Homework 2 Solutions: Managerial Economics

Question 1

a. All average variable costs are constant. Therefore, we can use the formula:

$$Q^{break-even} = \frac{TFC}{P - AVC}. \tag{1}$$

So for the store:

$$Q^{break-even} = \frac{\$33{,}750 + \$7{,}594 + \$3{,}375 + \$4{,}219}{\$150 - (\$45 + \$4.5)} = \frac{\$48{,}938}{\$100.50} = 486.95 \text{ units.} \tag{2}$$

The store needs to sell about 487 pairs of jeans per month to break even. It is per month because the store incurs all of the fixed costs over again each month.

For the online only store:

$$Q^{break-even} = \frac{\$1{,}406 + \$8{,}438 + \$4{,}219}{\$150 - (\$45 + \$10)} = \frac{\$14{,}063}{\$95} = 148.03 \text{ units.} \tag{3}$$

The online store must sell about 148 pairs per month to break even. Because of shipping, the online store actually has higher variable cost per unit, but of course the rent savings is huge and allows the online store to break even at less than half the sales of the retail store.

Notice the article reports the fixed costs as average costs, which is not useful.

b. Sales of 281 units per month is not enough to break even for the retail store (487 are needed). In contrast, the online store is quite profitable at 281 pairs (only 148 are needed to break even).

c. Since we have 150 stores, monthly sales across all stores are $150 \cdot 281 = 42{,}150$. The online monthly profits (exclusive of the \$23M) are:

$$\begin{aligned} \pi &= TR - TC = 150Q - (14{,}063 + 55Q) \\ &= -14{,}063 + 95Q = -14{,}063 + 95 \cdot 42{,}150 = \$3{,}990{,}187. \end{aligned} \tag{4}$$

The number of months M needed to earn \$23M is:

$$\$3{,}990{,}187 \cdot M = \$23{,}000{,}000, \quad \rightarrow \quad M = 5.76. \tag{5}$$

The investment pays off in about six months, which would be great. However, brands without a retail presence often lose sales and struggle to stay noticed.

Question 2

a. For $Q = 48$ we can compute the total fixed costs. We have:

$$TC = TFC + TVC, \tag{6}$$

$$TC = TFC + Q \cdot AVC, \tag{7}$$

$$1070 = TFC + 48 \cdot 15, \ \rightarrow \ TFC = 350. \tag{8}$$

The total fixed costs do not change with the quantity; they are the same for all values of Q.

Next, we can compute average variable costs for the remaining quantities. For $Q = 18$, I get:

$$AVC = \frac{TVC}{Q} = \frac{TC - TFC}{Q} = \frac{433 - 350}{18} = 4.61. \tag{9}$$

For average total costs when $Q = 18$:

$$ATC = \frac{TC}{Q} = \frac{433}{18} = 24.06. \tag{10}$$

For marginal costs we need only total costs and Q. For $Q = 21$:

$$MC_{21} = \frac{466 - 433}{21 - 18} = 11. \tag{11}$$

For problem (d), we will also need the profits. For $Q = 18$ given that the price is \$22, I get:

$$\pi_{18} = P \cdot Q - TC = 22 \cdot 18 - 433 = -\$37. \tag{12}$$

The rest of the numbers are in the table.

Production (Q)	Total costs	Total Fixed Costs	Average Variable Costs	Average Total Costs	Marginal Costs	Profit
18	433	350	4.61	24.06	NA	-37
21	466	350	5.52	22.19	11.0	-4
24	505	350	6.46	21.04	13.0	23
26	535	350	7.12	20.58	15.0	37
28	568	350	7.79	20.29	16.5	48
30	604	350	8.47	20.13	18.0	56
32	643	350	9.16	**20.09**	19.5	61
34	684	350	9.82	20.12	**20.5**	64
36	729	350	10.53	20.25	**22.5**	63
40	828	350	11.95	20.70	24.8	52
44	940	350	13.41	21.36	28.0	28
48	1070	350	15	22.29	32.5	-14

Table 1: Average and marginal costs: Artisanal Bologna Company.

b. To maximize profits, we set price equal to marginal cost. The price is \$22, and marginal costs are \$22 at approximately 34-36 units (highlighted in blue in the table).

c. Average profits are:

$$\frac{\pi}{Q} = \frac{TR}{Q} - \frac{TC}{Q}, \tag{13}$$

$$= \frac{P \cdot Q}{Q} - ATC = P - ATC. \tag{14}$$

The price is constant so average revenues are always $P = \$22$. Therefore, to maximize average profits, we need to make the second term in equation (14), average total costs, as small as possible. On the table, average total costs are smallest at about 32 units (highlighted in red).

d. Units between 32 and 34 make profits for the firm, since $P > MC$ for these units. They make less profits than the previous units, thus causing average profits to fall. Nonetheless, they still add to profits and therefore should be produced.

e. Since average variable costs in the table are not constant, we must calculate profits directly. These are calculated in the last column of table 1, using $\pi = TR - TC$. The break even point is between 21 and 24 units. At this point, we have paid off the fixed costs. There is second point with zero profits at 44-48 units. At this point, production is so high that diminishing marginal product has set in and workers are so numerous and unproductive that profits drop to zero. However, this is not a break even point, but instead just illustrates that if we produce too much profits can be negative.

Question 3

a. Long run average costs are u-shaped. By increasing output (number of screens), average cost per screen falls. The cost of the single restroom, lobby, ticket seller, and projection and concession operators are spread across more screens. So average costs fall with the number of screens initially. However, if the number of screens is large enough, the theater faces additional costs to relieve congestion. For example, larger lobbies and parking lots. Thus average costs start to rise when the number of screens is large.

b. Indivisibilities is a clear reason for decreasing long run average costs. When screens are added, additional labor is not needed. So there must not have been enough work to fully utilize each type of worker. One could similarly argue that the restroom and lobby also have indivisibilities.

   One could also argue engineering reasons for decreasing long run average costs. It is cheaper per screen to build a theater with many screens versus a smaller theater.

Question 4

a. Long run average costs are decreasing. As stated in the quote, as firms in the industry get bigger, they get better pricing from suppliers, which decreases their long run average costs.

b. Since long run average costs are decreasing, Sears should get bigger, not smaller. However, as stated in class, this is easier said than done. First, the demand is not there, and installing more stores is unlikely to generate much more demand. Second, the company has negative cash flows, so obtaining financing for an expansion would be difficult. Third, the company needed to sell assets to stave off bankruptcy. However, this creates the "death spiral". By selling off assets, the company gets worse deals from suppliers and long run average costs rise. Sears will then lose even more money in the future and will have to sell off still more assets.

   The correct strategy is to sell the entire firm (or liquidate assets). Only by merging with a larger competitor can Sears hope to remain competitive. Indeed, two weeks after this article, an analyst came out recommending exactly this strategy.

Question 5 (Requires Tuesday's notes)

a. To minimize long run average costs, we set the derivative equal to zero:

$$\frac{dLRAC}{dQ} = -26 + 0.04Q = 0, \;\; \rightarrow \;\; Q = 650. \tag{15}$$

Long run average costs are minimized for a hospital system with 650 beds.

b. In the long run competitive equilibrium, economic profits are zero (if positive, then the industry would see entrants and pricing power).

$$P = LRAC = 10450 - 26Q + 0.02Q^2, \tag{16}$$

$$P = LRAC = 10450 - 26 \cdot 650 + 0.02 \cdot 650^2, \;\; \rightarrow \;\; P = \$2000. \tag{17}$$

The long run equilibrium price is \$2,000 per bed.

c. We have:

$$\frac{\pi}{Q} = \frac{PQ - TC}{Q} = P - LRAC. \tag{18}$$

$$\frac{\pi}{Q} = 2000 - \left(10450 - 26 \cdot 40 + 0.02 \cdot 40^2\right) = -\$7{,}442. \tag{19}$$

UM is losing \$7,442 per bed. Although UM earns \$2,000 in revenue per bed, its costs are just too high because it has not taken advantage of scale economies that occur in a larger hospital. These include better deals from suppliers and indivisibilities such as billing.

d. UM needs to merge with a larger hospital system. The ideal size is 650 beds, so UM needs to merge with a hospital that has $650 - 40 = 610$ beds. Although these numbers are not real, the problem and solution are: university hospitals across the country are merging with larger hospital systems to take advantage of scale economies and improve their pricing power with insurers.

Question 6 (Requires Tuesday's Notes)

a. To calculate the price elasticity, we use the delta formula:

$$e_P = \frac{\Delta Q}{\Delta P}\frac{P}{Q} = \frac{0 - 2939}{130{,}000 - 75{,}000}\frac{75{,}000}{2939} = -1.36. \tag{20}$$

Notice I am careful not to confuse the old value with the new value in the deltas.

b. Tesla demand is elastic. Luxury cars purchased by relatively wealthy consumers can be inelastic, but if the increase in prices is large enough, demand becomes elastic as many consumers can no longer afford the good. Note that actual demand is probably more elastic than the number appears. Demand could not fall past zero, so the loss of demand was limited by the lower bound here.

Question 7

a. If demand is 150 seats, we need either 2 737s or one of the other planes. Thus average total costs are:

$$ATC = AFC + AVC, \tag{21}$$

$$ATC = \frac{TFC}{Q} + AVC. \tag{22}$$

Thus for the 737,

$$ATC_{737} = \frac{\$12{,}351 \cdot 2}{150} + (\$32.68 + \$11.64 + \$10.37 + \$43.15) = \$262.52/\text{seat}, \tag{23}$$

For the other planes:

$$ATC_{767} = \frac{\$39{,}437}{150} + (\$29.14 + \$10.38 + \$9.25 + \$39.48) = \$350.17 \tag{24}$$

$$ATC_{777} = \frac{\$60{,}459}{150} + (\$28.04 + \$9.99 + \$8.90 + \$37.03) = \$487.00 \tag{25}$$

$$ATC_{747} = \frac{\$52{,}005}{150} + (\$26.39 + \$9.40 + \$8.38 + \$34.85) = \$425.72 \tag{26}$$

For the rest of the seats I get:

	Average Total Cost			LRAC
Demand Forecast	737	767	777	747
150	$262.52	$350.17	$487	$425.72
300	$221.35	$218.71	$285.48	$287.04
450	$207.62	$262.53	$218.31	$194.59
600	$200.76	$218.71	$285.48	$165.70

Table 2: Average total cost of alternative sized planes.

b. The LRAC is the lowest cost of production for each output level. So for demand of 150, two 737s has the lowest cost. The point on the LRAC is (150,$262.52). Similarly, the other points are (300,$218.71), (450,$194.59), and (600,$165.70). The airline should use two 737s, one 767, one 747, and one 747, respectively. The airline should never purchase a 777: it is simply too expensive even if demand is 550 (ideal for the 777).

c. We should put all passengers on the 747 and leave the 737 idle, because the 747 has lower average variable (operating) costs. The fixed costs are sunk and do not matter.

   This part of the question was generated by a former student, who came to me with the opposite problem: the smaller factory had lower average variable costs, so I recommended operating the small plant to capacity and producing the remainder at the large plant.

d. No. Average fixed costs go to zero for cruise ships and nursing homes, since we can keep building bigger and bigger ships/homes. We need only one "factory" regardless of Q. Here as Q increases, we add more and more planes which keeps costs from falling to zero. In addition, average variable costs cannot go below the average variable costs of the cheapest plane, $79.02 (the 747).

Question 8 (Requires Tuesday's Notes)

a. We have the equation, so using the calculus formula:

$$e_I = \frac{dQ}{dI}\frac{I}{Q} = -500I^{-2}\frac{I}{Q} = -500\frac{1}{I^2}\frac{I}{\frac{500}{I}}, \tag{27}$$

   Notice I moved the exponent (-1) down and subtracted one from the exponent $-1-1 = -2$ using the exponent rule.

$$e_I = \frac{-500}{I^2}\frac{I^2}{500} = -1. \tag{28}$$

b. The elasticity is negative so fast food is inferior.

c. We know a 1% increase in income results in a 1% decrease in demand. So a 22% increase in income produces a 22% decrease in fast food demand (!).

d. Income increases slowly over time, posing a problem to producers of inferior goods. To solve this problem such producers must periodically increase the quality and price of the product. If done slow enough, they can remain the "cheaper alternative" without seeing demand drop to zero. Indeed fast casual burgers such as Shake Shack and Five Guys are the new McDonalds, but would have been luxury brands 20 years ago when income was lower.