1.011 Project Evaluation
Comparing Alternatives
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1. Capital Budgets and Hurdle ROI
2. Mutually Exclusive Alternatives
3. Dealing With Projects with Unequal Lives

What is an Acceptable Investment?
- PW is greater than zero, which is equivalent to both AW > 0 and FW > 0
- Note that ranking of investment options will be the same whether PW, AW, or FW is used.
- If we are given i and N, then PW is proportional to AW and FW
  \[ PW(\text{option 1}) > PW(\text{option 2}) \]
  \[ AW(\text{option 1}) = k \cdot PW(\text{option 1}) > k \cdot PW(\text{option 2}) = AW(\text{option 2}) \]
  \[ FW(\text{option 1}) > FW(\text{option 2}) \]
- This is a very convenient property! Use PW, AW, or FW and choose the options with the highest values (go for the "biggest bang for the buck")

Capital Budgets & Hurdle Rates
- In general, we expect to have many investment opportunities where PW > 0
- BUT! We almost certainly won't have enough capital to fund them all (our banker, our partners, or our stockholders eventually get nervous!)
- SO: companies tend to ration their capital and to select the best projects using a hurdle ROI and a capital budget
  - Hurdle rate > or = MARR
  - Capital budget determines how much we can do

Assumptions for this Capital Budgeting Process
- We know the MARR
  - In principle we should, but this is a little fuzzy!
- We know the limits for capital expenditures
  - This is always a negotiated limit - who has the power in the corporation? Who can convince the board to go along with the project? Who can convince people to buy bonds?
- We have an ordered list of ALL feasible projects, none of which are mutually exclusive
  - Highly unlikely! No one who has seriously considered design assumes they can EVER know ALL of the alternatives, many of which are mutually exclusive!

The Inconsistent Ranking Problem
- There may be a problem with this methodology
  - We advised ranking by PW, AW or FW to get proper rankings of projects
  - BUT: the capital budget typical ranks by IRR (and we would argue for using ERR)
  - Will ranking by IRR give the best project?
An Example of Inconsistent Rankings
(E.E. Section 5.4.2.1)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Investment</td>
<td>-$60,000</td>
<td>-$73,000</td>
<td>-$13,000</td>
</tr>
<tr>
<td>Revenue - Expense</td>
<td>$22,000/yr</td>
<td>$26,225/yr</td>
<td>$4,225/yr</td>
</tr>
<tr>
<td>PW</td>
<td>$9,738</td>
<td>$10,131</td>
<td></td>
</tr>
<tr>
<td>IRR</td>
<td>17.3%</td>
<td>16.3%</td>
<td></td>
</tr>
<tr>
<td>Project life</td>
<td>4 years</td>
<td>4 years</td>
<td></td>
</tr>
</tbody>
</table>

How Do We Resolve the Inconsistency?

Is the smaller investment acceptable? Yes, PW > 0
Is the INCREMENTAL investment of $13,000 justified by the incremental return?

$4,225 extra for four years, at MARR = 10%

PW = $4225 * (P/A,10%,4) = $4,225*3.169
= $13,393 > $13,000

The PW of the INCREMENTAL investment is positive, so the incremental investment is better, even though the IRR is lower!

Example 1: Lesson

■ Of all the options with PW > 0, let the base case be the option with the lowest capital cost
■ Consider the next largest investment if the incremental return on the incremental investment is greater than the MARR
  ■ This means that the IRR on the incremental investment exceeds the MARR
■ Recommend the largest investment where the incremental investment is justifiable

Example 2: More Options
(Amounts in $1000s)

<table>
<thead>
<tr>
<th></th>
<th>Invest</th>
<th>Net Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking Lot</td>
<td>$200</td>
<td>$22</td>
</tr>
<tr>
<td>B1 1 Story Building</td>
<td>4,000</td>
<td>$600</td>
</tr>
<tr>
<td>B2 2 Story Building</td>
<td>5,500</td>
<td>$720</td>
</tr>
<tr>
<td>B3 3 Story Building</td>
<td>7,500</td>
<td>$960</td>
</tr>
</tbody>
</table>

Example 2: Incremental Analysis
(Amounts in $1000s)

<table>
<thead>
<tr>
<th></th>
<th>B1-P</th>
<th>B2-B1</th>
<th>B3-B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ K</td>
<td>-$3,800</td>
<td>-$1,550</td>
<td>-$3,500</td>
</tr>
<tr>
<td>□ Inc</td>
<td>$578</td>
<td>$120</td>
<td>$360</td>
</tr>
<tr>
<td>□ IRR</td>
<td>15.2%</td>
<td>7.7%</td>
<td>10.3%</td>
</tr>
</tbody>
</table>

OK  NDG!  OK

If Project Lives Are Different

■ Use a longer life that is an integral multiple of both lives, e.g. use a 20 year life to compare projects of 4, 5, or 10 years duration
■ Estimate a residual value for the project with a longer life and use the life of the shorter-lived project
■ Use a sufficiently long life that the differences will be negligible
■ Use the AW method (and assume that you would replace your project with one that is at least that good)
■ Use common sense and do sensitivity analysis if you are in doubt! There is NO right method!
Comparing Projects With Unequal Lives Using MARR & Residual Value

Comparison of Short & Long Lives

Comparison Over 15 Year Project

Summary

- The equivalent worth methods are computationally less cumbersome to use and to understand.
- Both the equivalent worth and the IRR/ERR methods will give the correct choice if used properly.
- IRR/ERR methods will give the WRONG choice if a manager insists on the highest return rather than ensuring that the incremental IRR is greater than the MARR.