Lecture 4

How to Value Bonds and Stocks

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Valuation of Bonds and Stock

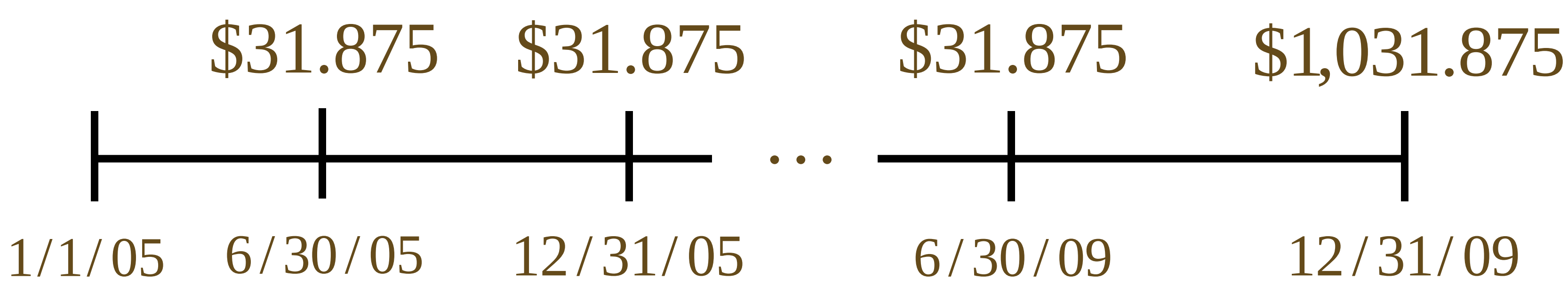
- First Principles:
  - Value of financial securities = PV of expected future cash flows
- To value bonds and stocks we need to:
  - Estimate future cash flows:
    - Size (how much) and
    - Timing (when)
  - Discount future cash flows at an appropriate rate:
    - The rate should be appropriate to the risk presented by the security.

Definition and Example of a Bond

- A bond is a legally binding agreement between a borrower and a lender:
  - Specifies the principal amount of the loan.
  - Specifies the size and timing of the cash flows:
    - In dollar terms (fixed-rate borrowing)
    - As a formula (adjustable-rate borrowing)

Definition and Example of a Bond

- Consider a U.S. government bond listed as 6 3/8 of December 2009.
  - The *Par Value* of the bond is $1,000.
  - *Coupon payments* are made semi-annually (June 30 and December 31 for this particular bond).
  - Since the *coupon rate* is 6 3/8 the payment is $31.875.
  - On January 1, 2005 the size and timing of cash flows are:



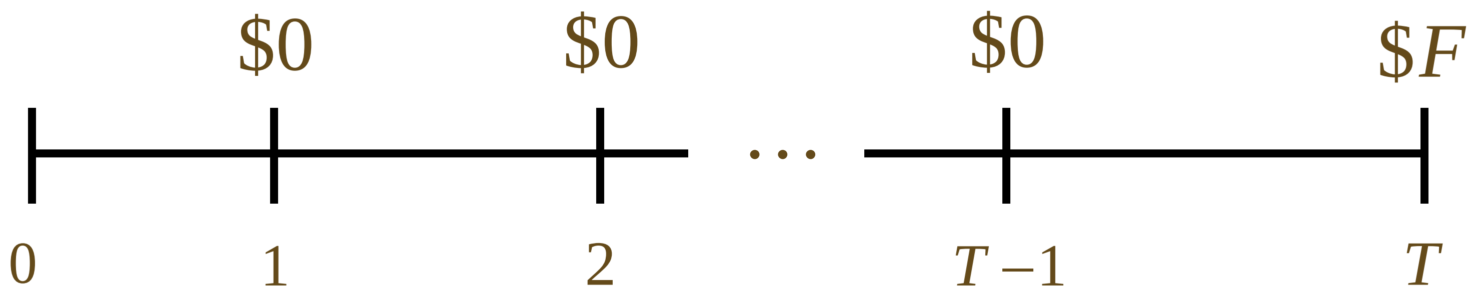
5.2 How to Value Bonds

- Identify the size and timing of cash flows.
- Discount at the correct discount rate.
  - If you know the price of a bond and the size and timing of cash flows, the *yield to maturity* is the discount rate.

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)

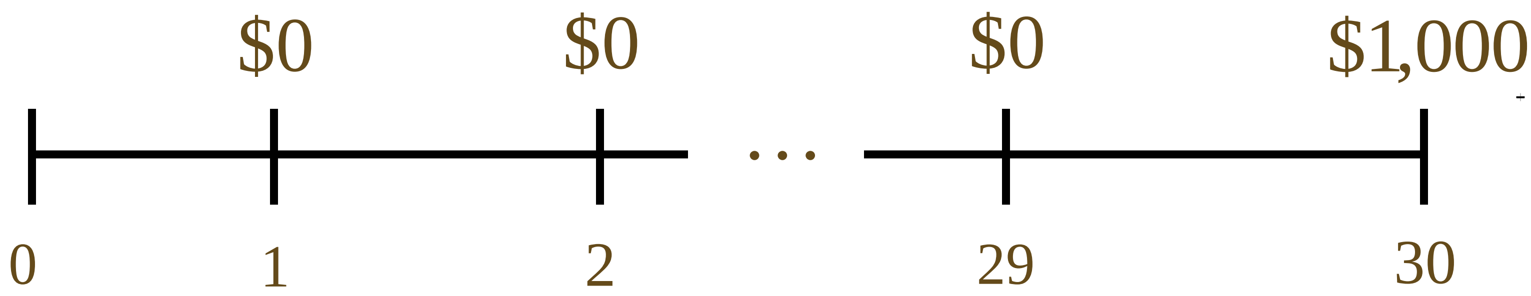


Present value of a pure discount bond at time 0:

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

Pure Discount Bonds: Example

Find the value of a 30-year zero-coupon bond with a $1,000 par value and a YTM of 6%.



$$PV = \frac{F}{(1+r)^T} = \frac{\$1{,}000}{(1.06)^{30}} = \$174.11$$

Level-Coupon Bonds

Information needed to value level-coupon bonds:

- Coupon payment dates and time to maturity (T)
- Coupon payment (C) per period and Face value (F)
- Discount rate

Value of a Level-coupon bond

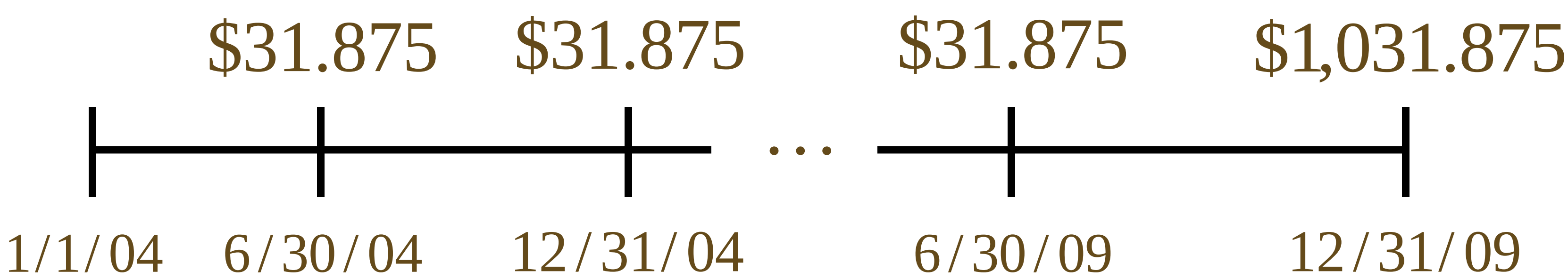
= PV of coupon payment annuity + PV of face value

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

Level-Coupon Bonds: Example

Find the present value (as of January 1, 2004), of a 6-3/8 coupon T-bond with semi-annual payments, and a maturity date of December 2009 if the YTM is 5-percent.

- On January 1, 2004 the size and timing of cash flows are:



$$PV = \frac{\$31.875}{.05/2}\left[1 - \frac{1}{(1.025)^{12}}\right] + \frac{\$1,000}{(1.025)^{12}} = \$1,070.52$$

Bond Concepts

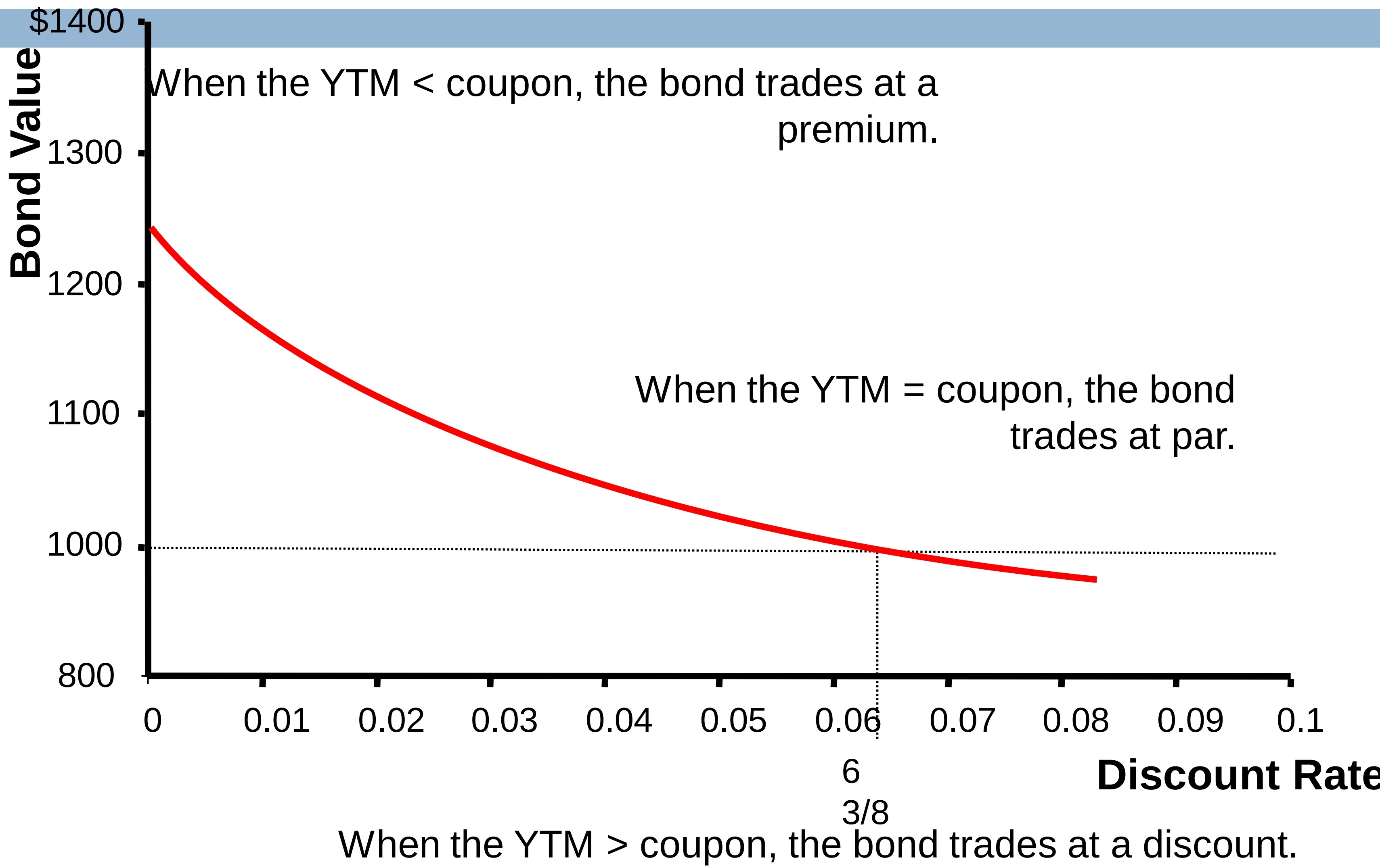
1. Bond prices and market interest rates move in opposite directions.

2. 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)

3. A bond with longer maturity has higher relative (%) price change than one with shorter maturity when interest rate (YTM) changes. All other features are identical.

4. A lower coupon bond has a higher relative price change than a higher coupon bond when YTM changes. All other features are identical.

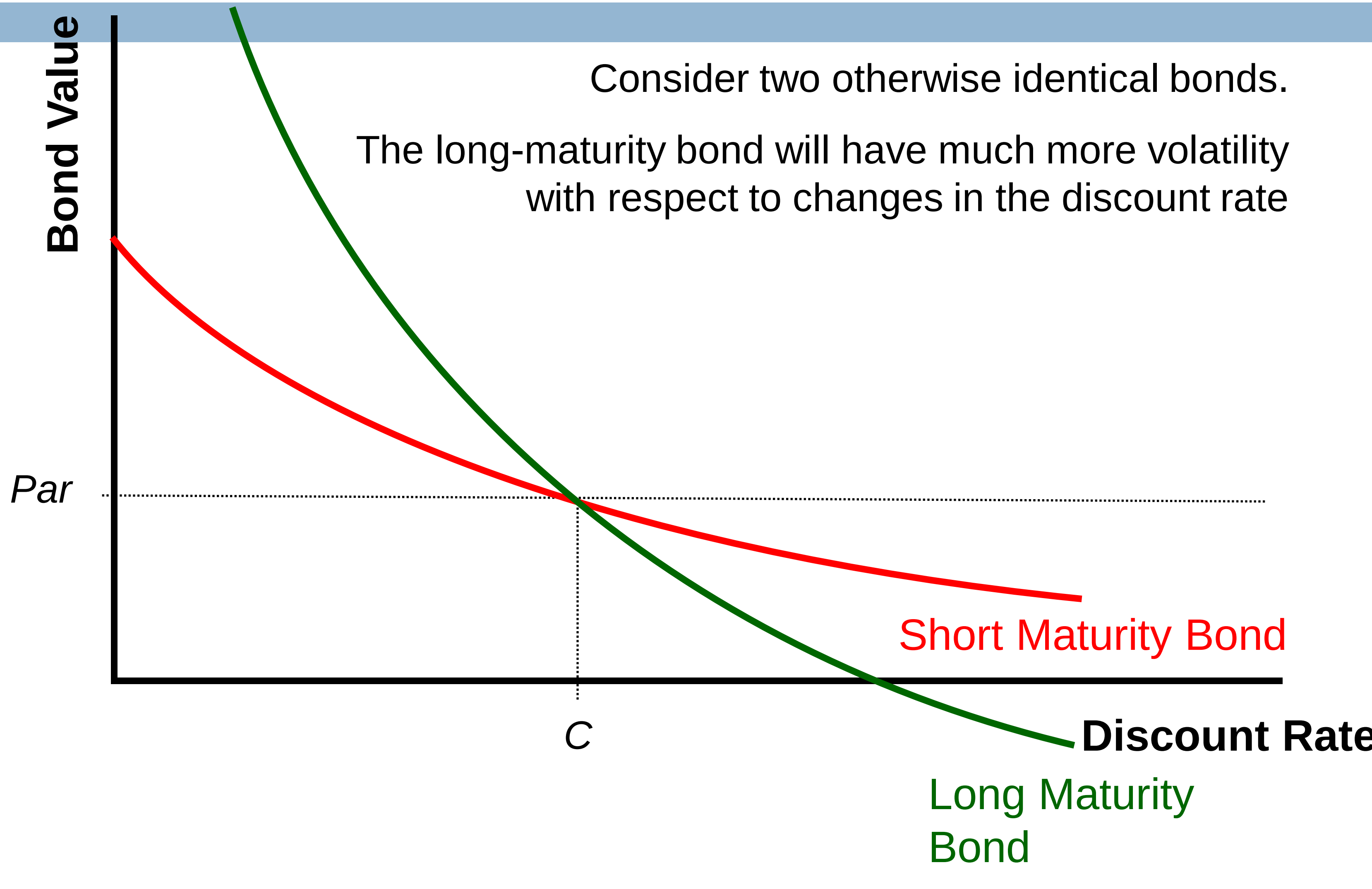
YTM and Bond Value



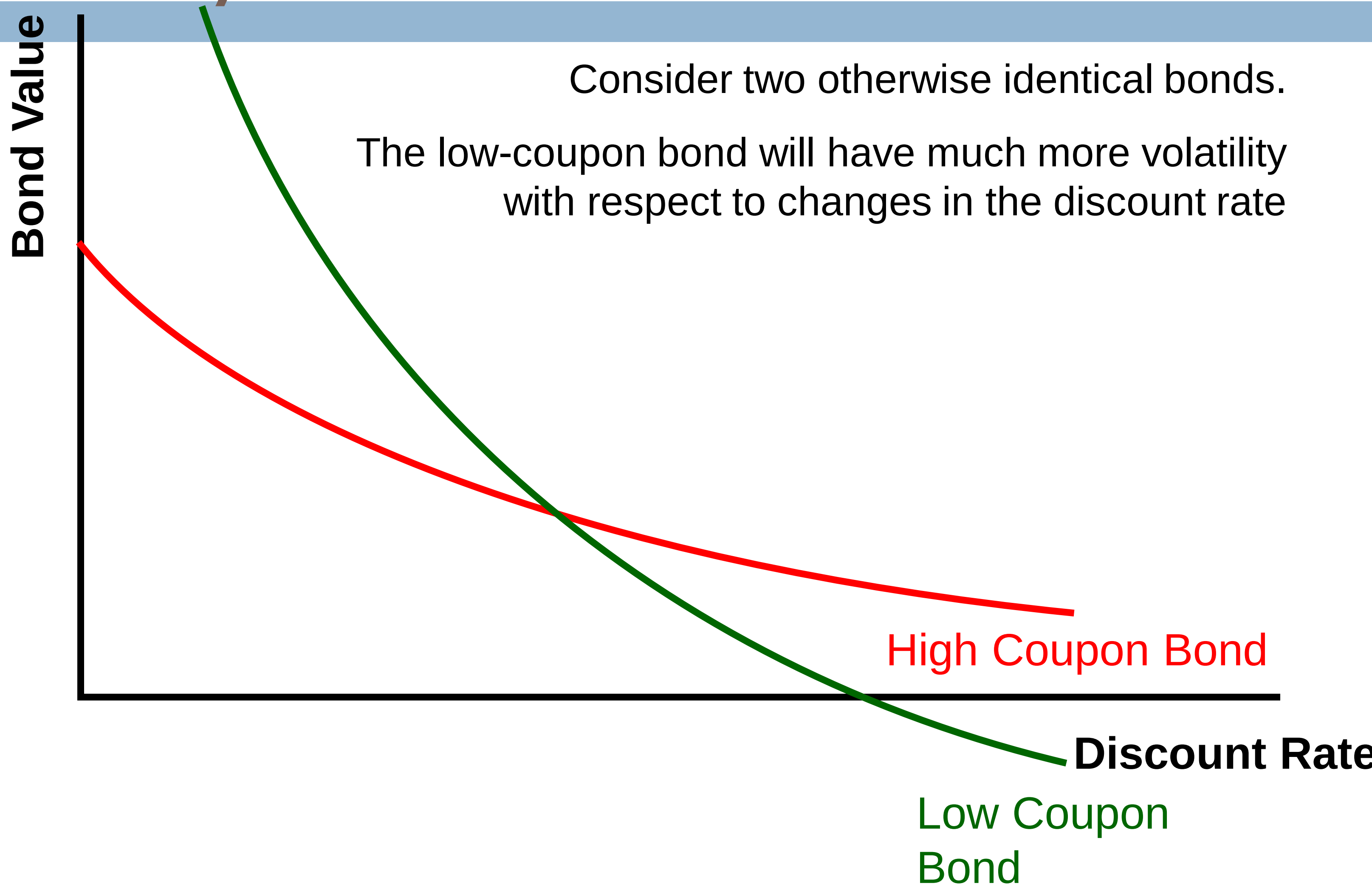
Maturity and Bond Price Volatility

Consider two otherwise identical bonds.

The long-maturity bond will have much more volatility with respect to changes in the discount rate



Coupon Rate and Bond Price Volatility



The Present Value of Common Stocks

- Dividends versus Capital Gains
- Valuation of Different Types of Stocks
  - Zero Growth
  - Constant Growth
  - Differential Growth

Case 1: Zero Growth

- Assume that dividends will remain at the same level forever

$$\text{Div}_1 = \text{Div}_2 = \text{Div}_3 = \cdots$$

- Since future cash flows are constant, the value of a zero growth stock is the present value of a perpetuity:

$$P_0 = \frac{\text{Div}_1}{(1+r)^1} + \frac{\text{Div}_2}{(1+r)^2} + \frac{\text{Div}_3}{(1+r)^3} + \cdots$$

$$P_0 = \frac{\text{Div}}{r}$$

Case 2: Constant Growth

Assume that dividends will grow at a constant rate, *g*, forever. *i.e.*

$$\text{Div}_1 = \text{Div}_0(1+g)$$

$$\text{Div}_2 = \text{Div}_1(1+g) = \text{Div}_0(1+g)^2$$

$$\text{Div}_3 = \text{Div}_2(1+g) = \text{Div}_0(1+g)^3$$

$$\vdots$$

Since future cash flows grow at a constant rate forever, the value of a constant growth stock is the present value of a growing perpetuity:

$$P_0 = \frac{\text{Div}_1}{r-g}$$

Case 3: Differential Growth

- Assume that dividends will grow at different rates in the foreseeable future and then will grow at a constant rate thereafter.
- To value a Differential Growth Stock, we need to:
  - Estimate future dividends in the foreseeable future.
  - Estimate the future stock price when the stock becomes a Constant Growth Stock (case 2).
  - Compute the total present value of the estimated future dividends and future stock price at the appropriate discount rate.

Case 3: Differential Growth

- Assume that dividends will grow at rate g_1 for N years and grow at rate g_2 thereafter

$$\text{Div}_1 = \text{Div}_0(1+g_1)$$

$$\text{Div}_2 = \text{Div}_1(1+g_1) = \text{Div}_0(1+g_1)^2$$

$$\vdots$$

$$\text{Div}_N = \text{Div}_{N-1}(1+g_1) = \text{Div}_0(1+g_1)^N$$

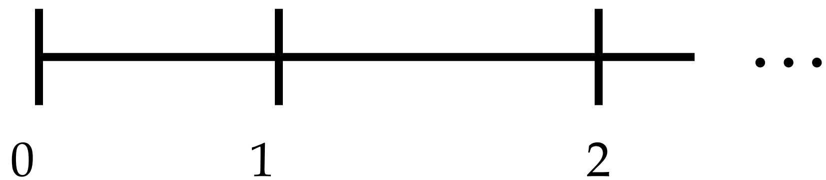
$$\text{Div}_{N+1} = \text{Div}_N(1+g_2) = \text{Div}_0(1+g_1)^N(1+g_2)$$

$$\vdots$$

Case 3: Differential Growth

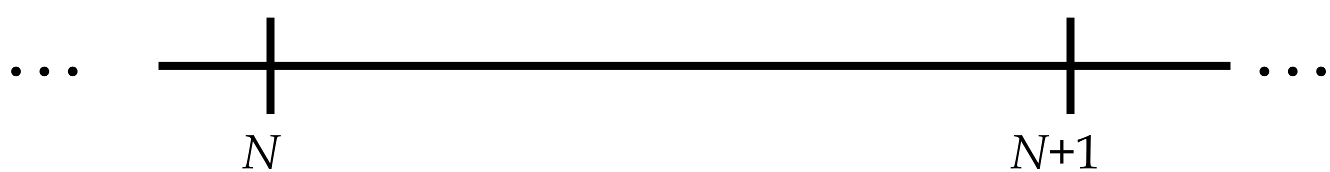
- Dividends will grow at rate g_1 for N years and grow at rate g_2 thereafter

$$\text{Div}_0(1+g_1) \qquad \text{Div}_0(1+g_1)^2$$



$$\text{Div}_0(1+g_1)^N$$

$$\text{Div}_N(1+g_2) = \text{Div}_0(1+g_1)^N(1+g_2)$$



Case 3: Differential Growth

We can value this as the sum of:

an N-year annuity growing at rate g_1

$$P_A = \frac{C}{r-g_1}\left[1-\frac{(1+g_1)^T}{(1+r)^T}\right]$$

plus the discounted value of a perpetuity growing at rate g_2 that starts in year N+1

$$P_B = \frac{\left(\frac{\mathrm{Div}_{\mathrm{N+1}}}{r-g_2}\right)}{(1+r)^N}$$

Case 3: Differential Growth

To value a Differential Growth Stock, we can use

$$P = \frac{C}{r - g_1}\left[1 - \frac{(1+g_1)^T}{(1+r)^T}\right] + \frac{\left(\frac{\text{Div}_{\text{N+1}}}{r - g_2}\right)}{(1+r)^N}$$

- Or we can cash flow it out.

A Differential Growth Example

A common stock just paid a dividend of $2. The dividend is expected to grow at 8% for 3 years, then it will grow at 4% in perpetuity.

What is the stock worth? The discount rate is 12%.

With the Formula

$$P = \frac{C}{r-g_1}\left[1-\frac{(1+g_1)^T}{(1+r)^T}\right]+\frac{\left(\frac{\mathrm{Div}_{N+1}}{r-g_2}\right)}{(1+r)^N}$$

$$P = \frac{\$2\times(1.08)}{.12-.08}\left[1-\frac{(1.08)^3}{(1.12)^3}\right]+\frac{\left(\frac{\$2(1.08)^3(1.04)}{.12-.04}\right)}{(1.12)^3}$$

$$P = \$54\times[1-.8966]+\frac{(\$32.75)}{(1.12)^3}$$

$$P = \$5.58+\$23.31 \qquad P = \$28.89$$

A Differential Growth Example (continued)

$\$2(1.08)$ $\quad$ $\$2(1.08)^2$ $\quad$ $\$2(1.08)^3$ $\quad$ $\$2(1.08)^3(1.04)$ $\quad \ldots$

0 $\quad$ 1 $\quad$ 2 $\quad$ 3 $\quad$ 4

$\$2.16$ $\quad$ $\$2.33$ $\quad$ $\$2.52 + \dfrac{\$2.62}{.08}$

0 $\quad$ 1 $\quad$ 2 $\quad$ 3

The constant growth phase beginning in year 4 can be valued as a growing perpetuity ***at time 3***.

$$P_3 = \frac{\$2.62}{.08} = \$32.75$$

$$P_0 = \frac{\$2.16}{1.12} + \frac{\$2.33}{(1.12)^2} + \frac{\$2.52 + \$32.75}{(1.12)^3} = \$28.89$$

Estimates of Parameters in the Dividend-Discount Model

- The value of a firm depends upon its growth rate, g, and its discount rate, r.
  - Where does g come from?
  - Where does r come from?

Where does *g* come from?

g = Retention ratio $\times$ Return on retained earnings

Where does *r* come from?

- The discount rate can be broken into two parts.
  - The dividend yield
  - The growth rate (in dividends)
- In practice, there is a great deal of estimation error involved in estimating *r*.

Growth Opportunities

- Growth opportunities are opportunities to invest in positive NPV projects.
- The value of a firm can be conceptualized as the sum of the value of a firm that pays out 100-percent of its earnings as dividends and the net present value of the growth opportunities.

$$P = \frac{EPS}{r} + NPVGO$$

The Dividend Growth Model and the NPVGO Model (Advanced)

- We have two ways to value a stock:
  - The dividend discount model.
  - The price of a share of stock can be calculated as the sum of its price as a cash cow plus the per-share value of its growth opportunities.

The Dividend Growth Model and the NPVGO Model

Consider a firm that has EPS of $5 at the end of the first year, a dividend-payout ratio of 30%, a discount rate of 16-percent, and a return on retained earnings of 20-percent.

- The dividend at year one will be $5 × .30 = $1.50 per share.
- The retention ratio is .70 (= 1 -.30) implying a growth rate in dividends of 14% = .70 × 20%

From the dividend growth model, the price of a share is:

$$P_0 = \frac{\text{Div}_1}{r-g} = \frac{\$1.50}{.16-.14} = \$75$$

The NPVGO Model

First, we must calculate the value of the firm as a cash cow.

$$P_0 = \frac{\text{Div}_1}{r} = \frac{\$5}{.16} = \$31.25$$

Second, we must calculate the value of the growth opportunities.

$$P_0 = \frac{\left[-3.50 + \frac{3.50 \times .20}{.16}\right]}{r-g} = \frac{\$.875}{.16-.14} = \$43.75$$

Finally, $P_0 = 31.25 + 43.75 = \$75$

5.8 Price Earnings Ratio

- Many analysts frequently relate earnings per share to price.
- The price earnings ratio is a.k.a. the *multiple*
  - Calculated as current stock price divided by annual EPS
  - *The Wall Street Journal* uses last 4 quarter's earnings

$$\text{P/E ratio} = \frac{\text{Price per share}}{EPS}$$

- Firms whose shares are "in fashion" sell at high multiples. *Growth stocks* for example.
- Firms whose shares are out of favor sell at low multiples. *Value stocks* for example.

Other Price Ratio Analysis

- Many analysts frequently relate earnings per share to variables other than price, e.g.:
  - Price/Cash Flow Ratio
    - cash flow = net income + depreciation = cash flow from operations or operating cash flow
  - Price/Sales
    - current stock price divided by annual sales per share
  - Price/Book (a.k.a. Market to Book Ratio)
    - price divided by book value of equity, which is measured as assets – liabilities

Stock Market Reporting

52	WEEKS				YLD		VOL				NET
HI	LO	STOCK	SYM	DIV	%	PE	100s	HI	LO	CLOSE	CHG
52.75	19.06	Gap Inc	GPS	0.09	0.5	15	65172	20.50	19	19.25	-1.75

Gap pays a dividend of 9 cents/share

Gap ended trading at $19.25, down $1.75 from yesterday's close

Gap has been as high as $52.75 in the last year.

Given the current price, the dividend yield is ½ %

Gap has been as low as $19.06 in the last year.

Given the current price, the PE ratio is 15 times earnings

6,517,200 shares traded hands in the last day's trading

Stock Market Reporting

52	WEEKS				YLD		VOL				NET
HI	LO	STOCK	SYM	DIV	%	PE	100s	HI	LO	CLOSE	CHG
52.75	19.06	Gap Inc	GPS	0.09	0.5	15	65172	20.50	19	19.25	-1.75

Gap Incorporated is having a tough year, trading near their 52-week low. Imagine how you would feel if within the past year you had paid $52.75 for a share of Gap and now had a share worth $19.25! That 9-cent dividend wouldn't go very far in making amends.

Yesterday, Gap had another rough day in a rough year. Gap "opened the day down" beginning trading at $20.50, which was down from the previous close of $21.00 = $19.25 + $1.75

Looks like cargo pants aren't the only things on sale at Gap.