Lesson 4: Net Present Value (NPV)

The Bottom Line
Learning Objectives

1. Understand the concept of net present value (NPV)
   A. What it is
   B. What it means
   C. Why it is important
2. Understand the importance of a common time horizon
3. Understand the concept of internal rate of return (IRR) and its relationship to NPV
Comparing Economic Performance

• Suppose we are trying to choose between two forestry rotations that each would require a $500/ac cost today for site preparation and planting
  – Rotation A would yield $1,000/ac at year 20 and $2,000/ac at year 40
  – Rotation B would yield $4,000/ac at year 40

• Which rotation performs better economically? Should we invest in either??

• We cannot simply add the yields and subtract the costs, because they occur at different times
  – Rotation A: $1,000 + $2,000 - $500 = $2,500
  – Rotation B: $4,000 - $500 = $3,500
Apples to Apples

• In order to make an “apples to apples” comparison, we need to have a common time reference
• We can do this by finding the present value of each cash flow
• When we add up these discounted cash flows we arrive at the Net Present Value (NPV)
• The higher the NPV, the better the economic return
Finding the NPV of our example rotations

- **Rotation A:**
  - 0: Plant, -$500
  - 20: Harvest, $1,000
  - 40: Harvest, $2,000

- **Rotation B:**
  - 0: Plant, -$500
  - 40: Harvest, $4,000
NPV of our example rotations @ 5% interest

• NPV of Rotation A:

\[
NPV_A = -500 + \frac{1,000}{(1+.05)^{20}} + \frac{2,000}{(1+.05)^{40}}
\]

\[
= -500 + 377 + 284
\]

\[
= 161 \quad \text{Higher NPV}
\]

• NPV of Rotation B:

\[
NPV_B = -500 + \frac{4,000}{(1+.05)^{40}}
\]

\[
= -500 + 568
\]

\[
= 68
\]

Try it using the Economagic Calculator
Interpreting NPV

• Positive NPV
  – Present value of revenues > Present value of costs
  – Future revenues exceed costs plus interest

• Negative NPV
  – Present value of revenues < Present value of costs
  – Future revenues do not cover costs plus interest
    • High costs (relative to revenues)
    • High interest rate
Example

Suppose you are considering pruning your stand at a cost of $150/ac. You expect this to increase your stumpage value by $500/acc when you harvest in 20 years. Is this a good investment given a 5% interest rate?

\[
NPV = -150 + \frac{500}{(1+.05)^{20}}
\]

\[
= -150 + 188
\]

\[
= 38
\]

\[\rightarrow NPV \text{ is } > 0, \text{ so it is a good investment}\]
Example

• Suppose you are considering growing a rotation of Douglas-fir.
  – Cost of $300/ac for site preparation and planting in year 0
  – Cost of $100/ac for *precommercial thin (PCT)* in year 15
  – $1,500/ac *commercial thin (CT)* revenue in year 35
  – $10,000/ac revenue in year 50 for final harvest
• What is the NPV of this project at:
  – 5%?
  – 10%?
NPV at different interest rates

<table>
<thead>
<tr>
<th>0</th>
<th>15</th>
<th>35</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td>PCT</td>
<td>CT</td>
<td>H</td>
</tr>
<tr>
<td>-$300</td>
<td>-$100</td>
<td>$1,500</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

- **NPV @ 5%:**

\[
-300 - \frac{100}{(1.05)^{15}} + \frac{1,500}{(1.05)^{35}} + \frac{10,000}{(1.05)^{50}}
\]

\[= -300 - 48 + 272 + 872\]

\[= 796\]

- **NPV @ 10%:**

\[
-300 - \frac{100}{(1.10)^{15}} + \frac{1,500}{(1.10)^{35}} + \frac{10,000}{(1.10)^{50}}
\]

\[= -300 - 24 + 53 + 85\]

\[= -186\]

Try it with the Economagic Calculator
Appropriate rate of return

- *The interest rate makes a huge difference!*
- What should we use for \( i \) when evaluating NPV?
- The interest rate should reflect:
  - An individual’s time preference
  - *Cost of capital* (if borrowing the money to cover expenses)
  - *Alternative rate of return*—what you could get if investing money elsewhere (opportunity cost)
Mixing Series and Single Sums (the real world)

• Often a project will include cash flow series and individual cash flows. NPV calculations can include both of these.

• Example: suppose you want to grow a rotation of Douglas-fir.
  – Cost of $300/ac for planting and site prep in year 0
  – Cost of $100/ac in year 15 for PCT
  – $1,500/ac CT revenue in year 35
  – $10,000/ac revenue in year 50 for final harvest
  – $20/ac/year annual administrative costs
NPV @ 5% Interest

<table>
<thead>
<tr>
<th>Year</th>
<th>Plant</th>
<th>PCT</th>
<th>CT</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>-$100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>$1,500</td>
<td>$10,000</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
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</tr>
</tbody>
</table>

-$20 each year

Present values of single sums

$\frac{-300}{(1+.05)^{15}} + \frac{-100}{(1+.05)^{35}} + \frac{1,500}{(1+.05)^{35}} + \frac{10,000}{(1+.05)^{50}} - 20 \left[ \frac{(1+.05)^{50} - 1}{.05(1+.05)^{50}} \right]

\[= -300 - 48 + 272 + 872 - 365 \]

\[= 431 \]

Try it with the *Economagic Calculator*
NPV and unequal time horizons

- Suppose you are trying to choose between using an acre of land to grow different species at an interest rate of 5%:
  - Grow Douglas-fir
    - $250/ac planting and site prep
    - $100/ac PCT in year 15
    - $3,000/ac CT revenue in year 40
    - $18,000/ac final harvest revenue in year 60
  - Grow red alder
    - $250/ac planting and site prep
    - $5,000/ac final harvest revenue in year 30
Timeline

- Plant: -$250
- PCT: -$100
- CT: $3,000
- H: $18,000

- Plant: -$250
- H: $5,000
Compare the NPVs

• Douglas-fir:

\[ NPV = -250 - \frac{100}{(1.05)^{15}} + \frac{3,000}{(1.05)^{40}} + \frac{18,000}{(1.05)^{60}} \]

\[ = $1,092 \]

• Red alder:

\[ NPV = -250 + \frac{5,000}{(1.05)^{30}} \]

\[ = $907 \]

• So is Douglas-fir really the best option?
But wait—We could grow two rotations of red alder in the time it takes to grow one Douglas-fir rotation.
Now which is the best option?

- **Douglas-fir:**
  \[
  NPV = -250 - \frac{100}{(1.05)^{15}} + \frac{3,000}{(1.05)^{40}} + \frac{18,000}{(1.05)^{60}}
  \]
  \[
  = $1,092
  \]

- **Red alder:**
  \[
  NPV = -250 + \frac{5,000}{(1.05)^{30}} - \frac{250}{(1.05)^{30}} + \frac{5,000}{(1.05)^{60}}
  \]
  \[
  = $1,117
  \]
Internal Rate of Return

• The *Internal Rate of Return (IRR)* is the interest rate \(i\) that makes the NPV = zero
• This is another approach to comparing investments that is not dependent on a particular interest rate
Finding IRR

• “Guess & Check”
• Example: Find the IRR of the following rotation.
  – Cost of $350/ac for planting and site prep in year 0
  – Cost of $100/ac in year 15 for PCT
  – $14,273/ac revenue in year 50 for final harvest
1st Attempt: 7%

\[ NPV = -350 - \frac{100}{(1.07)^{15}} + \frac{14,273}{(1.07)^{50}} \]

\[ = -350 - 36 + 484 \]

\[ = 98 \]

→ If NPV is positive, try a higher \( i \)
2nd Attempt: 8%

\[
NPV = -350 - \frac{100}{(1.08)^{15}} + \frac{14,273}{(1.08)^{50}}
\]

\[
= -350 - 31 + 304
\]

\[
= -77
\]

→ If NPV is negative, try a lower \( i \)
3rd Attempt: 7.5%

\[
NPV = -\$350 - \frac{\$100}{(1.075)^{15}} + \frac{\$14,273}{(1.075)^{50}}
\]

\[
= -\$350 - \$34 + \$384
\]

\[
= \$0
\]

7.5% = IRR

→ When NPV = 0, \(i = IRR\)
NPV vs. IRR

• The alternative with the highest NPV at a given interest rate might not be the one with the highest IRR—which is the better measure?
• Identifying the appropriate interest rate and computing NPV will best reflect performance given the time preference of the investor
• IRR can be useful if the appropriate interest rate is unknown
• NPV and IRR together tell us more than either one alone
References


