Intermediate Microeconomic Theory
ECN 100B (Section B), Fall 2019

Professor Brendan Price

Midterm Exam #1

Name: _____

ID number: _____

- Write your answers on the exam itself, using only the space provided for each question.
  - If you run out of space for a given question, write "see extra space" in the space provided for that question, then finish your answer on the extra graded pages. Make sure to write the problem number. You may lose credit if we can't tell which question you're answering.
  - We've also included ungraded scrap pages for pure scrap work. Answers written on these ungraded pages will not be graded under any circumstances.
- You must show your work on every question that requires a calculation. We will award partial credit as appropriate. Correct results without adequate work will receive little or no credit.
- Simplify all mathematical expressions as much as possible.
- The exam is graded out of 50 points. Each question is worth the indicated number of points.
- You will have 80 minutes. You must drop your pen/pencil immediately when time is up.
- As a reminder: UC Davis has a strict code of Academic Conduct. Any violations, including copying or attempting to copy from another student, will result in a score of 0.
- Good luck!

Do not turn this page until I tell you to start.

1. **True or false (10 points total)**

Indicate whether each of the following statements is true or false. Provide a brief explanation (1–3 sentences) justifying your answer.

a. (2 pts.) A firm will always stay in the market if its revenues exceed its variable costs.

False. If a firm's fixed costs are recoverable, it may exit the market even if its revenues exceed its variable costs. (If its fixed costs are sunk, however, then it will stay in the market as long as revenues exceed variable costs.)

b. (2 pts.) A uniform-pricing monopolist will never choose a price at which demand is relatively inelastic ($-1 < \varepsilon < 0$).

True. If demand is relatively inelastic, the monopolist should raise its price: doing so will increase its revenues and either decrease its costs (if marginal cost is positive) or leave them unchanged (if marginal cost is zero), so that profits will go up. Since there is a profitable deviation, the monopolist can't be optimizing.

c. (2 pts.) Lenovo produces laptops using a combination of labor (L) and capital (K). If wages go up ($w \uparrow$), Lenovo might increase its demand for capital ($K^* \uparrow$).

True. When $w \uparrow$, the substitution effect causes Lenovo to substitute away from labor and towards capital (increasing K^*), but the scale effect causes it to demand less of both labor and capital (decreasing K^*). If the substitution effect is stronger, then Lenovo will increase its demand for capital ($K^* \uparrow$).

d. (2 pts.) Under group price discrimination, consumer surplus is sometimes positive.

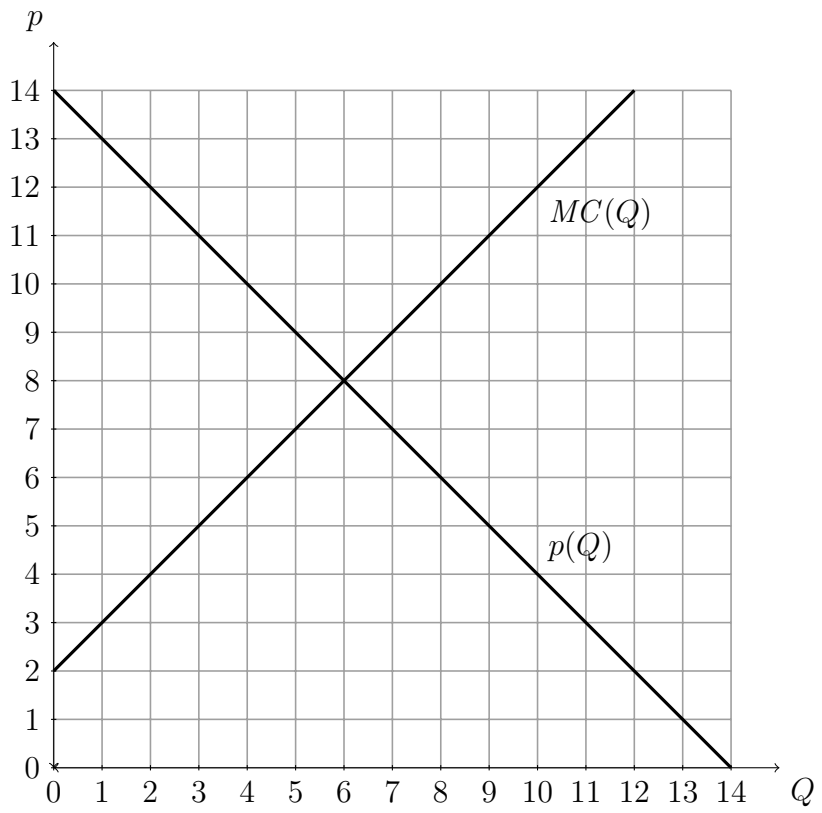
True. If a group's demand curve is downward-sloping, then under group price discrimination, some consumers will be charged less than their willingness to pay and therefore get a positive amount of consumer surplus.

e. (2 pts.) Imposing a price cap on a monopolist can sometimes increase its profits.

False. When we impose a price cap, we are restricting the firm's choice set, i.e., giving it fewer options to choose from. Doing this might decrease the firm's profits, or it might leave profits unchanged (if the price cap is not binding), but it can never increase its profits.

2. **Graphical questions (10 points total)**

Fill in the blanks using the graph below. (You do not need to show your work here.)



a. Suppose that the market shown above is perfectly competitive.

   i. (2 pts.) The equilibrium quantity is 6. The consumer surplus is 18.

   ii. (1 pt.) If producers have to pay an \$8 tax for each unit sold, total tax revenue is 16.

b. Now suppose that the market shown above represents a uniform-pricing monopoly.

   i. (2 pts.) The monopoly price is 10. The monopoly profit is 24.

   ii. (1 pt.) At the monopoly's optimal price, the markup equals 2/3.

   iii. (1 pt.) We can get the monopoly to produce the competitive quantity by setting a price $\underbrace{\textit{ceiling}}_{\text{(floor or ceiling)}}$ equal to 8.

   iv. (1 pt.) Marginal revenue equals zero at the point where $Q = 7$ units.

c. Now suppose that the market shown above represents perfect price discrimination.

   i. (1 pt.) The consumer surplus equals 0 and the deadweight loss equals 0.

   ii. (1 pt.) The total variable cost equals 30.

3. **Staying afloat (10 points total)**

Jing faces demand for haircuts given by $p(Q) = 24 - 2Q$. Her variable costs are $VC(Q) = 8Q$. She has already paid a fixed cost $FC = 80$ to enter the market.

a. (3 pts.) Compute the elasticity of demand as a function of Q. For what value of Q are consumers most price-sensitive? For what value of Q is demand unit elastic?

The elasticity is given by $\varepsilon = 1 - \frac{12}{Q}$. Consumers are most price-sensitive when $\varepsilon = -\infty$, which occurs when $Q = 0$. Demand is unit elastic when $\varepsilon = -1$, i.e., when $Q = 6$.

b. (5 pts.) Suppose that Jing is a uniform-pricing monopolist.

i. Write Jing's profits as a function of Q. (Include the fixed cost.)

Profit is $\pi(Q) = (24 - 2Q)Q - 8Q - 80$, which simplifies to $\pi(Q) = 16Q - 2Q^2 - 80$.

ii. Assuming she stays in business, how many haircuts will she sell (Q_m)? How does your answer to this question depend on the value of FC?

The FOC is $16 - 4Q = 0 \implies Q_m = 4$. (I didn't ask for the price, but it's $p_m = 16$.) Since FC is a constant, it doesn't affect the optimal choice of Q for a firm that decides to operate—it only affects entry/exit decisions.

iii. If her fixed cost is (100%) sunk, will she stay in business or exit?

If she stays in business, profit is $\pi = R(Q_m) - C(Q_m) = 16 \cdot 4 - 8 \cdot 4 - 80 = 32 - 80 = -48$. If she exits, her profits are -80. So it's better to stay in business.

iv. If her fixed cost is (100%) recoverable, will she stay in business or exit?

In this case, exiting yields profits of 0, which is better than losing money. She exits.

c. (2 pts.) Now suppose Jing knows her clients so well that she can perfectly price discriminate.

i. Assuming she stays in business, how many haircuts will she sell (Q^*)?

She sells to anyone with $WTP \geq MC$: $p(Q^*) = MC \implies 24 - 2Q^* = 8$, so $Q^* = 8$.

ii. If she can recover 50% of her fixed costs, will she stay in business or exit?

If she stays, her profit is the area below the demand curve and above the cost curve from $Q = 0$ to $Q = 8$, which is 64, minus the full fixed cost, so she gets $\pi = 64 - 80 = -16$. If she exits, she gets $-80 \times 50\% = -40$. So she is better off staying in the market.

4. **In it to win it (10 points total)**

Jie runs a small coaching company that offers tennis lessons in both Davis and Sacramento.

In Davis, she faces downward-sloping demand for tennis lessons given by $p_D(Q_D) = 60 - Q_D$. In Sacramento, she faces perfectly elastic demand given by $p_S = 48$.

She can provide Q_D lessons in Davis and Q_S lessons in Sacramento, in whatever combination she wants, at a total cost $C(Q_D, Q_S) = 2(Q_D + Q_S)^2$.

a. (3 pts.) Write profits as a function of Q_D and Q_S. What is $MR_D(Q_D)$? What is $MR_S(Q_S)$?

Jie's profits are

$$\pi(Q_D, Q_S) = (60 - Q_D)Q_D + 48Q_S - 2(Q_D + Q_S)^2$$

The marginal revenues are $MR_D(Q_D) = 60 - 2Q_D$ and $MR_S(Q_S) = 20$.

b. (3 pts.) Find Q_D^*, Q_S^*, and p_D^*.

The two FOCs are

$$\begin{aligned} 60 - 2Q_D^* &= 4(Q_D^* + Q_S^*) \\ 48 &= 4(Q_D^* + Q_S^*) \end{aligned}$$

Solving this system of equations gives $Q_D^* = 6$, $Q_S^* = 6$, and $p_D^* = 54$.

c. (2 pts.) Jie chooses $Q_D^* = 0$ if $p_S \geq x$, and she chooses $Q_D^* > 0$ if $p_S < x$. Find x.

If $p_S > 60$, the marginal revenue from a Sacramento lesson always exceeds the marginal revenue from a Davis lesson. Since the marginal costs are the same, Jie sets $Q_D^* = 0$. If $p_S < 60$, then the marginal revenue from the first Davis lesson exceeds the marginal revenue from the first Sacramento lesson, so she chooses $Q_D^* > 0$. (If $p_S = 60$ exactly, she also chooses $Q_D^* = 0$.) So $x = 60$.

d. (2 pts.) Now suppose Jie has to charge Davis and Sacramento customers the same price p. Will she charge $p = 48$ in both markets, or will she charge $p > 48$ and only sell in Davis?

If Jie charges $p = 48$, she doesn't care who buys her lessons, so she solves the maximization problem

$$\max_Q \; 48Q - 2Q^2 \implies Q^* = 12 \implies \pi = 48 \cdot 12 - 2 \cdot 12^2 = 288$$

If she charges $p > 48$, she just sells to Davis and solves the maximization problem

$$\max_{Q_1} (60 - Q_1)Q_1 - 2Q_1^2 \implies Q_1^* = 10 \implies p^* = 50 \implies \pi = 300$$

Choosing the price $p^* = 50$ yields greater profit, so sets $p^* = 50$ and only sells in Davis.

5. **Cost-minimization (4 points total)**

In each of the following cases, find the cheapest combination of labor and capital needed to produce 1 unit of output. (L and K don't have to be integers: for example, L^* could equal $\frac{3}{2}$.) Also state whether labor and capital are perfect substitutes, perfect complements, or neither.

a. (2 pts.) $q(L, K) = 5L + 6K$, with $w = 10$, $r = 13$

Each unit of capital is 20% more productive than each unit of labor, but costs 30% more. It's cheaper to use workers. Since each worker produces 5 units of output, we should employ $L^* = \frac{1}{5}$ (and $K^* = 0$) to produce a single unit of output. L and K are perfect substitutes.

b. (2 pts.) $q(L, K) = \sqrt{LK}$, with $w = 2$, $r = 8$

We solve the cost-minimization problem

$$\min_{L,K} \; wL + rK \quad \text{subject to} \quad \sqrt{LK} = 1$$

Isolating K in the constraint gives $K = \frac{1}{L}$. Plugging this into the objective function:

$$\min_{L} \; wL + \frac{r}{L} = 2L + \frac{8}{L}$$

which has the FOC: $2 - \frac{8}{L^2} = 0 \implies L^* = 2 \implies K^* = \frac{1}{2}$. L and K are neither perfect substitutes nor perfect complements.

6. **Wheelers and dealers (6 points total)**

A bike shop hires workers to "produce" bicycle repairs, with output given by the production function $q(L) = 6\sqrt{L + 4}$. It's both a price-taker ($p = 20$) and a wage-taker ($w = 15$).

a. (3 pts.) Compute the marginal physical product of labor in terms of L. Then compute the marginal revenue product of labor. What is the bike shop's marginal revenue?

The MPPL is $q'(L) = \frac{3}{\sqrt{L+4}}$ and the MRPL is $pq'(L) = \frac{60}{\sqrt{L+4}}$. Since the bike shop is a price-taker, its marginal revenue is just the price: $MR = 20$.

b. (3 pts.) Write the shop's profits as a function of L. Then find the profit-maximizing choice of labor L^*. How many bike repairs are made (q^*), and what is the total revenue?

We find L^* by setting MRPL equal to the wage: $\frac{60}{\sqrt{L+4}} = 15 \implies L^* = 12$. With this choice of labor, the bike shops sells $q^* = 24$ repairs, and total revenue is $p \cdot q^* = 480$.

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