EGCP 401 – Engineering Economics & Professionalism
(Fall 2020)
Homework no 1 (Due date: 09/09/2020)

Q1-10 A food processor is considering the development of a new product. Depending on the quality of raw material, he can expect different yields process-wise, and the quality of the final products will vary considerably. The product development department has identified three alternatives, which it has produced on a pilot scale. The marketing department has used those samples for surveys to estimate potential sales and pricing strategies. The three alternatives, which would use existing equipment, but different process conditions and specifications, are summarized as follows. Indicate which alternative seems to be the best according to the estimated data, if the objective is to maximize total profit per year.

	Alternative		
	1	2	3
Pounds of raw material A per unit of product	0.05	0.07	0.075
Pounds of raw material B per unit of product	0.19	0.18	0.26
Pounds of raw material C per unit of product	0.14	0.12	0.17
Other processing costs ($/unit product)	$0.16	$0.24	$0.23
Expected wholesale price ($/unit product)	0.95	1.05	1.25
Projected volume of sales (units of product)	1,000,000	1,250,000	800,000
Cost of raw material A $3.45/lb			
Cost of raw material B $1.07/lb			
Cost of raw material C $1.88/lb			

1-10

Solution

	Alternative		
	1	2	3
Cost of raw material A ($/unit product) $0.05 \times 3.45 =$	0.1725	0.2415	0.2587
Cost of raw material B ($/unit product) $0.19 \times 1.07 =$	0.2033	0.1926	0.2782
Cost of raw material C ($/unit product) $0.14 \times 1.88 =$	0.2632	0.2256	0.3196
Other processing costs ($/unit product)	$0.16	$0.24	$0.23
Total cost ($/unit product)	0.799	0.8997	1.0865
Wholesale price ($/unit product)	0.95	1.05	1.25
Profit/unit	0.151	0.1503	0.1635
Projected sales (units of product)	1,000,000	1,250,000	800,000
Projected profits	151,000	187,875	130,800

Therefore, choose Alternative 2.

Q1-13 A new warehouse is being planned, and 3 locations are being compared. Factors being considered include local labor cost, taxes, and access to interstate highways. These are summarized in table follows:

Factor	Location 1	Location 2	Location 3	Factor weight
Labor cost	7	6	5	35%
Taxes	8	7	6	25%
Highway access	3	5	8	40%

Which location should be selected?

1-13

Solution

Weighted score for Location $1 = 0.35(7) + 0.25(8) + 0.40(3) = 5.65$

Weighted score for Location $2 = 0.35(6) + 0.25(7) + 0.40(5) = 5.85$

Weighted score for Location $3 = 0.35(5) + 0.25(6) + 0.40(8) = 6.45$

Choose Location 3 because it has the higher score.

Q1-25 A farmer must decide what combination of seed, water, fertilizer, and pest control will be most profitable and environmentally conscious for the coming year. The local agricultural college did a study of this farmer's situation and prepared the following table.

Plan	Direct Cost/Acre	Extra-market Cost/Acre	Income/Acre
A	$750	$150	$1200
B	$800	$450	$1400
C	$1000	$250	$1500
D	$1300	$200	$1650

The last page of the college's study was torn off, and hence the farmer is not sure which plan the agricultural college recommends. Which plan should the farmer adopt considering:

a) Only the direct cost,

b) Both the direct and extra-market costs?

a) Considering only direct costs:
  Plan A: Profit = Income − Cost = $1,200 – $750 = $450/acre
  Plan B: Profit = Income − Cost = $1,400 – $800 = $600/acre
  Plan C: Profit = Income − Cost = $1,500 – $1,000 = $500/acre
  Plan D: Profit = Income − Cost = $1,650 – $1,300 = $350/acre

  To maximize profit, <u>choose Plan B.</u>

b) Considering both direct and extra-market costs:
  Plan A: Profit = Income − Cost = $1,200 – $750 - $150 = $300/acre
  Plan B: Profit = Income − Cost = $1,400 – $800 - $450 = $150/acre
  Plan C: Profit = Income − Cost = $1,500 – $1,000 - $250= $250/acre
  Plan D: Profit = Income − Cost = $1,650 – $1,300 - $200 = $150/acre

  To maximize profit, <u>choose Plan A.</u>

Q1-57 Cathy Gwynn for a class project is analyzing a "Quick Shop" grocery store. The store emphasizes quick service, a limited assortment of grocery items, and higher prices. Cathy wants to see if the store hours (currently 0600 to 0100) can be changed to make the store more profitable.

Time Period	Daily Sales in the Time Period
0600-0700	$40
0700-0800	$70
0800-0900	$120
0900-1200	$400
1200-1500	$450
1500-1800	$500
1800-2000	$600
2000-2200	$200
2200-2300	$50
2300-2400	$85
2400-0100	$40

The cost of the groceries sold averages 65% of sales. The incremental cost to keep the store open, including the clerk's wage and other operating costs, is $23 per hour. To maximize profit, when should the store be opened, and when should it be closed?

	A	B	C	D	E	F
4	Time Period	Daily Sales in Time Period	Cost of Groceries	Hours in Period	Wage Cost for Period	Hourly Profit
5	0600–0700	$40	$26	1.0	$23	-$9
6	0700–0800	$70	$46	1.0	$23	$2
7	0800–0900	$120	$78	1.0	$23	$19
8	0900–1200	$400	$260	3.0	$69	$24
9	1200–1500	$450	$293	3.0	$69	$30
10	1500–1800	$500	$325	3.0	$69	$35
11	1800–2000	$600	$390	2.0	$46	$82
12	2000–2200	$200	$130	2.0	$46	$12
13	2200–2300	$50	$33	1.0	$23	-$6
14	2300–2400	$85	$55	1.0	$23	$7
15	2400–0100	$40	$26	1.0	$23	-$9

Hourly Profit = (Daily Sales – Cost of Groceries – Wage Cost)/Hours in Period

The first profitable operation is in 0700–0800 time period. In the evening the 2200–2300 time period is unprofitable, but next hour's profit barely covers the loss.

Conclusion: Open at 0700, close at 2200. Given the low profit level in the first hour, it would be wise to monitor the first hour to be sure it is a profitable period.

Q1-62 A firm is planning to manufacture a new product. As the selling price is increased, the quality that can be sold decreases. Numerically the sales department estimates:

$$P = \$475 - 0.25Q$$

Where P= selling price per unit

Q = quantity sold per year

On the other hand, management estimates that the average unit cost of manufacturing and selling the product will decrease as the quantity sold increases. They estimate

$$C = \$48Q + \$22,500$$

Where C= cost to produce and sell Q per year

The firm's management wishes to maximize profit. What quantity should the decision makers plan to produce and sell each year and what profit will be earned?

1-62

Profit = Income – Cost
$\quad$ = PQ – C
where: $\quad$ PQ = $475Q - 0.25Q^2$
$\qquad\quad$ C = 48Q + 22,500

Profit = $427Q - 0.25Q^2 - 22,500$
d(Profit)/dQ = $427 - 0.50Q = 0$

Solve for Q:
$\quad$ Q = 427/0.5 = 854 units/year

d^2 (Profit)/dQ^2 = –0.50

The negative sign indicates that profit is maximum at Q equals 854 units/year.
Answer: Q = 854 units/year

Q2-6 CleanTech Manufactures equipment to mitigate the environmental effects of waste
a) If Product A has fixed expenses of $15,000 per year and each unit of product has a $0.20 variable cost, and Product B has fixed expenses of $5,000 per year and a $0.50 variable cost, at what number of units of annual production will A have the same overall cost as B?
b) As a manager at CleanTech what other data would you need to evaluate these two products?

a) x = annual production units
$\quad$ Total Cost of Product A = Total Cost of Product B
$\quad$ $15,000 + $0.20 x = $5,000 + $0.50 x
$\quad$ x = $10,000/$0.30 = 33,333 units of annual production

b) Need to examine the benefits of each product and their performance in light of their environmental impact.

Q2-23 A firm believes a product's sales volume (S) depends on its unit selling price (P) as S=100-P. The production cost (C) is $1,000+10S.
a) Graph the sales volume (S) from 0 10 100 on the x axis, total cost and total income from $0 to $2500 on the y axis, C=$1000+10S, and plot the curve of total income. Mark the breakeven points on the graph.
b) Determine the breakeven point (lowest sales volume at which total sales income just equals total production cost).
c) Determine the sales volume (S) at which the firm's profit is a maximum.

2-23

a)
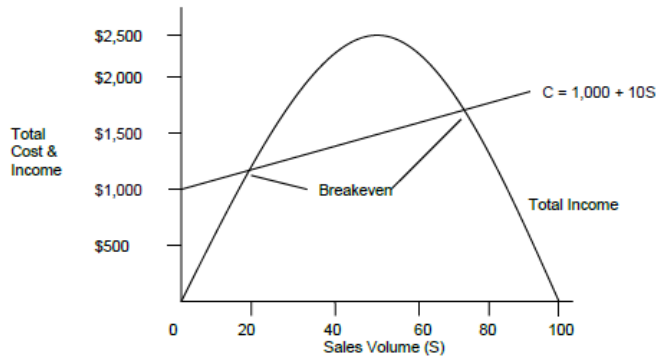
b) For breakeven, set Profit = 0
    $-S^2 + \$90S - \$1,000 = \$0$

   $S = (-b \pm (b^2 - 4ac)^{\frac{1}{2}})/2a = (-\$90 \pm (\$90^2 - (4)(-1)(-1,000))^{\frac{1}{2}})/-2$
      $= 12.98, 77.02$

c) For maximum profit
    $dP/dS = -\$2S + \$90 = \$0$
    $S = 45$ units

   Answers: Breakeven at 13 and 77 units. Maximum profit at 45 units.

Alternative Solution: Trial & Error

Price	Sales Volume	Total Income	Total Cost	Profit
$20	80	$1,600	$1,800	−$200
$23	77	$1,771	$1,770	$0 (Breakeven)
$30	70	$2,100	$1,700	$400
$50	50	$2,500	$1,500	$1,000
$55	45	$2,475	$1,450	$1,025
$60	40	$2,400	$1,400	$1,000
$80	20	$1,600	$1,200	$400
$87	13	$1,131	$1,130	$0 (Breakeven)
$90	10	$900	$1,100	−$200