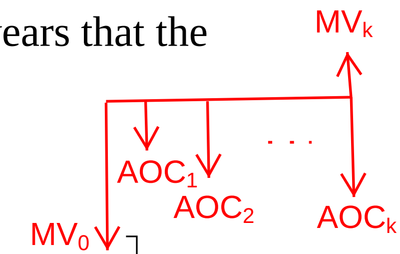
Chapter 11 Replacement and Retention Decisions

- **Reasons for replacing an asset**
  - Reduced Performance
    - Wear and tear
    - Decreasing reliability and productivity
    - Increasing operating and maintenance costs
  - Altered Requirements
    - New production needs, accuracy, speed, etc.
  - Obsolescence
    - Current assets may be less productive
    - Not state of the art – need to meet competition

- **Terminology**
  - *Defender Asset*. Currently installed asset.
  - *Challenger Asset*. Could replace the defender asset.
  - *Equivalent Uniform Annual Cost* (EUAC). AW for costs.
  - *Economic Service Life* (ESL). Number of years at which lowest AW of costs occur.
  - *Defender First Cost*. Initial investment in the defender (P).
  - *Market value* (MV_k) *of the defender in year k*. Salvage value of the defender in year k.
  - *Challenger first cost*. Initial cost necessary to acquire and install the challenger.

- **Economic Service Life (ESL)**
  - Number of years, k^*, at which the equivalent annual worth AW_k of costs is minimized over all possible years that the asset may provide a needed service.
  - AW_k is given by



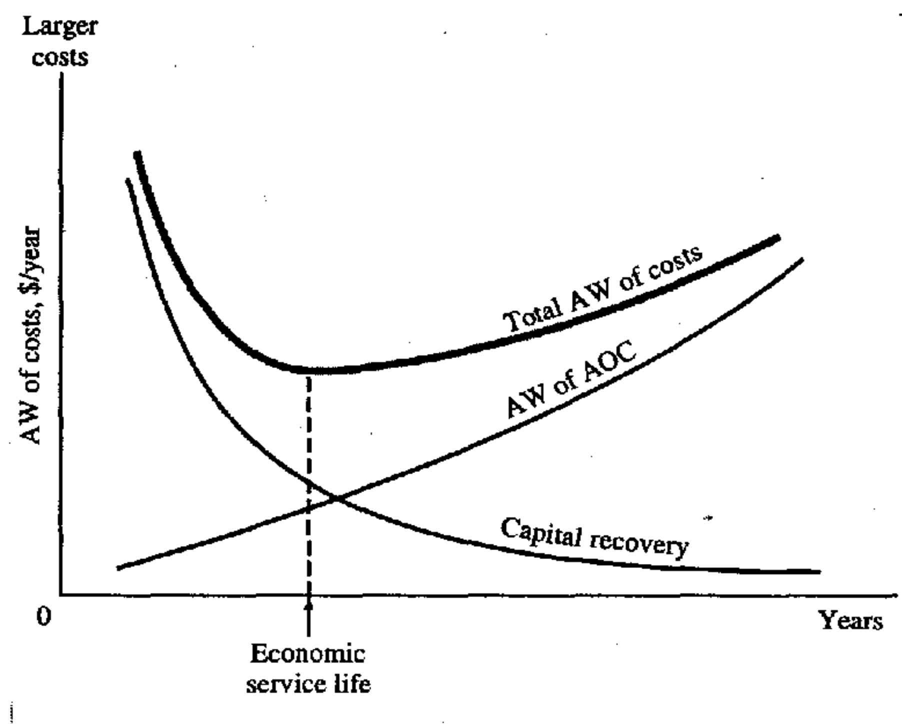
$$AW_k = -MV_0(A/P,i,k) + MV_k(A/F,i,k) - \left[\sum_{j=1}^{k} AOC_j(P/F,i,j)\right](A/P,i,k)$$

$$= -CR_k - AW_k(AOC)$$

  - Symbolically,

$$k^* = \arg\min_k |AW_k| = \arg\min_k CR_k + AW_k(AOC).$$

  - Usually, AOC increase with time, k and CR decreases with k.
  - The ESL, k^*, strikes a balance between these two costs.
  - High CR means that the asset has been utilized long enough and generated enough value.

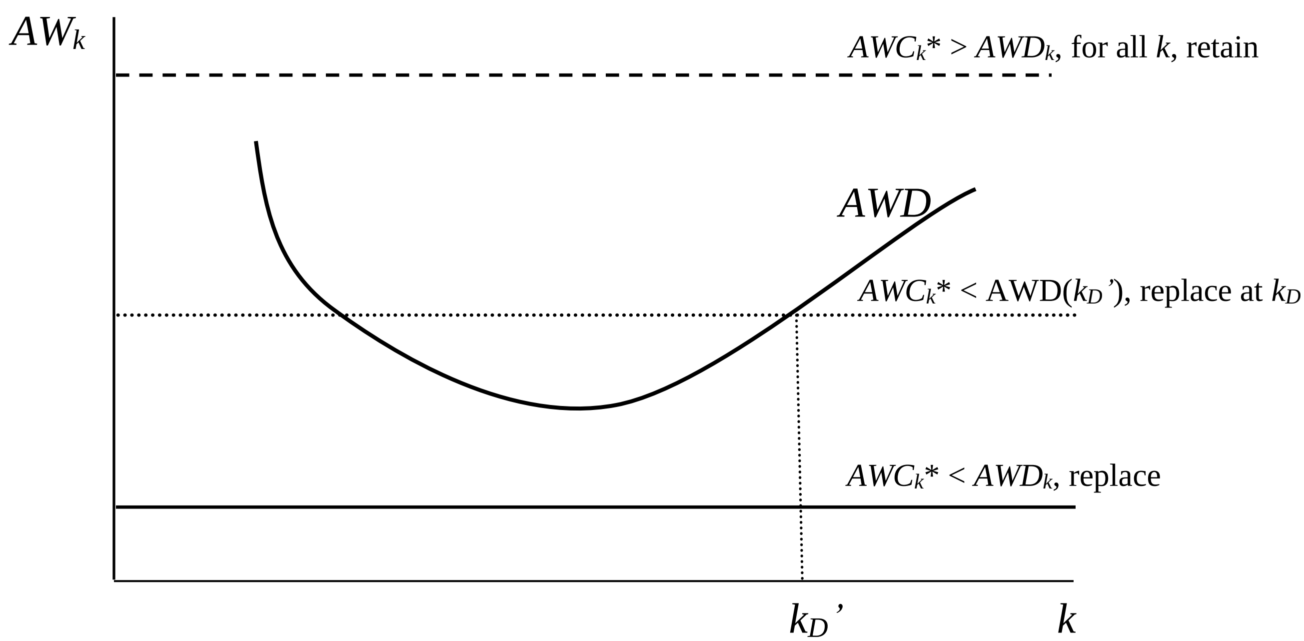


- **Special cases for ESL**
  - If AOC are the same for all years, then k^*. Then, set k^*at the maximum possible number of years.
  - If AOC is increasing with time and MV is the same for all years, then replace in year 1. Then, $k^* = 1$.

- **Replacement with an identical challenger**
  - We are considering here setting a replacement policy, i.e., the planning horizon is assumed to be long (infinity).
  - Suppose an asset is to be replaced with an identical challenger. Let k_0 be the age of the defending asset.
  - Then, replace the asset if $k_0 \geq k^*$, where k^* is the ESL. Otherwise (if $k_0 < k^*$), then keep the asset.
  - This will minimize the long run cost assuming that replacement is only possible with identical assets.
  - For example, an asset with $k^* = 3$ should be replaced if its age is 3 or more years, and retained, otherwise.

- **Replacement with a nonidentical asset**
  - Suppose we are comparing (now) a defender asset with challenger having different characteristics.
  - The implicit assumption is that whichever asset is chosen, it will be replaced each ESL with an identical asset (later).
  - Let k_D^* and AWD_k^* be the ESL and corresponding AW of the defender, and k_C^* and AWC_k^* be those of the challenger.

- Then, replace the defender *immediately* if $AWC_k{}^* < AWD_k{}^*$.
- Otherwise,
  - If $AWC_k{}^* > AWD_k{}^*$, but $AWC_k{}^* < AWD_k$ for some year $k_D' > k_D{}^*$, then replace the defender at year k_D'. *If no such k_D' exists, then keep defender*.
  - If $AWC_k{}^* > AWD_k$, for all k, then keep the defender as long as possible.



- The assumption here is that no other challenger will be identified in future years.

- **Generalized replacement models**
  - Sometimes one can expect emergence of future challengers.
  - In these cases, one should include future alternatives in the analysis.
  - This complicates the replacement problem since many options are now possible.
  - For example, suppose there is a challenger now and a challenger next year. The options are:

    (i) Replace now with current challenger and retain current challenger thereafter.

    (ii) Replace now with current challenger and replace and replace with next year's challenger.

    (iii) Retain now and replace with next year's challenger.

    (iv) Retain defender throughout.