

Problem Set #4

1) Suppose fast food firms have production functions of the form:

$$Q = G(\text{FM}, \text{Teens})$$

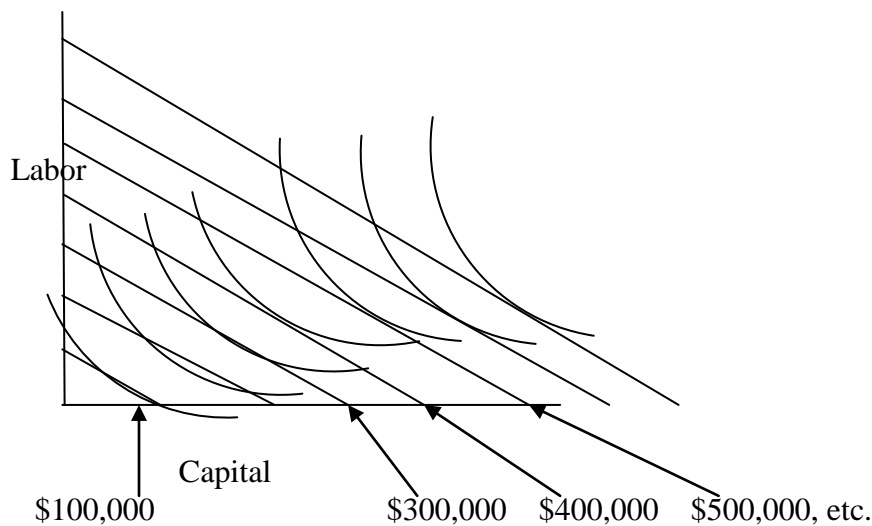
Where:  $Q$  is the quantity of fast food produced per week,

FM is the number of frying machines leased per week.

Teens is the number of teenagers, ages 16-19, employed per week.

Let  $V$  be the cost of leasing a frying machine for a week and  $W$  be the wage required to hire a teenager for a week. Assume the production function,  $G(\ )$  allows for normal substitution between frying machines and teenagers. That is, it produces standard “curved” isoquants rather than the “right angle” isoquants of the one-person-with-one-shovel example we briefly discussed in class.

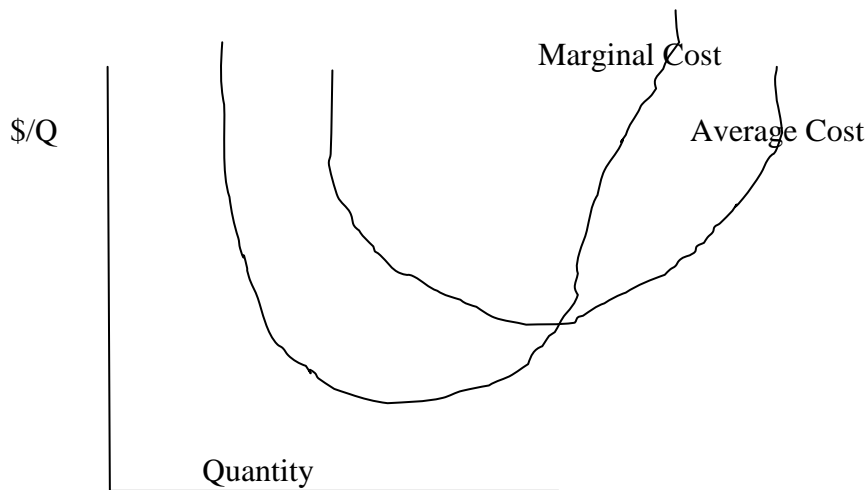
a, Draw a set of diagrams that shows how we begin with isoquants and isocost lines and cost minimization and show how this leads to the total cost curve for a fast food firm. Then show how the total cost curve leads to the average and marginal cost curves. Draw the isocost lines to show equal increments of cost - \$10,000, \$20,000, \$30,000 etc. Then label the isoquant lines so that the resulting total cost curve first shows increasing returns as output expands and then decreasing returns.

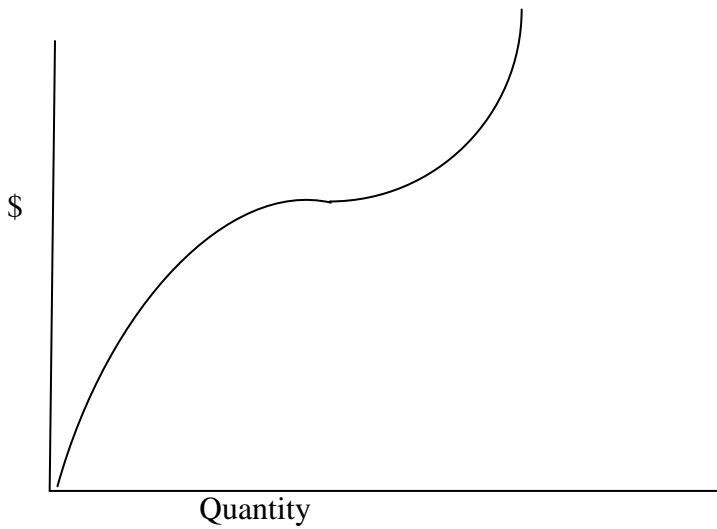


Answer (part 1) (I am still a little challenged by the drawing tools in Word). As asked for in the problem, the isocost lines are spaced at equal distances – say each line representing \$100,000 more in expenditure than the previous line. Increasing returns means that if you double your expenditure, you more than double your output. So if the lowest isoquant is labeled 200 units, then the second lowest isoquant should be labeled something larger than 400 units – say 450. The third isocost line is \$300,000 - a 50% increase over the second isocost line – so increasing returns here would mean more than a 50% increase in 450 units – say 700 units.

As you continue to move out, you can illustrate decreasing returns using the same logic. If we move from the \$500,000 isocost line to the \$600,000 isocost line, we have increased the cost of inputs by 20 percent and decreasing returns here says that the increase in output should be less than 20 percent, etc.

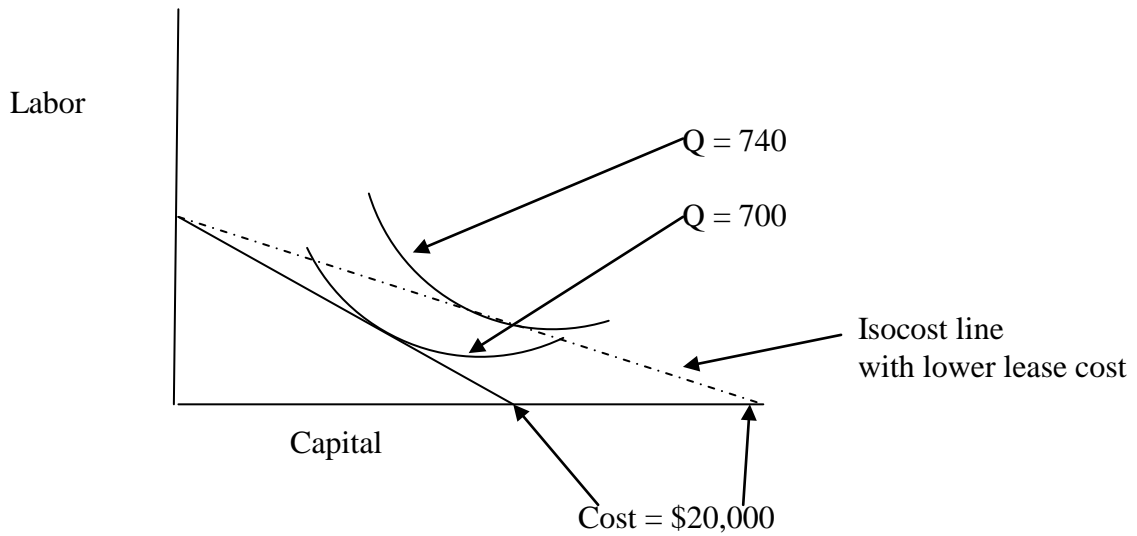
This isocost/isoquant diagram results in the standard Average Cost/Marginal Cost Diagram that shows first falling Average Costs (reflecting increasing returns to scale) and then rising Average Costs and a the corresponding drawing for total costs.





b. Suppose a technical innovation in frying machines reduces  $V$ , the lease cost, by one-half. Use a series of drawings to show (roughly) how this fall in  $V$  changes your isoquant/isocost map, the total cost curve, average cost curve and the marginal cost curve.

Answer: We can see the main story by looking at a typical tangency on the isocost/isoquant map:



As the lease cost of frying machines falls, the isocost line (in this case for \$20,000) rotates counter-clockwise – i.e. if you spend all your money on labor, you can purchase the same as before but if you spend all your money on leasing frying machines, you can purchase twice as much as before. The new isocost line is the dashed line above).

While the isocost lines rotate counterclockwise, the isoquant lines don't change <sup>1</sup>. In the drawing above, the old \$20,000 isocost line was tangent to an isoquant of 700 units of food. After the fall in the leasing cost of frying machines, the new \$20,000 isocost line is tangent to a higher isoquant – in this case 740 units of food.

Bottom line: After the lease cost of frying machines falls, every level of output,  $Q$ , costs less than it used to cost. This means that at any level of output, your Total Cost Curve, Average Cost Curve and Marginal Cost Curve should all shift down. From the information given, we don't know whether every point on a, say, the MC curve, shifts down by the same amount because that depends on the particular isoquants/production function.

c. The lower lease rate of frying machines means that fewer teenagers will be hired *per unit of fast food*. Does it follow that fewer teenagers will be hired in *the fast food industry*? How does the price elasticity of demand for fast food affect your answer?

Answer: Since minimum average cost is now lower for each individual firm, competition will force the price of fast food to be lower. If demand is very elastic, the lower price may cause a sufficient increase in demand and output that the number of teenagers hired increases – i.e. there are fewer teenagers hired per unit of food but the number of units of food produced grows enough to compensate. In some sense, this was the strategy used by Henry Ford in instituting the assembly line – the

2) Assume that chickens are produced by many farmers in a perfectly competitive industry. All farmers have identical technologies and minimum average cost is reached at \$3.00 per chicken.

- On Friday, October 7, 2010, the industry is in long run equilibrium.

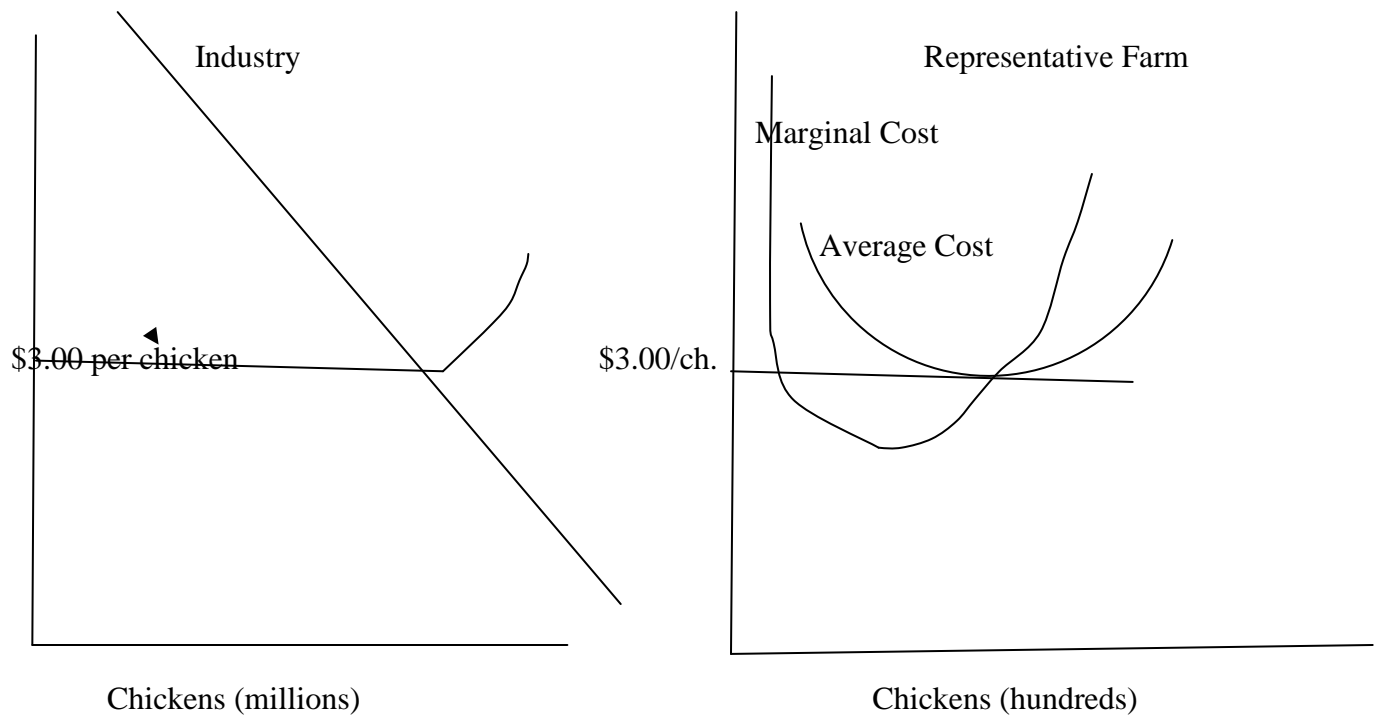
- On Monday, October 10, 2010, the government imposes a tax of 25 cents per chicken.

a) Using appropriate diagrams, draw the equilibrium for the industry and the representative chicken farmer as of October 5.

Answer: By saying October 5 instead of October 7, I was unnecessarily confusing. I wanted a picture of the industry and firm in equilibrium. That picture looks like this:

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<sup>1</sup> Make sure you understand why the isoquants don't change. Think about the analogy to utility maximization. If the price of hamburgers falls, the budget line will rotate and your utility maximizing solution will probably involve more hamburgers and fewer apples but the shape of the indifference curves does not change.

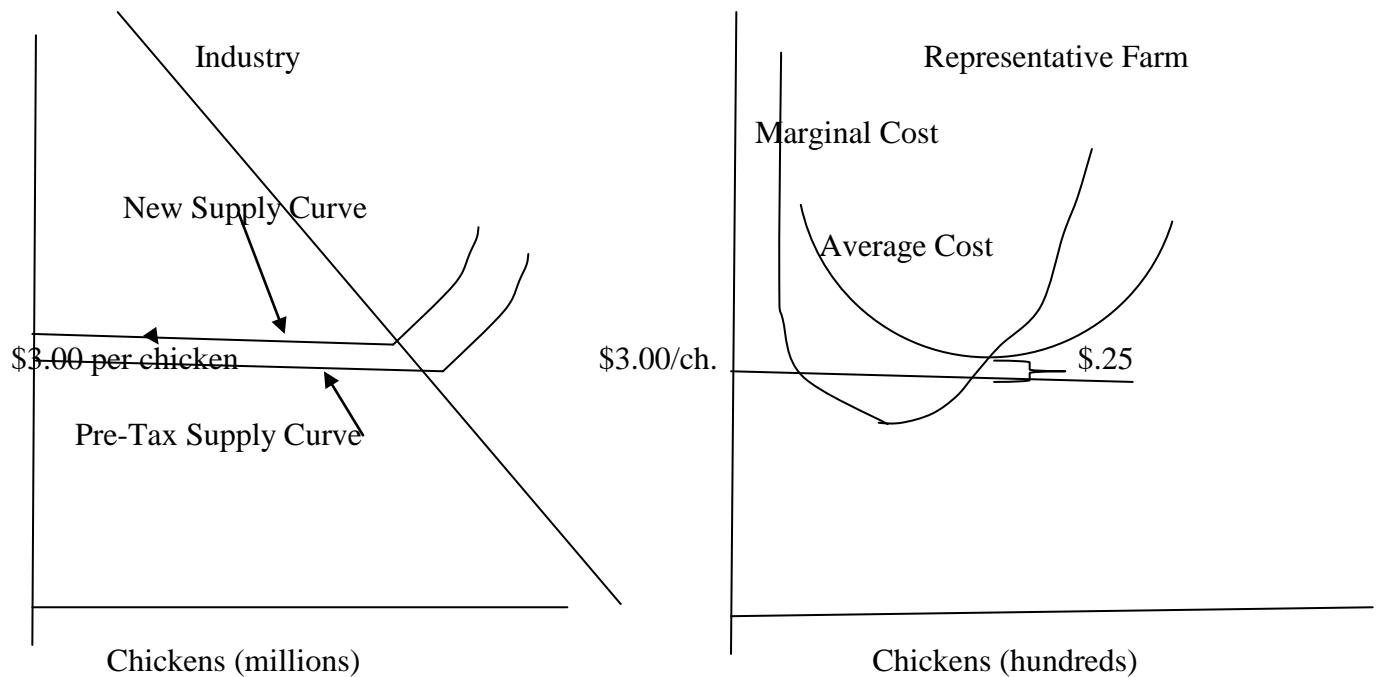


Answer: This is our standard drawing. In considering how to draw the firm, begin with two ideas:

- The farmer seeks to maximize profit. This means that he will set  $P = MC$ .
- The industry is in equilibrium. Another way of saying this is that farms are neither entering nor leaving the industry. This means that farms in the industry must be breaking even (if they were making profit, other farms would be entering; if they were making losses, some farms currently in the industry would be dropping out). If farms are breaking even, this means that  $P = AC$  (i.e. price = average cost which leads to zero profit or loss)
- If you put these two conditions together,  $P = MC$  and  $P = AC$  only occur when  $P = MC$  at minimum AC which is what we have drawn.

As for the industry, the supply curve has an elastic segment at \$3.00 and then a short run supply curve which we get by adding up the marginal cost curves (above \$3.00) of all firms currently in the industry).

b) Again, using appropriate diagrams, show in both the short run and the long run how the industry and the representative farm adjusts to the 25 cent per chicken tax.



Answer: As we know from earlier discussion (and pointed out again by Maryann) we can start drawing the impact of the tax as either an increase in costs of the firm or a decrease in price seen by the firm. I find it easier to start the problem as if the firm has to pay \$.25 on each chicken as it goes out the door (this is just a start – we have to follow through the logic).

I have drawn this above. The average and marginal costs curves now shift up at all points by 25 cents.

You can see from the diagram that if the price stayed at \$3.00, all farms in the industry are now making a loss. As a result, some firms will start dropping out. (Since the firms all have the same cost curves, there is no way to say *which* farms will drop out – think of it as random.)

We can spin out the rest of the story: We know in the long run that if firms' minimum AC is now \$3.25, the price will have to rise to \$3.25 so that farms who remain in the industry will be able to break even again. The price rise will be caused by farms dropping out of the industry. In other words, the tax is passed; farms are now making a loss at \$3.00 a chicken, farms start to drop out of the industry, the supply of chickens contracts, and the price rises, and the process continues until the price has reached \$3.25 when we are back in equilibrium.

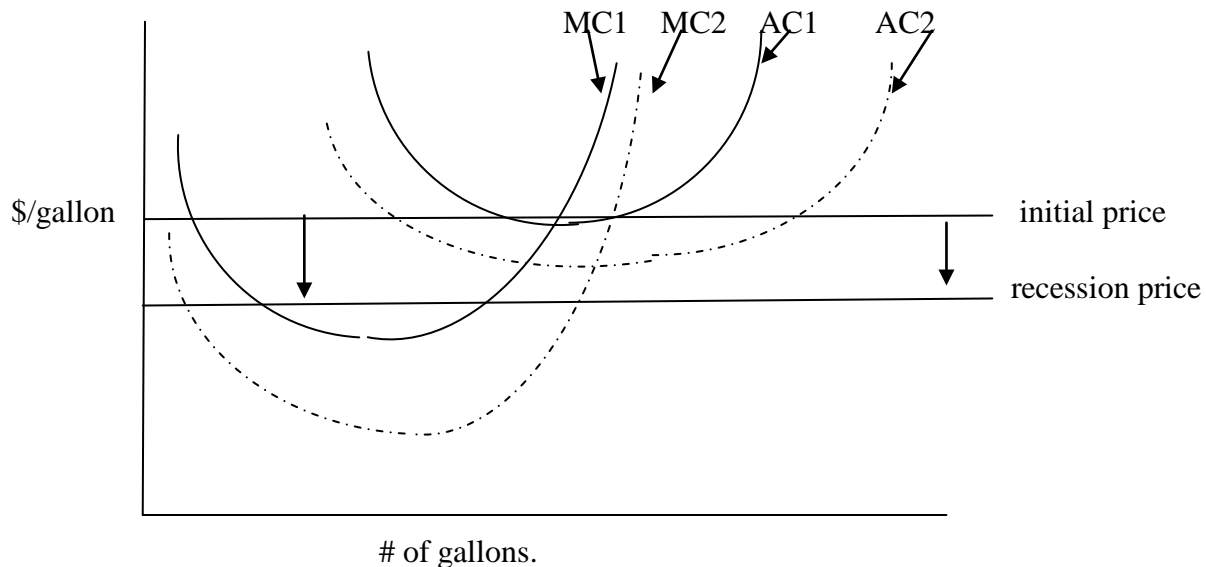
**Question to think about: On the one hand, we have described these firms as pure price takers – they have no power to set prices. On the other hand, the price of chickens has increased by \$.25 per chicken – i.e. consumers are paying the full amount of the tax. How can we reconcile these two ideas?**

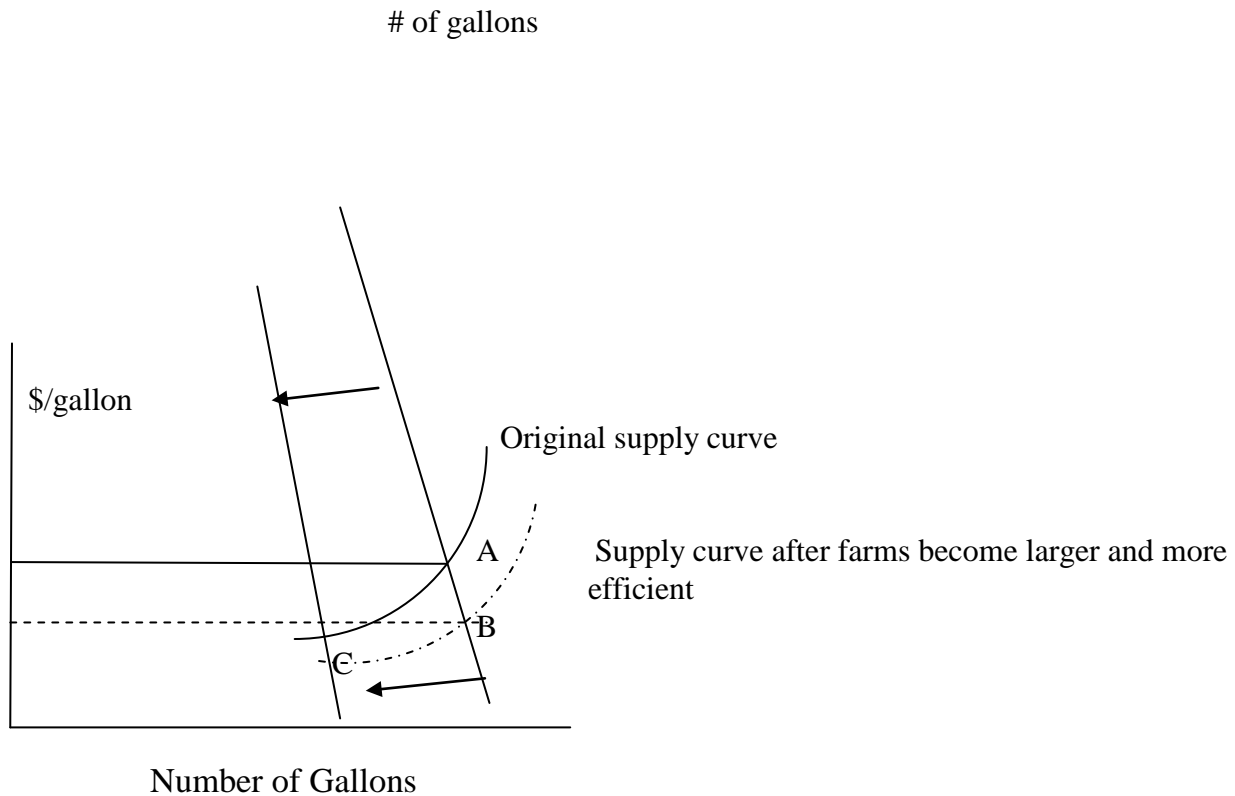
3. In class, we used various graphs to illustrate how a perfectly competitive industry expands and contracts. Go to [http://www.pbs.org/newshour/newshour\\_index.html](http://www.pbs.org/newshour/newshour_index.html), the web site for the Jim Lehrer News Hour, search for dairy farmers and view this segment - “Global Recession Impacts Dairy Prices, Farmers” –(Monday July 13). Then apply the graphs used in class to illustrate, as well as you can, the story told in the segment. For our purposes, the beginning of the story comes at the end of the segment.

Answer: The story as told involves two parts:

- Over time, farms consolidated and became more efficient. In our terms that means that the average farm has grown in size (which means it has reached minimum average cost at a bigger output) and minimum average cost is lower now than it used to be.
- The recession has caused the demand curve to shift in. As long as farms try to remain in the industry, supply will stay roughly the same and the price will eventually fall below minimum average cost. This means dairy farmers will be producing at a loss. (The fact that individual farms reach minimum average cost at larger output
- The bottom line is that farms are now producing at a loss and so are being forced to shut down and out of the industry.

For simplicity, assume these farms all have the same technology which have changed over time in the same way. Then the graph for a typical farm looks like this:





It is worth thinking through these graphs in detail:

- a) The cost graphs for the typical firm shows how consolidation and greater efficiency made the individual dairy farm larger and more productive. This is the change from AC1, MC1 to AC2, MC2. We will assume there are still a large number of farms even at the new size.
- b) The lower graph shows the corresponding change for the industry supply curve in the short run. The greater efficiency of farms is reflected in the curve shifting down and extending somewhat. The curved segments on the ends of the two curves refer to the sum of the marginal cost curves of the farms currently in the industry – i.e. the short run supply curve before firms can enter or exit.
- c) In sum, before the recession, the industry equilibrium had moved from (A) to (B) as farms had become more efficient.
- d) The central part of the story is that the recession shifts in the industry demand curve for milk. In the short run, before firms can exit, the best they can do is to set price = MC



(which is point C on the industry graph). But we know that this is below their minimum average cost and so farms will start closing down and drop out of the industry.

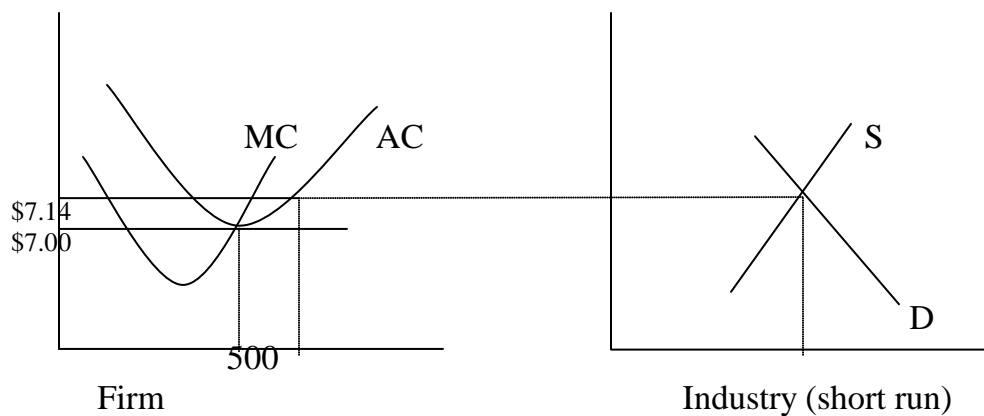
4) Cloves are a well known spice that are grown only in Zanzibar, a small island off the coast of East Africa. Suppose that the entire clove industry consists of 1,000 farms who act as perfect competitors. Each of these 1,000 farms can grow other crops if the clove market is weak. But no other farms, inside or outside of Zanzibar, are suitable for growing cloves.

Each of the 1,000 farms has the same technology with these characteristics:

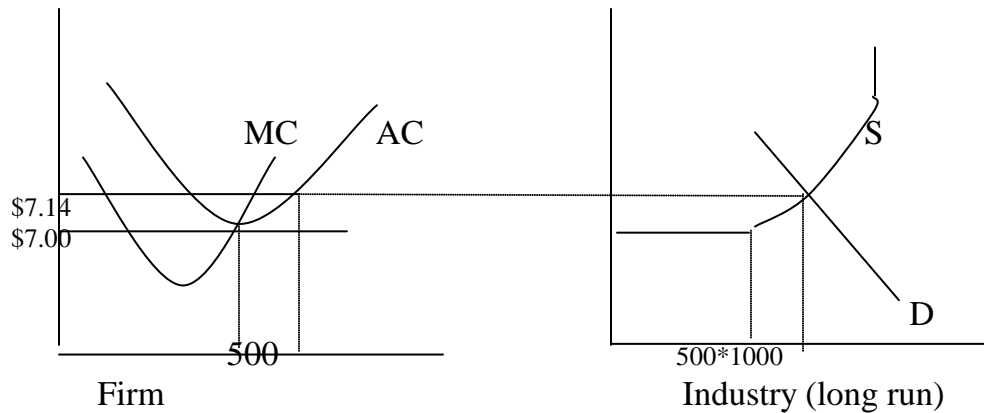
- Each farm has a maximum capacity of 1,000 pounds of cloves.
- Each farm achieves its minimum average cost at an output of 500 pounds of cloves, at which point the average cost is \$7.00 per pound.

a) On January 1, 2001, the market price for cloves is \$7.14 per pound. Using appropriate diagrams carefully draw this equilibrium for both the clove industry and for the typical clove farm, incorporating as much detail as the problem description allows.

ANS: This should be a standard graph with the average cost curve reaching a minimum of \$7.00 at 500 pounds (as given in the problem), price = \$7.14 = marginal cost so that firms in the industry are making a profit.



If you believe the price is already at long run equilibrium, you can also draw a long run industry equilibrium curve by specifying supply curve differently.



b) It seems reasonable to assume that a farmer will make the most profit if he/she produces at the output at which average cost is minimized. Does that apply to those farms that are growing cloves in (a) above? If not, briefly explain why.

ANS: Firms are not producing at minimum average cost (see above). The brief answer is that if demand is high enough, you can increase production beyond the point of minimum average cost and still add to your profit because the extra revenue will more than cover the increase in cost.

c) When a competitive industry is in equilibrium, it often occurs that only some of the firms in the industry are actually producing while other potential firms are sitting on the sidelines perhaps producing other goods. Explain why there is not enough information in the problem to determine whether all potential farms are producing cloves or not.

ANS: The missing information is how recently the price went up. If the price just went up to \$7.14, potential entrants have not had a chance to enter the market. If the price went up some time ago, then all 1,000 farm should be in the market and the \$7.14 price reflects the fact that the industry (with its fixed number of firms) cannot not enough to drive the price back to minimum average cost.

d) Suppose you were told that the price of cloves had been stable at \$7.14 per pound since July 1998. Would this cause you to change your answer in (c)?

ANS: It would mean that all 1,000 firms are now in (see previous answer).

5. Ten ounce bags of Wah-Hoo Potato Chips have the following demand curve:

$$Q = 100,000P^{-2.0}$$

where Q is the number of bags sold per week and P is the retail price per bag in dollars.

As you know from Problem Set 2, a straight line demand curve does not have the same elasticity at every point. But the demand curve shown above does have the same elasticity at all price/quantity points – in this particular case, an elasticity of -2.0.<sup>2</sup> Given this constant elasticity at all prices/quantities, carefully explain which parts of the following statement you agree and disagree with.

"We know from economic theory that when you reduce the price of a good along an elastic portion of the demand curve, total revenue will rise. This demand curve always has an elasticity of -2.0 and so it follows that the profit maximizing strategy is to sell Wah-Hoo Potato Chips at as low a price as possible."

Answer: This is one of those questions where it is best to step back and think about it a little. If the demand curve has a constant elasticity of -2.0, lowering the price to almost nothing is the way you maximize **REVENUE**. If the goal is to maximize **PROFIT**, you need to consider both revenues and costs. Since the problem doesn't give you any information about the production costs of the potato chips, you can't say that the profit maximizing strategy is to charge as low a price as possible.

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<sup>2</sup> To see this, begin with the fact that we can rewrite elasticity in terms of derivatives as follows:  
 $(\Delta Q/Q)/(\Delta P/P) = (\Delta Q/\Delta P) \times (P/Q) = (dQ/dP) \times (P/Q)$ . If you take the derivative of this demand curve,  $(dQ/dP)$  and then multiply by  $(P/Q)$ , you will see that the answer is always -2.0.

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11.203 Microeconomics  
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