Lecture 12

Retirement/Replacement Decisions

Review

- Last time, we learned how to evaluate retirement and replacement when:
  - Both options had same lifetime
  - Optimal life for each option was *known!*

Complicating factors

- Alternatives may have different lifetimes
- Optimal lifetime may not be known:
  - Given present and future salvage values,
  - Consider multiple possible salvage dates
    - To determine the optimal lifetime

Example

- Equipment is 2 years old
  - Purchased for $25,000
- Assume i* = 15% (before income tax)
- Resale value = $13,000 today
  - $10,000 in 1 year
  - $7,500 in 2 years
  - $5,500 in 3 or more years

Example

- Based on the *outsider viewpoint*
  - (i.e., opportunity cost, *not cash flow!*),

  keeping the equipment is the same as buying it used for $13,000
- Assuming operating costs are the same as for new equipment:
  - Can safely ignore in comparison!

Example

- Compare alternative lifetimes
- Cost of keeping equipment for 1 year:
  - $13,000 (A/P, 15%, 1) = $14,950
    - This is like a *cost* of keeping the equipment
    - You don't get it unless you sell!
  - Year 1 salvage value = -$10,000
  - Total = $4,950
    - (in year 1 dollars!)

Example

- Cost of keeping equipment for 2 years (given that I am keeping it for 1 year):
  - $10,000 (A/P, 15%, 1) = $11,500
  - Year 2 salvage value = -$7,500
  - Total = $4,000
    - (in year 2 dollars!)

Example

- Cost of keeping equipment for 3 years (given that I am keeping it for 2 years):
  - $7,500 (A/P, 15%, 1) = $8,625
  - Year 3 salvage value = -$5,500
  - Total = $3,125
    - (in year 3 dollars!)

Example

	Year	"Cash flow"	Discounted	Discount rate
	1	4950	4304	0.15
	2	4000	3025	
	3	3125	2055	
Present	Year 1		4304	
worth	Years 1 and 2		7329	
	Years 1, 2, 3		9384	
Annual	(already in year 1 dollars)		4950	
equivalent	7329	(A/P, 15%, 2)=	4508	
	9384	(A/P, 15%, 3)=	4110	

- What is the best option?
  - Keeping for 3 years has *lowest annual cost*

General formulation

- Equivalent annual cost of an asset:
  - Bought for $B in year 0
    - (or with *current value* of $B in year 0)
  - Sold for salvage value S_n in year n

  equals $B (A/P, i*, n) - S_n (A/F, i*, n)
- Can solve this for lots of values of n
  - To find optimum lifetime
    - (Minimum annual cost!)

General formulation

- If alternatives have same lifetime, then can treat year 0 salvage value as either:
  - A *cost* of keeping the current equipment or
  - A *benefit* of selling it
- If the alternatives have different lives, this is a problem
  - Why??

General formulation

- Assumption:
  - Each option is repeated over and over
- If we use the old equipment for 3 years and repeat over and over
  - (e.g., by buying similar used equipment),

  salvage value will be paid every 3 years

  so *should be annualized over 3 years!*

General formulation

- If alternatives have different lives, then:
  - Current salvage value *must* be considered a cost of keeping the equipment!
- If we subtract it from the cost of the new equipment:
  - It will be annualized over the wrong period

Realistic example

- In the previous example,
  - Optimum lifetime was determined *only* by declining salvage values over time
- In practice, equipment will have
  - Declining salvage values,

  but also
  - *Increasing annual expenses!*

Realistic example

- Current machine is 1 year old, i*=15%
  - Resale value = $12,500 today
    - $8,000 in 1 year
    - $5,000 in 2 years
    - $2,200 in 3 years
  - Annual expenses = $8,900 in year 1
    - $10,500 in year 2
    - $12,500 in year 3

Realistic example

- Compare based on annual equivalent
- If we keep equipment for 1 year, cost =
  - $12,500 (A/P, 15%, 1) = $14,375
    - Annualized opportunity cost
  - -$8,000 (A/F, 15%, 1) = -$8,000
    - Year 1 salvage value
  - $8,900 (already in year 1) = $8,900
  - Total annual cost = $15,275

Realistic example

- If we keep for 2 years, annual cost =
  - $12,500 (A/P, 15%, 2) = $7,689
  - -$5,000 (A/F, 15%, 2) = -$2,326
    - Year 2 salvage value
  - $8,900 (P/F,15%,1)(A/P,15%,2) = $4,760
  - $10,500 (A/F, 15%, 2) = $4,884
  - Total annual cost = $15,008
- Is this better or worse?

Realistic example

- If we keep for 3 years, annual cost =
  - $12,500 (A/P, 15%, 3) = $5,475
  - -$2,200 (A/F, 15%, 3) = -$634
  - $8,900 (P/F,15%,1)(A/P,15%,3) = $3,390
  - $10,500(P/F,15%,2)(A/P,15%,3)= $3,477
  - $12,500 (A/F, 15%, 3) = $3,600
  - Total annual cost =$15,278
    - *This is worse again!* (optimal lifetime=2 years)

Realistic example

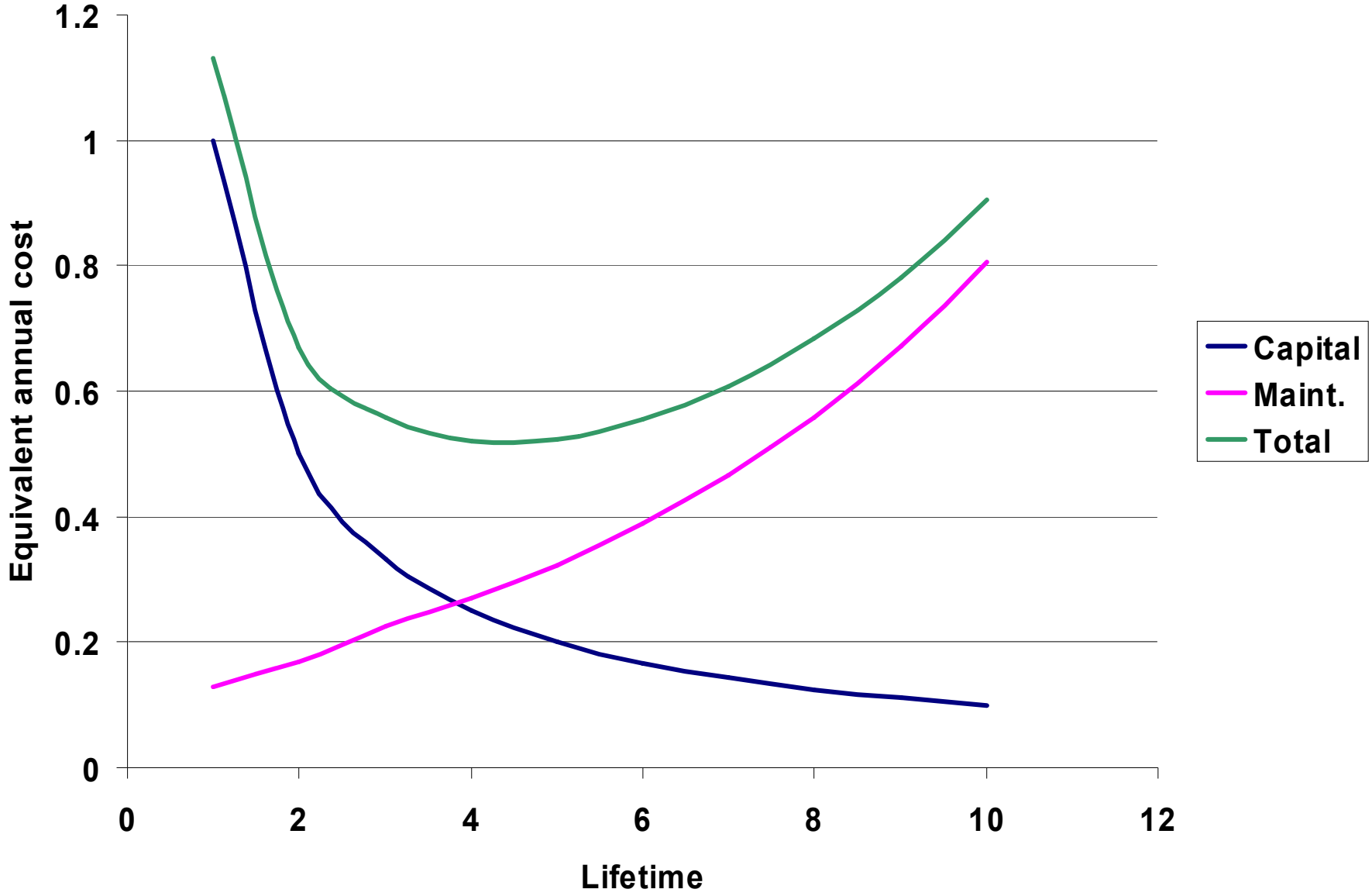
- Lowest possible annual cost = $15,008
- Optimal decision:
  - If the best replacement costs < $15,008,
    - *Then replace now!*
    - (The best you can do by keeping it is $15,008)
  - Otherwise, replace in 2 years
    - (Assuming cost of the replacement is the same)
  - Could even keep for 3 years--When???

Realistic example

- Information gathered in next 2 years may change that decision:
  - *Actual* optimal lifetime may be more or less than predicted!

Judging proposed investments

- Annualized capital recovery cost
  (based on capital cost minus salvage cost)
  usually decreases with longer lifetime:
  - *Can amortize capital cost over more years!*
- Annualized operation/maintenance cost usually increases with longer lifetime:
  - *Equipment wears out!*



- Maintenance cost is increasing
  - Capital recovery cost is decreasing

Judging proposed investments

- Minimum annual cost is often fairly flat:
  - Can choose any one of several lifetimes with only a modest difference in total cost
- In this example,
  - Cost of keeping equipment for 3 or 5 years is only slightly higher than optimum

Judging proposed investments

- Minimum annualized cost occurs when
  - Equivalent annual cost
    - = Marginal cost of an additional year
- If another year has total cost < average
  - *Then keep for one more year!*
- If another year has total cost > average
  - Then *don't* keep equipment for that year!

Judging proposed investments

- Different rules depending on whether we will replace with:
  - Similar equipment

  or
  - *Different equipment!*

Replace with similar item

- When annualized cost is increasing:
  - Then the best option is to replace *now!*

Replace with different item

- When annualized cost is increasing,
  - It may still be worth keeping equipment:
    - Depends on whether cost of current equipment is still less than cost of replacement!
- Future options must also be considered:
  - If development will yield a better option,
    - It might be worth waiting, even if the current option is *more* costly than the replacement that's currently available--Example?

Review

- We learned how to choose between
  - Life extension
  - Replacement
- When options have different lifetimes:
  - Annualize, treat current salvage as a *cost*
- When optimal lifetime is unknown:
  - Compute minimum annual cost, compare!