Overview of Lecture 8

- Stock Pricing
  - Present Value of Growth Opportunities (PVGO)
  - PE ratios and what they tell us

- Alternative Measures of Value

*(Lecture 6 in Reader book & Chpt. 5 in B&M textbook)*
Consider this base case for XYZ firm:
- \( \text{EPS}_1 = 10 \) and \( \text{DIV}_1 = 10 \), so plowback = 0, \( g = 0 \).
- If \( r = 0.10 \), then \( P_0 = 10 / 0.10 = 100 \)

In addition, suppose XYZ invests $2 in year 1 on a project that returns 10% per year forever.
- After year 1, it pays everything out as a dividends.
- Cash flow result:
  - \( \text{EPS}_1 = 10 \), \( \text{DIV}_1 = 8 \)
  - \( \text{EPS}_2 = 10.2 \), \( \text{DIV}_2 = 10.2 \)
  - \( \text{EPS}_3 = 10.2 \), \( \text{DIV}_3 = 10.2 \)
PVGO: Example 1 Continued

\[ P_0 = \frac{10 - 2}{1.1} + \frac{10 + .2}{(1.1)^2} + \frac{10 + .2}{(1.1)^3} + ... = \]

\[ = \left( \frac{10}{1.1} + \frac{10}{1.1^2} + \frac{10}{1.1^3} + ... \right) + \left( \frac{-2}{1.1} + \frac{.2}{1.1^2} + \frac{.2}{1.1^3} + ... \right) \]

PV of No Growth Component = $100

NPV of Growth Component = \(-\frac{2}{1.1} + \frac{.2}{1.1^2} + \frac{.2}{1.1^3} + ... = \)

PVGO: Present Value of Growth Opportunities

■ The investment did not alter the firm’s value. Why?
■ Because the NPV of the new investment is zero.
Consider this alternative for XYZ:

- XYZ invests $2 in year 1 in a project that returns 20% per year forever.
- After year 1 all earnings are paid as dividends.

Thus

- $\text{EPS}_1 = 10 \quad \text{DIV}_1 = 8$
- $\text{EPS}_2 = 10.4 \quad \text{DIV}_2 = 10.4$
- $\text{EPS}_3 = 10.4 \quad \text{DIV}_3 = 10.4$
PVGO: Example 2 Continued

\[ P_0 = \frac{10 - 2}{1.1} + \frac{10 + .4}{(1.1)^2} + \frac{10 + .4}{(1.1)^3} + ... = \]
\[ = \left( \frac{10}{1.1} + \frac{10}{(1.1)^2} + \frac{10}{(1.1)^3} + ... \right) + \left( \frac{-2}{1.1} + \frac{.4}{(1.1)^2} + \frac{.4}{(1.1)^3} + ... \right) \]

PV of No Growth Component = $100

NPV of Growth Component = \(-2/1.1 + .4/.1(1.1) = $1.818\)

Since the new investment ROE (20%) > r, the new project has NPV > 0.
PVGO: Summary

- A firm’s stock price can always be represented as the sum of two components:
  - PV of the no growth component of the firm +
  - PV of the growth opportunities (PVGO)

- This formulation is very general. It holds when the interest rate, growth rates and other factors vary over time.
The PV of the no growth component is:

$$P_0 = \frac{\text{EPS}}{r}.$$  

This assumes the firm does not invest (DIV = EPS) and therefore it does not grow.

The price of the firm can thus be written as:

$$P_0 = \frac{\text{EPS}}{r} + \text{PVGO}$$

Solving for the earnings-price ratio produces:

$$\frac{\text{EPS}}{P_0} = r \left[ 1 - \frac{\text{PVGO}}{P_0} \right].$$
If \( PVGO = 0 \) the earnings-price ratio equals \( r \). The earnings-price ratio then measures the capitalization rate.

Generally, the earnings-price ratio will be lower than \( r \).
Valuing a Business

- Value of firm’s equity = PV of firm’s dividends.
- Dividend = Cash left after investment
- But,
  - **Free Cash Flow** = Operating cash flow - Investment

- So we can equivalently value a firm by calculating the present value of its Free Cash Flows.
  - This makes valuing a firm the same as valuing a project
The correct criterion for evaluating projects is NPV.
   - When NPV > 0, take the project.
   - When choosing among projects, start with highest NPV.

In this section, we consider some alternative methods:
   - Some alternatives have benefit of simple computations.

Any method producing results that differ from NPV is WRONG. Use such methods with great care.
Internal Rate of Return (IRR): Definition

- IRR is the most popular alternative method, since it is intuitive and usually gives the right result.
- A project’s IRR is defined as the interest rate that sets the NPV of cash flows equal to zero. Given \( C_0, C_1, \ldots, C_t \) the IRR is the \( r \) solving the equation:

\[
0 = C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots
\]
Internal Rate of Return (IRR): Example

Suppose: $C_0 = -100$, $C_1 = 50$, $C_2 = 55$, $C_3 = 10$

$$0 = -100 + \frac{50}{1+r} + \frac{55}{(1+r)^2} + \frac{10}{(1+r)^3}.$$ 

HP–12C and Excel give answer $r = 8.92\%$.

- The programs search for the $r$ that makes $NPV = 0$.

IRR decisions: Adopt projects if $IRR > \text{hurdle rate}$, where hurdle rate equals the cost of capital for that project.
### NPV vs. IRR

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Investment Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking discount rate as given (r), calculate NPV</td>
<td>Accept project if NPV &gt; hurdle (zero)</td>
</tr>
<tr>
<td>Taking NPV as given (zero), calculate IRR.</td>
<td>Accept project if IRR &gt; hurdle (r)</td>
</tr>
</tbody>
</table>

- Most of the time, these rules are equivalent
- But not always…

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Projects A and B (from BM p. 101) each have an IRR of 50%. Are they equally desirable (at r = 10%)?

<table>
<thead>
<tr>
<th>Date</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1000</td>
<td>1000</td>
</tr>
<tr>
<td>1</td>
<td>1500</td>
<td>-1500</td>
</tr>
<tr>
<td>IRR</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

The NPV of A (r = 10%) is + $364; NPV of B is -$364

In A, we are lending money at 50% (a good thing).
In B, we are borrowing money at 50% (not so good….)
**IRR Pitfall 2: Multiple IRR Values**

- Example: $C_0 = -100$, $C_1 = 360$, $C_2 = -431$, $C_3 = 171.6$.

  Solve for $r$:

  
  \[
  0 = -100 + \frac{360}{(1+r)} - \frac{431}{(1+r)^2} + \frac{171.6}{(1+r)^3}
  \]

<table>
<thead>
<tr>
<th>Date</th>
<th>Computing Multiple IRRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-100        -100        -100        -100</td>
</tr>
<tr>
<td>1</td>
<td>360         360         360         360</td>
</tr>
<tr>
<td>2</td>
<td>-431        -431        -431        -431</td>
</tr>
<tr>
<td>3</td>
<td>171.6       171.6       171.6       171.6</td>
</tr>
</tbody>
</table>

Resulting IRR: 10.00% 20.00% 30.00% 30.00%

NPV: 0.0000 0.0000 0.0000 0.0000

With **multiple IRRs**, you don’t know which one to use!
Example: for simplicity, assume the discount rate is zero.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>( C_0 )</th>
<th>( C_1 )</th>
<th>IRR</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(-1)</td>
<td>2</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>(-100)</td>
<td>110</td>
<td>10%</td>
<td>10</td>
</tr>
</tbody>
</table>

Should you select project A or B?
You should select B, but A has a higher IRR.

The problem is that IRR does not adjust for a project’s scale.

What are some reasons that projects might be mutually exclusive?
The IRR rule: accept project if IRR > hurdle rate.

Example: Suppose 3-year IRR = 10.0%. Hurdle rates are: 
\[ r_1 = 7\%; \ r_2 = 10\%; \ r_3 = 13\%? \]
What to do?

The right answer is far from obvious. You must compute a complex weighted average (depending on the \( C_i \)) of the spot rates to compute the correct summary hurdle rate.

A much simpler solution is just to compute the NPV!!
IRR Pitfall 5: No Real Solution Exists

With problem 1 we had too many solutions. Now we consider a case where no real solution exists.

Example: \( C_0 = 4, C_1 = -8, C_2 = 104 \)

\[
0 = 4 + \frac{-8}{(1+r)} + \frac{104}{(1+r)^2}
\]

What r’s solve this equation? \( r = (-25)^{.5} = \pm 5i \).

This is an imaginary interest rate! Excel says #NUM!

<table>
<thead>
<tr>
<th>Date</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>-8</td>
</tr>
<tr>
<td>3</td>
<td>104</td>
</tr>
<tr>
<td>IRR</td>
<td>#NUM!</td>
</tr>
</tbody>
</table>
Why use IRR at all?

- Lots of other people use it.
- It works (it exists, is unique, and gives right decision) as long as:
  » One discount rate for all periods
  » One negative cash flow in period 0 followed by positive cash flows.
  » We are only looking at one investment
- It provides an intuitive measure of a project’s rate of return.

However, given a choice, you should always use NPV
Another Alternative to NPV: Payback Period

- Some firms require investment “payback period”.
  - In the BM (p. 96) example, Project A maximizes NPV, but fails to meet a payback rule of 2 years.

<table>
<thead>
<tr>
<th>Date</th>
<th>Project A</th>
<th>Project B</th>
<th>Project C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2000</td>
<td>-2000</td>
<td>-2000</td>
</tr>
<tr>
<td>1</td>
<td>500</td>
<td>500</td>
<td>1800</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>1800</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>5000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Payback</td>
<td>3 years</td>
<td>2 years</td>
</tr>
<tr>
<td></td>
<td>NPV (10%)</td>
<td>$2,624</td>
<td>($58)</td>
</tr>
</tbody>
</table>
So far, firm accepts all projects with NPV > 0. But what if the firm faces **capital rationing**. In this example (BM p. 109), capital = $10 million

<table>
<thead>
<tr>
<th>Date</th>
<th>Cash Flows $ Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project A</td>
</tr>
<tr>
<td>0</td>
<td>-10</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>NPV (10%)</td>
<td>$21</td>
</tr>
</tbody>
</table>

- In this case, best solution is Project B + Project C.
- More generally, programming solution (see BM 108-113.)
Overall Summary

- Given a choice, you should always use NPV.
- When you are asked or required not to use NPV, be sure to understand and adjust for built-in biases of technique being used.