LESSON 19:
ANALYSIS & VALUATION OF DEBT & EQUITY: DEBT VALUATION

DEBT/BOND Valuation
Debt instruments promise to pay a stipulated stream of cash flows. This generally comprises periodic interest payments over the life of the instrument and principal payment at the time of maturity.

A vast menu of debt instruments exists. They may be classified into two groups according to maturity, where maturity is defined as the length of time between the issue date and the redemption date. Debt instruments which have a maturity of one year or less are called money market instruments. Debt instruments which have a maturity of more than one year are called bonds (or debentures).

The debt market in India has registered an impressive growth particularly since 1993 and, not surprisingly, has been accompanied by increasing complexity in instruments, interest rates, methods of analysis, and so on. It is instructive to compare the characteristics of pre-liberalisation scenario with those of the post-liberalisation scenario. This comparison is given in Exhibit 10.1.

Since debt instruments loom large in the world of finance, a basic understanding of certain analytical concepts and methods used in debt valuation is essential for students of finance.

Types and Features of Debt Instruments
The variety of debt instruments may be classified as follows:
- Money market instruments
- Government securities and government-guaranteed bonds
- Corporate debentures

Money Market Instruments
Debt instruments which have a maturity of less than 1 year at the time of issue are called money market instruments. The important money market instruments in India are Treasury bills, certificates of deposits, and commercial paper.

Treasury Bills
Treasury bills represent short-term obligations of the Government which have maturities like 91 days, 182 days, and 364 days. They do not carry an explicit interest rate (or coupon rate). They are instead sold at a discount and redeemed at par value. Hence the implicit interest rate is a function of the size of the discount and the period of maturity.

Though the yield on Treasury bills is somewhat low, they have appeal for the following reasons: (i) They can be transacted readily as they are issued in bearer form. (ii) There is a very active secondary market for Treasury bills and the discount and Finance House of India is a major market maker. (iii) Treasury bills are virtually risk free.

Certificates of Deposit
A certificate of deposit (CD) represents a negotiable receipt of funds deposited in a bank for a fixed period. It may be in a registered form or a bearer form. The latter is more popular as it can be transacted more readily in the secondary market. Like Treasury bills, CDs are sold at a discount and redeemed at par value. Hence the implicit interest rate is a function of the size of the discount and the period of maturity.

CDs are a popular form of short-term investment for companies for the following reasons: (i) Banks are normally willing to tailor the denominations and maturities to suit the needs of the investors. (ii) CDs are fairly liquid. (iii) CDs are generally risk-free. (iv) CDs generally offer a higher rate of interest than Treasury bills or term deposits.

Commercial Paper
Commercial paper represents short-term unsecured promissory notes issued by firms that are generally considered to be financially strong. Commercial paper usually has a maturity period of 90 days to 180 days. It is sold at a discount and redeemed at par. Hence the implicit rate is a function of the size of discount and the period of maturity. Commercial paper is either directly placed with investor or sold through dealers. Commercial paper does not presently have a well developed secondary market in India.

The main attraction of commercial paper is that it offers an interest rate that is typically higher than offered by Treasury bills or certificates of deposit. However, its disadvantages is that it does not have an active secondary market. Hence, it makes sense for firms that plan to hold till maturity.

Government Securities and Government-Guaranteed Bonds
The largest borrowers in India are the central and state governments. The Government of India periodically sells central government securities. These are essentially medium to long-term bonds issued by the Reserve Bank of India on behalf of the Government of India. Interest payments on these bonds are typically semi-annual. State governments also sell bonds. These are also essentially medium to long-term bonds issued by the Reserve Bank of India on behalf of state governments. Interest payments on these bonds are typically semi-annual.

A part from the central and state governments, a number of governmental agencies issue bonds that are guaranteed by the central government of some state government. Interest payments on these bonds are typically semi-annual.

Corporate Debt
Bonds (or debentures) are issued frequently by public sector companies, financial institutions, and private sector companies.

A wide range of innovative debt securities have been created in India, particularly from early 1990s. This innovation has been stimulated by a variety of factors, the most important being the increased volatility of interest rates and changes in the tax and regulatory framework. A brief description of various types of corporate bonds is given below.

Straight Bonds
The straight bond (also called plain vanilla bond) is the most popular type of bond. It pays a fixed periodic (usually semi-
Zero Coupon Bonds
A zero coupon bond (or just zero) does not carry any regular interest payment. It is issued at a steep discount over its face value and redeemed at face value on maturity. For example, the Industrial Development Bank of India (IDBI) issued deep discount bonds in 1996 which have a face value of Rs. 200,000 and a maturity period of 25 years. The bonds were issued at Rs. 5,300. These bonds carry call and put options.

Floating Rate Bonds
Straight bonds pay a fixed rate of interest. Floating rate bonds, on the other hand, pay an interest rate that is linked to a benchmark rate such as the Treasury bill interest rate. For example, in 1993 the State Bank of India came out with the first ever issue of floating interest rare bonds in India. It issued 5million (Rs 1000) face value) unsecured, redeemable, subordinated floating interest rate bonds carrying interest at 3 percent per annum over the bank’s maximum term deposit rate.

Bonds with Embedded Options
Bonds may have options embedded in them. These options give certain rights to investors and/ or issuers. The more common types of bonds with embedded options are:
Convertible Bonds Convertible bonds give the bond holder the right (option) to convert them into equity shares on certain terms.
Callable Bonds Callable bonds give the issuer the right (option) to redeem them prematurely on certain terms.
Puttable Bonds Puttable bonds give the investor the right to prematurely sell them back to the issuer on certain terms.

Commodity-Linked Bonds
The payoff from a commodity linked bond depends to a certain extent on the price of a certain commodity. For example, in June 1986 Standard Oil Corporation issued zero coupon notes which would mature in 1992. The payoff from each note was defined as : $1,000 + 200 \times \text{Price per barrel of oil in dollars - $25}$. The second term of the payoff, however, was subject to a floor of 0.

Bond Features
Bonds tend to be confusing because of complex provisions attached to them. The financial contract between the issuer and the holder of bonds is called the bond indenture which spells out the features of the bond in terms of collateral, sinking fund, call provision, protective covenants, and so on.

Collaterla
Collateral represents a pledge of assets in favour of the bond holders. If serves as an insurance against any possible default by the borrower.

Sinking Fund
A sinking fund provision requires the issuing firm to retire a certain percentage of the bond issue at stipulated points of time.

Protective Covenants
The bond indenture often contains several covenants to protect the interest of lenders. These convenants impose restrictions on management and give bondholders greater confidence that the firm will honour its commitments. For example, convenants may put limits on dividend payment, managerial compensation, and total borrowings.

Bond Pricing
The value of a bond - or any asset, real or financial - is equal to the present value of the cash flows expected from it. Hence determining the value of a bond requires:

- An estimate of expected cash flows.
- An estimate of the required return.

To simplify our analysis of bond valuation we will make the following assumptions:
The coupon interest rate is fixed for the term of the bond.
The coupon payments are made every year and the next coupon payment is receivable exactly a year from now.
The bond will be redeemed at par on maturity.

Given these assumptions, the cash flow for a noncallable bond comprises an annuity of a fixed coupon interest payable annually and the principal amount payable at maturity. Hence the value of bond is :-

Where

- $P = \text{value (in rupees)}$
- $n = \text{number of years}$
- $C = \text{annual coupon payment}$
- $r = \text{periodic required return}$
- $M = \text{maturity value}$
- $t = \text{time period when the payment is received}$

Since the stream of annual coupon payments is an ordinary annuity, we can apply the formula for the present value of an ordinary annuity. Hence the bond value is given by the formula :

To illustrate how to compute the price of a bond, consider a 10-year, 12% coupon bond with a par value of 1,000. Let us assume that the required yield on this bond is 13%. The cash flows for this bond are as follows :-

- 10 annual coupon payments of Rs. 120
- Rs. 1000 principal repayment 10 years from now

The value of the bond is :

$$P = 120 \times PVIFA \ 13\%, \ 10yrs + 1,000 \times PVIF \ 13\%, \ 10yrs$$

= 120 \times 5.426 + 1,000 \times 0.295

= 651.1 + 295 = Rs. 946.1

Bond Values with Semi-annual Interest
Most of the bonds pay interest semi-annually. To value such bonds, we have to work with a unit period of six months, and not one year. This means that the bond valuation equation has to be modified along the following lines :

- The annual interest payment, $C$, must be divided by two to obtain the semi-annual interest payment.
- The number of years to maturity must be multiplied by two to get the number of half-yearly periods.
• The discount rate has to be divided by two to get the discount rate applicable to half-yearly periods.

With the above modifications, the basic bond valuation becomes:

Where  
\[ p = \text{value of bond} \]
\[ C/2 = \text{semi-annual interest payment} \]
\[ r/2 = \text{discount rate applicable to a half-year period} \]
\[ M = \text{maturity value} \]
\[ 2n = \text{maturity period expressed in terms of half-yearly periods} \]

As an illustration, consider a 5-year, 12% coupon bond with a par value of Rs. 1,000 on which interest is payable semi-annually. The required return on this bond is 12 percent.

Applying Eq(10.3), the value of the bond is:

- **Price-Yield Relationship**

A basic property of a bond is that its price varies inversely with yield. The reason is simple. As the required yield increases, the present value of the cash flow decreases; hence the price decreases. Conversely, when the required yield decreases, the present value of the cash flow increases; hence the price increases. The graph of the price-yield relationship for any callable bond has a convex shape as shown in Exhibit 10.2

- **Relationship between Bond Price and Time**

Since the price of a bond must equal its par value at maturity (assuming that there is no risk of default), bond prices change with time. For example, a bond that is redeemable for Rs. 1,000 (which is its par value) after 5 years when it matures, will have a price of Rs. 1,000 at maturity, no matter what the current price is. If its current price is, say, Rs. 1,000, it is said to be a premium bond. If the required yield does not change between now and the maturity date, the premium will decline over time as shown by curve A in Exhibit 10.3. On the other hand, if the bond has a current price of say Rs. 900, it is said to be a discount bond. The discount too will disappear over time as shown by curve B in Exhibit 10.3. Only when the current price is equal to par value – in such a case the bond is said to be a par bond – there is no change in price as time passes, assuming that the required yield does not change between now and the maturity date. This is shown by the dashed line in Exhibit 10.3.

Bonds are generally traded on the basis of their prices. However, they are usually not compared in terms of price because of significant variations in cash flow patterns and other features. Instead, they are typically compared in terms of yield.

In the previous section we learned how to determine the price of a bond and discussed how price and yield were related. We now discuss various yield measures.

The commonly employed yield measures are: current yield, yield to maturity, yield to call, and realized yield to maturity. Let us examine how these yield measures are calculated.

- **Current Yield**

The current yield relates the annual coupon interest to the market price. It is expressed as:

For example, the current yield of a 10-year, 12 percent coupon bond with a par value of Rs. 1,000 and selling of Rs. 950 is 12.63 percent.

The current yield calculation reflects only the coupon interest rate. It does not consider the capital gain (or loss) that an investor will realize if the bond is purchased at a discount (or premium) and held till maturity. It also ignores the time value of money. Hence it is an incomplete and simplistic measure of yield.

- **Yield to Maturity**

The yield to maturity (YTM) of a bond is the interest rate that makes the present value of the cash flows receivable from owning the bond equal to the price of the bond. Mathematically, it is the interest rate \( r \) which satisfies the equation:

Where  
\[ p = \text{price of the bond} \]
\[ C = \text{annual interest (in rupees)} \]
\[ M = \text{maturity value (in rupees)} \]
\[ n = \text{number of years left to maturity} \]

The computation of YTM requires a trial and error procedure. To illustrate this, consider a Rs. 1,000 par value bond, carrying a coupon rate of 9 percent, maturing after 8 years. The bond is currently selling of Rs. 800. What is the YTM on this bond?

The YTM is the value of \( r \) in the following equation:

\[ \text{Let us begin with a discount rate of 12 percent. Putting a value of 12 percent for } r \text{ we find the right-hand side of the above expression is} \]

\[ \text{Rs 90 (PVIFA}_{12\%,8\text{yrs}}) + \text{Rs 1,000 (PVIF}_{12\%,8\text{yrs}}) \]
\[ = \text{Rs 90(4.968) + Rs. 1,000(0.404) = Rs. 851.0} \]

Since the value is greater than Rs 800, we may have to try a higher value of \( r \). Let us try \( r = 13 \) percent. This makes the right-hand side equal to:

\[ \text{Rs 90 (PVIFA}_{13\%,8\text{yrs}}) + \text{Rs 1,000 (PVIF}_{13\%,8\text{yrs}}) \]
\[ = \text{Rs 90 (4.639) + Rs 1,000 (0.351) = Rs 768.1} \]

Since this value is less than Rs 800, we try a lower value for \( r \). Let us try \( r = 14 \) percent. This makes the right-hand side equal to:

\[ \text{Rs 90 (PVIFA}_{14\%,8\text{yrs}}) + \text{Rs 1,000 (PVIF}_{14\%,8\text{yrs}}) \]
\[ = \text{Rs 90 (4.600) + Rs 1,000 (0.376) = Rs 808} \]

Thus \( r \) lies between 13 percent and 14 percent. Using a linear interpolation 1 in the range 13 percent of 14 percent, we find that \( r \) is equal to 13.2 percent.

**An Approximation**

If you are not inclined to follow the trial-and-error approach described above, you can employ the following formula to find the approximate YTM on a bond:

Where  
\[ \text{YTM = yield to maturity} \]
\[ C = \text{annual interest payment} \]
\[ M = \text{maturity value of the bond} \]
\[ P = \text{present price of the bond} \]
\[ n = \text{years to maturity} \]

To illustrate the use of this formula, let us consider the bond discussed above. The approximate YTM of the bond works out to:

The procedure for linear interpolation is as follows:

a. Find the difference between the present value for the two rates, which in this case is Rs. 39.9 (Rs 808 – Rs 768.1).
h. Find the difference between the present value corresponding to the lower rate (Rs. 808 at 3 percent) and the target value (Rs. 800), which in this case is Rs. 8.

c. Divide the outcome of (b) with the outcome of (a), which is 8/0.2 or 0.2. Add this fraction to the lower rate, i.e. 13 percent. This gives the YTM of 13.2 percent.

Thus, we find that this formula gives a value which is very close to the true value. Hence it is very useful.

The YTM calculation considers the current coupon income as well as the capital gain or loss the investor will realize by holding the bond to maturity. In addition, it takes into account the timing of the cash flows.

- **Yield to Call**

Some bonds carry a call feature that entitled the issuer to call (buy back) the bond prior to the stated maturity date in accordance with a call schedule (which specifies a call price for each call date). For such bonds, it is a practice to calculate the yield to call (YTC) as well as the YTM.

The procedure for calculating the YTC is the same as for the YTM. Mathematically the YTC is the value of r in the following equation:

\[
P = C + \frac{M*}{(1 + r*)^{n*}}
\]

where

- \( M^* \) = call price (in rupees)
- \( n^* \) = number of years until the assumed call date

- **Realised Yield to Maturity**

The YTM calculation assumes that the cash flows received through the life of a bond are re-invest at a rate equal to the yield to maturity. This assumption may not be valid if the reinvestment rates applicable to future cash flows may be different. It is necessary to define the future reinvestment rates and figure out the realized yield to maturity.

How this is done may be illustrated by an example.

Consider a Rs 1000 par value bond, carrying an interest rate of 15 percent (Payable annually) and maturing after 5 years. The present market price of this bond is Rs 850. The re-investment rate applicable to the future cash flows of this bond is 16 percent. The future value of the benefits receivable from this bond, calculated in Exhibit 10.4, works out to 2032. The realized yield to maturity is the value of \( r^* \) in the following equation.

Present market price \( (1 + r^*)^5 = \) Future value

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

\( r^* = 0.19 \) for 19 percent

**Exhibit : Future value of Benefits**

**Risk In Debt**

Like any other investment, bonds should be viewed in terms of their risk and return. Bonds are subject to diverse risks, such as interest risk, inflation risk, real interest rate risk, default risk, call risk and liquidity risk.

**Interest Rate Risk**

Interest rates tend to vary over time, causing fluctuations in bond prices. A rise in interest rates will depress the market prices of outstanding bonds whereas a fall in interest rates will push the market prices up.

Interest rate risk, also referred to as market risk, a measured by the percentage change in the value of a bond in response to a given interest rate change. It is a function of the maturity period of the bond and its coupon interest rate. You can appreciate this easily by looking at the general formula for the current price of a bond.

\[
P = \frac{C}{(1 + r)^t} + \frac{M}{(1 + r)^n}
\]

An examination of this formula reveals that:

- Larger maturity period — Greater sensitivity of price to changes in interest rates.
- Larger coupon (interest) payment -- Lesser sensitivity of price to changes in interest rates.
- Duration, a precise measure of interest rate sensitivity, is discussed later in the next section.

**Inflation Risk**

Interest rates are defined in nominal terms. This means that they express the rate of exchange between current and future rupees. For example, a nominal interest of 12 percent on a one-year loan means that Rs 112 is payable a year hence for Rs 100 borrowed today. However, what really matters is the real rate of interest, the rate of exchange between current and future goods and services.

Since financial contracts are typically stated in nominal terms, the real interest rate should be adjusted for the expected inflation. According to the Fisher effect, the following relationship holds between the nominal rate \( r \), the real rate \( a \), and the expected inflation rate \( a \).

\[
r = 1 + a + aa (10.8)
\]

or,

\[
r = 1 + a + aa (10.9)
\]

For example, if the required real rate is 6 percent and the expected inflation rate is 8 percent, the nominal rate will be:

\[
(0.06) + (0.08) + (0.06)(0.08) = 0.1448 \text{ percent}
\]

When the inflation is higher than expected, the borrower gains at the expense of the lender and vice versa. Put differently, inflation is a zero-sum game.

The impact of a change in inflation rate is similar to that of a change in interest rate. This means that inflation risk is greater for long-term bonds. Hence, in a period of volatile inflation rates, borrowers will be disinclined to issue long-term fixed-interest bonds and investors, too, will be reluctant to buy such shares. During such times, floating rate bonds and shorter-maturity bonds become more popular.

**Real Interest Rate Risk**

Even if there is no inflation risk, borrowers and lenders are still exposed to the risk change in the real interest rate. Shifts in supply and/ or demand for funds will change the real rate of interest.

To understand the implications of real interest rate risk consider an example. Suppose that the real interest rate falls from 6 to 4 percent because a combination of tax law changes and heightened competition drives down the real interest rate. In this case a firm that has borrowed funds at 6 percent on its debt.
Irrespective of whether it gains or losses from a change in the real rate of interest, a firm that has locked itself into a long-term debt at a fixed real cost can experience a dramatic impact whenever the real rate of interest changes. As such changes can scarcely be predicted, they represent a source of risk that borrowers and lenders have to face.

**Default Risk**

Default risk refers to the risk accruing from the fact that a borrower may not pay interest and/or principal on time. Default risk, also referred to as ‘Credit Risk’, is normally gauged by the rating assigned to the debt instrument by an independent credit rating agency (like CRISIL, ICRA, or CARE). Other things being equal, bonds which carry a higher default risk (lower credit rating) trade at a higher yield to maturity. Put differently, they sell at a lower price compared to government securities which are considered free from default risk (as the government has the power to print money, it is believed that it will not default in honouring its commitments). Except in the case of highly risky instruments, referred to as junk bonds, investors seem to be more concerned with the perceived risk of default rather than the actual occurrence of default. Even though the actual default may be highly unlikely, they believe that a change in the perceived default risk of a bond would have an immediate impact on its market price.

**Call Risk**

A bond may have a call provision that gives the issuer the option to call the bond before its scheduled maturity. The issuer would generally exercise the call option when interest rates decline. While this is attractive from the issuer’s point of view, it exposes the investors to call risk. Since bonds are typically called for repayment after interest rates have fallen, investors will not find comparable investment vehicles. They almost invariably have to accept a lower yield when they reinvest the amount received on premature redemption.

**Liquidity Risk**

Barring some popular Government of India securities which are traded actively, most debt instruments do not seem to have a very liquid market. The market for debt is mainly an over-the-counter market and much of the activity seems to occur in the primary (new issues) market. Given the poor liquidity in the debt market, investors face difficulty in trading debt instruments, particularly when the quantity is large. They may have to accept a discount over the quoted price while selling and pay premium while buying. This seems to be a major problem in certain segments of the bond market, far bigger than what investors realize.

**Interest Rate Risk**

We have seen that bond prices and yields are inversely related. As interest rate fluctuate bondholders experience capital losses and gains. Why? The reason is that in a competitive market, securities are priced to offer fair expected rates of return. If a bond is issued with a 10 percent coupon when the competitive yield is 15 percent, then it will sell at par. If the market rate rises to 11 percent, the bond price must fall so that its yield rises to 11 percent; conversely if the market rate falls to 9 percent, its price must rise.

**Interest Rate Sensitivity**

Investors are concerned about the sensitivity of bond prices to changes in market rates. The following bond-pricing relationships throw light on the determinants of that sensitivity: There is an inverse relationship between bond prices and yields.

1. An increase in yield causes a proportionately smaller price change than a decrease in yield of the same magnitude.
2. Prices of long-term bonds are more sensitive to interest rate changes than prices of short-term bonds.
3. As maturity increases, interest rate risk increases but at a decreasing rate.
4. Prices of low-coupon bonds are more sensitive to interest rate changes than prices of high-coupon bonds.
5. Bond prices are more sensitive to yield changes when the bond is initially selling at a lower yield.

The above rules are illustrated in Exhibit 10.5 which presents the percentage change in price corresponding to changes in yield for four bonds differing in time to maturity, coupon rate, and initial yield to maturity. From the exhibit we find that:

- All four bonds illustrate rules 1 and 2: prices vary inversely with yield, but the price curve is convex, implying that yield decreases have a greater impact on price than yield increases of equal magnitude.
- Bonds A and B illustrate rules 3 and 4: the price of bond B, which has a longer maturity than bond A, is more sensitive to interest rate changes. However, while bond B has six times the maturity of bond A, its interest rate sensitivity is less than six times.
- Bond B ands C illustrate rule 5: Bond C, which has a lower coupon rate, exhibits greater sensitivity to interest, rate changes.
- Bonds C and D illustrate rule 6: Bond D, which has a lower yield, is more sensitive to interest rate changes.

**Exhibit 10.5: Relationship between Change in Yield to Maturity and Change in Bond Price**

**Duration**

The duration of bond is the weighted average maturity of its cash flow stream, where the weights are proportional to the present value of cash flows. Formally, it is defined as:

$$
\text{Duration} = \frac{\left( PV \left( C_1 \right) \times 1 + PV \left( C_2 \right) \times 2 + \ldots + PV \left( C_n \right) \times n \right)}{Vo} 
\text{(10.10)}$$

where $PV \left( C_t \right) = \text{present value of the cash flow receivable at the end of the year } t$

$t = 1,2,\ldots,n \text{ Vo = current value of the bond.}$

For calculating the present value of cash flow, the yield to maturity (the internal rate of return) of the bond issue is used as the discount rate.

The duration of a bond, in effect, represent value from the bond is received. To illustrate how low duration is calculated consider Bond A.

| Bond A | Face Value | Rs 100 | Coupon (inter Best rate) | 15 percent payable annually | Years to maturity | 6 | Redemption value | Rs 100 |
Current market price: Rs 89.50
Yield to maturity: 18 percent

Exhibit: shows the calculation of duration for this bond.

**Exhibit: Calculation of Duration** Duration is a key concept in bond analysis for the following reasons:

- It measures the interest rate sensitivity of a bond.
- It is a useful tool for immunising against rate risk.

**Duration and Volatility**

This proportional change in the price of a bond in response to the change on its yield is as follows:

\[
\frac{\Delta P}{P} = \frac{-D}{1 + y} \Delta y
\]

where \(\Delta P / P\) = proportional price change

\(D = \) duration of the bond

\(Y = \) yield

In practice, a slightly different form of Eq. (10.11) is used. A modified duration measure defined as \(D^* = D / (1 + y)\) is used. Since \(\Delta (1 + y) = \Delta y\), Eq. (10.11) may be rewritten as:

\[
\frac{\Delta P}{P} = -D^* \Delta y
\]

Thus the percentage change in bond price is equal to the product of modified duration and the change in the yield of the bond.

**Properties of Duration**

The following rules relate to duration:

1. The duration of a zero coupon bond is the same as its maturity.
2. For a given maturity, a bond’s duration is higher when its coupon rate is lower.
3. For a given coupon rate, a bond’s duration generally increases with maturity.
4. Other things being equal, the duration of a coupon bond varies inversely with its yield to maturity.
5. The duration of a level perpetuity is:

\[
(1 + Y) / Y
\]

For example, at a 9 percent yield, the duration of a perpetuity that pays Rs 100 per year forever will be equal to:

\[
(1.09 / 0.09) = 12.11.
\]

From this rule it is clear that maturity and duration can be substantially different. While the maturity of the perpetuity is infinite, the duration of the bond at a 9 percent yield is only 12.11 years.

6. The duration of a level annuity approximately is:

\[
\frac{1 + \text{yield}}{\text{Number of payments}} - 1
\]

For example, a 15-year annuity with a yield of 10 percent will have a duration of:

\[
1.10^{15} - 1 = 6.28 \text{ years}
\]

7. The duration of a coupon bond approximately is:

\[
1 + y \left(1 + y \right) + T(c-y) \quad c[1+y](t - 1) + y
\]

where \(y\) is the bond’s yield per payment period, \(T\) is the number of payment periods, and \(c\) is the coupon rate per payment period.

**Duration and Immunisation**

If the interest rate goes up it has two consequences for a bondholder: i) the capital value of the bond falls, and ii) the return on reinvestment of interest income improves.

By the same token, if the interest rate declines, it has two consequences for a bondholder: i) the capital value of the bond rises, and ii) the return on reinvestment of interest income decreases. Thus, an interest rate change has two effects in opposite directions. Can an investor ensure that these two opposite effects are equal so that he is immunised against interest rate risk? Yes, it is possible, if the investor chooses a bond whose duration is equal to his investment horizon. For example, if an investor’s investment horizon is 5 years he should choose a bond that has a duration of 5 years if he wants to insulate himself against interest rate risk. If he does so, whenever there is a change in interest rate, losses (or gains) in capital value will be exactly offset by gains (or losses) on reinvestments.

**Rating of Debt Securities**

Rating of the debt securities issued by companies, quasi-government organizations, and governments first originated in the United States where presently there are at least five firms offering such services. In recent years, rating agencies have been set up in several other countries.

In India, too, four rating agencies, viz., CRISIL, ICRA, and CARE and Phelps and Duff have been set up. Some more agencies are in the pipeline.

**Meaning of Debt Ratings**

To understand the meanings of debt ratings, consider some descriptions offered by well known rating agencies.

Moody’s: “Ratings are designed exclusively for the purpose of bonds according to their investment qualities.”3

Standard and Poor’s: “A standard and Poor’s corporate or municipal debt rating is a current assessment of the creditworthiness of an obligor with respect to specific obligation.”4

Australian Ratings: “A corporate credit rating provides lenders with a system of gradation by which the relative capacities of companies to make timely repayment of interest and principal on a particular type of debt can be noted.”5 Looking at the above description we find that a debt rating essentially reflects the probability of timely payment of interest and principal by a borrower. The higher the debt rating, the greater the likelihood that the borrower will fulfill his obligation to pay the interest and principal.

3 Moody’s Investor Service, Moody’s Bond record, New York: Moody’s investor service, December 1984, P.2

4 Standard and Poor credit overview: Corporate and International Ratings, New York: Standard and Poor’s, 1984, p. 10

5 Australian Ratings, An Introduction to Australian Ratings, Melbourne: Australian Ratings 1984, P.2

Having described what debt rating is we should also clarify what it is not.
A debt rating is not a recommendation for purchasing, selling, or holding a security. The important elements relevant for investment decision-making in a debt security are: (i) yield to maturity, (ii) risk tolerance of the investor, and (iii) credit risk of the security. Clearly, the focus of debt rating is on only one of these three elements, viz. credit risk of the security, and hence it cannot be the sole basis for investment decision making.

A debt rating is not a general evaluation of the issuing organization. If a debt issue of a firm X is rated higher than a debt issue of firm Y, it does not mean that firm X is better than firm Y. Remember that debt rating being security-specific is supposed to assess the credit risk of a particular debt security, nothing less and nothing more.

A debt rating does not create fiduciary relationship between the rating agency and the users of a rating since there is no legal basis for such a relationship.

A debt rating does not imply that the rating agency performs an audit function. While the rating agency may examine various facets of a company’s working and gather information relevant to its task, it is not expected to perform and audit function or attest to the veracity of information shares by the issuer.

A debt rating is not a one-time evaluation of credit risk, which can be regarded as valid for the entire life of the security. Changes in the dynamic world of business may imply a change in the risk characteristics of the security. Hence debt rating agencies monitor the business and financial condition of the issuer to determine whether a modification in rating is warranted.

**Functions of Debt Ratings**

Debt ratings (or debt rating firms) are supposed to:

- Provide superior information.
- Offer low-cost information.
- Serve as a basis for a proper risk-return tradeoff.
- Impose healthy discipline on corporate borrowers.
- Lend greater credence to financial and other representations.
- Facilitate the formulation of public policy guidelines on institutional investment.

**Superior Information**

A debt rating by an independent, professional rating firm offers a superior and more reliable source of information on credit risks for three interrelated reasons: (i) An independent rating firm unlike brokers and underwriters who have a vested interest in an issue, is likely to provide an unbiased opinion. (ii) Due to its professional resources, a rating firm has greater ability to assess risks. (iii) A rating firm has access to a lot of information which may not be publicly available.

**Low Cost Information**

A rating firm which gathers, analyses, interprets, and summarizes complex information in a simple and readily understood format (like a nine-point scale) for wide public consumption represents a cost-effective arrangement. Such an arrangement is extremely useful to most investors who would find it prohibitively expensive or simply impossible to do such a credit evaluation on their own.

**Basis for a Proper Risk-Return Tradeoff**

If debt securities are rated professionally and such ratings enjoy widespread investor acceptance and confidence, a more rational risk-return tradeoff would be established in the capital market. Securities which have a high rating would have a lower expected return.

**Healthy Discipline on Corporate Borrowers**

Public exposure is a good motivator for improving performance. The rating of a firm’s debt security increases its public visibility and normally has a healthy influence over its management because of its desire to have a clear image. The influence of a rating firm is somewhat analogous to that of a score keeper in a game if you know that someone is keeping the score you tend to play well.

**Greater Credence to Financial and Other Representations**

When a rating firm rates the debt security of an issuer, its own reputation is at stake. So it seeks financial and other information of a quality that is acceptable to it. As the issuer complies with the demands of the rating agency on a continuing basis, its financial and other representations acquire greater credibility.

**Formulation of Public Policy Guidelines on Institutional Investment**

Public policy guidelines on what kinds of securities are eligible for inclusion in different kinds of institutional portfolios can be developed with greater confidence if debt securities are rated professionally by independent rating firms.

It must be emphasized that the fulfillment of the above functions hinges critically on the credibility of debt ratings. This point has been expressed eloquently by Standard and Poor’s: "Ratings are of value only so long as they are credible …. Credibility is fragile… S&P operates with no governmental mandate, subpoena powers, or any other official authority. It simply has a right, as part of the media, to express its opinions in the form of letter symbols." Rating Methodology. Despite variations across individual rating agencies, the following features appear to be common in the rating methodology employed by different agencies.

1. Two broad types of analyses are done: (i) industry and business analysis, and (ii) financial analysis.
2. The key factors considered in industry and business analysis are: (i) growth rate and relationship with the economy (ii) industry risk characteristics, (iii) structure of industry and nature of competition, (iv) competitive position of the issuer and (v) managerial capability of the issuer.
3. The important factors considered in financial analysis are: (i) earning power (ii) business and financial risk, (iii) asset protection, (iv) cash flow adequacy, (v) financial flexibility, and (vi) quality of accounting.
4. Subjective judgment seems to play an important role in the assessment of the issue/issuer on various factors.
5. While each factor is normally scored separately no mechanical formula is used for combining the scores on
different factors to arrive at the rating conclusion. In the ultimate analysis, all variables are viewed as interdependent.

6. Industry risk characteristics are likely to set the upper limit on rating.

CRISIL Debenture Rating Symbols
CRISIL is the largest credit agency in India. It rates instruments like debentures, preference shares, fixed deposits, and commercial paper. The rating symbols employed by CRISIL for debentures are mainly of three types:

1. **High Investment Grades** Debentures rated ‘AAA’ are judged to offer highest safety of timely payment of interest and principal. Though the circumstances providing this degree of safety are likely to change, such changes as can be envisaged are most unlikely to adversely affect the fundamentally strong position of such issues.

2. Debentures rated ‘AA’ are judged to offer high safety of timely payment of interest and principal. They differ in safety from ‘AAA’ issues only marginally.

3. Investment Grades Debentures rated ‘A’ are judged to offer adequate safety of timely payment of interest and principal; however, changes in circumstances can adversely affect such issues more than those in the higher rated categories.

Debentures rated ‘BBB’ are judged to offer sufficient safety of timely payment of interest and repayment of principal; however, changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal than for debentures in higher rated categories.

4. **Speculative Grades** Debentures rated ‘BB’ are judged to carry inadequate safety of timely payment of interest and repayment of principal; while they are less susceptible to default than other speculative grade debentures in the immediate future, the uncertainties that the issuer faces could lead to inadequate capacity to pay timely interest and principal payments.

Debentures rated ‘B’ are judged to have greater susceptibility to default; while currently interest and principal payments are met, adverse business or economic conditions would lead to lack of ability or willingness to play interest or principal. Debentures rated ‘C’ are judged to have factors present that make them vulnerable to default; timely payment of interest and principal is possible only if favorable circumstances continue. Debentures rated ‘D’ are in default and in arrears of interest or principal payments and are expected to default on maturity. Such debentures are extremely speculative and return from these debentures may be realized only on reorganization or liquidation.

**Note:**

1. CRISIL may apply ‘+’ (plus) or ‘-’ (minus) signs for ratings from AA to D to reflect comparative standing within the category.
2. The contents within parenthesis are aguid to the pronunciation of therating symbols.
3. Preference share rating symbols are identical to debenture rating symbols except that the letters are prefixed to the debenture rating symbols, eg. Pf AAA ("pf Triple A")

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**The Yield Curve**

The term structure of interest rates, popularly called the yield curve, shows how yield to maturity is related to term to maturity for bonds that are similar in all respects, excepting maturity.

Consider the following data for government securities:

<table>
<thead>
<tr>
<th>Face value</th>
<th>Interest Rate</th>
<th>Maturity (years)</th>
<th>Current price</th>
<th>Yield to maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>0</td>
<td>1</td>
<td>88,968</td>
<td>12.40</td>
</tr>
<tr>
<td>100,000</td>
<td>12.75</td>
<td>2</td>
<td>99,706</td>
<td>13.13</td>
</tr>
<tr>
<td>100,000</td>
<td>12.75</td>
<td>3</td>
<td>100,522</td>
<td>13.75</td>
</tr>
<tr>
<td>100,000</td>
<td>13.50</td>
<td>4</td>
<td>99,706</td>
<td>13.60</td>
</tr>
<tr>
<td>100,000</td>
<td>12.75</td>
<td>5</td>
<td>99,484</td>
<td>12.90</td>
</tr>
</tbody>
</table>

The yield curve for the above bonds is shown in Exhibit 10.7. It slopes upwards, indicating that long term rates are greater than short term rates. Yield curves, however, do not have to necessarily slope upwards. They may follow any pattern.

Four patterns are depicted in Exhibit 10.8. Another perspective, on the term structure of interest rates is provided by the forward interest rates, i.e., the interest rates applicable to bonds in the future.

To get forward interest rates, begin with the one-year Treasury bill:

\[ 88,968 = \frac{100,000}{1 + r_1} \]

where \( r_1 \) is the one year spot rate, i.e., the discount rate applicable to risk less cash flow receivable a year hence. Solving for \( r_1 \) gives \( r_1 = 0.124 \). Next, consider the two year government security and split its benefits into two parts, the interest of Rs 12,750 receivable at the end of year 1 and Rs 112,750 (representing the interest and principal repayment) receivable at the of year 2. The present value of the first part is:

**Explaining The Term Structure**

What determines the term structure of interest rates? This question has long puzzled academicians and practitioners. Three principal explanations have been offered: the expectations theory, the liquidity preference theory, and the preferred habitat theory.

**Expectations Theory**

This theory holds that the shape of the yield curve can be explained by the interest rate expectations of those who participate in the market. More precisely, the expectations theory holds that any long term rate is equal to the geometric mean of current and future one year rates expected by the market participants.

\[
(1 + R_n) = \left(1 + (1 + tR_1) + (1 + tR_2) + \ldots + (1 + tR_n)\right)^{1/n}
\]

where \( R_n = \text{actual long term rate} \)

\( n = \text{term to maturity (in years) of the long issue} \)

\( tR_i = \text{current year rate} \)

\( t + IR_i = \text{expected one year rate during some future period} \)

Clearly, the expectations hypothesis can explain any shape of yield curve:
<table>
<thead>
<tr>
<th>Yield Curve</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascending</td>
<td>Short-term rates are expected to rise in future.</td>
</tr>
<tr>
<td>Descending</td>
<td>Short-term rates are expected to fall in future.</td>
</tr>
<tr>
<td>Humped</td>
<td>Short-term rates are expected to rise for a while and then fall.</td>
</tr>
<tr>
<td>Flat</td>
<td>Short-term rates are expected to remain unchanged in future.</td>
</tr>
</tbody>
</table>

**Liquidity Preference Theory**

An important criticism leveled against the expectations theory is that it assumes that investors know with certainty what lies ahead of them. The future, however, is not known. There is uncertainty about the one-year period return from a bond whose maturity is greater than one period. And this uncertainty regarding the one-period return increases with the maturity of the bond. Since investors are risk-averse, J.R. Hicks argued that they require an inducement to hold long-term bonds. They will ask for a long-term rate which is higher than the average of expected future rates. Put differently, forward rates should incorporate interest rate expectations as well as a risk (or liquidity) premium.

In formal terms, the liquidity preference hypothesis may be expressed as a variations of Eq. (10.16) Thus, according to the liquidity preference theory, an upward-sloping yield curve suggests that future interest rates will rise (or will be flat) or even fall if the liquidity premium increases fast enough to compensate for the decline in the future interest rates.

**Preferred Habitat Theory**

The liquidity preference theory assumes that risk premium must necessarily rise with maturity because investors wish to liquidate their investments at the earliest and borrowers want to borrow long. This assumption, however, may not be realistic.

According to Modigliani and Sutch who originally formulated the habitat theory, risk-aversion implies that investors will prefer to match the maturity of investment to their investment objective. Investors with long investment horizons would like to invest in instruments of longer maturities; otherwise they will be exposed to a reinvestment risk, i.e., the risk that the interest rate will decline when the proceeds of a short-term instrument have to be reinvested. Likewise short-term investors would like to invest in instrument of shorter maturity; otherwise they will be exposed to a price risk, i.e., the risk that the price of an asset will fall when it is sold prematurely because of a rise in interest rates. Similar considerations apply to borrowers; risk-version implies that borrowers would like to match the maturity of their borrowings to the length of time for which they need funds. If there is a mismatch between the demand and supply of funds in a certain maturity range, the preferred habitat theory asserts that some lenders and borrowers may have to be induced to shift out their preferred maturity of ranges.

Of course, they will have to be compensated for this in the form of a suitable risk premium which depends on the extent of risk aversion. The shape of the yield curve, according to the preferred habitat theory, is influenced by expectations of future interest rates as well as risk premia, positive or negative, required to move market participants out of the preferred habitats. Clearly, all types of yield curves, viz. upward-sloping, downward-sloping, flat, or humped, are possible.

**Market Segmentation Theory**

In a way, the market segmentation theory is an extreme form of the preferred habitat theory. It states that investors as well as borrowers are unwilling to shift from their preferred maturity range, come what may. Hence according to this theory the shape of the yield curve is determined entirely by the supply and demand forces within each maturity range. Since it presupposes absolute risk aversion, the market participants do shift out of their preferred habitats when there are large differences between market and expected rates.

**Determinants of Interest Rates**

Other things being equal, the price of a bond falls when the required rate of return falls.

Since the required rate of return has an important bearing on bond price, you should know what drives the required rate of return, which will hereafter, for the sake of simplicity, be referred to as the interest. The interest rate is determined by four factors or variables: short-term risk-free interest rate, maturity premium, default premium, and special features. These are discussed below in some detail.

**Short-term Risk-free Interest Rate**

The short-term risk-free interest rate is the yield on a one-year government security, say a 364 day Treasury bill. (Note that government securities are considered to be risk-free because the government is not expected to default on its obligations.) This may be decomposed into two parts:

Short-term risk-free interest rate = Expected real rate of return + Expected inflation

**Expected Real Rate of Return**

Intuitively the expected real rate of return represents the rate which society is willing to trade current consumption for future consumption. For example, if the society is willing to give up 100 units of real goods in return for 105 units a year from now, the expected real rate of return is 5 percent. As real rate is positive, there is current consumption over future consumption, the expected real rate is positive, but it tends to vary wisely across time and across economics. Since ultimately real returns stem from real growth in the economy, you may, as a first approximation, use the expected real rate of growth in the economy as a proxy for the expected real rate of return, which would also be 6 percent.

**Expected Rate of Inflation**

To get a handle over the determinants of the expected rate of inflation, let us look at the following identity:

\[ \text{Price level} = \frac{(\text{Money supply in the economy}) \times (\text{Velocity of money in circulation})}{\text{Real output in the economy}} \]

Hence, the expected rate of inflation which is nothing but the expected change in price level is:

\[ \text{Expected rate of inflation} = \frac{\text{Change in money supply in the economy}}{\text{Change in velocity of money in circulation}} \times \frac{\text{Change in real output}}{\text{Real output in the economy}} \]

For example, if money supply increases by 13 percent and velocity of money in circulation increases by 1 percentage when the real out put rises by 7 percent,
the expected inflation rate is:

\[(1.13)(1.01)/(1.07) - 1 = 0.0067 \text{ or } 0.67\%\]

**Maturity Premium**

Maturity premium represents the difference between the yield to maturity on a short term (one year) risk-free security and the yield to maturity on risk-free security a longer maturity. The yield curve is depicted in Exhibit 10.10. It shows graphically how the yield to maturity is related to the term to maturity. The yield curve ordinarily slopes upward because investors expect a higher yield for making investment over a longer period of time. This implies that the maturity premium increases with time.

What determines the yield curve? This question has long puzzled academicians and practitioners. Three principal explanations have been offered: **Expectation Theory** The yield curve depends on the expectations of the investors. If investors expect short-term rates to rise (fall) in the future, the yield curve will be ascending (descending). **Liquidity Preference Theory** Investors have a preference for liquidity. So they ask for a higher yield as an inducement to hold bonds of longer maturity. **Preferred Habitat Theory** The shape of the yield curve is determined by the supply and demand of funds in different maturity ranges (habitats).

**Default Premium**

While there is no risk of default on government securities, corporate bonds may default on interest and/or principal payment. When such a possibility exists, investors will ask for a default premium in addition, of course, to the maturity premium.

The default premium increases with default risk which inter alia is a function of the following:

- The business risk of the issuer as reflected in the volatility of its operating income.
- The financial risk of the issuer measured usually by the ratio of outside liabilities to shareholders funds.
- The size of the business and the value of collateral assets that are offered as security. Credit rating agencies consider these factors and several others and express their opinion on default risk through their ratings.

Note that default premiums reflect default risk as well as the state of the economy. Other things being equal, default premiums tend to increase during economic recession when investors turn more risk-averse and decrease during economic expansion when investors become more confident.

**Special Features**

The factors discussed above determine the interest rate on a plain vanilla bond, i.e. a bond which pays a fixed amount of interest (I) periodically and a certain principal sum (P) at a given maturity date. The time lone of such a bond is depicted in exhibit.

**Exhibit : Time line of Plain Vanilla Bond**

While plain vanilla bonds remain popular, bonds often have some special feature(s). They may have a call feature (which entitles the issuer to prematurely redeem them) or a put feature (which gives the investor the option to redeem them prematurely) or a combination of a call and put feature; they may be convertible, partly or fully, into equity shares on certain terms; they may carry a floating rate of interest, rather than a fixed rate of interest; they may be zero coupon bonds issued at deep discount and redeemed at par; and so on and so forth.

The effect of special features on interest rates is expected to be as follows:

- A call feature raises the interest rate because the investors are exposed to call risk.
- A put feature lowers the interest rate because the investors enjoy the put option.
- A conversion feature lowers the interest rate because the investors enjoy the option to convert.
- A floating interest rate feature may lower the interest rate as investors are protected against inflation risk.
- A conversion feature lowers the interest rate because the investors enjoy the option to convert.
- A floating interest rate feature may lower the interest rate as investors are protected against inflation risk.
- A coupon feature may lower the interest rate as investors are protected against reinvestment risk.

**Summing Up**

To sum up, the interest rate on corporate bonds is determined by four factors, viz. short-term risk-free interest rate, maturity premium, default premium and special features as portrayed in Exhibit.

**Analysis of Convertible Bonds**

With the repeal of the Capital issues Control Act and the enactment of SEBI Act in 1992, the rules of the game applicable to convertible bond have changed. As per SEBI guidelines issued in June 1992, the provisions applicable to fully convertible bonds and partially convertible bonds are as follows:

- The conversion premium and the conversion timing shall be predetermined and stated in the prospectus.
- Any conversion, partial or full, will be optional at the hands of the bond holder, if the conversion takes place at or after 18 months but before 36 months from the date of allotment.
- A conversion period of more than 36 months will not be permitted unless conversion is made optional with ‘put’ and ‘call’ options.
- Compulsory credit rating will be required if the conversion period for fully convertible bonds exceeds 18 months.

7 Convertible bonds partake some characteristics of straight bonds and some features of equity shares. Since this book does not have a separate chapter on convertible bonds, they are being discussed in this chapter.

From the SEBI guidelines it is clear that convertible bonds in India presently can be of three years.

- Compulsorily convertible bonds which provide for conversion within 18 months.
- Optionally convertible bonds which provide for conversion after 36 months.
- Bonds which provide for conversion after 36 months but which carry ‘call’ and ‘put’ features.
My guess is that the bulk of the convertible bonds in the immediate future will be of types (a) and (b), hence, our discussion on valuation of convertible bonds will focus on these two types.

**Valuation of compulsorily Convertible (Partly or Fully) bonds**

If you own a compulsorily convertible (partly or fully) bond you receive:

- A certain number of equity shares on part/full conversion.
- A certain stream of interest and principal repayment.
- Hence the value of such a bond is equal to the sum of two components.
- The present value of equity shares receivable on conversion.
- The present value of interest and principal payments receivable on the bond.

To illustrate the valuation of such a bond, let us consider an example. In June 1989, Tata Iron and Steel Company (TISCO) issued 30 lakh partly convertible debentures were:

1. **Conversion of Rs 600 par value into one equity share of Rs 100 at a premium of Rs 500 on February 1, 1990.**
2. **Interest rate of 12 percent per annum.**
3. **Redemption of non-convertible portion at the end of 8 years.** For evaluating the partly convertible debenture of TISCO, as on August 1, 1989, we may make two assumptions. The expected price per share of TISCO, as on February 1, 1990, the point of time when partial conversion will take place, would be Rs 1,200.

- The rate of return required by the investor is 18 percent semi-annually.

Give these assumptions, the value of the partly convertible TISCO debenture, assessed as on August 1, 1989, would be equal to the sum of the following components: Present value of the equity share: Present value of interest and principal payment.

**Valuation of Optionally Convertible Bonds**

An optionally convertible bond may be viewed as a bond-warrant package. Its value is a function of three factors:

- **Straight Bond Value**
- **Conversion Value**
- **Option Value**

**Straight Bond Value**

The straight bond value of a convertible bond is the discounted value of the interest and principal repayments receivable on it, if it is retained as a straight debt instrument. The discount rate used in this calculation depends on the general interest rates and the credit rating of the bond.

The value of a straight bond depends on the value of the firm. If a firm’s value declines, the value of its straight bond may fall. In the extreme, if the value of a firm shrinks to zero, the value of its straight bond becomes nil. The maximum value of a firm’s straight to bond would be equal to the value of an equivalent risk-free bond. Exhibit 10.13A illustrates the relationship between the value of the firm and the value of its straight bonds.

**Conversion Value**

The conversion value is the value of the bond if the bond holders seek conversion. It is equal to the stock price multiplied by the conversion rate. Thus the conversion value is linearly related to the value of the firm as shown in Exhibit 10.13B.

We have defined the straight bond value and the conversion value of a convertible bond. The value of a convertible bond theoretically cannot fall below its straight bond value as well as its conversion value. Put differently, the convertible bond has two floor values: as straight bond value and its conversion value.

The combined effect of these two lower bonds is shown by the heavy line in exhibit 10.13C, which simply reflects Max (Straight bond value, Conversion value).

**Option Value**

If you hold a convertible bond, you are not compelled to make an immediate choice in favour of or against conversion. You can wait, learn from hindsight, and finally choose the most profitable alternative. The option to wait is valuable. Hence, the value of the convertible bond lies above its floor value. It is shown as the dashed line in Exhibit 10.13C.

Thus the value of a convertible bond may be expressed as follows:

\[ \text{Value of the convertible bond} = \text{Max} (\text{Straight bond value, Conversion value}) + \text{Option value}. \]

**Bond Portfolio Management**

Bonds have acquired greater importance and managing a portfolio of bonds has become even more complex. Bond investors may follow either a passive or an active approach.

**Passive Strategy**

Many investors believe that securities are fairly priced in the sense that expected returns are commensurate with risks. Such a belief supports a passive strategy implying that the investor does not actively try to outperform the market.

Of course, passive strategy does not mean that the investor does nothing. Even a passive investor will have to a) determine whether bonds are suitable investment avenues for him, b) assess risks (default risks, call risks, and so on) and reasonably diversify his holdings, and c) periodically monitor his bond portfolio to ensure that his holdings match his risk preferences and objectives.

The three commonly followed strategies by passive bond investors are: buy and hold strategy, indexing strategy and immunisation strategy.

**Buy and Hold Strategy**

An investor who follows a buy and hold strategy selects a bond portfolio and stays with it. He does not churn his bond portfolio in an attempt to improve returns and/or reduce risks. Obviously, such an investor chooses a bond portfolio that promises to meet his investment objectives and hence spends time and effort in his initial selection.

**Indexing Strategy**

If the capital market is efficient, efforts to find under-priced securities or no time the market may be futile Empirical research
on this issue suggests that most investors are unlikely to outperform the market. Hence, they may find and indexing strategy appealing. Such a strategy calls for building a portfolio that mirrors a well-known bond index. In the US, two well-known bond indices are the Shearson Lehman Index and Salomon Brothers Index.

**Immunisation Strategy**
Protecting a portfolio against rate risk is referred to as immunisation. To understand how the immunisation strategy works, interest rate risk may be decomposed into two parts: a) The price risk arising from the inverse relation between interest rate and bond prices. b) The reinvestment rate risk reflecting the uncertainty about components reinvestment rates.

These two components of interest rate risk behave in a contrary manner. When the interest rates rise, bond prices decline but the reinvestment rates increase. On the other hand, when the interest rates fall, bond prices increase but the reinvestment rates decrease.

An investor who wishes to immunize (or protect) his bond portfolio against interest rate risk must ensure that the duration of his bond portfolio is set equal to a predetermined investment horizon for the bond portfolio.

- **Active Strategy** Those who employ an active approach to bond portfolio management seek to profit by (a) forecasting interest rate changes and/or (b) exploiting relative mispricings among bonds.

- **Forecasting Interest Rate Changes** Bond prices interest rates are inversely related. Hence, if an investor expects interest rates to fall, he should buy bonds, preferably bonds with longer maturity (more precisely, longer duration), for price appreciation. On the other hand, if an investor expects interest rates to rise, he should shun bonds, particularly bonds with longer maturity. While this approach may appear tempting, it must be borne in mind that interest rate forecasting is a difficult and uncertain task. Hence betting on interest rate movements is a risky proposition.

- **Exploiting Mispriangings Among Securities** Bond portfolio managers regularly monitor the bond market to identify temporary relative mispricings. They try to exploit such opportunities by engaging in bond swaps—purchase and sale of bond—to improve the rate of return. The most popular bond swaps are as follows:
  - Pure Yield pick up swap A swap that involves a switch from a lower bond yield bond to a higher yield bond of almost identical quality and maturity.
  - Substitution Swap A swap meant to take advantage of a yield spread between two bond issues, which is more than what is warranted by the difference in quality and maturity of the issues.
  - Tax Swap A swap that involves selling of an existing bond, at a capital loss, using the capital loss to offset capital gains in other securities, and purchasing another bond with near identical features.

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**Summary**

- The debt marketing in India has registered an impressive growth particularly since mid-nineties and, not surprisingly, has been accompanied by increasing complexity in instruments, interest rates, methods of analysis, and so on.
- The variety of debt instruments may be classified as follows: money market instruments, government securities and government guaranteed bonds, and corporate debentures.
- The value of a noncallable bond is:
- The commonly employed yield measures are: current yield, yield to maturity, yield to call, and realized yield to maturity.
- The current yield of a bond is: annual interest/price.
- The yield to maturity (YTM) of a bond is the interest rate that makes the present value of the cash flows receivable from owning the bond equal to the price of the bond.
- The following formula may be used to find the approximate YTM on a bond:
- Bonds are subject to diverse risks, such as interest rate risk, inflation risk, real interest rate risk, default risk, call risk and liquidity risk.
- Interest rate risk, also referred to as ‘market risk’, is measured by the percentage change in the value of a bond in response to a given interest rate change.
- The duration of a bond is the weighted average maturity of its cashflow stream, where the weights are proportional to the present value of cashflows.
- The proportional change in the price of a bond in response to the change in its yield are as follows:
- Interest rate risk can be eliminated if the duration of the debt instrument is equal to the investment horizon of the investor.
- Default risk refers to the risk that the borrower may not pay the interest and/ or principal on time. Default risk, also referred to as ‘credit risk’ is normally gauged by the rating assigned to the debt instrument by an independent rating agency.
- Despite variations across individual rating agencies, the rating methodology employed by different agencies have the following common features: i) two broad types of analyses are done: (a) industry and business analysis, and (b) financial analysis ii) though a lot of qualitative evaluation is done, subjective judgement, too, plays an important role, and iii) industry risk characteristics are likely to set the upper limit on rating.
- The term structure of interest rates, popularly called the yield curve, shows how yield to maturity is related to term to maturity for bonds that are similar in all respects, expecting maturity.
- Another perspective on the term structure of interest rates is provided by the forward interest rates, viz the interest rates applicable to bonds in the future.
- Three principal explanations have been offered to explain the term structure of interest rates: the expectations theory,
the liquidity preference theory, and the preferred habitat theory.

- The expectations theory propounds that any long-term rate is equal to the geometric mean of current and future one-year rates expected by the market participants. The liquidity preference theory holds that forward rates should incorporate interest rate expectations as well as risk premium (or liquidity premium). The preferred habitat theory argues that investors as well as borrowers have distinct preferences for certain maturities and these have an important bearing on the yield curve.

- The interest rate is determined by four factors or variables: short-term risk-free interest rate, maturity premium, default premium, and special features.

- For analytical purposes, an optionally convertible debenture may be viewed as a debenture-warrant package. Its value is a function of three factors: straight debenture value, conversion value, and option value.

- The straight debenture value of a convertible debenture is the discount value of the interest and principal payments receivable on it, if it is retained as a straight debt security.

- The conversion value is the value of the debenture if the debenture-holder seeks conversion.

- The holders of convertible debentures are not compelled to make an immediate choice in favour of or against conversion. They can wait learn from handsight, and finally choose the most profitable value of the convertible debenture.

- Bond investors may follow either a passive or an active approach. The three commonly followed strategies by passive bond investors are: buy and hold strategy, indexing strategy, and immunisation strategy.

- Those who follow an active approach to bond portfolio management seek to profit by (a) forecasting interest rate changes and/or (b) exploiting relative mispricings among bonds.

Questions

1. Discuss the changes that have started taking place in the debt market in the post-liberalisation scenario.

2. Briefly describe various types of corporate bonds.

3. State the basic bond valuation formula.

4. State the valuation formula for a bond which pays interest semi-annually.

5. What is the relationship between bond price and time?

6. Explain and illustrate the following yield measures: current yield, yield to maturity, yield to call, and realized yield to maturity.

7. State and illustrate the formula to find the approximate YTM on a bond.

8. Discuss the risks to which debt instruments are subject to.

9. State the important bond-pricing relationships.

10. What is duration and how is it calculated.

11. How is the volatility of a bond related to its duration?

12. What are the important properties of duration?

13. How can a bond investor immunize himself against interest rate risk?

14. What is the meaning of debt rating?

15. Discuss the functions of debt rating.

16. Describe the key features of the methodology used for debt rating.

17. What symbols are employed by CRISIL for rating debentures?

18. What is yield curve?

19. How would you calculate the forward interest rates?

20. Discuss the following theories: expectations theory, liquidity preference theory, and preferred habitat theory.

21. Discuss the key determinants of interest rates.

22. Explain the method for valuing a debenture that is compulsory convertible (partially or fully) into equity shares.

23. Show how the value of an optionally convertible debenture is influenced by its straight debenture value, its conversion value, and its option value.

24. Explain the strategies followed by passive bond investors and active bond investors.

Problems

1. A Rs 100 par value bond, bearing a coupon rate of 11 percent will mature after 5 years. What is the value of the bond, if the discount is 15 percent?

2. A Rs 100 par value bond, bearing a coupon rate of 12 percent will mature after 7 years. What is the value of the bond if the discount rate is 14 percent? 12 percent?

3. The market value of Rs 1,000 par value bond, carrying a coupon rate of 12 percent and maturing after 7 years, is Rs 750. What is the yield to maturity on this bond?

4. The market value of a Rs 100 par value bond, carrying a coupon rate of 14 percent and maturing after 10 years, is Rs 80. What is the yield to maturity on this bond?

5. A Rs 100 par value bond bears a coupon rate of 12 percent and matures after 6 years. Interest is payable semi-annually. Compute the value of the bond if the required rate of return is 16 percent, compounded semi-annually.

6. You are considering investing in one of the following bonds:

<table>
<thead>
<tr>
<th>Coupon Rate</th>
<th>Maturity</th>
<th>Price/ Rs 100 par value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond A</td>
<td>12%</td>
<td>10 years</td>
</tr>
<tr>
<td>Bond B</td>
<td>10%</td>
<td>6 years</td>
</tr>
</tbody>
</table>

   Your income tax rate is 30 percent and your capital gains tax is effectively 10 percent. Capital gains taxes are paid at the time of maturity on the difference between the purchase price and par value. What is your post-tax yield to maturity from these bonds? Use the approximate formula.

7. A company bonds have a par value of Rs 100, mature in 7 years, and carry a coupon rate of 12 percent payable semi annually. If the appropriate discount rate is 16 percent, what price should the bond command in the market place?
8. Consider two bonds, P and Q:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Face Value</th>
<th>Coupon (Interest Rate)</th>
<th>Years to Maturity</th>
<th>Redemption Value</th>
<th>Current Market Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>1,000</td>
<td>16 percent payable</td>
<td>8</td>
<td>1,000</td>
<td>918.5</td>
</tr>
<tr>
<td>Q</td>
<td>1,000</td>
<td>12 percent payable</td>
<td>5</td>
<td>1,000</td>
<td>761</td>
</tr>
</tbody>
</table>

What are the yields to maturity, durations and volatiles of these bonds?

9. Consider the following data for government securities:

<table>
<thead>
<tr>
<th>Face Value</th>
<th>Interest Rate</th>
<th>Maturity (years)</th>
<th>Current Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>0</td>
<td>1</td>
<td>89,000</td>
</tr>
<tr>
<td>100,000</td>
<td>12.5</td>
<td>2</td>
<td>99,000</td>
</tr>
<tr>
<td>100,000</td>
<td>13.0</td>
<td>3</td>
<td>99,500</td>
</tr>
<tr>
<td>100,000</td>
<td>13.5</td>
<td>4</td>
<td>100,050</td>
</tr>
<tr>
<td>100,000</td>
<td>13.75</td>
<td>5</td>
<td>100,100</td>
</tr>
</tbody>
</table>

What is the yield curve on these bonds? Calculate the forward rates.

10. Shiva Limited issues a partly convertible debenture for Rs 600, carrying an interest rate of 10 percent. Rs 200 will get compulsorily converted into two equity shares of Shiva Limited a year from now. The expected price per share of Shiva Limited’s equity shares of Shiva Limited a year from now would be Rs 150. The non-convertible portion will be redeemed in two equal instalments of Rs 200 each at the end of years 5 and 6 respectively.

a. What is the pre-tax rate of return earned by the debenture holder?

b. What is the post-tax cost of the convertible debenture to Shiva? Assume that the tax rate for Shiva is 30 percent and the net price per share Shiva would realize for the equity after a year would be Rs 120.

11. A Rs. 1,000 par value bond carries a coupon of 10 percent (payable annually) and has a remaining maturity for 4 years. The bond is presently selling for Rs 1020. The reinvestment rate applicable to the future cash inflows of the bonds is 9 percent per annum. What will be the realized yield to maturity?

12. A zero coupon bond of Rs 10,000 has a term to maturity of 8 years and a market yield of 10 percent at the time of issue.

a. What is the issue price?

b. What is the duration of the bond?

c. What is the modified duration of the bond?

d. What will be the percentage change in the price of the bond, if the yield declines by 0.5 percentage points (50 basis points)? You are considering the following bond for inclusion in your fixed income portfolio. Coupon rate 10% Yield to Maturity 10%

e. Term to Maturity 10 years

a. What is the duration of this Bond?

b. Why is the Bond’s duration less than its maturity?