EconS 301- Intermediate Microeconomic Theory
Midterm #2 - Due April 2nd at 9:10am, 2026.

1. A firm is considering to produce smartphones with the following total cost function $TC(q_S) = 100 + 4q_S(1 + 2q_S)$, where q_S is the quantity of smartphones.

   (a) Calculate the Average Cost (AC) and Marginal Cost (MC)

   - The AC is

$$\begin{aligned} AC &= \frac{TC(q_S)}{q_S} = \frac{100}{q_S} + 4(1 + 2q_S) \\ MC &= \frac{\partial TC(q_S)}{\partial q_S} = 4 + 16q_S \end{aligned}$$

   (b) Identify the minimum AC. When does the firm experiences economies of scale?

   - The min AC is

$$\begin{aligned} \frac{\partial AC}{\partial q_S} &= -\frac{100}{q_S^2} + 8 = 0 \\ 8 &= \frac{100}{q_S^2} \end{aligned}$$

   solving for q_S

$$\begin{aligned} q_S^2 &= \frac{100}{8} = \frac{25}{2} \\ q_S &= \sqrt{12.5} = 3.54 \end{aligned}$$

   The firm experiences economies of scale for $q_S \leq 3.54$.

   (c) The firm is planning to produce bluetooth wireless on-ear headphones. The total cost of only producing ear headphones is $TC(q_H) = 100 + 2q_H(1 + 4q_H)$ where q_H is the quantity of ear headphones, but if the firm decides to jointly produce these two gods the total cost becomes $TC(q_S, q_H) = 4q_S(1 + 2q_S - \theta) + 2q_H(1 + 4q_H - \theta) + (100 + \lambda)$.

   - Identify the condition on λ that induces this firm to jointly produce (Economies of Scope).

$$\begin{aligned} TC(q_S, q_H) &< TC(q_S) + TC(q_H) \\ 4q_S(1 + 2q_S - \theta) + 2q_H(1 + 4q_H - \theta) + (100 + \lambda) &< 100 + 4q_S(1 + 2q_S) + 100 + 2q_H(1 + \\ \lambda &< 2\theta(2q_S + q_H) + 100 \end{aligned}$$

   - Interpret the condition on λ
   - It is saying that the firm will decide to jointly produce these two goods if the cost-saving effects from jointly producing these two goods are higher than the increase in fixed costs from producing both goods.
   - Does an increase in the fixed cost affect the decision of the firm to jointly produce smartphones and ear headphones?

- Yes, an increase in the fixed cost, λ, can make more difficult for the firm to jointly produce these two goods.

2. Consider a monopolist producing electric cars and facing the following demand: $p = 750 - \frac{1}{2}q$ where p is the price and q is the output. In addition, the total cost is $TC(q) = 500 + 2q$.

   (a) Calculate the output level, price and monopolist's profits.

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$$\begin{aligned} MR &= MC \\ 750 - q &= 2 \\ q &= 748 \\ p &= 750 - 374 = 376 \\ \pi &= 748 \times 376 - 500 - 748 \times 2 \\ \pi^M &= 279,252 \\ CS^M &= \frac{748}{2}(750 - 376) = 139,876 \end{aligned}$$

   (b) Find the deadweight loss of this monopoly market. [Hint: identify welfare under perfect competition and compare it to that in monopoly]

   - First we need to identify the equilibrium output level in a perfect competitive market:

$$\begin{aligned} P &= MC \\ 750 - \frac{1}{2}q &= 2 \\ q &= 1496 \\ p &= 750 - 748 = 2 \\ \pi &= 2 \times 1496 - 500 - 1496 \times 2 \\ \pi^{PC} &= -500 \\ CS^{PC} &= \frac{1496}{2}(750 - 2) = 559,504 \end{aligned}$$

   - Hence the deadweight loss of this monopoly market is

$$\begin{aligned} DWL &= (\pi^M + CS^M) - (\pi^{PC} + CS^{PC}) \\ DWL &= -140,376 \end{aligned}$$

3. In Moscow, ID, there is only one fortune teller who acts as a monopoly. The inverse demand function for this service is given by $P = 18 - \frac{Q}{2}$, where P denotes the price charged per visit, and Q the quantity demanded for fortune telling.

   (a) Suppose the cost function of this fortune teller is given by $C(Q) = 2 + 0.5Q$. That is, the marginal cost is $c = \$0.5$ (consisting of her value time and other "communication" expenses), and the fixed cost is $F = \$2$ (say, monthly rent on her office space). Compute and draw the fortune teller's marginal cost and average functions, as well as the marginal revenue function.

- The marginal and average cost functions are given by:

$$\begin{aligned} MC(Q) &= \frac{\partial C(Q)}{\partial Q} = 0.5 \text{ and } AC(Q) = \frac{C(Q)}{Q} = \frac{2}{Q} + 0.5 \\ MR &= 18 - Q \end{aligned}$$

(b) Algebraically compute the fortune teller's profit-maximizing output, price, and profit.

- The monopoly equates $MR = 18 - Q = 0.5 = MC(Q)$ to obtain the profit-maximizing output level $Q = 17.5$. The monopoly price is then $P = 18 - \frac{17.5}{2} = \$9.25$. Finally, the profit is $\Pi = 9.25 \times 17.5 - 0.5 \times 17.5 = \$153.125$

(c) Compute the price elasticity at the profit-maximizing output.

- The direct demand function is $Q(p) = 36 - 2p$. Then, the price elasticity is:

$$\varepsilon_p = \frac{\partial Q}{\partial p} \times \frac{p}{Q} = -2 \times \frac{9.25}{17.5} \simeq -1.06$$

4. Consider that the demand function for the Barbie movie tickets is different between nonstudents (N) and students (S). The demand functions of the two consumer groups are $q_N = 7,290(p_N)^{-3}$ and $q_S = 40,960(p_S)^{-4}$. Assume that the movie theater's total cost function is $TC(Q) = 6Q$, where $Q = q_N + q_S$ is the aggregate number of tickets sold. Find the movie ticket prices set by this monopoly movie theater, and the resulting ticket sales, assuming that the movie theater can price discriminate between the two consumer groups, say by requiring students to submit their student ID cards.

- In the market for non students

$$\begin{aligned} MR_N &= p_N \left(1 + \frac{1}{-3}\right) = c = 6 \text{ and } p_N = \$9 \\ MR_S &= p_S \left(1 + \frac{1}{-4}\right) = c = 6 \text{ and } p_S = \$8 \end{aligned}$$

To find the amount of tickets sold to each group, solve

$$q_N = 7,290(9)^{-3}10 \text{ and } q_S = 40,960(8)^{-4} = 10$$

5. Some small towns may only have one restaurant, making them a monopoly in that town. Consider Rosie's Diner in a small mountain town. Her inverse demand is $p(q) = 20 - 0.4q$, where q represents meals per week, and her costs are $C(q) = 5q$.

(a) Find Rosie's profit-maximizing price, quantity, and profits.

- *Monopoly output.* We want to set Rosie's marginal revenue equal to marginal cost. Her marginal revenue is

$$MR(q) = p(q) - \frac{\partial p(q)}{\partial q} q = \underbrace{20 - 0.4q}_{p(q)} - 0.4(q) = 20 - 0.8q.$$

Her marginal cost is

$$MC = \frac{\partial C(q)}{\partial q} = 5$$

Setting $MR(q) = MC(q)$, we have that

$$20 - 0.8q = 5$$

solving for q, we find her profit-maximizing quantity

$$q^M = 18.75 \text{ meals.}$$

- *Monopoly price.* Plugging $q^M = 18.75$ into her inverse demand, we obtain the profit-maximizing price

$$p^M = 20 - 0.4(18.75) = \$12.5.$$

- *Monopoly profit.* Rosie's monopoly profit is

$$\begin{aligned} \pi^M &= p^M q^M - C(q^M) \\ &= 12.5(18.75) - 5(18.75) \\ &= \$140.63. \end{aligned}$$

(b) The road into the town has become considerably harder to traverse since a recent mudslide and Rosie's suppliers have increased their delivery price. This has increased her costs to $C(q) = 8q + 10$. How do her equilibrium prices, quantity, and profits change?

- *Monopoly output.* With her increased costs, her marginal costs change to

$$MC = \frac{\partial C(q)}{\partial q} = 8$$

Setting $MR(q) = MC(q)$, we have

$$20 - 0.8q = 8$$

or, simplifying, $12 = 0.8q$. Solving for q, we find that Rosie now sells

$$q^M = 15 \text{ meals,}$$

3.75 meals less than before the cost increase.

- *Monopoly price.* Her price increases to

$$p^M = 20 - 0.4(15) = \$14.$$

- *Monopoly profit.* Her profit now decreases to

$$\begin{aligned} \pi^M &= p^M q^M - C(q^M) \\ &= 14(15) - 8(15) - 10 \\ &= \$80. \end{aligned}$$

Intuitively, while her price went up, the reduced sales produce a decrease in her overall profits.

(c) After the mudslide, there have been less visitors hiking the trails around town, which has decreased demand to $p(q) = 15 - 4q$. Does Rosie stay in business?

- *Monopoly output.* With the new demand, her marginal revenue changes to

$$MR(q) = p(q) - \frac{\partial p(q)}{\partial q} q = \underbrace{15 - 4q}_{p(q)} - 4(q) = 15 - 8q.$$

Setting $MR(q) = MC(q)$, we have that

$$15 - 8q = 8$$

or, $0.8q = 7$. Solving for q, we obtain

$$q^M = 0.875 \text{ meals}$$

- *Monopoly price.* She will now charge a price

$$p^M = 15 - 4(0.875) = \$11.5,$$

which is also lower than that in part (b), where we found $p^M = \$14$.

- *Monopoly profit.* Her monopoly profit is

$$\begin{aligned} \pi^M &= p^M q^M - C(q^M) \\ &= 11.5(0.875) - 8(0.875) - 10 \\ &= -\$6.94. \end{aligned}$$

which is lower than in parts (a) and (b), implying that she does not stay in business.

6. Lawmakers in Washington State recently passed an income tax on high earners, called a "*millionaires' tax*." Considering the chapter on Production Functions and Monopoly discuss the following points:

- Analyze the primary winners and losers of this new tax legislation.
- How does it affect the demand for labor and capital?
- Explain the potential effects of this tax on welfare.