Chapter 5

Interest Rates and Bond Valuation

Acknowledgement

- This work is reproduced, based on the book [Ross, Westerfield, Jaffe and Jordan “Core Principles and Applications of Corporate Finance”].
- This work can be used in the financial management course with the original text book.
- This work uses the figures and tables from the original text book.

5.1 Bonds Terms

- Bonds – long-term IOU's, usually interest-only loans (interest is paid by the borrower every period with the principal repaid at the end of the loan).
- A bond is a legally binding agreement between a borrower and a lender that specifies the:
  - Par (face) value: principal, amount repaid at the end of the loan
  - Coupon rate :coupon quoted as a percent of face value
  - Coupon payment: the regular interest payments (if fixed amount – level coupon).
  - Maturity Date: time until face value is paid, usually given in years, although most bonds pay coupons semiannually.
- The **Yield to maturity (YTM)** of a bond is the discount rate that equates today's bond price with the present value of the future cash flows of the bond.

Bond Valuation

- *The price of a bond is found by adding together the present value of the bond's coupon payments and the present value of the bond's face value.*

- The formula is:

$$\text{Bond Price} = \frac{C}{YTM}\left[1 - \frac{1}{(1+YTM)^{T}}\right] + \frac{FV}{(1+YTM)^{T}}$$

- In the formula, C represents the **annual** coupon payments (in $), FV is the face value of the bond (in $), and T is the maturity of the bond, measured in years.

Conceptual Cash Flow of a 10 Year Bond

- Xanth Co. has issued a 10 year bond with an 8% annual coupon. The cash flows from the bond would be paid as follows:

FIGURE 5.1

Cash Flows for Xanth Co. Bond

Cash flows

Year	0	1	2	3	4	5	6	7	8	9	10
Coupon		$80	$80	$80	$80	$80	$80	$80	$80	$80	$ 80
Face value											1,000
		$80	$80	$80	$80	$80	$80	$80	$80	$80	$1,080

As shown, the Xanth bond has an annual coupon of $80 and a face, or par, value of $1,000 paid at maturity in 10 years.

$$PV = \frac{80}{(1+r)^1} + \frac{80}{(1+r)^2} + \ldots + \frac{1{,}000 + 80}{(1+r)^{10}}$$

Cited by the text book (p. 123)

The Bond-Pricing Equation

$$\text{Bond Value} = C\left[\frac{1-\frac{1}{(1+r)^{T}}}{r}\right] + \frac{F}{(1+r)^{T}}$$

Notice that:

- The first term is the present value of the coupon payments (an annuity); and,
- The second term is the present value of the bond's par value

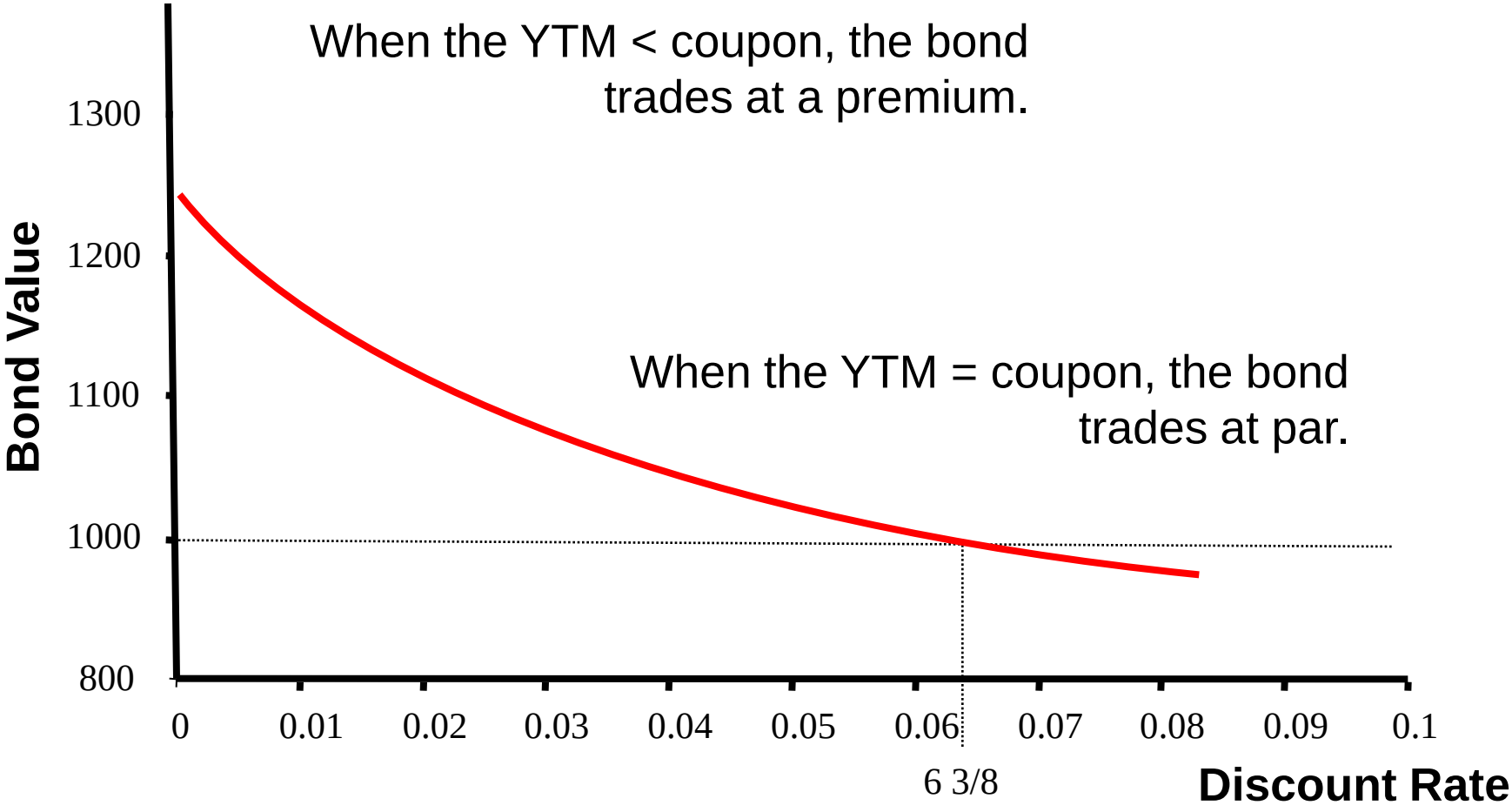
Frequency of Coupon Payments

- Bond terms dictate the frequency of coupon payments
- The coupon rate is expressed in annual terms
- If the rate is expressed annually and the payments are more frequent, calculation of bond value requires:
  - Dividing the annual coupon payment by the number of compounding periods per year to arrive at the value of each coupon payment (C);
  - Dividing the annual required rate of return by the number of compounding periods per year to arrive at the desired periodic yield (r);
  - Multiplying the remaining years of the bond's life by the number of compounding periods per year to arrive at the remaining number of coupon payments (T).

YTM and Bond Value

When the YTM < coupon, the bond trades at a premium.

When the YTM = coupon, the bond trades at par.



When the YTM > coupon, the bond trades at a discount.

Bond Concepts

- Bond prices and market interest rates move in opposite directions.
- When coupon rate = YTM, price = par value
- When coupon rate > YTM, price > par value (premium bond)
- When coupon rate < YTM, price < par value (discount bond)

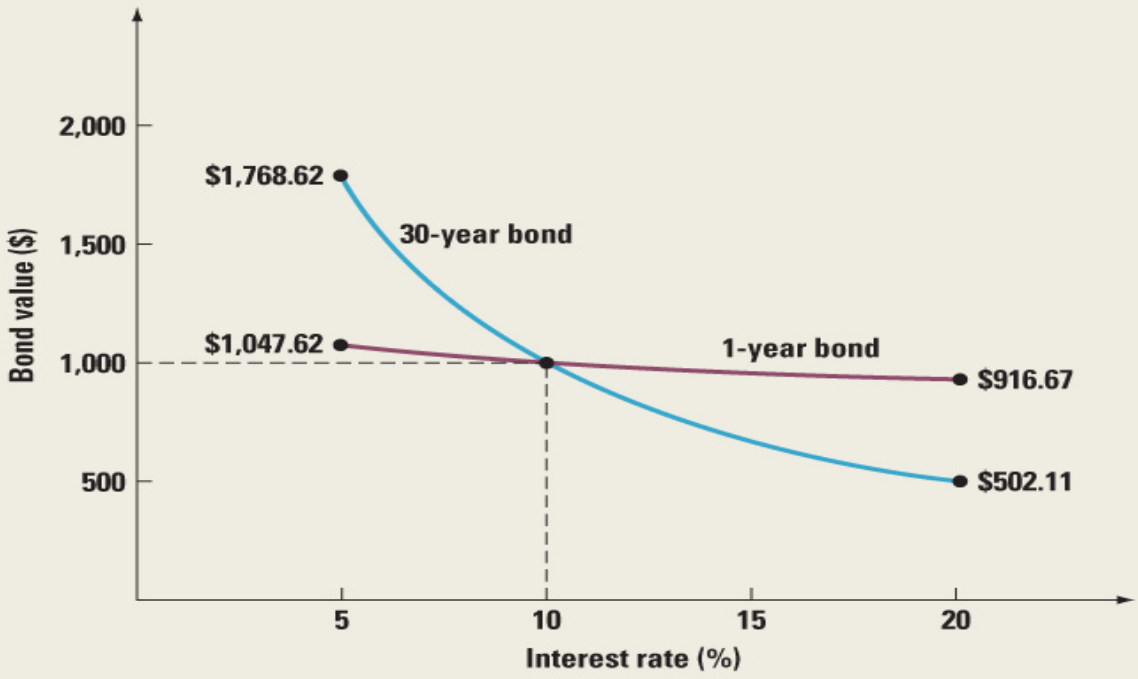
Cited by the text book (p. 171)

Interest Rate Risk

- Price Risk
  - Change in price due to changes in interest rates
  - Long-term bonds have more price risk than short-term bonds
  - Low coupon rate bonds have more price risk than high coupon rate bonds.
- Reinvestment Rate Risk
  - Uncertainty concerning rates at which cash flows can be reinvested
  - Short-term bonds have more reinvestment rate risk than long-term bonds.
  - High coupon rate bonds have more reinvestment rate risk than low coupon rate bonds.

Interest Rate Risk

FIGURE 5.2
Interest Rate Risk and Time to Maturity



Value of a Bond with a 10 Percent Coupon Rate for Different Interest Rates and Maturities

	Time to Maturity	
Interest Rate	1 Year	30 Years
5%	$1,047.62	$1,768.62
10	1,000.00	1,000.00
15	956.52	671.70
20	916.67	502.11

Cited by the text book (p. 172)

Summary of Bond Valuation

TABLE 5.1
Summary of Bond Valuation

I. Finding the Value of a Bond

Bond value = $C \times [1 - 1/(1 + r)^T]/r + F/(1 + r)^T$

where

C = Coupon paid each period

r = Discount rate per period

T = Number of periods

F = Bond's face value

II. Finding the Yield on a Bond

Given a bond value, coupon, time to maturity, and face value, it is possible to find the implicit discount rate, or yield to maturity, by trial and error only. To do this, try different discount rates until the calculated bond value equals the given value (or let a spreadsheet do it for you). Remember that increasing the rate *decreases* the bond value.

Cited by the text book (p. 174)

5.2 More on Bond Features

- There are two kinds of securities issued by corporations:
  - Equity – Ownership Interest
  - Debt – Short or Long Term Borrowing

- Bonds are classified as Debt

Debt versus Equity

- Debt
  - Not an ownership interest
  - Creditors do not have voting rights
  - Interest is considered a cost of doing business and is tax deductible
  - Creditors have legal recourse if interest or principal payments are missed
  - Excess debt can lead to financial distress and bankruptcy
- Equity
  - Ownership interest
  - Common stockholders vote for the board of directors and other issues
  - Dividends are not considered a cost of doing business and are not tax deductible
  - Dividends are not a liability of the firm, and stockholders have no legal recourse if dividends are not paid
  - An all-equity firm cannot go bankrupt

The Bond Indenture

- Contract between the company and the bondholders that includes:
  - The basic terms of the bonds– face value, par value, and form
  - The total amount of bonds issued
  - A description of property used as security, if applicable
  - Sinking fund provisions
  - Call provisions
  - Details of protective covenants

Bond Classifications

- Registered vs. Bearer Forms
  - Registered form – ownership is recorded, payment made directly to owner
  - Bearer form – payment is made to holder (bearer) of bond
- Security
  - Collateral – secured by financial securities
  - Mortgage – secured by real property, normally land or buildings
  - Debentures – unsecured
  - Notes – unsecured debt with original maturity less than 10 years
- Seniority-order of precedence of claims
  - Subordinated debenture – of lower priority than senior debt

Bond Classifications (Cont.)

- Sinking Funds
  - an account managed by the bond trustee for early redemption
- Call Provisions: allows company to “call” or repurchase part or all of an issue
  - Deferred Call -firm cannot call bonds for a designated period
  - Call Premium – amount by which the call price exceeds the par value
  - Call protected – the description of a bond during the period it can’t be called
- Protective Covenants – indenture conditions that limit the actions of firms

Required Yields

- The coupon rate depends on the risk characteristics of the bond when issued.
- Which bonds will have the higher coupon, all else equal?
  - Secured debt versus a debenture
  - Subordinated debenture versus senior debt
  - A bond with a sinking fund versus one without
  - A callable bond versus a non-callable bond

5.3 Bond Ratings – Investment Quality

- High Grade
  - Moody's Aaa and S&P AAA – capacity to pay is extremely strong
  - Moody's Aa and S&P AA – capacity to pay is very strong
- Medium Grade
  - Moody's A and S&P A – capacity to pay is strong, but more susceptible to changes in circumstances
  - Moody's Baa and S&P BBB – capacity to pay is adequate, adverse conditions will have more impact on the firm's ability to pay

5.3 Bond Ratings

- The highest-quality bonds are rated triple A. Bonds rated triple B or above are investment grade. Lower-rated bonds are called high-yield, or junk, bonds.

Moody's	Standard & Poor's and Fitch
Aaa	AAA
Aa	AA
A	A
Baa	BBB
Ba	BB
B	B
Caa	CCC
Ca	CC
C	C

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  - Moody's Baa and S&P BBB – capacity to pay is adequate, adverse conditions will have more impact on the firm's ability to pay

Bond Ratings - Speculative

- Low Grade
  - Moody's Ba and B
  - S&P BB and B
  - Considered speculative with respect to capacity to pay.
- Very Low Grade
  - Moody's C
  - S&P C & D
  - Highly uncertain repayment and, in many cases, already in default, with principal and interest in arrears.

5.4 Some Different Types of Bonds

- There are many different types of bonds
- Some common bonds include:
  - Government Bonds
    - Federal
    - State and Municipal
  - Zero Coupon Bonds (Pure Discount Bonds)
  - Floating Rate Bonds
- Each are discussed below

Government Bonds

- Treasury Securities
  - Federal government debt
  - T-bills – pure discount bonds with original maturity less than one year
  - T-notes – coupon debt with original maturity between one and ten years
  - T-bonds – coupon debt with original maturity greater than ten years
- Municipal Securities
  - Debt of state and local governments
  - Varying degrees of default risk, rated similar to corporate debt
  - Interest received is tax-exempt at the federal level

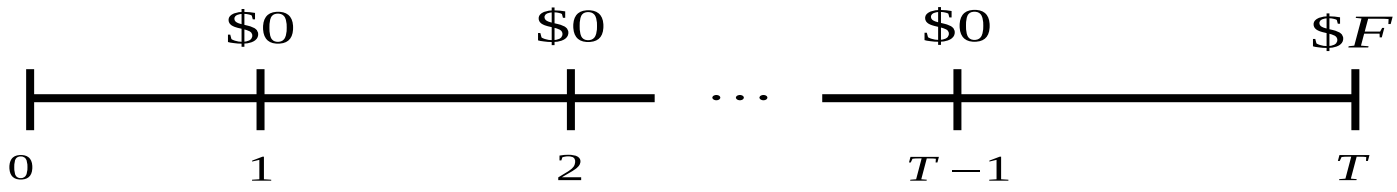
Zero Coupon Bonds

- Make no periodic interest payments (coupon rate = 0%)
- The entire yield to maturity comes from the difference between the purchase price and the par value
- Cannot sell for more than par value
- Sometimes called zeroes, deep discount bonds, or original issue discount bonds (OIDs)
- Treasury Bills and principal-only Treasury strips are good examples of zeroes

Pure Discount Bonds

Information needed for valuing pure discount bonds:

- Time to maturity (T) = Maturity date - today's date
- Face value (F)
- Discount rate (r)



Present value of a pure discount bond at time 0:

$$PV = \frac{F}{(1+r)^T}$$

Floating Rate Bonds

- Coupon rate floats depending on some index value
- Examples – adjustable rate mortgages and inflation-linked Treasuries
- There is less price risk with floating rate bonds.
  - The coupon floats, so it is less likely to differ substantially from the yield to maturity.
- Coupons may have a “collar” – the rate cannot go above a specified “ceiling” or below a specified “floor.”

Other Bond Types

- Income bonds - coupon is paid if income is sufficient
- Convertible bonds – can be traded for a fixed number of shares of stock
- Put bonds – shareholders can redeem for par at their discretion

- There are many other types of provisions that can be added to a bond, and many bonds have several provisions – it is important to recognize how these provisions affect required returns.

5.5 Bond Markets

- Primarily over-the-counter transactions with dealers connected electronically
- Extremely large number of bond issues, but generally low daily volume in single issues
- Makes getting up-to-date prices difficult, particularly on a small company or municipal issues
- Treasury securities are an exception

Treasury Quotations

FIGURE 5.4

Sample *Wall Street Journal* U.S. Treasury Bond Prices

Treasury Bonds

Maturity	Coupon	Bid	Asked	Chg	Asked yield
2016 May 15	7.250	126:07	126:12	unch.	2.7831
2017 Feb 15	4.625	110:21	110:23	+2	2.9707
2017 May 15	4.500	109:21	109:22	+3	3.0439
2018 Feb 15	3.500	101:29	101:31	+3	3.2268
2018 May 15	3.875	104:12	104:13	+4	3.2767
2019 Feb 15	8.875	143:14	143:18	+4	3.3553
2020 Feb 15	8.500	142:12	142:16	+5	3.5235
2020 May 15	8.750	144:30	145:02	+5	3.5660
2021 Aug 15	8.125	140:31	141:03	+8	3.7635
2021 Nov 15	8.000	140:00	140:05	+6	3.8021
2023 Feb 15	7.125	132:02	132:06	+11	3.9752
2023 Aug 15	6.250	123:02	123:06	+13	4.0365
2025 Aug 15	6.875	131:13	131:17	+18	4.1318
2026 Feb 15	6.000	121:06	121:10	+16	4.1791
2027 Feb 15	6.625	129:09	129:13	+17	4.2091
2027 Aug 15	6.375	126:17	126:21	+17	4.2245
2028 Aug 15	5.500	115:22	115:27	+17	4.2646
2029 Feb 15	5.250	112:12	112:17	+17	4.2867
2030 May 15	6.250	126:22	126:27	+18	4.2724
2031 Feb 15	5.375	114:23	114:28	+18	4.2996
2036 Feb 15	4.500	102:18	102:23	+16	4.3253
2037 Feb 15	4.750	106:15	106:20	+16	4.3330
2037 May 15	5.000	110:19	110:24	+16	4.3276
2038 Feb 15	4.375	100:11	100:16	+15	4.3447
2039 Feb 15	3.500	85:26	85:29	+14	4.3567
2039 Aug 15	4.500	102:12	102:15	+15	4.3509

Source: Thomson Reuters

Cited by the text book (p. 188)

5.6 Inflation and Interest Rates

- **Nominal interest rates** are interest rates as they are observed and quoted, with no adjustment for inflation.

- **Real interest rates** are adjusted for inflation effects.

Real interest rate = nominal interest rate – inflation rate

The Fisher Effect

- The Fisher Effect defines the relationship between real rates, nominal rates, and inflation.

$$(1+R)= (1+r)(1+h)$$

  - where
    - R = nominal rate
    - r = real rate
    - h = expected inflation rate

- Approximation
  - R = r + h

5.7 Determinants of Bond Yields

- The *term structure of interest rates* is the relationship between time to maturity and the interest rates for default-free, pure discount instruments.

- It is important to recognize that we pull out the effect of default risk, different coupons, etc.
- Yield curve – graphical representation of the term structure
  - Normal – upward-sloping, long-term yields are higher than short-term yields
  - Inverted – downward-sloping, long-term yields are lower than short-term yields

The Term Structure of Interest Rates

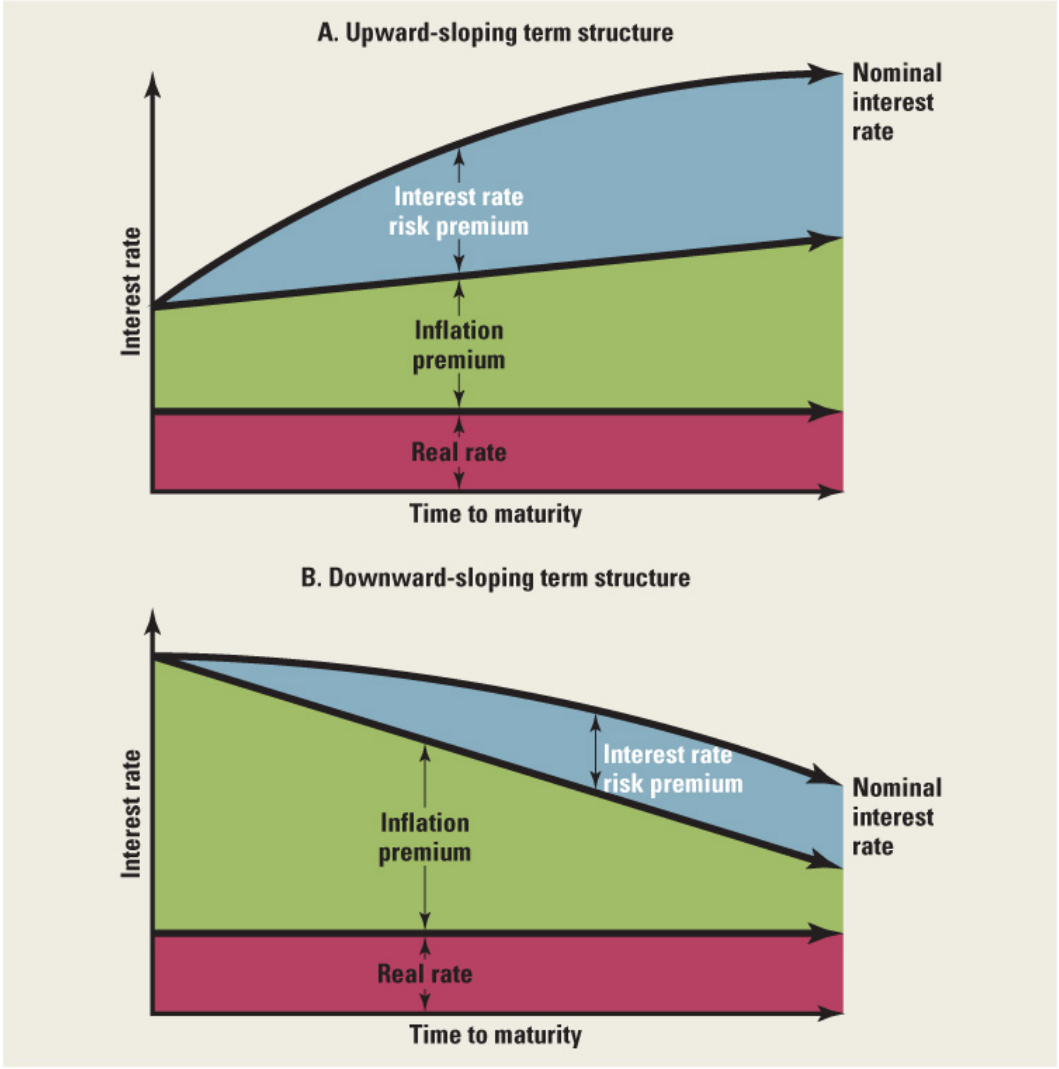


FIGURE 5.6
The Term Structure of Interest Rates

Cited by the text book (p. 193)

Factors Affecting Required Return

- Default risk premium – remember bond ratings
- Taxability premium – remember municipal versus taxable
- Liquidity premium – bonds that have more frequent trading will generally have lower required returns (remember bid-ask spreads)
- Anything else that affects the risk of the cash flows to the bondholders will affect the required returns.

References

- Ross, Westerfield, Jaffe and Jordan, Core Principles and Application of Corporate Finance, 3ed, McGraw Hill.
- Jordan, Miller, and Dolvin, Fundamentals of Investments, 6ed, MacGraw Hill.
- Berk, DeMarzo and Harford, Fundamentals of Corporate Fiance, 2nd ed, Pearson.