Eng Economics Equations

General Price-Demand

$p = a - bD$

Revenue, Cost & Profit

$R_{Total} = p \cdot D$

$C_{Total} = C_F - (c_v \cdot D)$

$P = aD - bD^2 - C_F - c_v D$

Max profit (units)

$D^* = \frac{a - c_v}{2b}$

Break even

$D' = \frac{-(a - c_v) \pm \sqrt{(a - c_v)^2 - 4(-b)(-C_F)}}{2(-b)}$

Constant price

$P = pD - C_F - c_v D$

$D^* =$ max capacity

$D' = \frac{C_F}{p - c_v}$

Indexes

$C_n = C_k \left(\frac{I_n}{I_k} \right)$

Factor Technique

$C = \sum_d C_d + \sum_m f_m U_m$

Power Sizing

$C_A = C_B \left(\frac{S_A}{S_B} \right)^X$

Learning Curve

$Z_u = K(u^n)$

$n = (\log s / \log 2)$

Interest

$I = PiN$

Compound interest

$I = P(1+i)^N$

P, F, A, i & N

$F = A\left[\frac{(1+i)^N - 1}{i}\right]$

↳ $A(F/A, i\%, N)$

$P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$

↳ $A(P/A, i\%, N)$

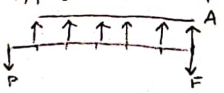
$P = F(1+i)^{-N}$

↳ $F(P/F, i\%, N)$

* inverse to reverse

Tips! ↓

- P/A → P 1 time period b4 1st A
- F/A → F same time as last A
- P/F or F/P $N = N_F - N_X$

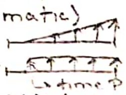


- If 2 cash flows are equivalent, they have the same equivalent value @ 1 point in time

Changing A value

(arithmatic)

split { ag / const



$P_T = P(P/A, i\%, N) + (P/G, i\%, N)$

$P/G = \frac{1}{i}\left[\frac{(1+i)^N - 1}{i(1+i)^N} - \frac{N}{(1+i)^N}\right]$

(geometric)

$P \begin{cases} \frac{A_1[1 - (P/F, i\%, N)(F/P, f\%, N)]}{i - f} & f \neq i \\ A_1 N(P/F, i\%, N) & f = i \end{cases}$

f = % increase/decrease

PROFITABILITY

① PW (MARR → i)

PW(in) − PW(out) ≥ 0 ✓

② FW

FW(in) − FW(out) ≥ 0 ✓

③ AW

Find PW or FW, then AW = ✓ (A/_, MARR, N) ≥ 0 ✓

* If stuck, convert to PW, then FW or AW!

④ B/C (inflow : outflow) ≥ 1 ✓

conventional ↓

$\frac{PW(B)}{Inv - PW(SV) + PW(O\&M)} = \frac{AW(B)}{CR + AW(O\&M)}$ (SV ← sale value)

$CR = I(A/P, i\%, N) - SV(A/F, i\%, N)$

modified ↓

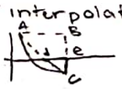
$\frac{PW(B) - PW(O\&M)}{I - PW(SV)} = \frac{AW(B) - AW(O\&M)}{CR}$

⑤ Internal Rate Return (IRR)

IRR ≥ MARR ✓

rate that makes proj break even

- set up PW w/ i = MARR
- if PW = 0, IRR = MARR
  else
  PW < 0, pick smaller i
  PW > 0, pick greater i
- guess until 2 values $x > i$ & $y < i$
- interpolation to est. i



$\frac{x - IRR}{x - y} = \frac{0 - PW(x)}{PW(y) - PW(x)}$

Mutually Exclusive Alts (MEA)

(+) greatest value

(−) smallest abs value

- can eliminate any alts w/ IRR ≤ MARR if IRR > MARR alts exist
- Using IRR
  ↳ PW (greater initial − less init)
  ↳ if resulting IRR ≥ MARR greater option is acceptable
- unequal lives
  ↳ use AW, study period = smallest common factor
  ↳ repeatability assumed

Taxable Income

TI = gross in − Σexpense − depreciation

↳ Σexp excludes capital investment

Book Value

$BK_v = \text{cost basis} - \sum_{1}^{k} (\text{dep deduction})$ (k ← life)

Straight Line

$d_k = \frac{B - SV_K}{K}$

$BK_{VN} = BK_{V1} - N(d_k)$

Declining-Balance

$d_N = B(1-R)^{N-1}(R)$

$R = \frac{(\% \text{ as decimal})}{K_{life}}$

$BK_{VN} = B(1-R)^N$

Cumulative Depreciation

$d_{N\Sigma} = B[1 - (1-R)^N]$

Modified Acc Cost Rec Sys (MACRS)

$d_k = r_k B$

r_k = recovery period, use chart

$BK_{VN} = B - \sum_{1}^{N} d_k$

Federal Tax

$t = 21\% + \text{state rate} - (21\%)(\text{state})$

(t ← effective tax rate; 21% ← fed rate; state ← 0%-15%)

Gain / Loss on Disposal

gain/loss = $MV_N - BK_{VN}$

Breakeven

$EW_A = EW_B$