Notes for Thursday, January 29, 2004

Announcements

By today you should have finished reading Chapter 4.
- Read Chapter 5 for Tuesday.
- Answer Study Questions 5.5 and 5.8.
You should have determined who will be in your group by this week.

Steps in Financial Analysis

Alternative Financial Criteria for Project Evaluation

Net Present Value (NPV)

\[ NPV = \sum_{t=0}^{T} \frac{Revenue_t - Cost_t}{(1 + i)^t} \]

Benefit/Cost Ratio (B/C)

\[ B / C = \frac{\sum_{t=0}^{T} Revenue_t}{\sum_{t=0}^{T} Cost_t} / \left( \frac{\sum_{t=0}^{T} Cost_t}{\sum_{t=0}^{T} (1 + i)^t} \right) \]

Internal Rate of Return (IRR)
- the discount rate for which the NPV of a project is 0.

Example
Steps in Financial Analysis

1. Identify exactly what the question is.
2. Establish the scope of the financial analysis problem.
3. Identify the schedule of events associated with the project.
4. Quantify and value events wherever possible.
5. Select an alternate rate of return and calculate the project’s net present value.

Alternative Financial Criteria for Project Evaluation

- Net Present Value (NPV)
- Benefit/Cost Ratio (B/C)
- Internal Rate of Return (IRR)
Alternative Financial Criteria for Project Evaluation

Net Present Value (NPV)

- The NPV is the sum of all of the discounted net benefits (benefits minus costs) associated with a project.

\[
NPV = \sum_{t=0}^{T} \frac{Revenue_t - Cost_t}{(1 + i)^t}
\]

- The criterion for project acceptability is NPV > 0.
  - All projects with NPV > 0 should be pursued.

- The NPV is the most widely accepted criterion for selecting between projects.

- The NPV of one project might be larger than the NPV for another project simply because it is bigger.
Alternative Financial Criteria for Project Evaluation

Benefit/Cost Ratio (B/C)

The B/C is the ratio of the discounted benefits over the discounted costs. It measures the relative size of the benefits to the costs of a project.

\[
B / C = \frac{\sum_{t=0}^{T} \frac{Revenue_t}{(1 + i)^t}}{\sum_{t=0}^{T} \frac{Cost_t}{(1 + i)^t}}
\]

The criterion for project acceptability is B/C > 1
- All projects with B/C > 1 should be pursued.
- If B/C > 1 then NPV > 0.

The B/C takes into account the size of the investment.
Alternative Financial Criteria for Project Evaluation

Internal Rate of Return (IRR)

- The IRR is the discount rate for which the NPV of a project is 0.
  \[ \text{IRR} = r \text{ such that } NPV(r) = 0 \]

- The IRR attempts to measure the inherent profitability of an investment.

- The criterion for project acceptability is that IRR > ARR.

- If the IRR > ARR, then NPV > 0.

- To calculate the IRR, you have to iteratively try different interest rates until NPV = 0.

- Generally not the best way to compare investment options.
  - The IRR assumes that all of the profit from an investment should be counted as a return to capital.
  - The IRR assumes that funds for intermediate costs can be borrowed at the IRR, and intermediate returns can be reinvested at the IRR.
  - It is possible to get more than one IRR for an investment (but not likely...)
**Example: NPV, IRR and B/C Ratio**

Consider two alternative investments. Option 1 is an example of low intensity forest management. With Option 1 you make a minimal investment of $50 per acre to establish the stand. At the end of each year, for 30 years, you will incur an annual management expense of $25 per acre with Option 1. At the end of 30 years, you expect to receive $4,000 per acre in stumpage fees. Option 2 is a more intensive management option. With Option 2, your initial stand establishment investment is $400 per acre, and your annual management expenses are projected to be $50 per acre. With Option 2, however, you expect to receive considerably more in stumpage fees: $8,000 per acre. Table 4.1 summarizes the cash flows for the two options.

**Table 4.1.** Cash flow summary for alternative investments.

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial investment</td>
<td>0</td>
<td>$50</td>
<td>$400</td>
</tr>
<tr>
<td>Annual mgmt. expense</td>
<td>All</td>
<td>$25</td>
<td>$50</td>
</tr>
<tr>
<td>Final expected return</td>
<td>30</td>
<td>$4,000</td>
<td>$8,000</td>
</tr>
</tbody>
</table>

**Net Present Value Calculation**
Calculate the NPV for these two investments using four interest rates: 4%, 6%, 8%, and 10%.

**Answer:** The general formula for the net present value in this example is:

\[
NPV = -E + \frac{-R[(1+i)^{30} - 1]}{i(1+i)^{30}} + \frac{V_{30}}{(1+i)^{30}}
\]

where \( E = \) the initial (establishment) investment, \( R = \) the annual management expense, and \( V_{30} = \) the final expected revenue in year 30.
Figure 4.1. Net present value of alternative investments at several interest rates.

Table 4.2. NPVs for alternative investments under several discount rates.

<table>
<thead>
<tr>
<th>Interest Rate</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>$750.97</td>
<td>$1,201.95</td>
</tr>
<tr>
<td>6%</td>
<td>$302.32</td>
<td>$304.64</td>
</tr>
<tr>
<td>8%</td>
<td>$66.06</td>
<td>-$167.87</td>
</tr>
<tr>
<td>10%</td>
<td>-$56.44</td>
<td>-$412.88</td>
</tr>
</tbody>
</table>

**Benefit/Cost Ratio Calculation**
Calculate the B/C ratio these two investments using four interest rates: 4%, 6%, 8%, and 10%.

**Answer:** The general formula for the benefit-cost ratio in this example is:

\[
B / C = \frac{V_{30}}{(1+i)^{30}} / E + \frac{R[(1+i)^{30} - 1]}{i(1+i)^{30}}
\]

where 
- \(E\) = the initial (establishment) investment,
- \(R\) = the annual management expense,
- and
- \(V_{30}\) = the final expected revenue in year 30.
Figure 4.2. Benefit-cost ratios of alternative investments at several interest rates.

Table 4.3. B/Cs for alternative investments under several discount rates.

<table>
<thead>
<tr>
<th>Interest Rate</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>4%</td>
<td>2.557</td>
<td>1.950</td>
</tr>
<tr>
<td>6%</td>
<td>1.767</td>
<td>1.280</td>
</tr>
<tr>
<td>8%</td>
<td>1.199</td>
<td>0.826</td>
</tr>
<tr>
<td>10%</td>
<td>0.802</td>
<td>0.526</td>
</tr>
</tbody>
</table>
**Internal Rate of Return Calculation**

Estimate the internal rate of return for the two investments to the nearest hundredth of a percent.

L Recall that the IRR is the interest rate at which the net present value of the investment equals zero.

L Looking at Figure 4.1, it is pretty clear that the IRR of Option 1 is about 9% and the IRR of Option 2 is about 7.5%.

L Use Excel’s Goal Seek function, which allows you to use the computer to find the value of a variable that results in a function taking on some target value:

<table>
<thead>
<tr>
<th>Table 4.4. IRRs for alternative investments.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
</tr>
<tr>
<td>IRR</td>
</tr>
</tbody>
</table>
Some Observations About the Example

L Option 1 has a higher B/C ratio at all of the interest rates considered.

L Option 1 has a higher IRR.

L If one’s ARR is greater than 6%, Option 1 has a higher NPV.

L However, if one’s ARR is less than or equal to 6%, then Option 2 is the better investment.

• This is because the NPV of Option 2 is higher than the NPV of Option 1 when the interest rate is less than or equal to 6%.