity and the underlying collateral securities. In the event that the Reference Entity defaults, the underlying collateral is liquidated and the investor receives the proceeds only after the Credit Swap counterparty is paid the Contingent Payment. If the underlying collateral

defaults, the investor is exposed to its recovery regardless of the performance o f the Reference Entity. This additional risk is recognize d by the fact that the yield o n the Credit-L inked Note is higher than that of the underlying collateral and the premium on the Credit Swap individually . Credit-Linked Notes may also be issued by a corporation or financial institution. In this case the investor assumes risk to both the issuer and the Reference Entity to which principal redemption is linked.

Example

A bank may sell some of its exposure to a particular emerging country by issuing a bond linked to that country's default or Convertibility risk. From the bank's point of view, this achieves the purpose of reducing its exposure to that risk, as it will not need to reimburse all or part of the note if a credit event occurs. However, from the point of view of investors, the risk profile is different from that of the bonds issued by the country. If the bank runs into difficulty, their investments will suffer even if the country is still performing well.

16.10 CREDIT DERIVATIVES: INDIAN SCENARIO

In the middle of the year 2002 RBI appointed a Working Group on introduction of Credit Derivatives in India, comprising officers from the Reserve Bank of India and industry. The working group was to study the need and scope for allowing banks and financial institutions to use credit derivatives, the regulatory issues involved and to make suitable recommendations in this regard. In the year 2003 RBI implemented and provided drafted guidelines for application and usage of credit derivatives for scheduled commercial banks. The guidelines are applicable only to banks and financial institutions.

Banks will initially be permitted to use credit derivatives only for managing their credit risk and not for market making activities i.e. banks are permitted to buy protection on loans and investments made and to sell protection for diversifying their credit risk.Banks should hold credit derivatives in their banking book and not in the trading book except in ca se of CLNs that may be held as investments in the trading book if the bank so desires.RBI proposes not to allow credit derivative transactions between related parties till the players gain experience and maturity in the use of credit derivatives. non-resident entities cannot be parties to credit derivative transactions given the current Indian exchange control regulations and the intention of RBI to initially develop credit derivatives as a domestic product for the loan and investments market.

To understand the concept of credit derivative lets go through an example; "ABC" a bank has lent to "D" an upcoming company. "D" has asked for further loans. "ABC" is worried and stagnant about investing all its money in the same company, but at the same time it does not want to lose its client to its ompetitor, so the banks gives the loan a 10% and at the same time enters into a credit derivative contract with a third party institution who is not having any credit exposure with "D". "ABC" bank agrees to pay 2% interest in exchange of third party covering the default risk. Credit derivative are a useful means of spreading default risks. They do not alter the lender – borrower relationship. In the above example, the borrower is in no way involved in the swap. Credit derivative allows lenders to continue to lend and earn normal banking profits (deposits-to-loan) without assuming the credit risk.

Participants of Credit Derivatives

Credit derivatives are very widely used by many institutions that are benefiting from their use. These include commercial banks which use credit derivative not only to protect their credit risk operations but also to own a more sophisticated management of these risks. As much as 90 percent of the total risks of commercial banks are credit risk. Banks utilize credit derivatives also to gain wide exposure to a wider range of markets than they currently have. Credit derivatives offer banks an opportunity to sell off

concentrated risks as they issue credit derivatives, as well. In other words, credit derivatives provide banks with a method of distributing the credit risk created in the loan or trading portfolios to outside investors. Credit derivative enables banks to both originate and distribute risk that was non –transferable in the past. They can also be very effective at reducing a bank's exposure to large corporate clients. However, banks should be careful not to neglect their relationship with their corporate borrower. Many are worried that in a credit crisis, they may not know who they are dealing with if the bank sells off their loan. Investment firms with large amount of liquidity bonds. Investors buy credit derivatives to hedge market vulnerabilities. Insurance companies that are required by regulators to hold certain assets to maturity and Investment funds and institutional investors around the world also use credit derivatives. Sellers include:

Nature of Participants in the Indian Market

Though initially the scheme is to start in a limited phase, as experience gains it is to be made more comprehensive and diversified. In order to ensure that the credit market functions efficiently, it is important to maximise the number of participants in the market to encompass banks, financial institutions, NBFC's, mutual funds, insurance companies and corporates. Banks would typically be both buyers and sellers of credit risk in the market. There may be cases where a bank believes that it is overexposed to a particular credit or industry. In such case, the bank will wish to buy protection. Conversely, there may be sectors or highly rated companies or fast growing companies to which a bank has little or no exposure. Entering the consortium may be a time consuming exercise. In such case, the bank will wish to sell protection. Buying and selling of participation in the priority sector is one example where credit derivatives, albeit in a different form, has been practiced for several years.

Financial Institutions and NBFC's may also find themselves in a similar position to the banks and are thus likely to be both buyers and sellers in the market. Mutual funds and insurance companies that have an investment where they anticipate spread widening would typically be buyers of protection. Similarly, mutual funds and insurance companies that are looking for yield enhancement and believe that spreads of a given company are expected to narrow would typically be sellers of protection. Mutual funds and insurance companies may also sell protection as a means to diversify their portfolio and broaden their asset base. Companies may participate in the credit derivatives market to either buy or sell protection. One instance where a company would wish to buy protection is when it is overexposed to one or more buyers. Conversely, parent companies sometimes provide guarantees to banks on behalf of subsidiaries and these could easily be structured as credit derivatives.

Credit derivatives are contracts seeking to transfer an asset's risk and returns from one counter party to another without transferring the ownership. Though these tools currently have a limited presence in India, their market could see an explosive growth given the needs for the product and thrust from key areas.

Most Indian nationalized banks are saddled with NPAs to the tune of 5-6% of their total asset base. Given the current disbursement patterns and government policies, NPAs are likely to accrue to these banks in the future as well. This creates an obvious need for credit protection for these banks. However, in the Indian context, the sell side market is absent. For the segment to develop, the sellers of credit protection need to be able to hedge their risks, enabling them to quote a price for the protection they are selling. It is in this regard that the government and the local regulators can aid the development of a credit derivative market by providing impetus in the following areas:

- **Improving the breadth of the Debt Market:** Liquidity in the bond market is a must for the derivative market to take off. Current liberalization measures have led the insurance sector to open up, possibly improving liquidity at the long end of the

curve. Due to its long-bond positions, the insurance sector, globally, has been historically a seller of credit derivatives (contributing 23% to the sell side in UK in 1999).

- **Convertibility of INR:** Currency conversion has been a long-standing demand of most corporates. Once implemented, this would attract more multinational banks to the Indian market. Given the freedom, they would definitely enter the FX option market, through which they can synthetically trace the long-term yield curve. And, as a direct consequence, the Swap market would also take off, given the high correlation between these markets.
- **Need for Standardization:** The proposed set of new regulations by the Bank of international settlements seek to attach a risk weightage commensurate with the credit ratings, giving in to long standing demands of industry insiders. This would force banks to buy protection against lower rated loans, to ensure that they fulfill the 8% adequacy norm. It is also proposed to provide significant capital relief to the protection buyer and capital charge to the seller.
- **Need for Structured Products:** Securitization is fast gaining acceptance in the Indian markets. Given the coupling with credit derivatives that exists in some securitization deals, the growth of securitization could possibly signal the entry of the related product. Such a product would look to transfer the credit risk from the bank to the SPV by way of a credit derivative.

However, in view of certain adverse developments witnessed in different international financial markets, particularly the credit markets during 2007-09, such as mounting losses suffered by banks on account of sub-prime crisis, need for the central banks of those countries to inject liquidity into the system, as also the level of risk management systems and possible non-adherence to the regulatory guidelines on complex products such as credit derivatives, RBI has decided that time is not considered opportune to introduce the credit derivatives in India, for the present.

16.11 SUMMARY

Over-the-counter (OTC) derivatives have come to play an important role in the financial systems the world over. An interest rate swap is an agreement between two parties to pay each other interest on a notional principal amount, calculated on two different bases, or a stated period of time.The agreed amount is called the "notional amount", and since it is not a loan or investment, the principal amount is not exchanged initially or repaid at maturity. Interest payment streams are exchanged according to predetermined rules and are based upon the underlying notional amount.Credit derivatives are contracts seeking to transfer an asset's risk and returns from one counter party to another without transferring the ownership. Though these tools currently have a limited presence in India, their market could see an explosive growth given the needs for the product and thrust from key areas.

16.12 SELF ASSESSMENT QUESTIONS

1) What is meant by interest rate collar?
2) What is a forward rate agreement?
3) What is a credit default swap?
4) What is a total return swap?
5) What is a interest rate swap?
6) Choose the Appropriate answer(Correct answer marked as ***)

1) .....is a bilateral derivative contract on one or more reference assets in which the protection buyer pays a fee through the life of the contract in return for a contingent payment by the protection seller following a credit event (e.g. failure to pay, credit rating downgrade, etc.) of the reference entities.

   a) Credit Default Swaps***
   b) Forward Rate Agreement
   c) Interest Rate Swaps
   d) None of the above

2) An interest rate swap is a contractual agreement to exchange a series of cash flows. One leg of cash flow is based on a fixed interest rate and the other leg is based on a floating interest rate over a period of time. There is no exchange of principal

   a) Interest Rate Swap***
   b) Interest Rate Floor
   c) Interest Rate Collar
   d) Interest Rate Cap

3) .....is an option contract between two parties regarding money market interest rate.It is a combination of interest rate floor and interest rate cap.

   a) Interest Rate Swap
   b) Credit Default Swap
   c) Interest Rate Collar***
   d) Forward Rate Agreement

4) ..... is the interest rate at which banks can borrow funds, in marketable size, from other banks in the Indian interbank market

   a) MIBOR****
   b) MIFOR
   c) LIBOR
   d) EURIBOR

5) .....is where cash flows on both the legs of the swap are referenced to different floating rates

   a) Basis Swap***
   b) Currency swap
   c) Principal Only swap
   d) Differential swap

16.13 FURTHER READINGS

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