Chapter 8: Profit Maximization and Competitive Supply

We have now described the firm in terms of its production technology and cost structure. We now turn toward the issue of describing how a firm will behave given this structure and its environment. In this chapter we focus on firm behavior in the world of perfect competition. We can describe the realm of perfect competition with three main assumptions:

1) Price Taking. We assume that there are many firms and many consumers in the market, so that each firm is small relative to the market. Each firm, in fact, is so small that it can produce and sell as much as it wants, and it won't influence the market price. Thus, firms take the market price as a given. We also assume that price taking behavior applies to consumers as well.

2) Product Homogeneity. In perfectly competitive markets, each firm's product is exactly the same as that of other firms. This assumption means that all firms' products are perfect substitutes, and consumers will want to buy from whichever firm offers the lowest prices, since the products differ in no other respects. This assumption, coupled with assumption (1), basically means that there will be one, unique market price charged by all firms; if a firm tries to charge more than this, its sales drop to zero.

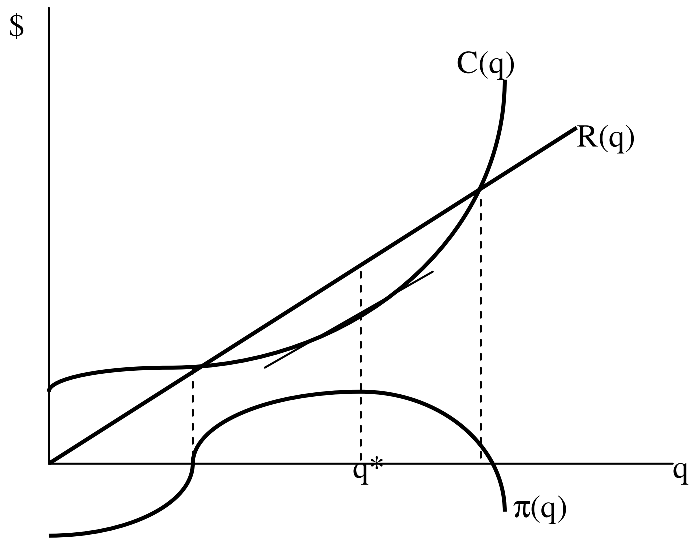
3) Free Entry and Exit. There are no special costs that make it difficult for a firm to enter or exit the industry. Firms can essentially come and go as they please.

Profit Maximization

As you know from Econ 201, we assume that firms maximize profits. It is true that we sometimes observe managers who seem to focus more on maximizing sales, or maximizing revenue, or maximizing market share, or some other variable. However, if managers follow these goals instead of profit maximization, they are directly eating into their shareholders' profits and could be replaced. Furthermore, firms that do not maximize profits may be unable to survive in a competitive marketplace (as we will see). In any case, the assumption of profit maximization seems to do a good job of predicting the behavior of firms, so we will stick with it.

A firm's profit $\pi(q)$ is the difference between total revenue $R(q)$ and total cost $C(q)$, so $\pi(q) = R(q) - C(q)$. Note that each of these depends on output. We write the firm's output as q to distinguish it from total market output Q. Remember that $R(q) = Pq$.

With this in mind, we can represent the firm's profit graphically:



Contrary to what P&R say, a perfectly competitive firm need not lower its price to sell more, so its revenue is simply $R(q) = Pq$, which is a straight line from the origin with slope P. $C(q)$ is drawn here as a typical cost function, and $\pi(q)$ is drawn as the difference between R and C. Initially π is negative because $C > R$. When R catches up to C the first time, $\pi = 0$, but it is still rising because R is rising at a faster rate than C. When the gap between C and R is largest, π is maximized, and this occurs at output q^*. Then, π falls back to zero (where C and R intersect again) and into negative territory if the firm foolishly produces more.

Notice that the gap between R and C is largest (and profit is maximized) when the slope of $R(q)$ is the same as the slope of $C(q)$. In other words, $\pi(q)$ is maximized when

$$\Delta R(q)/\Delta q = \Delta C(q)/\Delta q$$

but this simply says that MR = MC. This is our familiar condition for profit maximization from Econ 201. Remember why this has to hold. Suppose it doesn't.

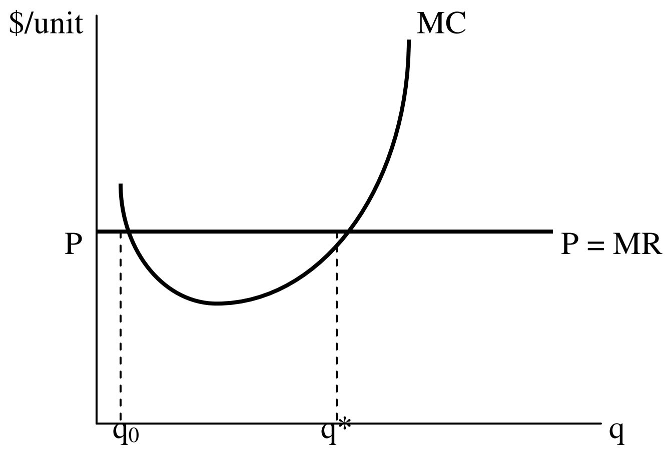
$MR > MC \Rightarrow$ the firm should produce more, since its revenues are rising faster than cost (so profit is rising if the firm produces more).

$MR < MC \Rightarrow$ the firm should produce less. If the firm produces a little less, its cost and revenue both fall, but cost falls more than revenue, so π rises.

Only when MR = MC is there no incentive for the firm to change its level of production. This rule holds for all firms, whether they operate in perfectly competitive industries or not. In the case of PC firms, though, we can say more. A PC firm has no control of P, can sell as much as it wants at P, and can sell nothing if it tries to charge more than P. Thus, the demand curve facing this firm (not the market demand curve) is perfectly elastic. Because this firm can always sell one more unit at P, then the market price P must be this firm's MR (P = MR). Thus, a PC firm will maximize profits by setting

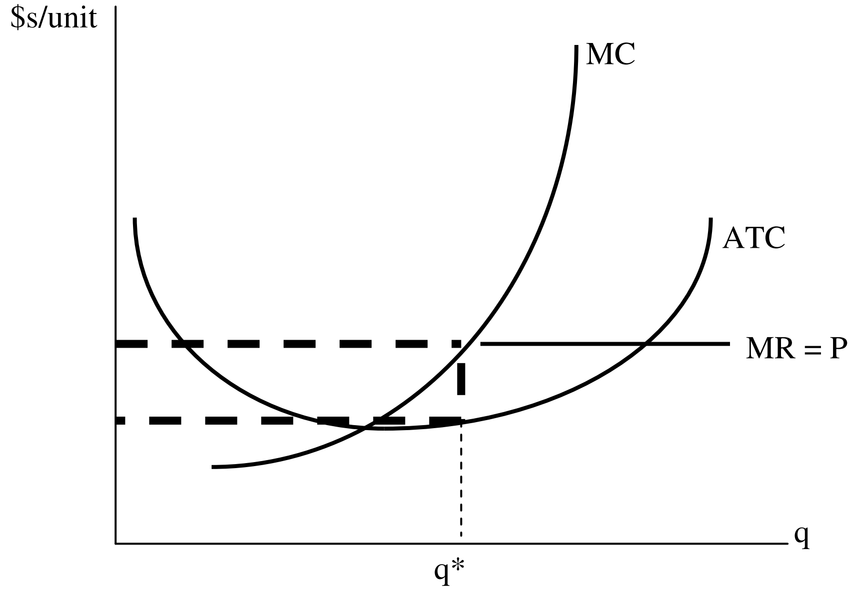
$$P = MC(q)$$

We can solve this for q to find the firm's profit-maximizing quantity. Graphically, the problem looks like this:



If this firm produces anything at all, it will produce q*, where P = MC and profit is maximized. Here I have drawn the typical J-shaped MC curve. Notice that at q_0, we also have P = MC, but here profit is minimized, so technically our profit-maximization condition requires that P = MC and MC be rising.

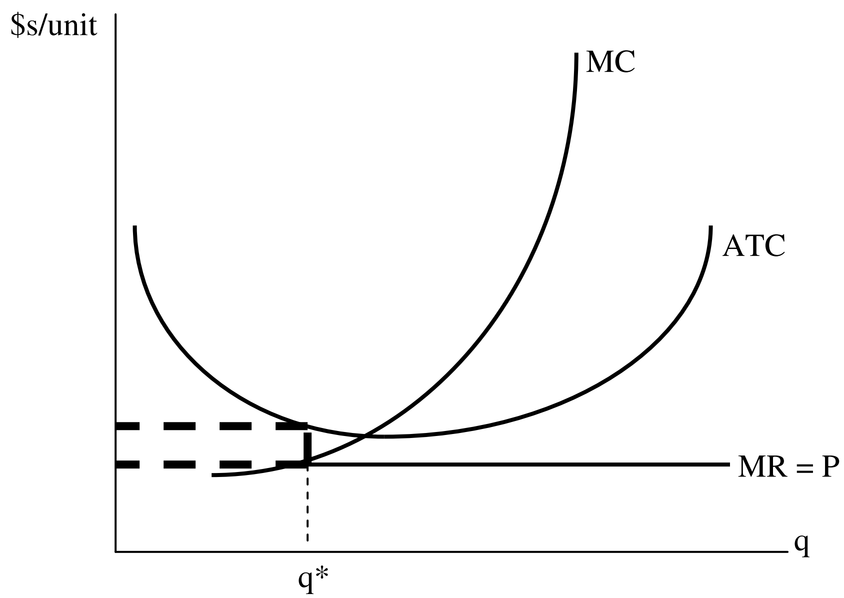
We can also illustrate this firm's profits on the graph.



Recall that profit = R(q) – C(q) = P*q – ATC*q = q * (P - ATC). This quantity is given by the area of the rectangle above; the base is q and the height is (P - ATC)

Notice that this firm is making a positive profit since P > ATC.

It is also possible for the firm to lose money (negative profits):



Here profits are negative since ATC > P $\Rightarrow$ C(q) > R(q).

Why would the firm produce at all if it is losing money? Well, the loss the firm would face by shutting down production (choosing $q = 0$) might be even worse. Remember that the firm must still pay its fixed costs even if it produces nothing. In the long run, though, the firm can escape its FC and therefore will shut down if it faces losses. We can therefore write two shut-down rules for the PC firm:

Short Run (FC > 0): shut down if $(-FC) > Pq^* - TC$
$\Rightarrow VC > Pq^*$
$\Rightarrow P < AVC$

Long Run (FC = 0): shut down if $0 > Pq^* - TC$
$\Rightarrow P < ATC$

In the long run, the firm shuts down if P < ATC, which is simply whenever its profits are negative. In the short run, though, the firm can at least cover its variable costs and recoup some of its FC by producing whenever P > AVC; in this case, the firm might be losing money, but it would lose even more by shutting down.

EXAMPLE: Suppose a firm is producing a product that sells for P = 30 and has the following cost function:

$$C(q) = 100 + q^2$$

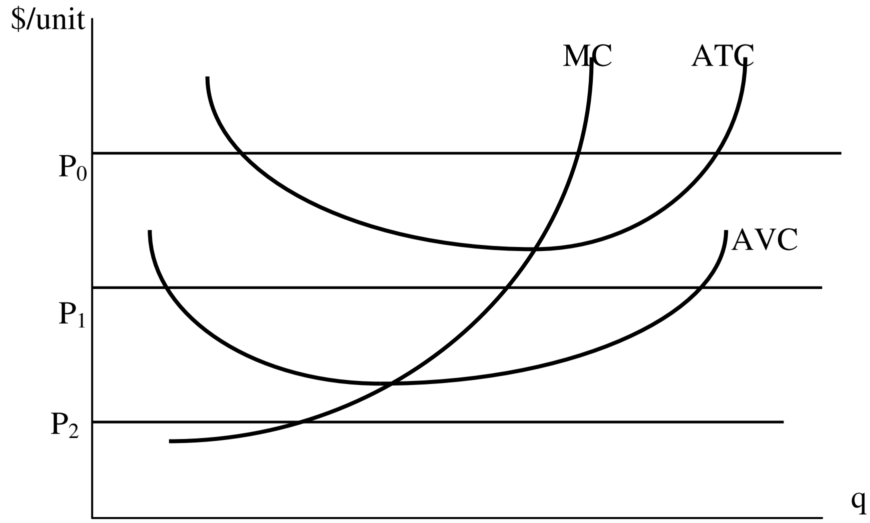
(Presumably $C(0) = 0$ if this is a long run cost function). MC = 2q. Setting MR = MC gives us

$$30 = 2q \qquad \Rightarrow \qquad q = 15$$

In this case, the firm is earning (450 – 100 – 225) = 125 in profits. The firm will exit the industry in the long run if P drops below 20, since that is the price at which
$\pi = p(1/2\ p) - 100 - (1/2\ p)^2 = 0$.

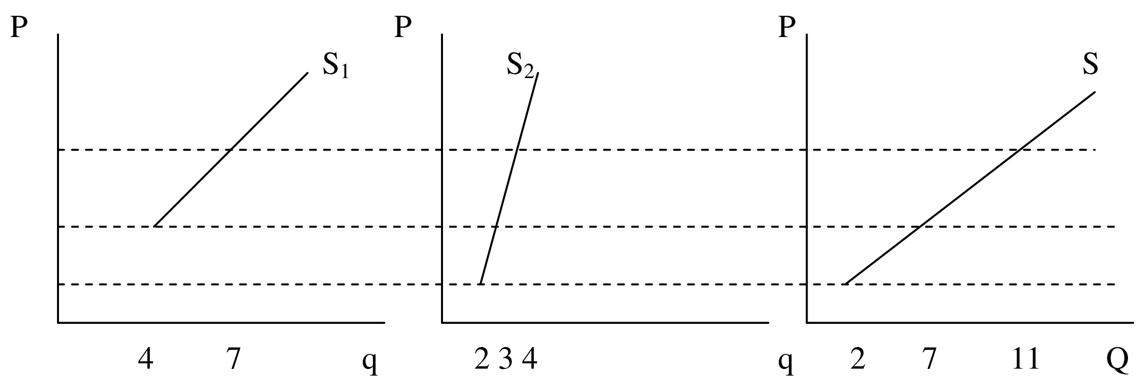
Short Run Supply

We thus find that the firm's short run supply curve is its MC curve above AVC. If P < AVC, the firm shuts down.



As P falls from P_0 to P_1, we move along MC. Once P falls below AVC (to P_2, for instance), the firm produces nothing.

We can get the industry supply curve by simply summing the supply curves of individual firms:



This sheds a little more light on market supply curves. For instance:

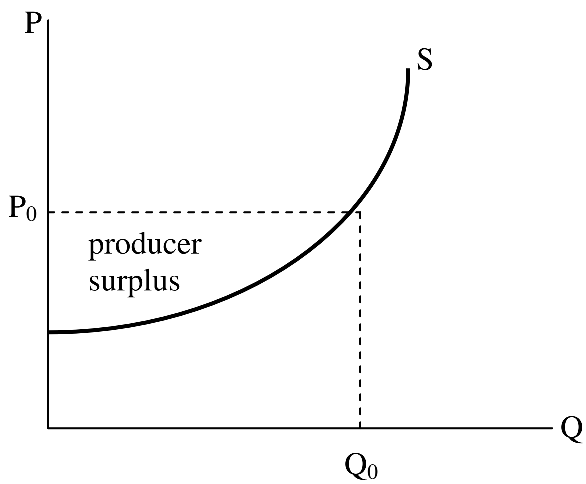
1) The market supply curve slopes up b/c MC slopes up b/c of diminishing marginal returns.

2) Anything that causes MC to rise (a tax, higher wages, etc) will cause each firm's supply curve to shift up (to the left), which must cause the market supply curve to shift to the left.

Producer Surplus

Just as we measured consumer surplus based on the difference between what consumers were willing to pay for a product and what they actually paid, we can define producer surplus as the difference between the price a firm would be willing to sell a product for and the price it actually received. Notice that this is not the same as profit. Rather, since a firm would be just willing to sell any particular unit of output for P = MC, producer surplus for each unit is equal to P – MC. When integrated over the firm's entire output, it is equal to the area under P and above MC

Since supply represents the sum of individual firms' supply curves (and their MC curves), then total producer surplus for an industry will be the area below P and above S.

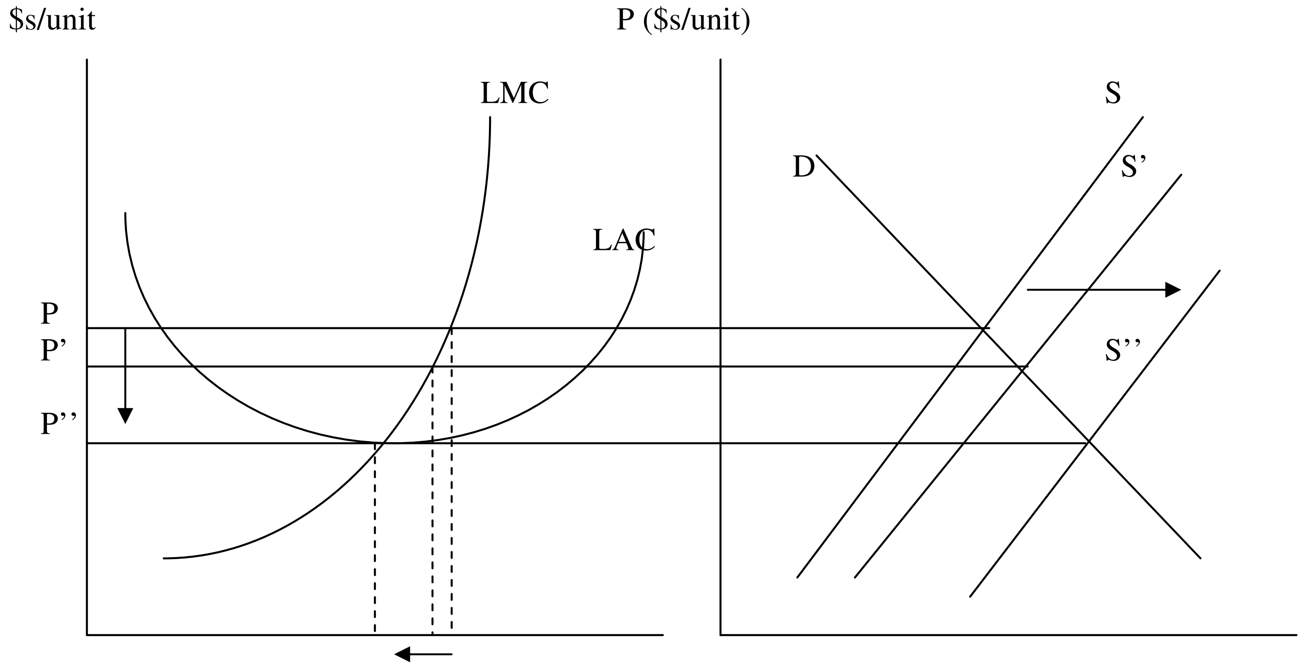


Long Run Supply

Assume a perfectly competitive market where all firms face the same LMC and LAC curves. Of course, these firms will all maximize profits by choosing the output level where P = LMC.

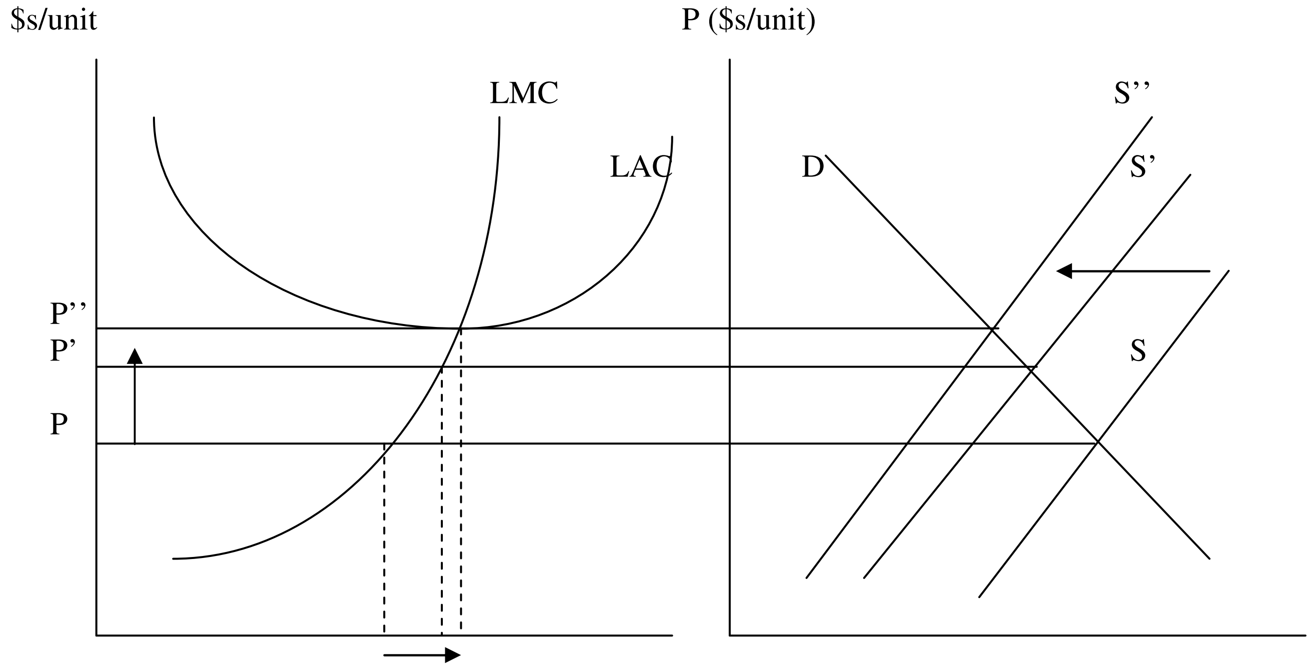
In the long run, though, firms need not stay in the market if they are losing money, since there is free exit. Thus, firms will leave if P < LAC. Likewise, firms will enter the market if P > LAC since they see the opportunity to earn positive economic profits and can enter freely. To see how this affects the long run supply of an industry, we'll consider two cases:

1) Firms in the industry are making economic profits ⇒ entry of new firms ⇒ market supply curve shifts to the right ⇒ ↓ P until entry stops ⇒ P = min(LAC)



You may wonder how we know that industry output is going up when the output for our typical firm is falling. We know that output is going up because price our supply-demand diagram tells us so. The fact that the typical firm is producing less is simply indicative of the scale of entry. In other words, price falls because of entry, and firms produce a little less due to the change in price. This does not feed back into a decrease in supply because the supply curve tells us what happens to Q when P changes!

2) Firms in the industry suffering economic losses ⇒ exit ⇒ market supply curve shifts to the left ⇒ ↑ P until exit stops ⇒ P = min(LAC)



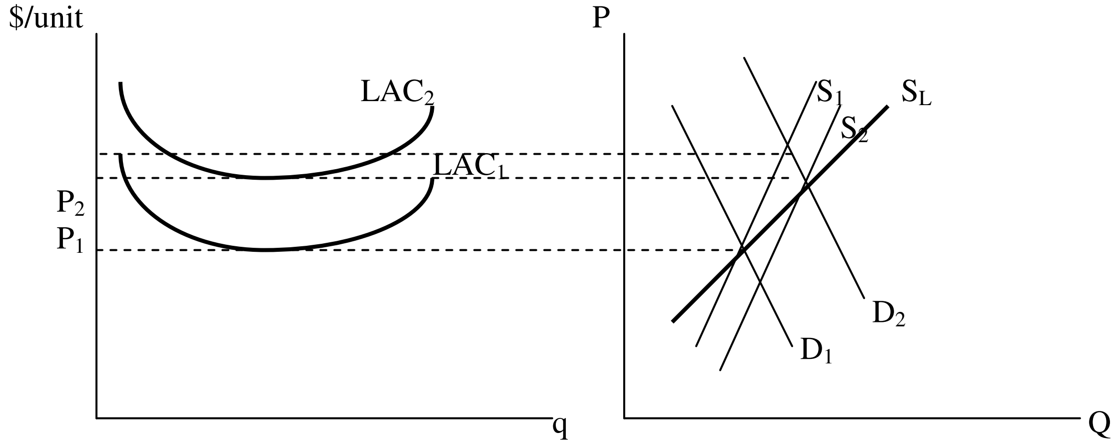
Notice that the market ends up with P = min(LAC) in the long run. At any other price, either entry is driving the price down or exit is driving it up. Only when P = min(LAC) is there no pressure for price to change.

Notice that in the long run, firms earn zero economic profit. In other words, they earn accounting profits comparable to what could have been earned in the next best alternate use of their resources. Hence, there is no incentive to enter or exit this industry when it is in long run equilibrium.

This analysis implies that if the LAC curve of firms in this industry is independent of the number of *other* firms, then the industry long-run supply curve will be a horizontal line, with P = min(LAC). P&R call this type of industry a constant cost industry, meaning that input prices do not change as more firms enter the market.

This need not be the case, though. Suppose that as more firms enter the market, input prices are bid up, so that LAC rises. In P&R's terminology, this industry would be an increasing cost industry. For example, suppose that as more people take up farming, the price of farmland rises. Thus, entry into agricultural markets leads to an increase in LAC, so that the long run price of agricultural products would rise as more firms entered (and Q rose). Thus, the industry long run supply curve would be upward-sloping.

We can illustrate this scenario as follows:



These graphs show the representative firm and the industry. Initially the market is in long run equilibrium with short run supply S_1 equal to demand D_1 and P = min(LAC). Suppose that demand rises, causing P to rise and generating positive economic profits for the typical firm.

The fact that $\pi > 0$ will attract firms into the industry, increasing supply. However, as firms enter the industry, the price of farmland is bid up, so LAC rises. The result is that the new long-run equilibrium price is equal to min(LAC_2) > P_1. The new equilibrium occurs at $P = P_2 > P_1$ and with $Q_2 > Q_1$ so the long run supply curve S_L must be upward sloping.