Chapter 6 Lecture – Interest Rates and Bond Valuation

Learning Objectives

After studying this chapter, you should be able to:

LO1 Identify important bond features and types of bonds.

LO2 Describe bond values and why they fluctuate.

LO3 Discuss bond ratings and what they mean.

LO4 Evaluate the impact of inflation on interest rates.

LO5 Explain the term structure of interest rates and the determinants of bond yields.

6-2

Definition of a Bond

Bond - evidence of debt issued by a corporation or a governmental body. A bond represents a *loan* made by investors to the *issuer.* In return for his/her money, the investor receives a legal claim on future cash flows of the borrower. The issuer promises to (a)

- Make regular coupon payments every period until the bond matures, and
- Pay the face/par/maturity value of the bond when it matures.

6-3

General Features of Bonds

- The bond's principal, par value or face value is the amount borrowed by the company and the amount owed to the bond holder on the maturity date.
- The bond's maturity date is the time at which a bond becomes due and the principal must be repaid.
- The bond's coupon is the specified amount that must be periodically paid.
- The coupon rate is the coupon divided by the principle
- The bond's current yield is the annual interest (income) divided by the current price of the security. The bond's yield to maturity is the yield (expressed as a compound rate of return) earned on a bond from the time it is acquired until the maturity date of the bond.
- Default risk: Risk that issuer will not make interest or principal payments.

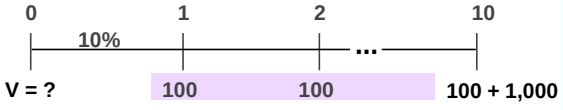
6-4

The Mechanics of Bond Pricing

- A fixed-rate bond is a contract detailing the par value, the coupon rate, and maturity date.
- The coupon rate is close to the market rate of interest on similar bonds at the time of issuance.
- In a fixed-rate bond, the interest income remains fixed throughout the term (to maturity). The value of a bond is the present value of future contractual cash flows discounted at the market rate of interest.
  - Cash flows are assumed to flow at the end of the period and are assumed to be reinvested at i (or r). Bonds typically pay interest semiannually.
  - Increasing i (or r) decreases the price of the bond (PB).

6-5

What's the value of a 10-year, 10% coupon bond if i = 10%?



$$V_B = \frac{\$100}{(1+i)^1} + \ldots + \frac{\$100}{(1+i)^{10}} + \frac{\$1{,}000}{(1+i)^{10}}$$

$$= \$90.91 + \ldots + \$38.55 + \$385.54$$

$$= \$1{,}000.$$

6-6

The bond consists of a 10-year, 10% annuity of $100/year plus a $1,000 lump sum at t = 10:

PV annuity	=	$ 614.46
PV maturity value	=	385.54
Value of bond	=	$1,000.00

- What would happen if expected inflation rose by 3%, causing i to rise to 13%? When i rises, above the coupon rate, the bond's value falls below par, so it sells at a discount.
- What would happen if expected inflation fell 3%, causing i to fall= 7%? When i falls, below the coupon rate, the bond's value rise above par, so it sells at a premium.

6-7

Bond Value

- Bond Value = PV(coupons) + PV(par)
- Bond Value = PV(annuity) + PV(lump sum)
- Remember:
  - As interest rates increase present values decrease (i ⬆→ PV ⬇)
  - As interest rates increase, bond prices decrease and vice versa

6-8

The Bond-Pricing Equation

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

PV(Annuity) PV(lump sum)

C = Coupon payment; F = Face value

6-9

Alternative Versions

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

$$P = \left(\frac{C}{1+i} + \frac{C}{(1+i)^2} + \ldots + \frac{C}{(1+i)^N}\right) + \frac{M}{(1+i)^N}$$

$$= \left(\sum_{n=1}^{N} \frac{C}{(1+i)^n}\right) + \frac{M}{(1+i)^N}$$

$$= C\left(\frac{1-(1+i)^{-N}}{i}\right) + M(1+i)^{-N}$$

6-10

Again, what is the value of a 10-year, 10% coupon bond if i = 10%?

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

$$\text{Bond Value} = C\left[\frac{1-\frac{1}{(1+.10^{10}}}{.10}\right] + \frac{1000}{(1+.10)^{10}} = \$1000$$

6-11

Valuing a Discount 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

$$B = 100\left[\frac{1-\frac{1}{(1.11)^5}}{0.11}\right] + \frac{1000}{(1.11)^5}$$

Using Excel: =PV(0.11, 5, 100, 1000, 0)

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

6-12

Valuing a Premium 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

$$B = 100\left[\frac{1-\frac{1}{(1.08)^{20}}}{0.08}\right] + \frac{1000}{(1.08)^{20}}$$

Using Excel: =PV(0.08, 20, 100, 1000, 0)

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

6-13

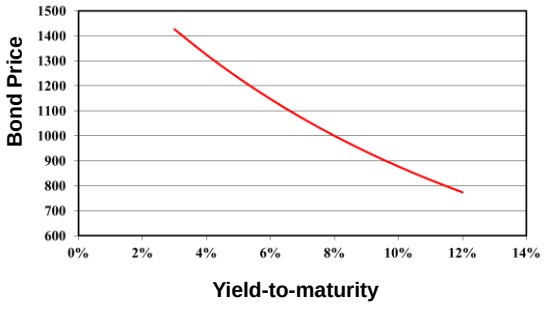
Excel Solutions

Rate	0.11		
Nper	5		
Pmt	100		
Fv	1000	FV or Bond Price=	($963.04)

Rate	0.08		
Nper	20		
Pmt	100		
Fv	1000	FV or Bond Price =	($1,196.36)

6-14

Graphical Relationship Between Price and Yield-to-maturity



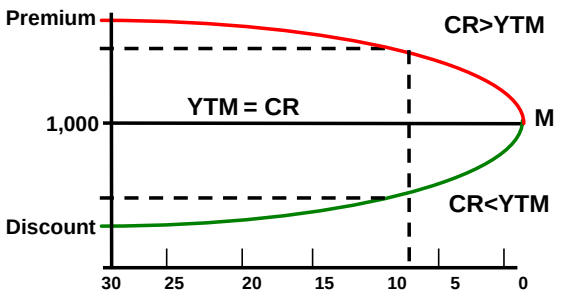
6-15

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?

6-16

Bond Value ($) vs Years remaining to Maturity



6-17

The Bond-Pricing Equation Adjusted for Semi-annual Coupons

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

C = Annual coupon payment ➡ C/2 = Semi-annual coupon

YTM = Annual YTM (as an APR) ➡ YTM/2 = Semi-annual YTM

t = Years to maturity ➡ 2t = Number of 6-month periods to maturity

6-18

Semiannual Bonds

- Coupon rate = 14% - Semiannual
- YTM = 16% (APR)
- Maturity = 7 years
  - Number of coupon payments? (2t or N)
    - 14 = 2 x 7 years
  - Semiannual coupon payment? (C/2 or PMT)
    - $70 = (14% x Face Value)/2
  - Semiannual yield? (YTM/2 or I/Y)
    - 8% = 16%/2

6-19

Example

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

- Semiannual coupon = $70
- Semiannual yield = 8%
- Periods to maturity = 14
- Bond value = $70[1 - 1/(1.08)^{14}] / .08 + 1000 / (1.08)^{14} = 917.56$

$$B = 70\left[\frac{1-\frac{1}{(1.08)^{14}}}{0.08}\right] + \frac{1000}{(1.08)^{14}}$$

6-20

Example

Excel Solution

=PV(0.08, 14, 70, 1000, 0)

Using the calculator:

14	N
8	I/Y
70	PMT
1000	FV

CPT PV = -917.56

Rate	0.08		
Nper	14		
Pmt	70		
Fv	1000	FV or Bond Price =	($917.56)

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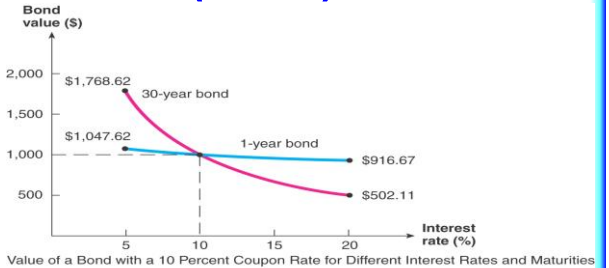
Bond Risk

- 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
- Exchange Rate Risk

6-22

Bond Value - Interest Rate (or Price) Risk



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

6-23

Interest Rate Risk

- Inflation Risk (IP)
- Interest Rate Risk. (LP)
- Call Risk or Maturity Risk (MRP)
- Default Risk (DFP)
  - Risk that the interest will not be paid
  - Risk that the principal will not be paid
  - Risk that the price of the bond will decline due to poor company prospects

$$r_i = r^* + IP + LP + MRP\ (call) + DRP$$

for debt securities.

6-24

Yield to Maturity Once Again

The yield to maturity (YTM) is the investor's expected or promised yield if the bond is held to maturity and the cash flows are reinvested at the yield to maturity.

Bond yields to maturity vary inversely with bond prices.

- If the market price of the bond increases, the yield to maturity declines.
- If the market price of the bond decreases, the yield to maturity increases.
- When the bond is selling at par, the coupon rate approximates the market rate of interest.
- Bond prices above par are priced at a premium; below par, at a discount.

To solve using excel use RATE function.

6-25

YTM with Annual Coupons

Consider a bond with a 10% annual coupon rate, 15 years to maturity and a par value of $1000. The current price is $928.09.

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

Excel Solution

=RATE(15, 100, -928.09, 1000, 0)

Using the calculator

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

Nper	15		
Pmt	100		
Pv	-928.09		
Fv	1000	Rate =	11%

6-26

YTM with Semiannual Coupons

Suppose a bond with a 10% coupon rate and semiannual coupons, has a face value of $1000, 20 years to maturity and is selling for $1197.93.

- Is the YTM more or less than 10%?
- What is the semiannual coupon payment?

- NOTE: Solving a semi-annual payer for YTM results in a 6-month yield. The calculator & Excel solve what you enter.

Excel Solution

Nper	40		
Pmt	50		
Pv	-1197.93		
Fv	1000	Rate =	4%

YTM = 4% x 2 = 8%

6-27

YTM with Semiannual Coupons

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

Using the calculator

40	N
1197.93	PV (negative)
1000	FV
50	PMT
CPT PV	4% (= ½ YTM)
	YTM = 4% x 2 = 8%

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

The calculator & Excel solve what you enter.

6-28

A 10%, 10-year, Annual Payment Bond vs. 10%, 10-year Semiannual Bond

You could buy, for $1,000, either a 10%, 10-year, annual payment bond or an equally risky 10%, 10-year semiannual bond. Which would you prefer?

$$EAR = EFF\% = \left(1 + \frac{i_{Nom}}{m}\right)^{m} - 1 = \left(1 + \frac{0.10}{2}\right)^{2} - 1 = 10.25\%$$

10.25% > 10% EFF% on annual bond, so buy semiannual bond.

6-29

Debt versus 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

6-30

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

6-31

Call Provision

- Issuer can refund if rates decline. That helps the issuer but hurts the investor.
- Therefore, borrowers are willing to pay more, and lenders require more, on callable bonds.
- Most bonds have a deferred call and a declining call premium.

Sinking Fund

- Provision to pay off a loan over its life rather than all at maturity.
- Reduces risk to investor, shortens average maturity.
- But not good for investors if rates decline after issuance.

6-32

Bond Classifications

- Registered vs. 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

6-33

Varieties of Corporate Debt

- Mortgage bonds are backed by real estate and/or the physical assets of the corporation.
  - The real assets pledged will have a market value greater than the bond issue.
  - If the company defaults on the bonds, the real assets are sold off to pay off the mortgage bond holders.
- Debentures are unsecured promissory notes that are supported by the general creditworthiness of the issuing company.
  - Because no assets are pledged, these bonds are riskier than collateralized bonds.
  - As a result, they are often referred to as subordinate debt and carry higher interest rates and/or other features to make them more desirable to investors.

6-34

Varieties of Corporate Debt

- Convertible bonds are one type of hybrid security.
  - They are like bonds in that they pay a fixed rate of interest and have a maturity date.
  - They are also like stock because they give the investor an option to convert the bond into a specified number of shares of stock.
  - The market price of a convertible bond therefore depends both on the firm's stock price and prevailing interest rates.
- Bonds also are occasionally issued with stock purchase warrants attached to them to make them more attractive to investors.
  - Warrants give the bondholder the right to purchase a certain number of shares of the same firm's common stock at a specified price during a specified period of time.
  - Including warrants typically allow the firm to raise debt capital at a lower cost than would be possible in their absence

6-35

Varieties of Corporate Debt

- Income bonds will only pay interest if income is earned by the issuing company and only to the extent that income is earned.
  - Income bonds are the only bonds issued where failure to pay the interest in a timely fashion does not lead to immediate default.
  - As a result, income bonds are considered to be extremely risky.
  - In general, income bonds are issued by a company in bankruptcy.
- The company facing bankruptcy will meet with its creditors (usually bond holders) and agree to issue new income bonds in exchange for the old bonds.
- Because failure to pay interest would land the company back into bankruptcy court, the creditors agree that interest will only be paid to the extent earned.

6-36

Varieties of Corporate Debt

- High-yield bonds are not a different type of bond -- simply a bond of lower quality.
- Bonds rated BB (S&P) or Ba (Moodys) or lower are considered to be junk.
- Junk bonds are usually debentures and are subordinated to the firm's other debt.
- In general, junk bonds pay around 3 to 4 percent higher yields to investors than higher-grade bonds.

International Bonds

- *Eurobonds* are issued by a country like the U.S. and sold in another country like France
  - In U.S. dollars
  - May be less regulatory interference
  - May be less disclosure requirements
  - Are bearer bonds - Anonymity
  - *Foreign bonds* are issued in a single foreign country with interest and principal paid in that foreign currency

6-37

Bond Characteristics and Required Returns

- Coupon rate
  - f(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
  - A bond with a sinking fund versus one without
  - A callable bond versus a non-callable bond

6-38

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 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

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Bond Ratings

Moody's	S&P	Meaning
Investment Grade Bonds		
Aaa	AAA	Bonds of the highest quality that offer the lowest degree of investment risk. Issuers are considered to be extremely stable and dependable.
Aa1, Aa2, Aa3	AA+, AA, AA-	Bonds are of high quality by all standards, but carry a slightly greater degree of long-term investment risk.
A1, A2, A3	A+, A, A-	Bonds with many positive investment qualities.
Baa1, Baa2, Baa3	BBB+, BBB, BBB-	Bonds of medium grade quality. Security currently appears sufficient, but may be unreliable over the long term.
Non Investment Grade Bonds (Junk Bonds)		
Ba1, Ba2, Ba3	BB+, BB, BB-	Bonds with speculative fundamentals. The security of future payments is only moderate.
B1, B2, B3	B+, B, B-	Bonds that are not considered to be attractive investments. Little assurance of long term payments.
Caa1, Caa2, Caa3	CCC+, CCC, CCC-	Bonds of poor quality. Issuers may be in default or are at risk of being in default.
Ca	CC	Bonds of highly speculative features. Often in default.
C	C	Lowest rated class of bonds.
--	D	In default.

6-40

Government Bonds

- 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

6-41

Government Bonds

- 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

6-42

Example

A taxable bond has a yield of 8% and a municipal bond has a yield of 6%

- If you are in a 40% tax bracket, which bond do you prefer?
  - 8%(1 - .4) = 4.8%
  - The after-tax return on the corporate bond is 4.8%, compared to a 6% return on the municipal
- At what tax rate would you be indifferent between the two bonds?
  - 8%(1 – T) = 6%
  - T = 25%

6-43

Zero Coupon Bonds

- Make no periodic interest payments (coupon rate = 0%)
- 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

6-44

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"

6-45

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

6-46

Quoted Price vs. 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

6-47

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

6-48

The Fisher Effect

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

$(1 + R(\text{or } i) = (1 + r)(1 + h)$

R = nominal rate (Quoted rate)

r = real rate

h = *expected* inflation rate

$1 + R = 1 + r + h + rh$

Approximation: $R = r + h$ *(we assume rh is relatively small and close to 0.*

6-49

Example

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

- $(1 + R) = (1 + r)(1 + h) = 1 + r + h + rh$
- R = (1.1)(1.08) – 1 = .188 = 18.8%
- 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.

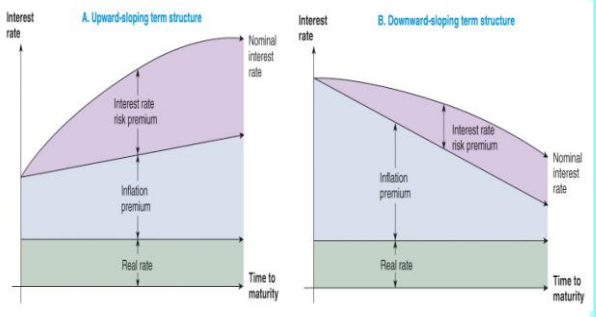
6-50

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

6-51

Upward and Downward-Sloping Yield Curves



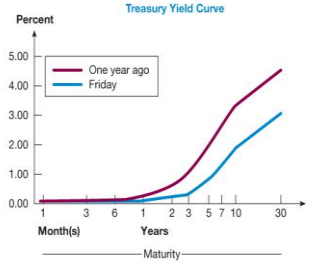
6-52

Treasury Yield Curve

FIGURE 6.6

The Treasury yield curve

Treasury Yield Curve
January 27, 2012



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http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/Historic-Yield-Data-Visualization.aspx

6-53

Bond Investment Strategies

- **Interest rate strategy:** selecting bonds for investment based on interest rate expectations
  - Purchase long-term bonds if you expect interest rates to fall
- **Passive strategy:** investing in a diversified portfolio of bonds that are held for a long period of time
- **Maturity matching strategy:** investing in bonds that will generate payments to match future expenses
  - For example, parents might invest in a bond that will mature at the right time to pay for their child's college education

6-54

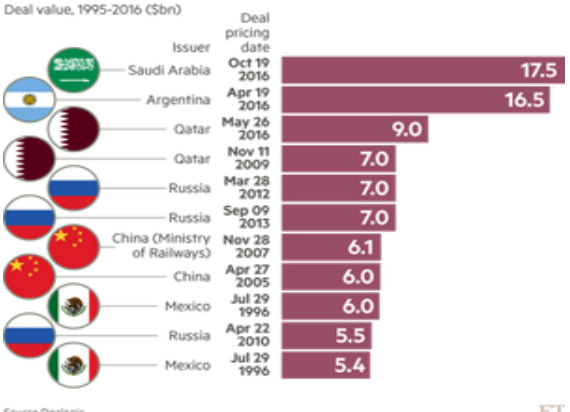
Maturity-Based Strategies Once Again

- **Laddering: for an investor who seeks greater interest income with minimum price volatility**
  - **Construct a portfolio using bonds with a series of targeted maturities, resembling a bond maturity "ladder"**

- Barbell strategy: concentrates on both very short term and very long term bonds (six month T-bill and 30 year T-bonds)

- Bond swap: the simultaneous sale and purchase of fixed income securities

6-55



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