Economics 101
Spring 2019
Answers to homework #4
Due Thursday, April 11, 2019

Directions:

- The homework will be collected in a box labeled with your TA's name **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 **staple** your homework: we expect you to take care of this prior to coming to the large lecture. You do not need to turn in the homework questions, but your homework should be neat, orderly, and easy for the TAs to see the answers to each question.
- Late homework will not be accepted so make plans ahead of time.
- Show your work. Good luck!

Part I: Production Costs

1. The following table gives cost information for a firm. Assume that labor is paid a constant wage and capital is paid a constant price, i.e., our firm is a price-taker both in the labor and capital markets.

L	K	Q	VC	FC	TC	AVC	AFC	ATC	MC	MPL
0	10	0		100	100	---	---	---	---	---
1	10	5		100	200					
2	10			100					5	
3	10			100						25
4	10			100						30
5	10			100				6		
6	10			100						5

a. Complete the above table with specific numbers.

L	K	Q	VC	FC	TC	AVC	AFC	ATC	MC	MPL
0	10	0	0	100	100	---	---	---	---	---
1	10	5	100	100	200	20	20	40	20	5

2	10	25	200	100	300	8	4	12	5	20
3	10	50	300	100	400	6	2	8	4	25
4	10	80	400	100	500	5	1 1/4	6 1/4	3 1/3	30
5	10	100	500	100	600	5	1	6	5	20
6	10	105	600	100	700	5 5/7	20/21	6 2/3	20	5

b. At what level of output is ATC at its minimum?

When Q = 100, ATC attains its minimum.

c. At what level of labor usage does the law of diminishing returns first occur?

When hiring the 5th unit of labor, the marginal product of labor starts to increase at a decreasing rate.

d. At what level of output does marginal cost attain its minimum?

When Q = 80, marginal cost attains its minimum.

e. When output is equal to zero units, why does the firm still incur costs in the short run? Explain your answer.

In the short run, the firm cannot get rid of its capital instantaneously. So even though the output level is zero, the firm still has to pay its fixed costs.

Part II: Perfect Competition

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

$$P = 200 - (1/10)Q$$

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

$$TC = 225 + 5q + q^2$$

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?

Take TC and divide by q to find ATC. ATC = 225/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?

To find the quantity the firm will produce in the long run recall that ATC = MC in the long run for the firm.
$225/q + 5 + q = 5 + 2q$
$q = 15$
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 (15 units) you can plug this value into the firm's MC curve and get P = 5 + 2*15 = $35.

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

From part (b) you know the market price is $35. Use this price and the market demand curve to find the market quantity:
$35 = 200 – (1/10)Q$
$Q = 1650$

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

Since each firm makes 15 units and Q = 1650, there are 110 firms.

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

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

3. Consider a perfectly competitive industry composed of six identical firms that produce widgets. Suppose you are told that the representative firm has the following cost curves where TC is total cost measured in dollars and q is units of widgets produced by a particular firm:

Total Cost: $TC = 4 + 4q + q^2$
Marginal Cost: $MC = 4 + 2q$

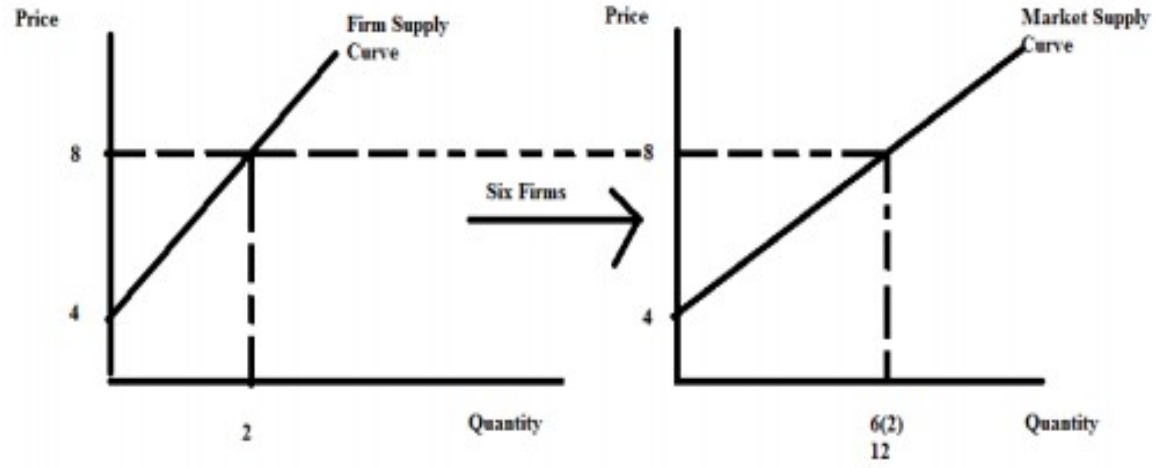
Suppose you also know that the market demand curve is given by the following equation where P is the market price in dollars and Q is the market quantity of widgets:

Market Demand: $P = 19 – (1/2)Q$.

Q represents market quantity and q represents firm quantity.

a. Given the above information write an equation for the market supply curve. Explain how you found this equation.

We know that the firm's MC curve is its supply curve: technically speaking the firm's MC above its AVC curve is its supply curve, but for this exercise we can just take the MC curve as the firm's supply curve (this is because AVC and MC only intersect when q=0, so the shutdown 4 point is also where P = MC gives zero quantity anyway). We also know that there are six firms in the industry. So, let's put this together graphically to illustrate the connection between these two ideas:



Graphing the representative firm's MC curve, we can see that the y-intercept is 4 and then choosing some cost per unit (in the graph I chose $8 per unit) we can see that the representative firm is willing to supply 2 units of output. Since there are six identical firms we can deduce that the total amount produced in the market when the cost for the additional unit is $8 per unit will be 12 units. The market supply curve can therefore be written as P = 4 + (1/3)Q.

b. Given the market supply curve you found in (a), calculate the short run market equilibrium quantity and price in this market. How many units of output will the representative firm produce in the short run? Calculate the short-run profits for the representative firm. Explain your work.

We know that the market demand and market supply curves are as follows:
Market Demand: P = 19 – (1/2)Q
Market Supply: P = 4 + (1/3)Q
Set these two equations equal to one another:
19 – (1/2)Q = 4 + (1/3)Q
114 - (3)Q = 24+ (2)Q
90 = 5Q
Q = 18 widgets and P = 19 – (1/2)Q = 19 - (1/2)(18) = 19 - 9 = $10.

The representative firm is a price-taking firm, so it will charge $10 per widget and it will view this market price as equivalent to its MR curve. Thus, MR = 10. The representative firm will equate MR to MC to decide its profit maximizing output. The firm does this because it wants to equate the addition to total cost from producing the last unit of the good (the MC) to the addition to total revenue from selling the last unit of the good (the MR): when the firm produces that quantity where MR = MC the firm knows that it is profit maximizing.
Thus, 10 = 4 + 2q
6 = 2q
q = 3 widgets

In the short run the firm will produce 3 widgets and charge $10 per widget. Short-run profit for the firm can be computed as TR – TC. For the representative firm:
TR = P*q = ($10 per widget)(3 widgets) = $30

TC = 4 + 4q + q 2 = 4 + 4(3) + (3)(3) = 4 + 12 + 9 = $25
Profit in the Short-run for the firm = $30 - $25 = $5

c. Given your calculations in (b), will the representative firm produce in the short-run? Explain your answer.

The firm will produce in the short-run since its profits are greater than zero. This tells us that total revenue is greater than total cost and it assures us that this firm's revenue in the short run is sufficient to cover its variable costs of production in the short run. We know that the total revenue in the short run exceeds the sum of variable cost and fixed cost in the short run, so total revenue must exceed the short-run variable cost.

d. Given your answer in (b), what do you predict will happen in the long-run in this industry?

Since short-run profits are positive, you can predict that firms will enter the industry in the long-run. This will cause the market supply curve to shift to the right and result in a decrease in the market price, an increase in the market quantity, and a decrease in the level of production by firms in the industry.

e. Given no changes in the firm's cost curves or the market demand curve, calculate the following and explain how you found your answers:

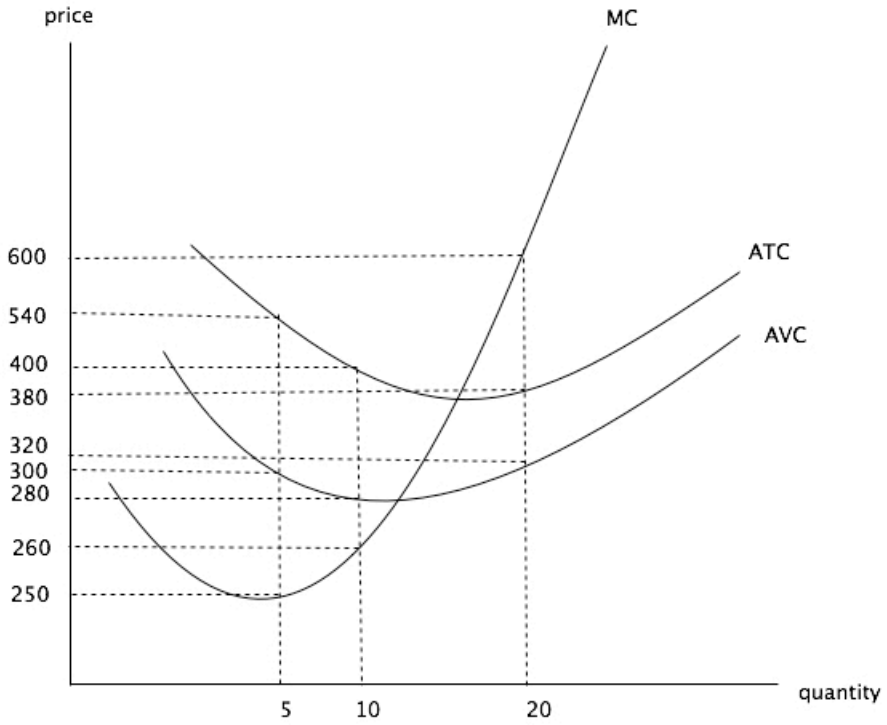
Long-run equilibrium market price; long-run equilibrium market quantity; level of production by the representative firm and number of firms in industry in the long-run.

In the long-run ATC = MC for the representative firm since the representative firm earns zero economic profit in the long-run.
Thus, (4/q) + 4 + q = 4 + 2q
4/q = q
q = 2 widgets
We also know that in the long-run, the firm continues to profit maximize by producing where MR = MC and we can use this idea to find the long-run market price.
Thus, MR = MC
MR = 4 + 2q
MR = 4 + 2(2) = $8 per widget = Long-run market price
We can use this market price (the price that will result in all firms left in the industry earning zero economic profit) and the market demand curve to calculate the long-run market equilibrium quantity.
Thus, P = 19 – (1/2)Q
8 = 19 – (1/2)Q
Q = 22 widgets
To find the number of firms in the industry in the long-run we can divide the market quantity, Q, by the representative firm's production, q:
Thus, Q/q = (22 widgets)/(2 widgets per firm) = 11 firms in the industry

To sum up: Long-run equilibrium market price = $8
Long-run equilibrium market quantity = 22 widgets
Level of production by representative firm = 2 widgets
Number of firms in industry in the long-run = 11 firms

Part III: Interpreting Cost Curves

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



a. Find variable cost, fixed cost, total cost and profits at output levels q = 5, 10 and 20.

	q = 5	q = 10	q = 20
Variable Cost	1500	2800	6400
Fixed Cost	1200	1200	1200
Total Cost	2700	4000	7600
Profit	-1450	-1400	4400

Profits = TR – TC = P*Q – TC = MC*Q – TC

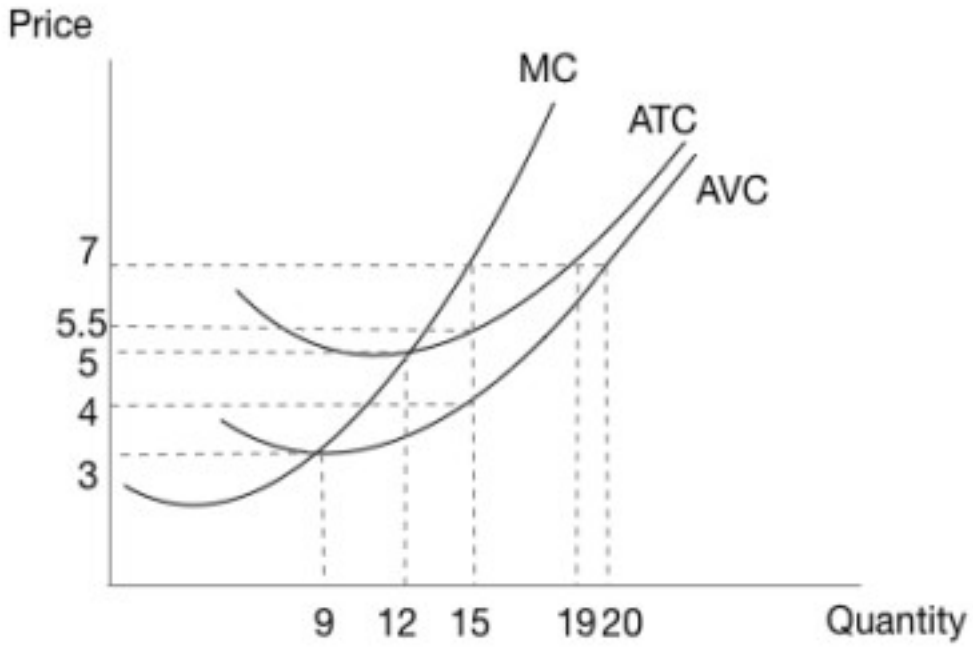
b. At which of the output levels (q = 5, 10 and 20) will the firm operate in the short run?

The firm will operate at q = 20 but will shut down at q = 5 and q = 10.

c. At which of the output levels (q = 5, 10 and 20) will the firm operate in the long run?

The firm will operate at q = 20 but will shut down at q = 5 and q = 10.

5. The figure below depicts the cost structure of a t-shirts company in a competitive market.



a. What is the fixed cost for this company?

When quantity is 15, ATC is $5.5 per unit of output and AVC is $4 per unit of output, so total cost is 15*$5.5= $82.50. Total variable cost is 15*$4 =$60, so the fixed cost is total cost - total variable cost = $82.50 - $60 = $22.50.

b. When the price level is $7, what is the profit for this profit-maximizing firm?

When the price level is $7, the optimal quantity to produce for the firm is 15 units of output. This is because when the quantity is less than 15 units, the marginal cost of producing the last unit is lower than the price level, and when the quantity is greater than 15 units, the marginal cost of producing the last unit is higher than the price level. So when the quantity is 15 units, the firm is maximizing profit. When the quantity is 15 units, the average total cost (ATC) for the firm is $5.50 per unit of output, so the total profit is (7 - 5.50) *15 = $22.50.

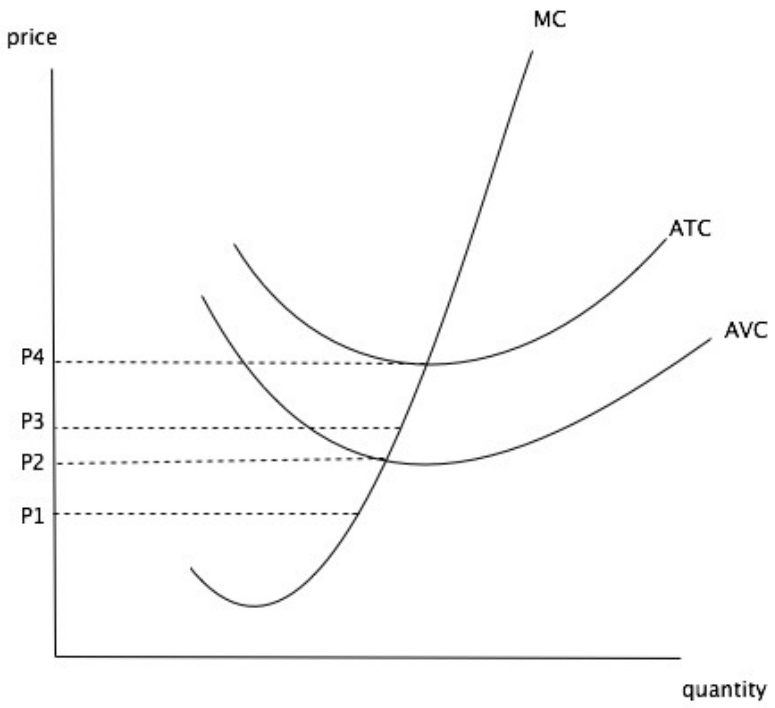
c. What are the Breakeven and Shutdown prices for this firm?

The Breakeven-price for the firm is the price at the minimum of ATC, which is the intersection point of MC and ATC, so for this firm the Breakeven price is $5. The Shutdown price is the price at the minimum of AVC, which is the intersection point of MC and AVC, so for this firm the Shutdown price is $3.

d. Assume there are many t-shirts companies in the market that are identical to one another and the market is perfectly competitive. Given this information, what is the long run equilibrium price in this market, and how many t-shirts will each firm produce in the long run?

In the long run equilibrium, firms will be making zero profits, so the equilibrium price must be the breakeven price, which is $5. When the price is $5, it is optimal for firms to set the quantity level such that MC = 5. Each firm in this market in the long run will therefore produce 12 t-shirts.

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



a. How can you find the supply curve for a firm in the short run?

The Short Run supply curve is the portion of the firm's marginal cost curve above its average variable cost. In this example, the firm's supply curve is the MC curve at prices greater than or equal to P2.

b. For which price range does the firm produce but incur losses in the short run? Why does the firm continue operating in the short run, even though it is making negative profits? Show it mathematically.

For price range from P2 to P4 the firm operates although it is earning negative profits. As long as the price is above the firm's shutdown price which is the min AVC (which happens when AVC = MC) the firm operates due to the notion of fixed costs. Fixed costs are sunk in the short run and cannot be changed. Another way to think about this is that the firm can do nothing about its fixed costs in the short run so the firm's only issue in the short run is to make sure its revenue is sufficient to cover its variable costs. Provided its price is equal to or greater than the minimum AVC the firm will cover its variable costs.
Short run losses if the firm operates = profits = $Q*P - TC = Q*P - (AVC + AFC)*Q = Q*(P - AVC) - Q*AFC = Q*(P - AVC) - FC$.
Short run losses if the firm operates = FC. Therefore, as long as $P > AVC$, firm will continue operating in the short run.

c. For what prices does the firm produce in the long run?

In the long run the firm will shut down if the price is below the breakeven price: min ATC (which happens where ATC = MC, P4).