

**Economics 101**  
**Spring 2011**  
**Homework #5**  
**Due 4/12/11**

**Directions:** The homework will be collected in a box **before** the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Please remember the section number for the section **you are registered**, because you will need that number when you submit exams and homework. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!

1. Suppose there is a perfectly competitive industry with a market demand curve that can be expressed as:

$$P = 100 - (1/10)Q$$

where P is the market price and Q is the market quantity. Furthermore, suppose that all the firms in this industry are identical and that a representative firm's total cost is:

$$TC = 100 + 5q + q^2$$

where q is the quantity produced by this representative firm. The representative firm's marginal cost is:

$$MC = 5 + 2q.$$

- a. What is the average total cost for the representative firm?

Key: Take TC and divide by q to find ATC.  $ATC = 100/q + 5 + q$

- b. In the long run, how many units will this firm produce and what price will it sell each unit for in this market?

Key: To find the quantity the firm will produce in the long run recall that  $ATC = MC$  in the long run for the firm.

$$100/q + 5 + q = 5 + 2q$$

$$q = 10$$

We can then figure out the market price by remembering that in the long run this firm's  $MC = MR = P$ . Once you know the quantity the firm will produce in the long run (10 units) you can plug this value into the firm's MC curve and get

$$P = 5 + 2 \cdot 10 = \$25.$$

- c. What is the total market quantity produced in this market in the long run?

Key: From part (b) you know the market price is \$25. Use this price and the market demand curve to find the market quantity:

$$25 = 100 - (1/10)Q$$

$$Q = 750$$

d. How many firms are in the industry in the long run?

Key: Since each firm makes 10 units and  $Q = 750$ , there are 75 firms in the industry.

e. How do short-run profits change for the firm if demand decreases? Increases?

Key: If demand decreases, short run profits decrease since marginal revenue decreases. If demand increases, short run profits increase since marginal revenue increases.

f. How do long-run profits change for the firm if demand decreases? Increases?

Key: Long run profits are always equal to zero. Firms will enter and exit the industry until this condition holds in the long run.

2. Consider another perfectly competitive industry with a market demand curve given as:

$$Q = -2P + 1,000$$

Again, suppose that all the firms in this industry are identical. But now, we do not know the total cost, instead we know that the long run average total cost for a representative firm in the industry is:  $LRATC = q^2 - 10q + 100$ . And each firm's marginal cost is given by:  $MC = 3q^2 - 20q + 100$ .

a. In the long run, how many units will a representative firm produce and what price will it sell each unit for in this market?

Key: Set LRATC equal to MC:

$$q^2 - 10q + 100 = 3q^2 - 20q + 100$$

$$q = 5$$

In a competitive market, price equals marginal cost. Plugging the quantity we found into the marginal cost equation gives  $P = MC = 75$ .

b. How many firms are in the industry in the long run?

Key: Plugging the price into the market demand equation to find market demand is  $Q = -2 * 75 + 1,000 = 850$ . Since each firm produces 5, the number of firms is 170.

c. Suppose there is an increase in the market demand for the good. The new demand curve is given by:

$$Q^{\text{new}} = -2P + 1,196.$$

Briefly describe what will happen to the existing firms' profit in the short run and the number of firms in the industry in the long run.

Key: In the short run, the demand curve shifts to the right. The market price increases. Each firm produces the level of output where market price equals marginal cost. Since marginal cost is above the average cost curve at this point, each of the firms will earn positive profits.

In the long run, new firms will enter the industry attracted by the positive profits. The market supply curve will shift back until each firm is producing at the lowest point of its average cost curve and profits for each firm are equal to zero.

d. In the short run, each firm's supply curve will be its marginal cost curve. Suppose we know that each firm will produce 6 units in the short run. What is a representative firm's short run profits?

Key: In the short run, there are still 170 firms. But each firm is now producing 6 units. Thus, market supply is  $Q = 170 * 6 = 1,020$ .

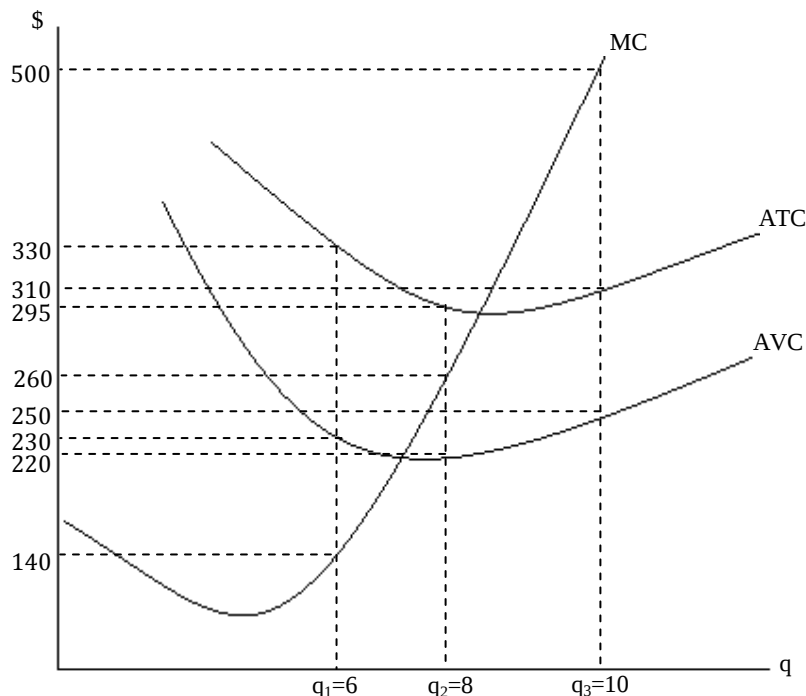
Since the market is in equilibrium, we can plug the quantity into the new demand curve and get the new market price is  $P = (1,196 - 1,020)/2 = 88$

Profits = total revenue - total cost =  $6 * 88 - 6 * (6^2 - 10 * 6 + 100) = \$72$ .

e. In the long run, approximately how many new firms will enter?

Key: In the long run, each firm in the industry makes zero profit. And the output of each firm will again be exactly 5 units. The market price will go back to 75. Given the new market demand  $Q = -2 * 75 + 1,196 = 1046$ , there are approximately 209 firms in the industry. So there will be approximately 39 new firms.

3. Use the graph below to answer the following questions.



- a. Find (i) variable cost, (ii) fixed cost, (iii) total cost, and (iv) profits at output levels  $q_1$ ,  $q_2$ , and  $q_3$ .

|                                                                             |                                        |
|-----------------------------------------------------------------------------|----------------------------------------|
| (i) Variable Cost: $VC = AVC \cdot q$                                       | $q_1: VC = 230 \cdot 6 = 1380$         |
| $q_2: VC = 220 \cdot 8 = 1760$                                              | $q_3: VC = 250 \cdot 10 = 2500$        |
| (ii) Fixed Cost: $FC = AFC \cdot q = (ATC - AVC) \cdot q$                   | $q_1: FC = (330 - 230) \cdot 6 = 600$  |
| $q_2: FC = (295 - 220) \cdot 8 = 600$                                       | $q_3: FC = (310 - 250) \cdot 10 = 600$ |
| (iii) Total Cost: $TC = VC + FC$                                            | $q_1: TC = 1380 + 600 = 1980$          |
| $q_2: TC = 1760 + 600 = 2360$                                               | $q_3: TC = 2500 + 600 = 3100$          |
| (iv) Profits: $\text{Profits} = TR - TC = P \cdot Q - TC = MC \cdot Q - TC$ |                                        |
| $q_1: \text{Profits} = 140 \cdot 6 - 1980 = -1140$                          | $q_2: TC = 260 \cdot 8 - 2360 = -280$  |
| $q_3: TC = 500 \cdot 10 - 3100 = 1900$                                      |                                        |

- b. At which of the output levels ( $q_1$ ,  $q_2$ , and  $q_3$ ) will the firm operate in the short run?

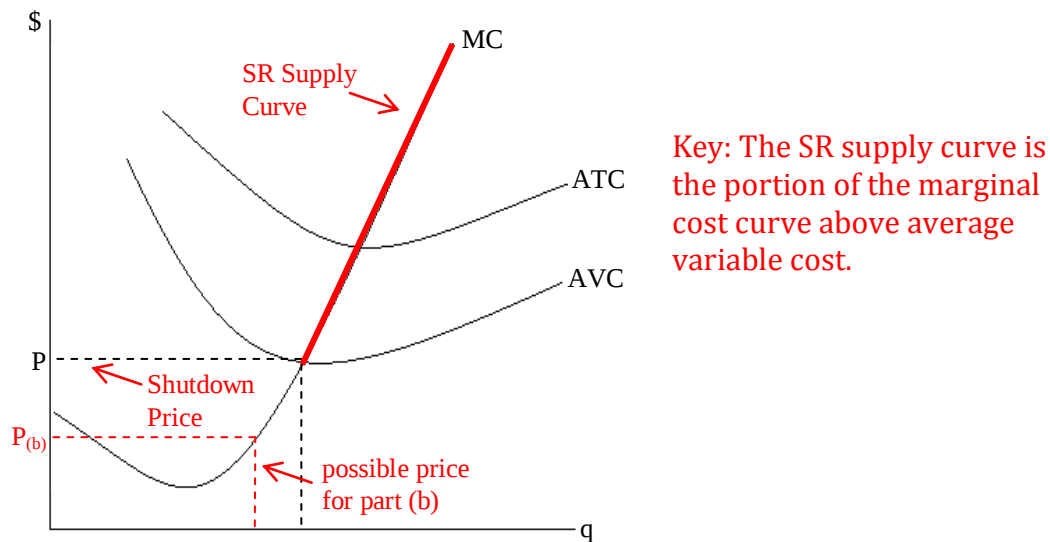
Key: The firm will operate at  $q_2$  and  $q_3$  in the short run. It will shut down at  $q_1$ .

- c. At which of the output levels ( $q_1$ ,  $q_2$ , and  $q_3$ ) will the firm operate in the long run?

Key: The firm will operate at  $q_3$  in the long run. It will shut down at  $q_1$  and  $q_2$ .

4. In each of the following questions, draw MC, ATC, AVC, and any other things relevant to the question in addition to answering in words.

- a. How can you find the supply curve for a firm in the short run? Label the SR supply curve on your graph.



- b. Suppose you know that the price level is below average variable cost. Label such a price on your graph. Also, show where this price lies on the SR supply curve or

explain why you cannot. What does price being below AVC mean for a firm in the short run?

Key: See graph in (a) for a possible price. The price does not lie on the SR supply curve. This is because if price is below AVC, then a firm will not produce in the SR. If the price is below AVC, then the firm will shut down.

- c. Suppose that the firm is earning positive profits in the short run. On a separate graph, label a possible price on your graph that would give positive profits and shade the area representing the firm's profits.

Key: See graph below in part (d).

- d. Suppose that the firm is earning negative profits in the short run. On a separate graph, label a possible price that would give negative profits and shade the area representing the firm's losses. Why does the firm continue operating in the short run, even though it is making negative profits? Compare these losses to the firm's losses if it shuts down in the short run.

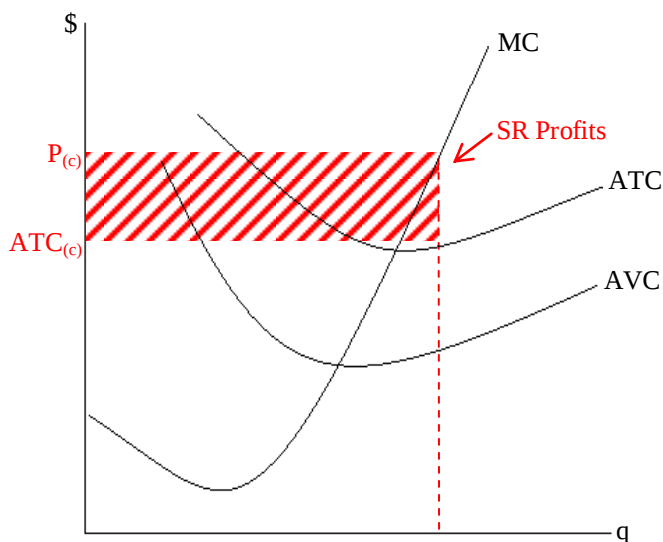
Key: The firm continues to operate even though it is earning negative profits, because as long as price is above AVC the firm is no worse-off than if it shut down. This is true because the firm cannot do anything about its fixed costs: fixed costs are sunk costs in the short run and cannot be changed. If the firm earns anything greater than its average variable cost, it might as well continue operating in the short run.

SR losses if operate: Profits =  $q^*(P - (AVC + AFC)) = q^*(P - AVC) - FC$

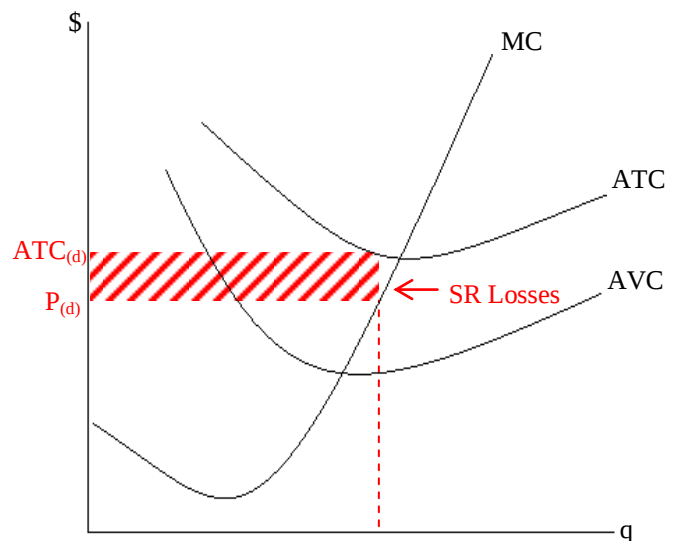
SR losses if don't operate: Losses = FC

→ Operate as long as  $q^*(P - AVC) - FC > 0$ , → operate if  $P > AVC$ .

Graph for Part (c)

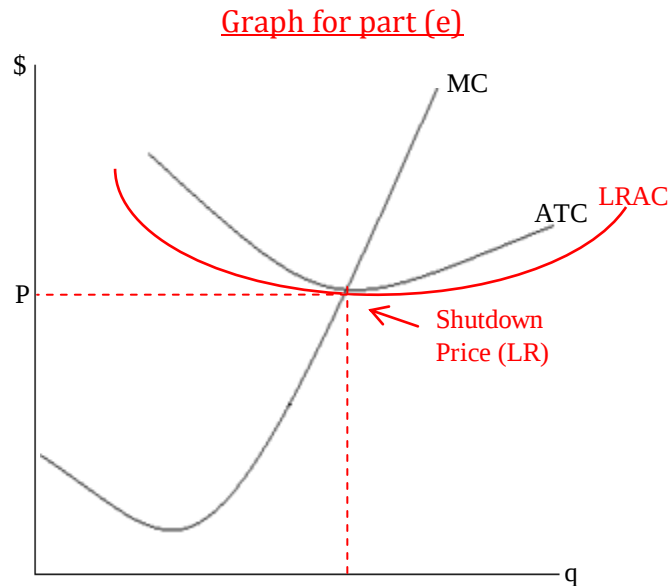


Graph for Part (d)



- e. Suppose now you are looking at the long run. Using the original setup, add the long run average cost curve. At what price will a firm shut down in the long run? Label this point on your graph.

**Key:** In the long run, a firm will shut down if price is below LRAC.



5. A firm in the textbook industry has the total cost function  $TC = 40 + 100q + 10q^2$ , and the marginal cost function  $MC = 100 + 20q$ .

- a. What are the firm's fixed costs?

**Key:** The firm's fixed costs are the parts of the TC curve that don't depend on quantity:  $FC = 40$

- b. What is the firm's variable cost curve?

**Key:** The variable cost curve is the part of TC that does depend on quantity:  
 $VC = 100q + 10q^2$

- c. What is the firm's average variable cost curve?

**Key:**  $AVC = VC/q = 100 + 10q$

- d. In the short run, this firm will produce a positive quantity as long as the price is larger than what?

Key: The firm will produce a positive quantity as long as the price is larger than where MC intersects AVC. Since we know the firm produces where  $P = MC$ , this means the firm will produce as long as  $MC > AVC$ :

$$100 + 20q > 100 + 10q$$

$$10q > 0, \text{ which means } q > 0$$

So,  $MC = P > 100 + 20 \cdot (0) = 100$ . The firm will produce for  $P > 100$ .

e. At what price will the firm's total profits be equal to zero?

Key: Profits are zero when  $ATC = MC = P$ .

$$40/q + 100 + 10q = 100 + 20q$$

$$40/q = 10q$$

$$40 = 10q^2$$

$$4 = q^2, \text{ which means profits are zero when } q = 2$$