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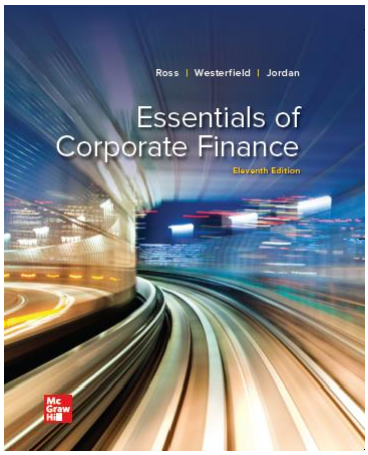
Chapter 06

Interest Rates and Bond Valuation



Key Concepts and Skills

After studying this chapter, you should be able to:

- Identify important bond features and types of bonds.
- Describe bond values and why they fluctuate.
- Discuss bond ratings and what they mean.
- Evaluate the impact of inflation on interest rates.
- Explain the term structure of interest rates and the determinants of bond yields.

Chapter Outline

6.1 Bonds and Bond Valuation.

6.2 More on Bond Features.

6.3 Bond Ratings.

6.4 Some Different Types of Bonds.

6.5 Bond Markets.

6.6 Inflation and Interest Rates.

6.7 Determinants of Bond Yields.

Bond Definitions

Bond.

- Debt contract.
- Interest-only loan.

Par value (face value) approximately $1,000.

Coupon rate.

Coupon payment.

Maturity date.

Yield to maturity.

Key Features of a Bond 1

Par value:

- Face amount.
- Repaid at maturity.
- Assume $1,000 for corporate bonds.

Coupon interest rate:

- Stated interest rate.
- Usually = YTM at issue.
- Multiply by par value to get coupon payment.

Key Features of a Bond 2

Maturity:

- Years until bond must be repaid.

Yield to maturity (YTM):

- The market required rate of return for bonds of similar risk and maturity.
- The discount rate used to value a bond.
- Return if bond held to maturity.
- Usually equals the coupon rate at issue.
- Quoted as an APR.

Bond Value

Bond Value = PV(coupons) + PV(par).

Bond Value = PV(annuity) + PV(lump sum)

Remember:

- As interest rates increase present values decrease.

  ($r \uparrow \rightarrow$ PV $\downarrow$)

- As interest rates increase, bond prices decrease and vice versa.

The Bond-Pricing Equation

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

PV(Annuity) **PV(lump sum)**

C = Coupon payment; F = Face value

Return to Quick Quiz

Texas Instruments BA-II Plus

N = Number of periods to maturity.

I/Y = Period interest rate = YTM.

PV = Present value = Bond value.

PMT = Coupon payment.

FV = Future value = Face value = Par value.

Spreadsheet Formulas

=FV(Rate,Nper,Pmt,PV,0/1).

=PV(Rate,Nper,Pmt,FV,0/1).

=RATE(Nper,Pmt,PV,FV,0/1).

=NPER(Rate,Pmt,PV,FV,0/1).

=PMT(Rate,Nper,PV,FV,0/1).

Inside parentheses: (RATE,NPER,PMT,PV,FV,0/1).

“0/1” Ordinary annuity = 0 (default).

Annuity Due = 1 (must be entered).

Pricing Specific Bonds on the TI BAII+

Bond Worksheet: ***2nd BOND*** (above "***9***").

SDT CPN RDT RV ACT $2/Y$ YLD PRI.

- SDT = Actual Settlement date (enter MM.DDYY).
- CPN = Annual rate in percent.
- RDT = Actual Redemption (maturity) date.
- RV = Redemption value as a percent of par.
- ACT = ACT/360 day count setting.
- $2/Y = 2/Y - 1/Y$ coupons per year.
- YLD = Yield to redemption.
- PRI = Dollar price per $100 of par value.

Pricing Specific Bonds in Excel

=PRICE(Settlement,Maturity,Rate,Yld,Redemption, Frequency,Basis).

=YIELD(Settlement,Maturity,Rate,Pr,Redemption, Frequency,Basis).

- Settlement = Actual date as a serial number.
- Maturity = Actual date as a serial number.
- Redemption and Pr(ice) = percent of par value.
- Rate (coupon) and Yld = Annual rates as decimals.
- Frequency = # of coupons per year.
- Basis = Day count convention (enter "***2***" for ACT/360).

Valuing a Premium Bond with Annual Coupons

Coupon rate = 10%

Annual coupons

Par = $1,000

Maturity = 5 years

YTM = 11%

Using the calculator:

5	**N**
11	**I/Y**
100	**PMT**
1000	**FV**
CPT PV	**= − 963.04**

Using the formula:

***B* = PV(annuity) + PV(lump sum)**

***B* = $369.59 + 593.45 = $963.04**

Using Excel: **=PV(.11,5,100,1000,0)**

$$B = \$100\left[\frac{1-\frac{1}{1.11^5}}{.11}\right] + \frac{\$1{,}000}{1.11^5}$$

Note: When YTM > Coupon rate → Price < Par = "Discount Bond"

Valuing a Discount Bond with Annual Coupons

Coupon rate = 10%

Annual coupons

Par = $1,000

Maturity = 20 years

YTM = 8%

Using the calculator:

20	**N**
8	**I/Y**
100	**PMT**
1000	**FV**
CPT PV	**= − 1196.36**

Using the formula:

***B* = PV(annuity) + PV(lump sum)**

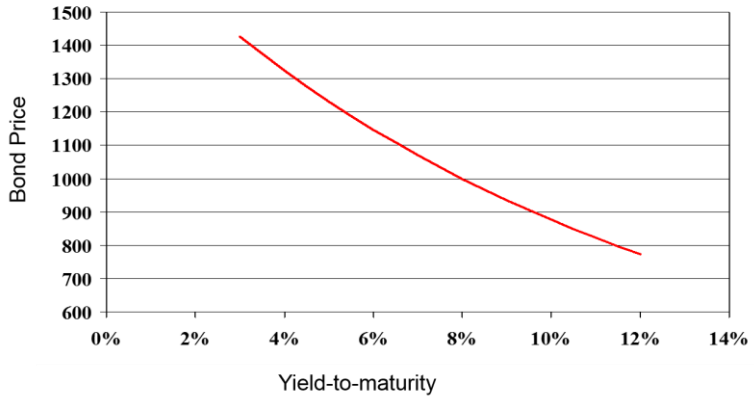
***B* = $981.81 + 214.55 = $1196.36**

Using Excel: **=PV(.11,5,100,1000,0)**

$$B = \$100\left[\frac{1-\frac{1}{1.08^{20}}}{.08}\right] + \frac{\$1000}{1.08^{20}}$$

Note: When YTM < Coupon rate → Price > Par = "Premium Bond"

Graphical Relationship Between Price and Yield-to-Maturity



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Bond Prices: Relationship Between Coupon and Yield

Coupon rate = YTM → Price = Par.

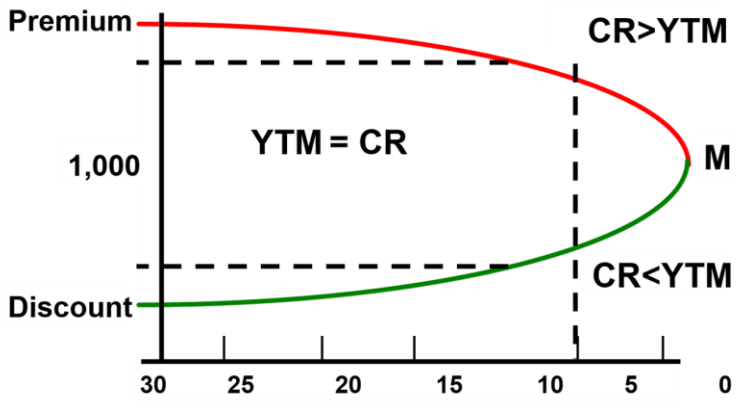
Coupon rate < YTM → Price < Par.

- "Discount bond" … Why?

Coupon rate > YTM → Price > Par.

- "Premium bond" … Why?

Bond Value ($) versus Years Remaining to Maturity



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The Bond-Pricing Equation Adjusted for Semiannual Coupons

$$\text{Bond Value} = \frac{C}{2}\left[\frac{1-\frac{1}{(1+YTM/2)^{2t}}}{YTM/2}\right] + \frac{F}{(1+YTM/2)^{2t}}$$

C **= Annual coupon payment**	→	***C*** **÷ 2 = Semiannual coupon**
r **= Annual yield**	→	***r*** **÷ 2 = Semiannual yield**
t **= Years to maturity**	→	**2*t* = Number of 6-month periods to maturity**

Semiannual Bonds Example 6.1

Coupon rate = 14 percent semiannually.

r = 16 percent.

Maturity = 7 years

Number of coupon payments? (2*t* or N).

- 14 = 2 × 7 years.

Semiannual coupon payment? $\left(C/2 \text{ or PMT}\right)$.

- $\$70 = \left(14\% \times \text{Face value}\right)/2.$

Semiannual yield? $\left(r/2 \text{ or I/Y}\right)$.

- $8\% = 16\%/2$

Example 6.1

Semiannual coupon = $70.

Semiannual yield = 8%.

Periods to maturity = 14.

$$\text{Bond Value} = C/2\left[\frac{1-\frac{1}{\left(1+YTM/2\right)^{2t}}}{YTM/2}\right]+\frac{F}{\left(1+YTM/2\right)^{2t}}$$

Bond value = $\$70\left[1-1/1.08^{14}\right]/.08+\$1{,}000/1.08^{14}=\$917.56.$

$$B=\$70\left[\frac{1-\frac{1}{1.08^{14}}}{.08}\right]+\frac{\$1{,}000}{1.08^{14}}$$

Using Excel: **=PV(.08,14,70,1000,0).**

Using the calculator:

14	**N**
8	**I/Y**
70	**PMT**
1000	**FV**
CPT PV	**= − 917.56**

Interest Rate Risk 1

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.

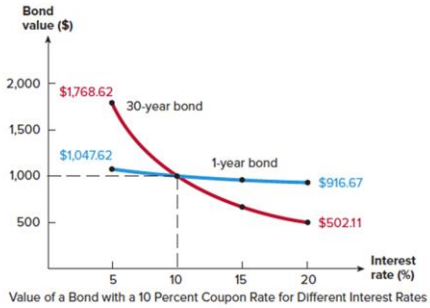
Interest Rate Risk 2

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.

Figure 6.2

Figure 6.2: 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

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Computing Yield-to-Maturity (YTM)

Yield-to-maturity (YTM): Market required rate of return implied by the current bond price.

With a financial calculator:

Enter N, PV, PMT, and FV.

Remember the sign convention.

- PMT and FV need to have the same sign (+).
- PV the opposite sign (−).
- CPT I/Y for the yield.

YTM with Annual Coupons

Consider a bond with a 10 percent annual coupon rate, 15 years to maturity, and a par value of $1,000. The current price is $928.09.

- Will the yield be more or less than 10 percent?

15	N
928.09	PV (enter as a negative)
1000	FV
100	PMT
CPT PV	= 11% ← Result = YTM

Using Excel: **=RATE(15,100,−928.09,1000,0).**

YTM with Semiannual Coupons [1]

Suppose a bond with a 10 percent coupon rate and semiannual coupons, has a face value of $1000, 20 years to maturity, and is selling for $1,197.93.

- Is the YTM more or less than 10 percent?
- What is the semiannual coupon payment?
- How many periods are there?

YTM with Semiannual Coupons 2

Suppose a bond with a 10 percent coupon rate and semiannual coupons, has a face value of $1,000, 20 years to maturity, and is selling for $1,197.93.

40	N
1197.93	PV (negative)
1000	FV
50	PMT
CPT PV	4% (= ½ YTM)

YTM = 4%×2 = 8%

NOTE: Solving a semiannual payer for YTM results in a 6-month yield.

The calculator and Excel solve what you enter.

Using Excel: **=RATE(40,50,−1197.93,1000,0) = 4%.**

Table 6.1 1

Table 6.1 Summary of Bond Valuation

I. Finding the value of a bond

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

where:

C = Coupon paid each period

r = Rate per period

t = Number of periods

F = Bond's face value

Table 6.1 [2]

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 in the preceding formula until the calculated bond value equals the given bond value. Remember that increasing the rate *decreases* the bond value.

Debt or Equity

Debt.

- Not an ownership interest.
- No voting rights.
- Interest 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 to elect the board of directors and on other issues.
- Dividends are not tax deductible.
- Dividends are not a liability of the firm until declared. Stockholders have no legal recourse if dividends are not declared.
- An all-equity firm cannot go bankrupt.

The Bond Indenture “Deed of Trust”

Contract between issuing company and bondholders includes:

Basic terms of the bonds.

Total amount of bonds issued.

Secured versus Unsecured.

Sinking fund provisions.

Call provisions.

- Deferred call.
- Call premium.

Details of protective covenants.

Return to Quiz

Bond Classifications

Registered versus Bearer Bonds.

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.

- Senior versus Junior, Subordinated.

Bond Characteristics and Required Returns

Coupon rate.

- A function of the risk characteristics of the bond when issued.
- Usually ≈ yield at issue.

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.

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.

Return to Quiz

Bond Ratings – Speculative

Low Grade.

- Moody's Ba, B, Caa and Ca.
- S&P BB, B, CCC, CC.
- Considered speculative with respect to capacity to pay. The "B" ratings are the lowest degree of speculation.

Very Low Grade.

- Moody's C and S&P C – income bonds with no interest being paid.
- Moody's D and S&P D – in default with principal and interest in arrears.

Government Bonds [1]

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.
- Interest usually exempt from state tax in issuing state.

Government Bonds 2

Treasury Securities = Federal government debt.

Treasury Bills (T-bills).

- Pure discount bonds.
- Original maturity of one year or less.

Treasury notes.

- Coupon debt.
- Original maturity between one and ten years.

Treasury bonds.

- Coupon debt.
- Original maturity greater than ten years.

Example 6.4

A taxable bond has a yield of 8 percent and a municipal bond has a yield of 6 percent.

If you are in a 40 percent tax bracket, which bond do you prefer?

- 8%(1 − .4) = 4.8%.
- The aftertax return on the corporate bond is 4.8 percent, compared to a 6 percent return on the municipal.

At what tax rate would you be indifferent between the two bonds?

- 8%(1 − t^*) = 6%.
- t^* = 25%.

Zero Coupon Bonds

Make no periodic interest payments (coupon rate = 0 percent).

Entire yield-to-maturity comes from the difference between the purchase price and the par value (capital gains).

Cannot sell for more than par value.

Sometimes called zeroes, or deep discount bonds.

Treasury Bills and U.S. Savings bonds are good examples of zeroes.

Floating Rate Bonds

Coupon rate floats depending on some index value.

Examples – adjustable rate mortgages and inflation-linked Treasuries.

Less price risk with floating rate bonds.

- Coupon floats, so 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

Structured notes.

Convertible bonds.

Put bonds.

Many types of provisions can be added to a bond.

- Important to recognize how these provisions affect required returns.
- Who does the provision benefit?

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.

Getting up-to-date prices difficult, particularly on small company or municipal issues.

Treasury securities are an exception.

Work the Web Example

Bond information is available online.

One good site:

finra-markets.morningstar.com/BondCenter

Click on this link to go to the site.

- Use “Quick Bond Search” to observe the yields for various bond types, and the shape of the yield curve.

Corporate Bond Quotations

ABC 8.375 Jul 15, 2033 100.641 8.316 362 30 763,528

What company are we looking at?

What is the coupon rate? If the bond has a $1,000 face value, what is the coupon payment each year?

When does the bond mature?

What was the trading volume on that day?

What is the quoted price? (Ask price).

What is the bond’s yield?

Treasury Quotations 1

Figure 6.3 Sample Wall Street Journal U.S. Treasury note and bond prices

U.S. Treasury Quotes

Treasury note and bond data are representative over-the-counter quotations as of 3 p.m. Eastern time.

Maturity	Coupon	Bid	Asked	Chg	Asked Yield
8/15/2021	2.125	101.040	101.044	−0.006	0.077
2/28/2022	1.125	101.036	101.042	−0006	0.089
3/31/2023	1.500	102.310	102.314	−0004	0.128
4/30/2025	0.375	100.042	100.046	0.012	0.340
12/31/2026	1.750	106.256	106.262	0.024	0.579
11/15/2027	6.125	136.020	136.024	0.710	0.688
11/15/2028	3.125	117.020	117.030	0.708	0.856
8/15/2029	6.125	143.034	143.044	0.720	0.880
5/15/2030	6.250	147.014	147.024	0.728	0.951
2/15/2031	5.375	141.126	141.136	0.026	1.028
2/15/2037	4.750	148.126	148.136	0.090	1.378
5/15/2038	4.5	146.230	146.25	0.098	1.437

Treasury Quotations 2

Figure 6.3 Sample Wall Street Journal U.S. Treasury note and bond prices (*Continued*)

U.S. Treasury Quotes

Treasury note and bond data are representative over-the-counter quotations as of 3 p.m. Eastern time.

Maturity	Coupon	Bid	Asked	Chg	Asked Yield
5/15/2039	4.250	144.006	144.026	0.780	1.489
2/15/2040	4.625	151.024	151.044	0.808	1.523
2/15/2041	4.750	154.232	154.252	0.126	1.559
2/15/2043	3.125	126.162	126.182	0.112	1.679
8/15/2044	3.125	126.312	127.012	0.120	1.724
11/15/2045	3.000	125.006	125.026	0.784	1.749
5/15/2046	2.500	114.194	114.214	0.098	1.777
5/15/2047	3.000	125.200	125.220	0.100	1.774
8/15/2048	3.000	126.014	126.034	0.780	1.795
11/15/2049	2.375	112.090	112.110	0.778	1.822
11/15/2050	1.625	94.242	94.262	0.090	1.852

Source: www.wsj.com, 6/14/2018.

Treasury Quotations 3

Highlighted quote in Figure 6.4.

5/15/2038	**4.500**	**146.230**	**146.250**	**0.098**	**1.437**

- When does the bond mature?
- What is the coupon rate on the bond?
- What is the bid price? What does this mean?
- What is the ask price? What does this mean?
- How much did the price change from the previous day?
- What is the YTM based on Ask price?

Treasury Quotations 4

5/15/2038	**4.500**	**146.230**	**146.250**	**0.098**	**1.437**

Maturity = May 15, 2038.

Coupon rate = 4.500 percent per year.

Bid price = 146.230 percent of par.

- Price at which dealer is willing to buy from you.

Ask price = 146.250 percent of par.

- Price at which dealer is willing to sell to you.

Bid-Ask spread = Dealer's profit.

Change = Ask price is up .098 percent since the previous day.

Asked yield = 1.437 percent.

Quoted Price versus Invoice Price

Quoted bond prices = “clean” price.

- Net of accrued interest.

Invoice Price = “dirty” or “full” price.

- Price actually paid.
- Includes accrued interest.

Accrued Interest.

- Interest earned since last coupon payment is owed to bond seller at time of sale.

Inflation and Interest Rates

Real rate of interest.

= Change in purchasing power.

Nominal rate of interest.

= Quoted rate of interest.

= Change in purchasing power and inflation.

The ex ante nominal rate of interest includes our desired real rate of return plus an adjustment for expected inflation.

The Fisher Effect

The Fisher effect defines the relationship between real rates, nominal rates and Inflation.

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

R = Nominal rate (Quoted rate).

r = Real rate.

h = *Expected* inflation rate.

Approximation: $R = r + h$.

Return to Quiz

Example 6.6

If we require a 10 percent real return and we expect inflation to be 8 percent, what is the nominal rate?

- R = (1.1)(1.08) − 1 = .1880, or 18.80%.
- Approximation: R = 10% + 8% = 18%.
- Because the real return and expected inflation are relatively high, there is significant difference between the actual Fisher effect and the approximation.

Term Structure of Interest Rates

Term structure: The relationship between time to maturity and yields, all else equal.

- The effect of default risk, different coupons, etc., has been removed.

Yield curve: Graphical representation of the term structure.

- Normal = upward-sloping → L/T > S/T.
- Inverted = downward-sloping → L/T < S/T.

Return to Quiz

Figure 6.6 A: Upward-Sloping Yield Curve

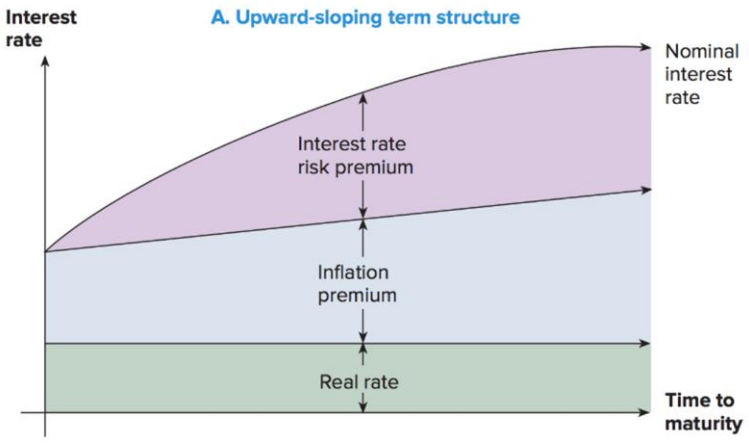

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Figure 6.6 B: Downward-Sloping Yield Curve

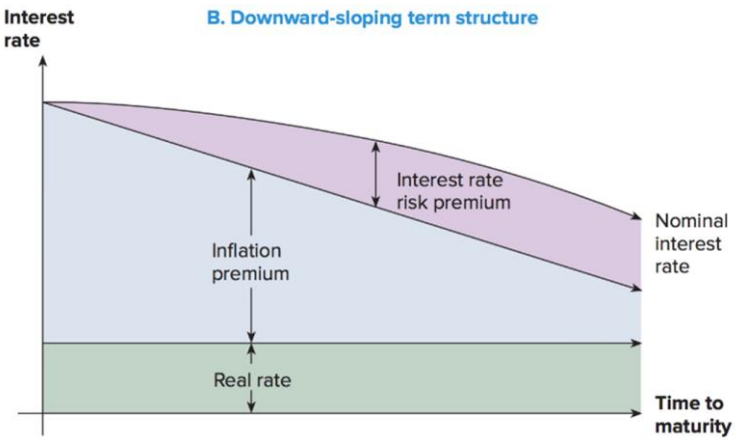
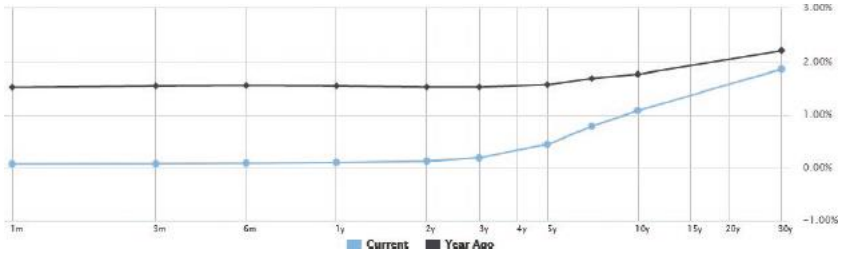


Figure 6.7: Treasury Yield Curve

Figure 6.7: Treasury Yield Curve June 14, 2018



Source: www.treasury.gov, June 14. 2018

More information can be found at this link.

Access the text alternative for these images

Factors Effecting Required Return

Default risk premium – bond ratings.

Taxability premium – municipal versus taxable.

Liquidity premium – bonds that have more frequent trading will generally have lower required returns.

Maturity premium – longer term bonds will tend to have higher required returns.

Anything else that affects the risk of the cash flows to the bondholders will affect the required returns.

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Quick Quiz

How do you find the value of a bond and why do bond prices change? (Slide 6.8).

What is a bond indenture and what are some of the important features? (Slide 6.31).

What are bond ratings and why are they important? (Slide 6.34).

How does inflation affect interest rates? (Slide 6.51).

What is the term structure of interest rates? (Slide 6.53).

What factors determine the required return on bonds? (Slide 6.57).

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