Lesson 2.
How to Value Bonds and Stocks

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2. How to value bonds and stocks

1. Introduction

Focus: right hand side of the balance sheet of the firm: total value of the firm to investors:

- current liabilities
- long-term debt
- shareholder’s equity
2. How to value bonds and stocks

The firm determines its capital structure: how to split the value of the firm in financial markets ($V$)

$$ V = B + S $$

where

- $B$ is the value of the debt,

- $S$ is the value of the equity.
What is the difference between debt and equity?

Debt: a promise by the borrowing firm to repay a fixed dollar amount by a certain date.

Equity: the value of the firm at the end of the period once debtholders have been paid.

How the firm chooses its capital structure is very important.
2. How to value bonds and stocks

**First Principles:**
Value of financial securities $= \text{PV of expected future cash flows}$

To value bonds and stocks we need to:

- estimate future cash flows:
  - size (how much)
  - timing (when)

- discount future cash flows at an appropriate rate (rate appropriate to the risk presented by the security)
2. How to Value Bonds

A *bond* is a legally binding agreement between a borrower and a lender. A borrowing arrangement in which the borrower issues (sells) an IOU to the investor.

- Specifies the principal amount of the loan.

- Specifies the size and timing of the cash flows:
  - in $ terms: fixed-rate borrowing
  - as a formula: adjustable-rate borrowing.

The arrangement obligates the issuer to make specified payments to the bondholder on specified dates.
Some useful concepts:

- **maturity date**: the date when the issuer of the bond makes the last payment;

- **face value** ($F$): the payment made at maturity, also called the *principal*, *denomination* or *par value*;

- **coupons** ($C$): cash payments delivered by a bond made not only at maturity but also at regular times in between;

- **coupon rate**: is the coupon payment divided by the bond’s par value.

The *par value* of the bond is $1,000

Semi-annual *coupon payments*: Jun. 30 and Dec. 31, for this particular bond

Since the *coupon rule* is 6 3/8 → the payment is $31.875

Size and timing of cash flows on January 1, 2005

<table>
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<tr>
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</table>
Types of bonds:

- **Pure discount bonds**: a promise to make a single payment at a fixed future date (one-year discount bond; two-year discount bond,...).

Also called *zero-coupon bonds* (*zero, bullet, or discount bonds*): the holder receives no cash payments until maturity.

\[
\begin{array}{cccccc}
0 & 0 & 0 & \ldots & F \\
0 & 1 & 2 & \ldots & T
\end{array}
\]

Present Value of a Pure Discount Bond

\[
PV = \frac{F}{(1 + r)^T}
\]
2. How to value bonds and stocks

- **Level-coupon bonds**: bonds that pay the same coupon \( C \) every six months throughout the life of the bond. Also called simply *coupon bonds*.

\[
\begin{array}{cccccc}
0 & C & C & ... & C + F \\
\hline
0 & 1 & 2 & ... & T
\end{array}
\]

**Present Value of a Level-Coupon Bond**

\[
PV = \frac{C}{1 + r} + \frac{C}{(1 + r)^2} + \ldots + \frac{C}{(1 + r)^T} + \frac{F}{(1 + r)^T}
\]

or

\[
PV = \frac{C}{r} \left[ 1 - \frac{1}{(1 + r)^T} \right] + \frac{F}{(1 + r)^T}
\]
• **Consols:** bonds that never stop paying a coupon, have no final maturity date, and therefore never mature.

\[
\begin{array}{cccc}
  0 & C & C & \ldots & C \\
  \downarrow \quad \downarrow \quad \downarrow \quad \ldots \quad \downarrow \\
  0 & 1 & 2 & \ldots & \infty
\end{array}
\]

Present Value of a Consol

\[
PV = \frac{C}{1 + r} + \frac{C}{(1 + r)^2} + \ldots = \frac{C}{r}
\]

\(\text{Perpetuity}\)
3. **Bond concepts**

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

   \[
   \begin{align*}
   &\text{When coupon rate } = \text{YTM, price } = \text{par value} \\
   &\text{When coupon rate } > \text{YTM, price } > \text{par value (premium bond)} \\
   &\text{When coupon rate } < \text{YTM, price } < \text{par value (discount bond)}
   \end{align*}
   \]

2. 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.

3. A lower coupon bond has a higher relative price change than a higher coupon bond when YTM changes. All other features are identical.
3.1 Bond prices and market interest rates move in opposite directions

Example: The interest rate is 10%. A two-year bond with a 10% coupon pays interest of $100. For simplicity, we assume that the interest is paid annually. The bond is priced at its face value of $1,000

\[
1,000 = \frac{100}{1.10} + \frac{1,000 + 100}{(1.10)^2}
\]

If the interest rate unexpectedly rises to 12%, the bond sells at

\[
996.20 = \frac{100}{1.12} + \frac{1,000 + 100}{(1.12)^2}
\]

Because $996.20 < $1,000, the bond is said to sell at a discount.
If interest rates fell to 8\%, the bond would sell at

\[
$1,035.67 = \frac{$100}{1.08} + \frac{$1,000 + $100}{(1.08)^2}
\]

Because $1,035.67 \geq $1,000, the bond is said to sell at a *premium*. 

3.2 Yield to Maturity and Bond Value

The yield to maturity is a measure of the average rate of return that will be earned on a bond if it is bought now and held until maturity. Also called the bond’s yield to maturity.

Example: Suppose that the 8% 30-year coupon bond were selling at $1,276.76. What rate of return would be earned by an investor purchasing the bond at market price? To answer this question, we solve for $r$ in the following equation:

$$
$1,276.76 = \sum_{t=1}^{60} \frac{$40}{(1 + r)^t} + \frac{$1,000}{(1 + r)^{60}}.
$$

If we solve it for $r$ we obtain $r = 0.03$, or 3% per half year.
The bond’s yield to maturity quoted in the financial press will be at an APR of 6%, despite the \( EAR \) will be

\[
\left(1 + \frac{0.06}{2}\right)^2 - 1 = 0.0609 = 6.09\%
\]
2. How to value bonds and stocks

YTM and Bond Value

if $YTM < coupon$ → bond trades at premium
if $YTM = coupon$ → bond trades at par
if $YTM > coupon$ → bond trades at discount

In our example:
3.3 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, and hence a higher relative price.
3.4 Coupon Rate and Bond Price Volatility
Consider again two otherwise identical bonds.

The low-coupon bond will have much more volatility with respect to changes in the discount rate.
4. The Present Value of Common Stocks

4.1 Dividends versus Capital Gains  A stock provides two kinds of cash flows:

1. most stocks pay dividends on a regular basis, 

2. stockholder receives the sale price when she sells the stock.

The value of a firm’s common stock to the investor is equal to the present value of all of the expected future dividends, that is, 

\[ P_0 = \frac{Div_1}{1 + r} + \frac{Div_2}{(1 + r)^2} + \frac{Div_3}{(1 + r)^3} + \ldots = \sum_{t=1}^{\infty} \frac{Div_t}{(1 + r)^t} \]
4.2 Valuation of different types of stocks

Case 1: Zero growth. Assume that dividends will remain at the same level forever

\[ Div_1 = Div_2 = Div_3 = \ldots \]

then, the value of a zero growth stock is the present value of a perpetuity

\[
P_0 = \frac{Div_1}{1 + r} + \frac{Div_2}{(1 + r)^2} + \frac{Div_3}{(1 + r)^3} + \ldots =
\]

\[
P_0 = \frac{Div}{r}
\]
Case 2: Constant growth. Assume that dividends will grow at a constant rate, $g$, forever

$$Div_1 = Div_0(1 + g)$$

$$Div_2 = Div_1(1 + g) = Div_0(1 + g)^2$$

... 

i.e. the value of a constant growth stock is the present value of a growing perpetuity

$$P_0 = \frac{Div_1}{1 + r} + \frac{Div_2}{(1 + r)^2} + \frac{Div_3}{(1 + r)^3} + ... = \frac{Div_1}{1 + r} + \frac{Div_1(1 + g)}{(1 + r)^2} + \frac{Div_1(1 + g)^2}{(1 + r)^3} + ... =$$

$$P_0 = \frac{Div_1}{r - g}$$
Case 3: Differential growth.

Example:

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

What is the stock worth? The discount rate is 12%
The cash flow is

\[ P_0 = \frac{\$2(1.08)}{1.12} + \frac{\$2(1.08)^2}{(1.12)^2} + \frac{\$2(1.08)^3}{(1.12)^3} + \frac{\$2(1.08)^3(1.04)}{(1.12)^4} + \frac{\$2(1.08)^3(1.04)^2}{(1.12)^5} + \ldots \]
2. How to value bonds and stocks

\[ P_0 = \frac{\$2(1.08)}{1.12} \left[ 1 + \frac{1.08}{1.12} + \frac{(1.08)^2}{(1.12)^2} \right] + \frac{\$2(1.08)^3(1.04)}{(1.12)^4} \left[ 1 + \frac{1.04}{1.12} + \left( \frac{1.04}{1.12} \right)^2 + \ldots \right] \]

\[ P_0 = \frac{\$2(1.08)}{1.12} \left[ \frac{1.12}{0.04} - \left( \frac{1.08}{1.12} \right)^3 \frac{1.12}{0.04} \right] + \frac{\$2(1.08)^3(1.04)}{(1.12)^4} \left[ \frac{1.12}{0.08} \right] \]

\[ P_0 = \frac{\$2(1.08)}{0.04} \left[ 1 - \left( \frac{1.08}{1.12} \right)^3 \right] + \frac{\$2(1.08)^3(1.04)}{(1.12)^3} \left[ \frac{1}{0.08} \right] = \$28.89 \]
5. Estimates of the 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?

$$g = \text{Retention ratio} \times \text{ROE}$$

where ROE is return on equity.
Where does $r$ come from? The discount rate can be broken into:

1. the dividend yield

2. the growth rate (in dividends)

$$r = \left(\frac{Div}{P_0}\right) + g$$

where $Div$ is the dividend and $P_0$ is the initial price.
6. Growth opportunities

*Cash cow* company: a company that pays all of its earnings out to stockholders as dividends in perpetuity, that is,

\[ EPS = Div \]

where \( EPS \): earnings per share.

**Value of a share of stock when firm acts as a cash cow**

\[ \frac{EPS}{r} = \frac{Div}{r} \]

where \( r \) is the discount rate on the firm’s stock.
Paying out all earnings as dividends may not be optimal if there are 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% of its earnings as dividends and the net present value of the growth opportunities.

**Stock price after a firm commits to new project**

\[ P = \frac{EPS}{r} + NPVGO \]

where \( NPVGO \) stands for *net present value (per share) of the growth opportunity*. 
2. How to value bonds and stocks

**Conditions required to increase value**

1. Earnings must be retained so that projects can be funded.

2. The projects must have positive net present value.
7. The dividend-growth model and the NPVGO 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.

\[ P = \frac{EPS}{r} + NPVGO \]

Exercise:

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%, and a return on retained earnings of 20%. What is the price of a share for this firm?
8. Price earnings ratio (PER)

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

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

Firms whose shares are “in fashion” sell at high multiples. (Example: growth stocks)

Firms whose shares are out of favor sell at low multiples. (Example: value stocks)
The P/E ratio is a function of three factors:

1. Growth opportunities of the firm

2. Risk of the firm

3. Accountability manner.
### NEW YORK BONDS
#### Corporation Bonds

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