INTRODUCTION TO ENGINEERING ECONOMICS

• A. J. Clark School of Engineering •Department of Civil and Environmental Engineering

by

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ENCE 202
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Economic Equivalence Involving Inflation

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- Measure of Inflation and Deflation
  - The consumer price index (CPI) is the ratio between the current price of a commodity or service to the price at some earlier reference time.
  - For example, the base year is 1967 (index =100), commodity price is $1.46/lb. The price in 1993 is $5.74/lb. Therefore, the 1993 index is 5.74/1.46 = 393.2

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- The Annual Inflation Rate
  - The annual inflation rate at *t*+1 can be computed as
  - annual inflation rate at *t*+1 = $\dfrac{CPI_{t+1} - CPI_t}{CPI_t}$

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- The Annual Inflation Rate
  - Assume the average inflation rate = $\bar{f}$
  - The average rate can be computed as

$$CPI_t(1+\bar{f})^n = CPI_{t+n}$$

Or

$$\bar{f} = \sqrt[n]{\frac{CPI_{t+n}}{CPI_t}} - 1$$

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■ Example

$$\bar{f} = \sqrt[14]{\frac{246.80}{97.2}} - 1 = \left(\frac{246.80}{97.2}\right)^{1/14} - 1 = 6.882\%$$

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■ Purchasing Power of Money

– Purchasing power at *t* in reference to *t-n*

– It is equal to

$$\frac{CPI_{t-n}}{CPI_t}$$

– Define *k* = annual rate of loss in purchasing power. Therefore, the average rate of loss of purchasing power is

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$$\frac{CPI_{base\ year}}{CPI_t}(1-\bar{k})^n = \frac{CPI_{base\ year}}{CPI_{t+n}}$$

– Resulting into $CPI_t = (1-\bar{k})^n CPI_{t+n}$

– Therefore, $(1+\bar{f})^n = \frac{1}{(1-\bar{k})^n}$

This equation relates the average *f* and *k*.

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Depreciation and Depreciation Accounting

- ***Depreciation*** is the loss in value of a piece of equipment over time, generally caused by wear and tear from use, deterioration, obsolescence, or reduced need.
- ***Depreciation accounting*** is the *systematic* allocation of the costs of a capital investment over some specific number of years.

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Depreciation Accounting

- Reasons for calculating the depreciation accounting value (usually termed *book value)* of a piece of equipment:
  1. To provide the construction owner and project manager with an easily calculated *estimate* of the current market value of the equipment.
  2. To provide a systematic method for allocating the depreciation portion of equipment ownership costs over a period of time and to a specific productivity rate.
  3. To allocate the depreciation portion of ownership costs in such a manner that the greatest tax benefits will accrue.

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Depreciation Accounting

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Information needed for depreciation accounting:

1. The purchase price of the piece of equipment, ***P***
2. The optimum period of time to keep the equipment or the *recovery* period allowed for income tax purposes, ***N***
3. The estimated resale value at the close of the optimum period of time, ***F***

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Depreciation Calculation Methods

1. Straight-line (SL) Method
2. Sum-of-the-years (SOY) Method
3. Declining-balance (DB) Method

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Straight-line (SL) Method

The annual amount of depreciation $D_{m,}$,for any year m, is a constant value, and thus the book value BV_m decreases at a uniform rate over the useful life of the equipment.

Depreciation rate	$R_m = \quad 1/N$
Annual depreciation amount	$D_m = R_m (P - F) = (P - F)/N$
Book value at year *m*	$BV_m = P - mD_m$

Note: The value ($P - F$) is often referred to as the ***depreciable value*** of the investment.

Example 1

A piece of equipment is available for purchase for $12,000, has an estimated useful life of 5 years, and has an estimated salvage value of $2,000. Determine the depreciation and the book value for each of the 5 years using the SL method.

R_m = 1/5 = 0.2

D_m= 0.2(12,000 - 2,000) = $2,000 per year

The table of values is:

$$BV_2 = 12{,}000 - 2(2{,}000) = \$8{,}000$$

m	BV_{m-1}	D_m	BV_m
0	$0	$0	$12,000
1	12,000	2,000	10,000
2	10,000	2,000	8,000
3	8,000	2,000	6,000
4	6,000	2,000	4,000
5	4,000	2,000	2,000

If the equipment is expected to be used about 1,400 hours per year then its estimated hourly depreciation portion of the ownership cost is

$2,000/1,400 = $1.428 = $1.43 per hour

Sum-of-the-years (SOY) Method

- SOY is an accelerated depreciation method (fast write-off), which is a term applied to accounting methods which permit rates of depreciation faster than straight line.

- The rate of depreciation is a factor R_m (depreciation rate) times the depreciable value ($P - F$).
  $D_m = R_m (P-F)$
  SOY = $N(N+1)/2$
  $R_m = (N-m+1)/\text{SOY}$

- The annual depreciation D_m for mth year (at any age m) is
  $D_m = \{(N-m+1)/\text{SOY}\}(P-F)$

- The book value at the end of year m is
  $BV_m = P-(P-F)[m(N-m/2+0.5)/\text{SOY}]$

Example 2

Using the same values as given in Example 1, calculate the allowable depreciation and the book value for each of the 5 years using the SOY method.

SOY = 1+2+3+4+5 = 15 or =5(6)/2 = 15

R_m = (5-m+1)/15

D_m = R_m(12,000-2,000) = (5-m+1)10,000/(15)

Year	R_m	D_m	BV_m
0		$ 0	$12,000
1	5/15	3,333	8,667
2	4/15	2,667	6,000
3	3/15	2,000	4,000
4	2/15	1,333	2,667
5	1/15	667	2,000

Declining-balance (DB) Method

- Declining-balance (DB) methods also are accelerated depreciation methods that provide for even larger portions of the cost of a piece of equipment to be written off in the early years.
- DB method often more nearly approximates the actual loss in market value with time.
- Declining methods range from 1.25 times the current book value divided by the life to 2.00 times the current book value divided by the life (the latter is termed *double declining balance).*

Note: Although the estimated salvage value ***F*** is not included in the calculation, the book value *cannot* go below the salvage value.

Declining-balance (DB) Method

The following equations are necessary to use the declining-balance methods.

The symbol ***R*** is used for the depreciation rate for the declining-balance method of depreciation:

1. For 1.25 declining-balance (1.25DB) method, $R = 1.25/N$
   For 1.50 declining-balance (1.5DB) method, $R = 1.50/N$
   For 1.75 declining-balance (1.75DB) method, $R = 1.75/N$
   For double-declining-balance (DDB) method, $R = 2.00/N$

2. The allowable depreciation D_m, for any year m and any depreciation rate R is

   $$D_m = R\,P(1 - R)^{m-1} \quad \text{or} \quad D_m = (BV_{m-1})R$$

3. The book value for any year *m* is

   $$BV_m = P(1-R)^m \quad \text{or} \quad BV_m = BV_{m-1} - BV_m \text{ provided that } BV_m > F$$

Example 3

For the same piece of equipment described in Example 2, calculate the allowable depreciation and the book value for each of the 5 years of its life.

$R = 2.0/5 = 0.4$

$D_m = 0.4(BV_{m-1})$

$BV_m = BV_{m-1} - D_m$

Year	D_m	BV_m
0	0	12,000
1	0.4x12,000 = 4,800	7,200
2	0.4x7,200 = 2,880	4,320
3	0.4x4,320 = 1,728	2,592
4	0.4x2,592 = 592	**2,000**
5	0	**2,000**

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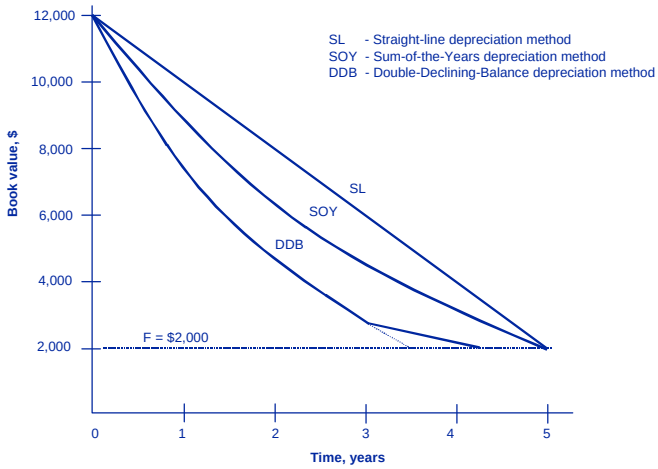
Depreciation Curves for the Examples



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