Lecture 8

Internal Rate of Return

Judging proposed investments

- IRR gets more complicated when comparing multiple alternatives
  - (Rather than evaluating a single project)
- Why?
  - Desirability depends on both
    - IRR

    and
    - size of initial investment

Example

- Consider two alternatives:
  - Invest $1 at an IRR of 100%
  - Invest $1,000,000 at an IRR of 20%
- Which investment would you prefer?

Example

- Consider two alternatives:
  - Invest $1 at an IRR of 100%
  - Invest $1,000,000 at an IRR of 20%
- The more expensive project has:
  - Smaller IRR

but

  - *Larger present worth!*

Judging proposed investments

- If you are going to pick only one alternative from several,
  - Need to compare them against each other!
    - (based on differences in cost)
  - not only against the base rate of return i*
- Need to evaluate each incremental investment to see if it is worthwhile

Example

- Compare options A and B:

  A: First cost = $1420

  - Annual benefit = $256/year for 40 years
  - Rate of return = 18%

  B: First cost = $1684

  - Annual benefit = $300/year for 40 years
  - Rate of return = 17.8%
    - You can only do *one* of these!

Example

- Option B has:
  - Slightly lower rate of return,
- but
  - Higher initial investment
- Present worth of benefit may be *greater* than option A!

Example

- Need to evaluate the incremental investment to see if it is worthwhile:
  - Delta first cost = $1684 - 1420 = $264
  - Delta annual benefit = $300 - 256 = $44
    (for 40 years)
  - Rate of return = 16.6%
- Is option B worthwhile?
  - (Depends on i*)

Example

- Option A has IRR 18%, first cost $1420
  - (B - A) has IRR 16.6%, first cost $264
- If i* = 15%, then:
  - Option A is worthwhile
  - The delta for option B is also worthwhile
- If i* = 17%, then:
  - Option A is worthwhile, but not B

Example

- Option A has IRR 18%
  - (B - A) has IRR 16.6%
- If i* = 20%, then:
  - Neither option A nor option B is good

Judging proposed investments

- To compare multiple alternatives with:
  - Different initial investments
  - Same lifetimes
- Look at differences between options
- Compare them against each other!
  - Not only against the base rate of return i*

Judging proposed investments

- To compare multiple alternatives with:
  - Same initial investments
  - Different lifetimes

  can just compare IRR values directly
- Assume that each option is repeated:
  - The one with the better IRR in early years will still have the better IRR later on!

Judging proposed investments

- To compare multiple alternatives with:
  - Different initial investments
  - Different lifetimes
- Must first convert to equal lifetimes:
  - Then look at differences between options
  - Compare them against each other!
    - Not only against the base rate of return i*

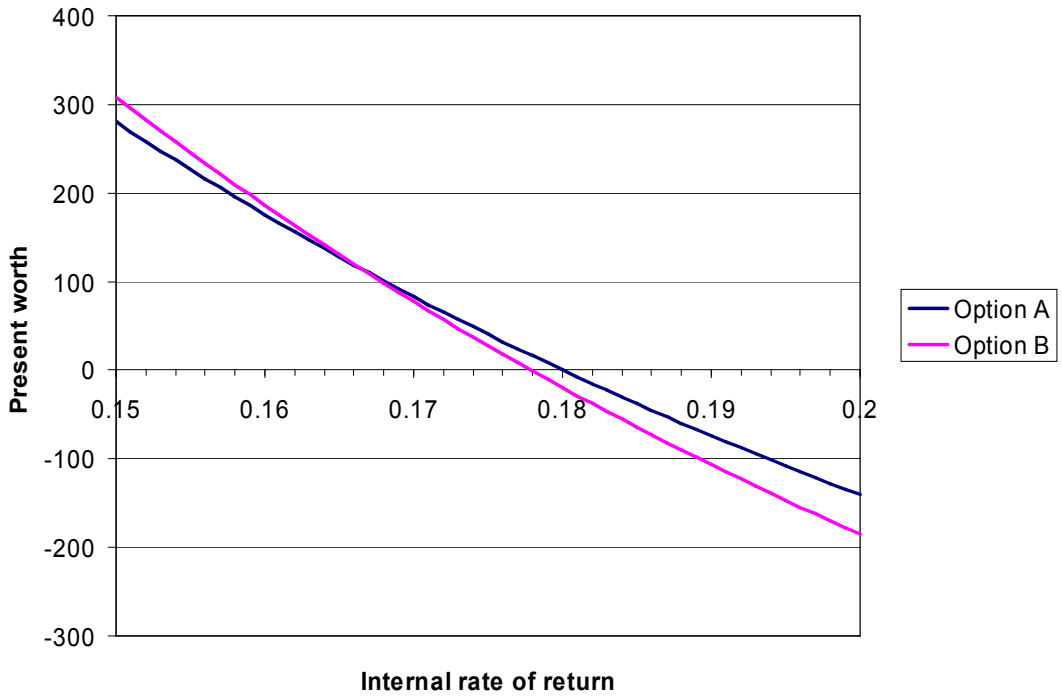
Judging proposed investments

- Possible mistakes:
  - Highest IRR is not necessarily best
    - Another project with a *larger investment* might yield a larger total benefit!
  - Project with largest initial investment is also not necessarily best
- But we know that options with IRR < i* will *never* be chosen!

Judging proposed investments

- Compute incremental rate of return:
  - Based on a smaller investment that is already known to acceptable!
- Example:
  - i* = 15%
  - IRR of option A = 12%
  - Option B may not be worthwhile
    - Even if IRR of (B - A) is > i*!

Can also plot graphically



- Overall IRR is where it crosses X axis
  - *Incremental* IRR is where 2 curves cross

Judging proposed investments

- If i* < IRR of (B - A), then:
  - Option B is better
- If IRR of (B - A) < i* < IRR of A:
  - Option A is better
- If i* > IRR of A, then:
  - Neither option has positive present worth
  - *Don't do either one!*

Combinations of investments

- Buy a mine for $1.5 million, n=8:
  - Annual benefit = $391,000
  - IRR = 20%
- Put aside money each year at 4% for 8 years (equal annual deposits), to pay $1.5M in year 8:
  - Annual amount A equals $163,000/year
  - Remaining mine revenue = $228,000/year

Combinations of investments

- Combined investment:
  - *Pay* $1.5 million in year 0
  - *Receive* $228,000/year for 8 years
  - *Receive* $1.5 million in year 8
- IRR = 15.2% for this combination
  - But investing at 4% is not worth it even if i* < 15%!
  - Must judge both investments *separately!*

Note

- In some cases:
  - Sequences of investments over time
  - Rather than one investment period at start

  there may be *no* IRR
  - (or more than one!)
- Increasing discount rate makes benefits worth less, but costs *also* worth less

Example with no IRR

- Pay $15,000 in year 0
- Receive $5,000 in year 1:
  - $6,000 in year 2
  - $7,000 in year 3
- Pay $10,000 in year 4
- Small i* makes present worth of years 1-3 positive, *but makes cost count more*

Example with two IRR values

- Pay $700 in year 0
- Receive $200/year in years 1-10
  - $100/year in years 11-20
- Pay $3,000 in year 21
- @IRR function requires a guess:
  - With a guess of 2%, we get IRR = 2.8%
  - With a guess of 25%, we get IRR = 26.2%

Judging proposed investments

- @IRR function may create problems when there are multiple IRR values:
  - This happens for cash flow series with two or more reversals of sign
    - E.g., - + + + -
    - Or - + + - + + - + +
  - See Grant and Ireson, Appendix B

Review

- What is the single most important pitfall to avoid when using present worth to compare projects?
- What is the single most important pitfall to avoid when using internal rate of return to compare projects?