Chapter 3 Valuing Bonds

OVERVIEW

- This chapter shows how present value concepts can be applied to the valuation of bonds.
- The concept of the term structure of interest rates is explained.
- Various theories of the term structure of interest rates are explored along with the relationship between real rate and nominal rate of interest.
- The impact of inflation on nominal interest rates is discussed.

LEARNING OBJECTIVES

After studying this chapter, you must have:

- learnt how to calculate the value of a bond;
- explored the relationship between bond prices and interest rates;
- learnt the concept of term structure of interest rates;
- understood various theories that explain the term structure of interest rates; and
- explored the relationship between real and nominal rates of interest.

POINTS EMPHASISED IN THIS CHAPTER

Using present-value formulas to value bonds

- We covered the pricing of bonds with fixed-coupon rates, including the case of semiannual payments.
- The relationship between the price and the yield to maturity of a bond using numerical examples was explained.
- Any bond can be valued as a package of an annuity and a single payment. In other words, the bond price is the present value of the interest payments and the principal payment (face value) discounted at the yield to maturity of the bond. The pricing of both annual and semi-annual coupon bonds is explained.

$$\text{PV(bond)} = \text{PV(coupon payments)} + \text{PV(final payment)},$$

$$\text{PV} = (\text{PMT})\times[1/r - 1/\{r(1+r)^N\}] + (F)/[(1+r)^N],$$

where: r = yield to maturity
N = maturity
PMT = interest payment
F = face value of the bond

How bond prices vary with interest rates
There is an inverse relationship between bond prices and yield to maturity. An increase in yield to maturity causes the bond price to decrease and vice-versa. The price of long-term bonds is affected more by changing interest rates than the price of short-term bonds. The concept of "duration" is very helpful in exploring this relationship. Duration is defined as the average time of payments received and volatility is defined as the percentage change in bond price caused by a 1% change in bond yield. The calculation of duration is quite complicated. It is the weighted average of the time to each cash flow.

$$\text{Duration} = \Sigma[PV(C_t) \times (t)]/V \qquad (t \text{ varying from 1 to } N)$$
$$\text{Volatility (percent)} = \text{Duration}/(1 + \text{yield}); \text{ and}$$
$$\text{Change in bond price} = (\text{Volatility}) \times (\text{Change in interest rate})$$

Bond volatility measures the effect on bond prices of a change in interest rates.

The term structure of interest rates
Here the relationship between yield to maturity and maturity is reviewed. This section distinguishes between yield to maturity and spot rate of interest. In principle, the term structure should be expressed as the relationship between the spot rate and maturity. Yield to Maturity (YTM) is a complicated average of spot rates and should be used with care. The yield to maturity is widely used in practice. Term structure of interest rate is the relationship between yield to maturity and the maturity of a bond. This relationship is shown using treasury strips.

$$(1 + r_2)^2 = (1 + r_1) \times (1+ f_2),$$

where: r_1 = one-year spot rate
r_2 = two-year spot rate
f_2 = one-year forward rate one year from today.

Explaining the term structure
The expectations theory of the term structure states that the expected rate of return from investing in bonds is independent of the maturity of the bonds, provided that investors are unconcerned with the risks of investing in bonds. If the expectations hypothesis is true, then the term structure tells us about investors' expectations of future short-term interest rates. If investors are concerned with risk, the story becomes more complicated. If the important uncertainty is about future real rates, investors will prefer to hold maturities that match their investment horizons. In principle, this could twist the term structure either way. If the important uncertainty is about inflation, investors will demand a premium for investing in long bonds; this is the inflation-premium theory. Each of these theories is discussed in some detail. Several numerical examples are given. Mention is also made of theories that attempt to explain how price movements are related.

Real and nominal rates of interest
- The relationship between real and the nominal rate of interest is explored.
- Treasury inflation-protected securities (TIPS) was mentioned.
- The relationship between inflation and nominal interest rate was discussed.

- The classical theory of interest rates, by Irving Fisher, states that the real rate of interest is determined by the willingness to save and the attractiveness of real investment opportunities.

- A change in the expected rate of inflation affects the nominal but not the real rate. Empirical evidence provides some support for the theory, although the real rate of interest does not remain constant in the long run.

$$(1 + r_{\text{Real}}) = (1 + r_{\text{Nominal}})/(1 + \text{inflation rate})$$

$$\text{Real cash flow}_t = (\text{nominal cash flow})/[(1 + \text{inflation rate})^t]$$

The risk of default

- The risk of default is real for corporate bonds.

- An interest rate premium is demanded by investors to accept the risk.

- The amount of the risk premium originates from the rating assigned to the bond by a variety of firms. Concepts related to risk and bond ratings were also mentioned.