Recitation 4 Answer Key

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Week 4 (9/18-9/24): Seller Choice

Recap of this week's most important concepts (Seller Choice):

- Production and costs (from tutorial):

  - Marginal product MP_L: compute it in a table, know its shape and why (labor specialization / diminishing marginal product)
  - Average product AP_L and relationship with marginal product
  - Costs:
    * Definition of costs: VC, FC, TC
    * Average costs AVC, AFC, ATC: compute in a table, with equations, and know shape of curves.
    * AFC is vertical distance between AVC and ATC curves
    * Marginal cost MC: relationship with AVC and ATC curves.

- Monopolistic competition:

  - Product differentiation: market demand vs. individual demand
  - Marginal revenue curve: twice the slope of demand if linear market demand ; MR = 0 where demand is unit elastic
  - Profit maximizing quantity such that $MR = MC$. Corresponding price and profit (graphically and mathematically)
  - Firm produces in the elastic portion of its demand curve
  - Short run profits can be positive or negative.
  - Producer surplus: area below price and above MC, but can also be calculated as $PS = TR - VC$ (so $\pi = PS - FC$)
  - Shut-down rule (if short-run loss, shut down if $TR < VC$ or $P < AVC$; operate otherwise).
  - Free entry implies zero profits (break-even) in the long run equilibrium (if positive SR profits: demand shifts in and becomes more elastic; if negative SR profits: demand shifts out and becomes less elastic, until it is tangent to ATC)

This week's group presentations:

- Group red: Question 5 Final Exam Fall 2015 (Modified)

  Seth produces and sells a differentiated product. Assume all fixed costs are sunk in the short-run. Seth has two short-run options: produce nothing, or produce and sell 1,000 units at a price of $10 per unit. If he produces 1,000 units, his average variable cost is $7 and his average fixed cost is $4. What should Seth do?

    a. Produce and sell 1,000 units at a price of $10, even though his profits will be negative

    b. Produce and sell zero units, even though his profits will be negative

    c. Produce and sell 1,000 units at a price of $10, making a profit because price is greater than average variable cost.

    d. There is not enough information

  Solution: a. If he sells 1,000 units at a price of $10, $AVC < P < ATC$, so he makes a negative profit (because $P < ATC$, which implies $TR < TC$), but he would lose even more by shutting down (because $AVC < P$, which implies $VC < TR$). Another way to check this is to compare his profit when he sells 1,000 units at a price of $10 with his profit when he shuts down. if he sells 1,000 units, his profit is $\pi = q(P - ATC) = 1,000(\$10 - \$11) = -1,000$; if he shuts down, he loses his (sunk) fixed cost. We know that if $q = 1,000$, $AFC = \$4$ so his fixed cost is $FC = 4,000$ (for any quantity). It is worse to lose $4,000 than to lose $1,000, so it is worse shutting down than producing.

- Group green: Question 4 Midterm 2 Spring 2012

  We know that a firm with $MC = 0$ and $MR = 10 - 2q$ is producing at $q = 5$. Which of the following must be true?

    I. The firm is maximizing profit.

    II. The firm is maximizing its revenue.

    a. Only I

    b. Only II

    c. Both I and II

    d. Neither I nor II

  Solution: c. $q = 5$ is the quantity such that $MR = 0$, which implies demand is unit elastic. So the firm maximizes revenue. Here, $MC = 0$ so $q = 5$ is also the quantity such that $MR = MC$ which implies that the firm maximizes profit. So both statements are correct.

- Group orange: Question 4 Final Exam Fall 2012 (Modified)

Consider a profit maximizing firm selling a differentiated good and facing a positive marginal cost. If the firm were to increase its price by a small amount, which of the following would certainly occur?

I. The firm's producer surplus would decrease.

II. Consumer surplus would decrease.

III. The firm's total revenue would decrease.

Which of the above is (are) unambiguously correct?

a. II

b. I and II

c. I and III

d. II and III

e. I, II and III

Solution: e. At the profit maximizing price, profit is maximum, and so is producer surplus (remember that $\pi = PS - FC$, and FC does not depend on the firm's strategy). Therefore, if the firm changes its price, its profit and producer surplus will not be maximum anymore so they will decrease (so I is true). If the firm increases its price, consumers pay a higher price and buy a lower quantity so consumer surplus shrinks (so II is true). The firm always produces in the elastic portion of the demand curve (or at the unit-elastic point, if $MC = 0$. Therefore, an increase in price (which implies a decrease in quantity) will move to another point on the elastic portion of demand: the decrease in quantity will offset the increase in price, so that total revenue ($TR = P \times q$) will decrease (so III is true).

(If times allows)

1. Consider a firm selling smartphone, a differentiated product. The cost of producing one phone is $MC = 12q$ and the firm faces a demand of $P = 200 - 4q$ (where P is in dollars and q is in millions). How many phones should the profit-maximizing firm produce? What price should it charge per phone?

a. $12,500,000$ phones at \$150 each

b. $12,500,000$ phones at \$100 each

c. $10,000,000$ phones at \$160 each

    d. $10,000,000$ phones at \$120 each

Solution: c. The firm's marginal revenue is $MR = 200 - 8q$ The profit maximizing quantity is such that $MR = MC$, i.e. $200 - 8q = 12q$, i.e. $q = 10$. The corresponding price is determined by demand: $P = 200 - 4 \times 10 = 160$. So c. is the right answer.

2. On Penn's campus there are a variety of restaurants (Allegro's, Greek Lady, etc.) that all aim to take advantage of students' poor reception of dining hall food. What can we say about this market?

    I. These firms are able to charge a price higher than their marginal cost.

    II. There are profits to be made in the long run.

    III. It's possible for new firms to enter the market.

    a. Only I.

    b. I. and III.

    c. II. and III.

    d. None of the above.

Solution: b. The market is monopolistically competitive. These restaurants have market power each of them faces a downward sloping demand curve and therefore is able to charge a price above its marginal cost (so I. is correct). In monopolistic competition there is free entry (so III. is correct), so long run profits are 0 (so II. is incorrect).

The next questions are for your own practice.

3. The cost function of a firm is: $TC(q) = 6 + 4q^3 + q$. When the output is 2, which of the following is correct?

    I. $ATC = 20$

    II. $AVC = 17$

    III. $AFC = 6$

    a. I., II. and III.

    b. I. and II.

    c. II. and III.

    d. I. and III.

e. Neither I., II. nor III.

Solution: b. From the total cost equation, we find that $FC = 6$ and $VC = 4q^3 + q$, so $AFC = FC/q = 6/q$ and $AVC = VC/q = 4q^2 + 1$. Moreover, $ATC = TC/q = 6/q + 4q^2 + 1$. When $q = 2$, $ATC = 6/2 + 4 \times 2^2 + 1 = 20$ (so I. is correct), $AFC = 6/2 = 3$ (so III. is incorrect) and $AVC = 4 \times 2^2 + 1 = 17$ (so II. is correct).

4. A food truck produces 500 units of the meal "chicken and rice". The AVC of the dish at that point is 2 dollars but is 2.5 dollars at a quantity of 550. We thus know that from 500 to 550:

   I. MC is increasing

   II. MC is higher than AVC

   a. I. only
   b. II. only
   c. I. and II.
   d. Neither I. nor II.

Solution: c. We know that AVC is increasing. Therefore, $MC > AVC$ (so II. is correct). Moreover, MC can be decreasing or increasing if it is below AVC, but it is only increasing if it is above AVC. Therefore, I. is correct.

5. In preparation for Hurricane Sandy, Ms. O'Malley has set up groups of high school kids to fill sand bags. She has found that by increasing the number of students per groups from 2 to 3 to 4 to 5, the number of sand bags filled per hour increases from 12 to 15 to 20 to 22. She deduces that:

   I. the marginal productivity is diminishing past the 4th student.

   II. the fifth student in each group should be sent home.

   a. Only I
   b. Only II
   c. Both I and II
   d. None of the above

Solution: a. The marginal product is 3 for the 3rd student, 5 for the 4th student, and 2 for the 5th student. So marginal product increases up to the 4th student, and then starts to decrease, so I. is correct.

Cost per unit, $

MC

A

ATC
AVC

B

Quantity, units
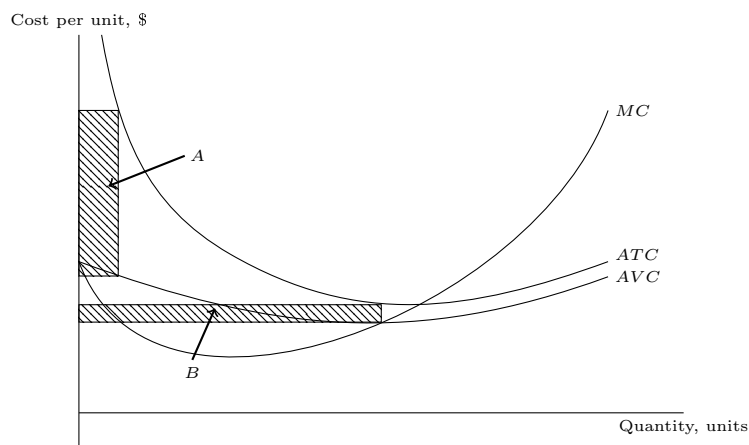
6. Consider a firm facing the cost curves as below. *Note: Picture Not Drawn to Scale.*

   A and B represent the two rectangles as indicated on the graph. Which of the following is true?

   I. $A > B$

   II. $A = B$

   II. $A < B$

   IV. Not enough information

   Solution: II. Both A and B represent the fixed cost: $(ATC - AVC)Q = AFC \times Q = FC$

7. Kate was originally producing at a quantity where she maximized her profits ($MR = MC$). She now wants to produce at the quantity where she maximizes her producer surplus. She will now produce:

   a. More than before

   b. Less than before

   c. The same amount as before

   d. not enough information to tell

   Solution: c. Producer surplus is $PS = TR - VC$ while profit is $\pi = TR - TC$, so $PS = \pi + FC$. The fixed cost does not depend on the quantity, so the quantity that maximizes producer surplus is the same as the quantity that maximizes profit.

8. Which of the following occur in a long-run equilibrium of a market characterized by monopolistic competition?

I. The price charged to consumers is "marked up" above marginal cost

II. There is free entry

III. Firms make positive profits

   a. I. only

   b. II. only

   c. III. only

   d. I and II.

   e. I. and III.

   f. II. and III.

   g. I., II. and III.

Solution: d. I is correct: price is above MC (firm has market power); II is correct: there is free entry in the long run; III is incorrect: profits are 0 in LR equilibrium.

9. Consider a differentiated firm whose goal is not maximizing profit, but rather maximizing revenue. Suppose the marginal cost is positive. We can deduce that the firm is:

   I. maximizing producer surplus.

  II. maximizing consumer surplus.

 III. maximizing total surplus.

   a. All three statements are correct.

   b. All three statements are false.

   c. Statement I may be correct, but II and III are false.

   d. Statement II may be correct, but I and III are false.

   e. Statement III may be correct, but I and II are false.

Solution: e. The quantity that maximizes producer surplus is the same as the quantity that maximizes profit (because $PS = \pi + FC$ and the fixed cost does not depend on the quantity). Since the firm is not maximizing its profit, it is also not maximizing its producer surplus (so I. is false). The quantity produced by the firm is the quantity that maximizes revenue, such that $MR = 0$, i.e. such that demand is unit elastic. If the marginal cost happens to intersect demand at the unit elastic point of demand, then the quantity produced by the firm will happen to be the efficient quantity, i.e. the quantity that maximizes total surplus (so III. may be correct). Consumer surplus would be maximum if the quantity was the x intercept of demand and the price was zero. That's not the price and quantity that are set by the firm when it maximizes revenue (so II. is false).