Lecture 11

Retirement/Replacement Decisions

Reasons for retirement

- A better alternative exists
- Needs have changed
- The equipment has deteriorated
- The equipment has been damaged

Retirement or replacement

- An asset that is "retired" from one application may be used elsewhere
  - (Either sold to another business, or kept)
- Replacement may not mean retirement:
  - Old equipment may be kept for other uses

Complicating factors

- Extending the life of an existing asset is different from replacing it
- Retirement and replacement may have implications for income taxes
  - (Will be addressed in more detail later)
- The existing asset and the replacement may have different lifetimes

Example

- Should we sell our old warehouse
  - And rent space?
- Warehouse is 10 years old
  - Purchased for:
    - $40,000 land
    - $160,000 building
  - Is this relevant???
- Assume i* = 20% (before income tax)

Example

- Current annual expenses:
  - $14,000/year operations and maintenance
  - $4,600/year property tax
  - $1,500/year insurance on warehouse
  - $3,000/year insurance on inventory
  - $23,100/year total
- (Ignore income tax for now)

Example

- Plan was to sell 10 years from now:
  - For $250,000
- Just received an offer today:
  - For $350,000

Example

- New expenses if we rent space:
  - $65,000/year rent
  - $5,200/year operations and maintenance
  - $1,600/year insurance on inventory
  - $71,800/year total

Example

- Compare based on annual equivalent
- Annual equivalent of current option:
  - Annual expenses $23,100
  - $350,000 (A/P, 20%, 10) = $83,500
    - This is like a *cost* of keeping the warehouse
    - You don't get it unless you sell!
  - -$250,000 (A/F, 20%, 10) = -$9,600
  - Total = $97,000

Example

- Annual equivalent of renting:
  - Annual expenses $71,800
- Annual equivalent of current option:
  - Annual expenses $97,000
- Is renting better?
  - Yes, it's cheaper to rent!
    - In practice, might want to do after-tax analysis with lower i*

Example

- Compare based on IRR
- Keeping warehouse has higher first cost
  - Because we forego the current sale price
- Cost of renting - cost of owning:
  - Year 0 -$350,000
  - Years 1-10 ($71,800-$23,100)= $48,700
  - Year 10 salvage value $250,000

Example

Year	Cash flow	Discounted	Discount rate
0	-350.0	-350.00	0.2
1	48.7	40.58	
2	48.7	33.82	
3	48.7	28.18	
4	48.7	23.49	
5	48.7	19.57	
6	48.7	16.31	
7	48.7	13.59	
8	48.7	11.33	
9	48.7	9.44	
10	48.7	7.87	
10	250.0	40.38	
Present worth		-105.45	

- First try: discount rate i* = 20%

Example

Year	Cash flow	Discounted	Discount rate
0	-350.0	-350.00	0.1
1	48.7	44.27	
2	48.7	40.25	
3	48.7	36.59	
4	48.7	33.26	
5	48.7	30.24	
6	48.7	27.49	
7	48.7	24.99	
8	48.7	22.72	
9	48.7	20.65	
10	48.7	18.78	
10	250.0	96.39	
Present worth		45.63	

- Second try: discount rate i* = 10%

Example

Year	Cash flow	Discounted	Discount rate
0	-350.0	-350.00	0.123
1	48.7	43.37	
2	48.7	38.62	
3	48.7	34.39	
4	48.7	30.62	
5	48.7	27.27	
6	48.7	24.28	
7	48.7	21.62	
8	48.7	19.25	
9	48.7	17.14	
10	48.7	15.27	
10	250.0	78.37	
Present worth		0.19	

- Converged: discount rate i* = 12.3%

Example

- Analysis is easy:
  - Because both options have the same lives
    - (10 years)
- Keeping the old warehouse is like investing money at 12.3%:
  - Since our i* is 20%, this is not good!

Judging proposed investments

- In this example, we used annual equivalent and internal rate of return interchangeably
  - This is OK, because options had same life
- With different lives:
  - *Use annual equivalent!*

Judging proposed investments

- Decisions about life extension involve both present and future salvage values
  - Forego present value to get future one *(opportunity cost!)*
- Present salvage value can be either
  - Added to the life extension cost, or
  - Subtracted from the replacement cost,
  - But not both!

Judging proposed investments

- When lifetimes are different,
  - Present salvage value *must be* added to the life extension cost!
  - Or else it won't recur with right frequency!
- This seems unintuitive:
  - You don't actually *get* the salvage value unless you *replace* the equipment!

Judging proposed investments

- Think of it as "buying a used item of equipment" from scratch:
  - You are choosing the best *policy*,
  - Not making a one-time choice
- If keeping your used equipment is best,
  - Assume that you will eventually replace it with a *similar* used item of equipment
  - Take an outsider's viewpoint!

Another example

- Wrong equipment bought:
  - Pump cost $3,600 one year ago
  - Power cost = $2,000/year
    - Because of poor pump choice
  - Is this relevant???
- Assume i* = 18%
  - (before income tax)

Another example

- New expenses if we replace pump:
  - $3,400 cost of new pump
  - $1,100/year power cost
  - $700 salvage value of old pump

Another example

- Should we replace the pump?
- Assume a 10-year remaining life
  - (For both new pump and existing pump)

Another example

- Compare based on annual equivalent
- Annual equivalent of current pump:
  - Annual expenses $2,000/year
  - $700 (A/P, 18%, 10) = $156/year
    - This is like a *cost* of keeping the current pump,
    - because you don't get it unless you sell!
  - Total = $2,156/year

Another example

- Annual equivalent of replacing pump:
  - Annual expenses $1,100/year
  - $3,400 (A/P, 18%, 10) = $757/year
  - Total = $1,857/year
- Is it better to replace the pump?

Note

- Sunk cost
  - E.g., sell asset before its expected lifetime
- Does this show that the past decision was “bad”?

Review

- We learned how to choose between
  - Life extension
    - (Keeping old item of equipment)
  - Replacement
- So far:
  - Both options had same lifetime
  - Optimal life for each option was *known!*

Dynamic example (study on your own?)

- Should we replace leaking gas mains?
  - Gas costs $5/thousand feet^3
  - New pipe costs $40,000/mile
  - Old pipe has $0 salvage value
- New pipe has no leaks for 15 years,
  - Then increases by 100,000 feet^3/mile/year
- Assume i* = 10%

Dynamic example

- Annual equivalent of replacing pipe:
  - Need annual equivalent of gas losses
  - This is complicated:
    - Non-equal (gradient) amounts by year
    - Doesn’t start for 15 years
  - Two ways to do this:
    - Convert gradient to annual (in several steps)
    - Trial and error in spreadsheet

Dynamic example

- Convert gradient to annual
  - Leaks in years 16-25 are equivalent to:
    - 11-year gradient starting in year 15
      - (1st year of gradient is always 0)
  - Convert to "present" value in year 14 (before start of gradient) according to:
    - \$5/thousand ft^3 (100,000 ft^3) (P_{14}/G, 10%, 11)
      - = \$500 (26.4) = \$13,200

Dynamic example

- Convert gradient to annual
  - Can we convert "present" value in year 14 directly to annual amount over years 1-25?
    - *No!* Two different time periods involved:
      - P_{14} is 14 years into the future
      - But we want to annualize it over 25 years!
    - Convert to year 0 by $13,200 (P/F, 10%, 14)
      - = $3475
    - Annualize by $3475 (A/P, 10%, 25) = $383

Year	Losses	Discounted	Annual	Discounted	Discount rate
1	0	0.00	382.9	348.09	0.1
2	0	0.00	382.9	316.45	
3	0	0.00	382.9	287.68	
4	0	0.00	382.9	261.53	
5	0	0.00	382.9	237.75	
6	0	0.00	382.9	216.14	
7	0	0.00	382.9	196.49	
8	0	0.00	382.9	178.63	
9	0	0.00	382.9	162.39	
10	0	0.00	382.9	147.62	
11	0	0.00	382.9	134.20	
12	0	0.00	382.9	122.00	
13	0	0.00	382.9	110.91	
14	0	0.00	382.9	100.83	
15	0	0.00	382.9	91.66	
16	500	108.81	382.9	83.33	
17	1000	197.84	382.9	75.75	
18	1500	269.79	382.9	68.87	
19	2000	327.02	382.9	62.61	
20	2500	371.61	382.9	56.92	
21	3000	405.39	382.9	51.74	
22	3500	429.96	382.9	47.04	
23	4000	446.71	382.9	42.76	
24	4500	456.87	382.9	38.87	
25	5000	461.48	382.9	35.34	
Present worth		3475.48		3475.60	

- Converged: annual equivalent = 383

Dynamic example

- Compare based on annual equivalent
- Annual equivalent of replacing pipe:
  - Annualized gas losses $383
  - $40,000 (A/P, 10%, 20) = $4,407
    - Annualized capital cost
  - Total = $4,790

Dynamic example

- Replace current pipe if losses > $4,790
- Assumptions:
  - Current losses are only going to grow
  - Original cost of current pipe is a *sunk cost!*
  - Current pipe has 0 salvage value,
    - So there is no opportunity cost of keeping it
    - Only annualized losses (no capital cost)