Answers to Chapter 8 Homework Questions (pages 281-284 in the textbook)

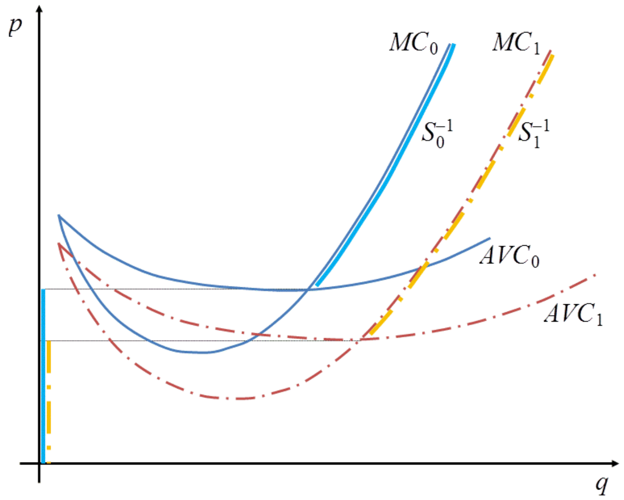
1. Yes sometimes it will keep producing. When it can still cover its operating costs (same as the variable costs) and it has positive outlook on the future. This would be the case when it expects the business conditions to improve, for example, when it expects the output price to go up or input prices go down or adopting a new cost-saving technology.

2. Solution is in the textbook at the end of Chapter 8.

3. Solution is in the textbook at the end of Chapter 8.

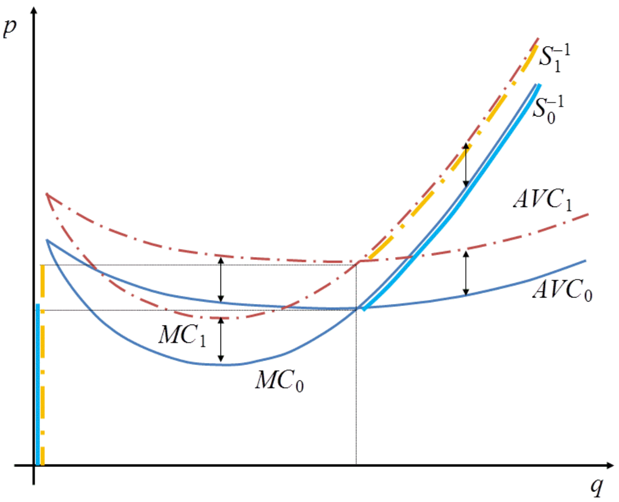
9. Solution is in the textbook at the end of Chapter 8.

10. The new technology lowers the cost curves. The picture shows the original cost curves (in blue color and solid curves): marginal cost curve MC_0, the average variable cost curve AVC_0, and the inverse supply curve S_0^{-1}; and the new cost curves (in red/orange color and dash/dot curves): MC_1, AVC_1, and S_1^{-1}. Notice that the inverse supply has two parts: the vertical part at $q = 0$ and then the part that overlaps with the portion of the MC curve that is above the lowest point of the average cost curve.

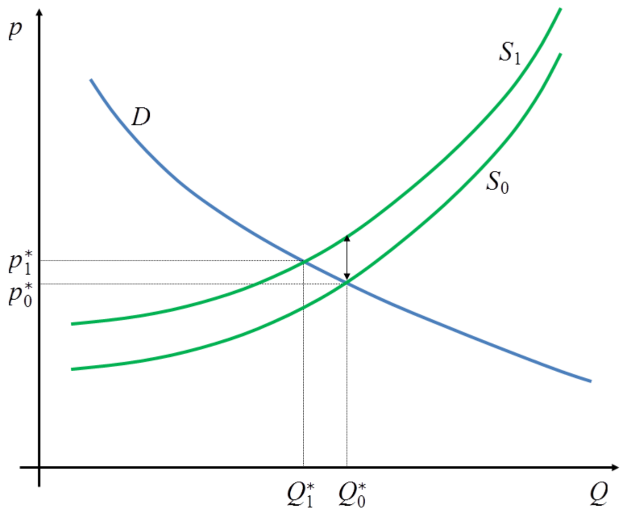


15. The impact of the increase in the wholesale gasoline price on the cost curves is shown below. The picture shows the marginal cost curve MC_0, the average variable cost curve AVC_0, and the inverse supply curve S_0^{-1} before the wholesale price increase and the corresponding curves (MC_1, AVC_1, and S_1^{-1}) after the price increase. As a result of the wholesale price increase

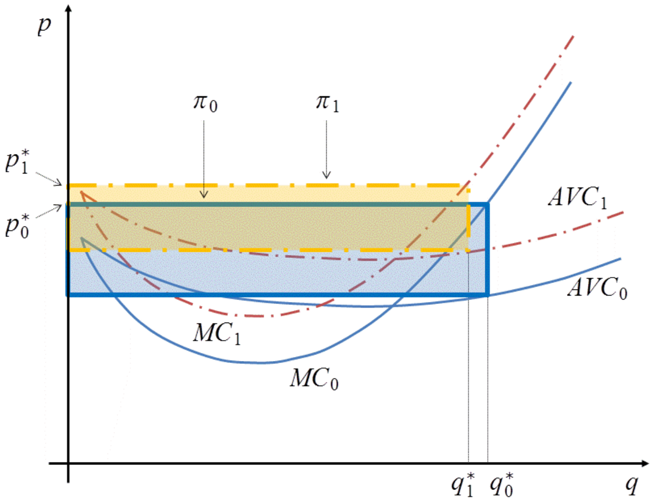
all cost curves shift up by the same proportion.



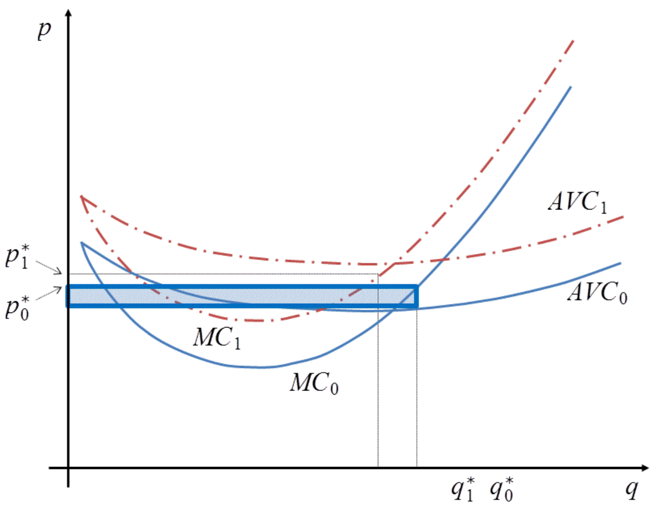
The next picture shows the market equilibrium before and after the wholesale price increase. The original supply function S_0 shifts in so that the vertical gap between the old and the new supply curve (S_1) exactly corresponds to the amount of the wholesale price increase. The old market equilibrium price is p_0^*. After the supply shifts in the new equilibrium price is p_1^*. Notice that the new market price will go up by less than the wholesale price increase. The reason is that the demand curve D is downward-sloping. Notice that if the demand curve were a vertical line (an extreme case) then the new equilibrium price would have risen by exactly the same amount by which the wholesale price has increased. If, instead, the demand curve were a horizontal line (another extreme case) then the new price would have not risen at all – it would have been equal the old price ($p_1^* = p_0^*$). Try to draw these two extreme cases on your own.



The profits are shown on the picture below. The firm's profit is the area of the box that is formed by profit margin and quantity: $(p - AVC(q^*)) \times q^*$. (The profit margin is the difference between the price and the average variable cost at the optimal quantity q^*.) Before the wholesale price increase the firm's profit was the area of the blue box and after the wholesale price increase the profit became the area of the orange box. The new profit is smaller as we would expect. (For practice try different variations of this problem and think about how the profit would have changed had the demand function been steeper of flatter.)

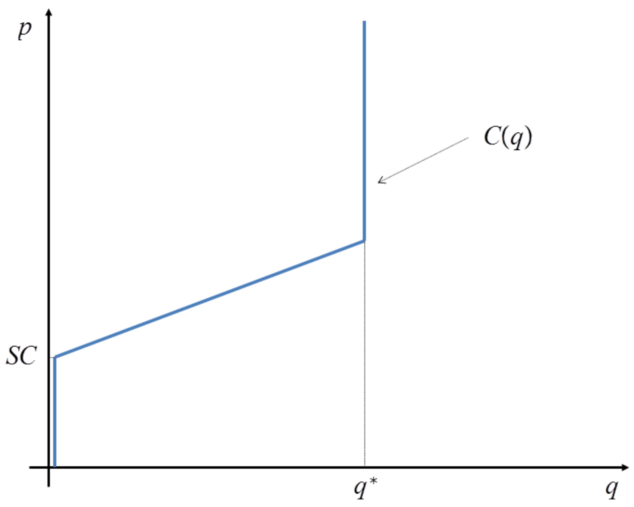


Finally, possibly the reason why so many firms exited the market was that the original price p_1^* was already quite low to begin with and because so that many firms in the market were only barely able to cover their operating expenditures. After the wholesale price jumped up the costs increased by that amount but the market output price increased by only a fraction of that (again because the demand curve is downward-sloping). Therefore, the firms that were just barely functional before could not anymore afford to cover their operating costs and were forced to shut down. Notice the blue box (profit before the wholesale price increase) is quite small and there is no orange box because the firm has exited the market.

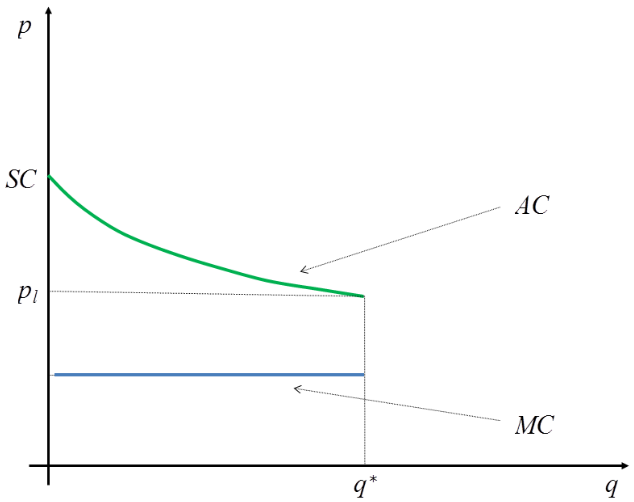


16. The problem description implies that the cost function has a sizable cost component associated with setting up the production. On the picture below I assume a very simple form of the cost function with the set-up cost component SC and a constant marginal cost MC (i.e., this

implies the cost function is a straight line).



In the short run (when the firm is already set up to extract gas) we would be referring to SC as the fixed cost. But because the firm has not yet entered the market, SC is not a fixed cost – it has not been sunk yet. Also the cost curve implies that the firm can extract at most q^* of natural gas form this particular gas field. Therefore the cost curve is vertical at q^*. The right way to look at this problem is form the long run perspective. That is, no firm is currently set up to be able to extract gas. The firm has to decide whether to enter or not (recall that market entry is only possible in the long run). If the firm can at least break even, then it will enter. The marginal cost and the average cost curves are on the second picture (notice that beyond q^* the MC and AC is infinite).



If the market price of natural gas is bellow the lowest point of the average cost curve, p_l, then the firm will not enter. If the price is above p_l the firm will enter and produce quantity q^*.

32. The cost function is

$$C(q) = 100 + 10q - q^2 + \frac{1}{3}q^3.$$

The marginal cost function is

$$MC(q) = 10 - 2q + q^2.$$

The profit maximizing condition is the optimality condition

$$\begin{aligned} MR(q^*) &= MC(q^*) \\ 10 - 2q + q^2 &= p. \end{aligned}$$

Instead of the supply curve I am going to find the expression for the *inverse supply curve* – which is the price as a function of the quantity supplied. To get it I will first find the average variable costs

$$AVC(q) = 10 - q + \frac{1}{3}q^2.$$

Next I know that the firm will supply zero units of output for all prices that are below the minimum average variable cost (firm is shut down); and will supply the optimal quantity q^* (where $MR = MC$) for all prices that are greater than the minimum average variable cost. So the first step is to find the quantity $\hat{q}$ at which the AVC is minimized. Because I know the AVC curve is U-shaped I will find the "bottom of the valley" in the usual way by differentiating AVC and setting it to zero:

$$\begin{aligned} \frac{dAVC(q)}{dq} &= -1 + \frac{2}{3}\hat{q} = 0 \\ \hat{q} &= 3/2 \end{aligned}$$

so now I know that at $\hat{q} = 3/2$ the average variable cost is minimized. Next I calculate the actual variable cost at $\hat{q}$ (by plugging $\hat{q}$ into AVC) and get

$$10 - 3/4 = 37/4 = 9.25.$$

Now I can write down the *inverse supply curve* p^S (price as a function of quantity produced):

$$p^S(q) = \begin{cases} 10 - 2q + q^2 & \text{if} \quad q \geq 3/2 \\ [0, 9.25] & \text{if} \quad q = 0 \end{cases}.$$

In words, the firm will be shut down – produce nothing ($q = 0$) – for all prices between 0 and 9.25. When the price jumps up above 9.25 then the inverse supply curve will overlap with the marginal cost curve: $10 - 2q + q^2$. Please sketch a picture that corresponds to what I just did here algebraically.

33. Solution is in the textbook at the end of Chapter 8.

34. The total cost function is $C(q) = 16 + q^2$. The market demand function is $Q = 24 - p$. We are asked to determine the long run market equilibrium price, quantity, the number of firms in the market and output per firm. In the long run firms can enter and exit the market. In the long run a firm cannot make losses because such firm would be forced to exit the market; also, in the long run no firm in the market can make any profits because this would have enticed other firms to enter the market. The supply would shift out and the output price go down eliminating all the profits. So all firms in the long run competitive market will be operating at zero profits and optimally produce a quantity $q^* = \hat{q}$ at which the average cost is minimized. This is the key insight to realize in this problem. From now on it is just a matter of simple algebra.

    First we find the quantity produced by each firm: we know each firm will optimally produce a quantity $\hat{q}$ at which the average cost is minimized. Let us first find that quantity. First write down the average cost function

$$\begin{aligned} AC(q) &= (16 + q^2)/q \\ &= \frac{16}{q} + q; \end{aligned}$$

next find where it has the "bottom of the valley" by setting its first order derivative to zero

$$\begin{aligned}\frac{dAC(q)}{dq} &= -\frac{16}{\hat{q}^2}+1=0\\ \hat{q}^2 &= 16\\ \hat{q} &= 4.\end{aligned}$$

This gives us the output of each firm in the long run competitive market – each firm will produce 4 units.

Next, we know that in the long run each firm makes zero profit which means that at $\hat{q}=4$ the market price intersects the marginal cost MC (because the optimality condition $MR=MC$ has to hold) and also the average cost function AC (which is at its minimum). This means the average cost at $\hat{q}=4$ is

$$AC(4)=\frac{16}{4}+4=8.$$

And we know that in long run competitive market:

$$p^*=AC(\hat{q})=8.$$

The long run inverse supply curve is a flat line corresponding to firms' minimum average cost: 8. Finally, we can calculate the total market output at the intersection of inverse demand and inverse supply

$$\begin{aligned}\text{Inverse demand} &= \text{Inverse supply}\\ 24-Q^* &= 8\\ Q^* &= 16.\end{aligned}$$

Finally, the number of firms in the market has to equal to total market quantity divided by the quantity produced by each firm: $16/4=4$. The market has 4 firms.

39. Same effect as the increase of the wholesale price had on gas retailers in problem 15. Please review problem 15 and apply the same reasoning to this problem.

40. The cost function is:

$$C(q)=6,860+(p_T+t+\frac{7}{12})q+\frac{37}{27\times 10^6}q^3$$

and $p_T=\$11,50, t=\$2,00$.
a) As first thing we plug in the prices in the cost function and marginal cost function:

$$\begin{aligned}C(q) &= 6,860+\frac{162}{7}q+\frac{37}{27\times 10^6}q^3\\ MC(q) &= \frac{dC(q)}{dq}=\frac{162}{7}+\frac{37}{9\times 10^6}q^2.\end{aligned}$$

b) The shutdown price is at the minimum of average variable costs. Therefore we need to find $AVC(q)$ function and find its lowest value:

$$\begin{aligned}AVC(q) &= \frac{VC(q)}{q}=\frac{162}{7}+\frac{37}{27\times 10^6}q^2\\ \min_q AVC(q) &= \frac{dAVC(q)}{dq}=\frac{74}{27\times 10^6}\hat{q}=0 => \hat{q}=0\end{aligned}$$

So the average variable costs are minimized at production of zero units ($\hat{q} = 0$) and the $AVC(\hat{q}) = AVC(0) = \frac{162}{7}$ which is also the shutdown price.

c) The seller's short run inverse supply function is the part of a marginal cost function that lies above the minimum value of the average variable costs. The inverse supply function is the following:

$$p = \frac{162}{7} + \frac{37}{9 \times 10^6} q^2.$$