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- Vollkommener Wettbewerb

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- **Chapter 12 – Perfect Competition**
  Frank, Robert H, & Cartwright, Edward. (2016). *Microeconomics and Behaviour (2nd European ed.)*. London: McGraw-Hill Education.

CHAPTER

12

PERFECT COMPETITION

Cloud computing allows firms and individuals to store and process data in a shared resource. This frees users from having their own computing memory allowing significant gains from economies of scale. Consider, for instance, two university professors who need to run a time-consuming computer simulation. Rather than each having their own high-powered computer they can now share use of a far more powerful computer. All they need to do is coordinate so as to not be using the resource at the same time.

The cloud has a long history but it is only since the turn of the century that cloud computing has become widely available to all. GoogleDrive, iCloud, OneDrive, DropBox, AmazonCloudDrive, and so forth, offer a wealth of possibilities. This is good news for consumers. But is it good news for cloud providers? In 2015 the market for cloud services was estimated to be around €150 billion. This is already sizeable and the strong expectation is that the market will grow hugely over the coming years. The problem is that cloud providers have so far only managed to make *losses* from cloud services. Moreover, investors are worried that cloud services will never be able to turn a profit.

To understand why cloud computing is unlikely to yield significant profits any time soon we need to look at outcomes in perfectly competitive markets. In doing so we shall see that what is bad for producers can be good for consumers and society. Indeed, perfectly competitive markets lead to efficient outcomes.

CHAPTER PREVIEW

In this chapter we will develop a model of price and output determination in perfectly competitive markets. Our first step will be to characterize the competitive firm's objective as that of earning the highest possible profit. This is clearly not the only goal a firm might pursue, but we will see several reasons why firms might often behave as if profit were all they cared about.

We will then consider the four conditions that define a perfectly competitive market: (1) the existence of a standardized product, (2) price-taking behaviour on the part of firms, (3) perfect long-run mobility of factors of production, and (4) perfect information on the part of consumers and firms. While these conditions are unlikely to be satisfied in full for any industry, we will see that the economic model of perfect competition can still generate useful insights.

Next, using the cost curves discussed in Chapter 11, we will derive the necessary condition for profit maximization in the short-run. The rule calls for the firm to produce an output level at which its short-run marginal cost is equal to the price of the product. We will see that implementation of this rule fortunately does not require that firms have a detailed understanding of the economist's concept of marginal cost.

From the individual firm's supply decision, we will move to the issue of industry-wide supply. The technique for generating the industry supply schedule turns out to be closely analogous to the one for aggregating individual demand curves into a market demand curve: we simply add the individual firms' supply curves horizontally.

The industry short-run supply and demand curves interact to determine the short-run market price, which forms the basis for output decisions by individual firms. We will see that a firm's short-run profitability acts as a signal governing the movement of resources into and out of the industry—more specifically, that profits prompt resources to enter while losses prompt them to leave.

We will see that in the long-run, if tastes and technology are unchanging, a competitive industry whose firms have U-shaped LAC curves will settle at an equilibrium price equal to the minimum value of the LAC curve. And we will also see that, under certain conditions, it will not be possible in such a market for anyone to enter into additional transactions that would benefit some people without at the same time harming some others.

THE GOAL OF PROFIT MAXIMIZATION

In studying not only perfect competition but also a variety of other market structures, economists traditionally assume that the firm's central objective is to maximize profit. Two things must be said about this assumption. The first is to clarify just what is meant by the term 'profit', and the second is to explain why it often makes sense to assume that firms try to maximize it.

Profit—or, more precisely, *economic profit*—is defined as the difference between total revenue and total cost, where total cost includes all costs—both explicit and implicit—associated with resources used by the firm. This definition is significantly different from the one used by accountants and many other non-economists, which does not subtract opportunity or implicit costs from total revenue. *Accounting profit* is simply total revenue less all explicit costs incurred.

To illustrate the distinction, suppose a firm produces 100 units of output per week by using 10 units of capital and 10 units of labour. Suppose the weekly price of each factor is €10/unit, and the firm owns its 10 units of capital. If output sells for €2.50/unit, the firm's total revenue will be €250/wk. To calculate the week's economic profit, we subtract from €250 the €100 spent on labour (an explicit cost) and the €100 opportunity cost of capital (an implicit cost), which leaves €50. (Under the assumption that the firm could have rented its capital to some other firm at the weekly rate of €10/unit, the €100 opportunity cost is simply the earnings forgone by using the capital in its own operation.) The week's accounting profit for this firm, by contrast, is €150, the difference between the €250 total revenue and the €100 out-of-pocket expenditure for labour.

Accounting profit may be thought of as the sum of two components: (1) *normal profit*, which is the opportunity cost of the resources owned by the firm (in this example, €100), and (2) economic profit, as defined above (here, €50). Economic profit is profit over and above the normal profit level.

The importance of the distinction between accounting and economic profits is driven home forcefully—if a bit fancifully—by the following example.

EXAMPLE 12.1 Cullen Gates runs a miniature golf course in the traditional English seaside resort of Margate. He rents the course and equipment from a large recreational supply company and supplies his own labour. His monthly earnings, net of rental payments, are £800, and he considers working at the golf course just as attractive as his only other alternative, working in a supermarket for £800/mo.

Now Cullen learns that his Uncle Bill has given him some land in Knightsbridge in the centre of London. The land has been cleared, and Cullen discovers that a construction company is willing to install and maintain a miniature golf course on it for a payment of £4,000/mo. Cullen also commissions a market survey, which reveals that he would collect £16,000/mo in revenue by operating a miniature golf course there. (A mini-golf course in the centre of London would no doubt be very popular.) After deducting the £4,000/mo payment to the construction company, this would leave him with £12,000/mo free and clear. Given these figures, and assuming Cullen's living costs will remain the same, should Cullen, a profit maximizer, switch his operation to London?

Since he is a profit maximizer, he should switch to London only if his economic profit there will be higher than in Margate. Suppose, however, that Cullen is unfamiliar with the concept of economic profit and instead compares his accounting profits in the two locations. In Margate, his accounting profit is £800/mo, the amount he has left over after paying all his bills. In London, the corresponding figure will be £12,000/mo. On this comparison, he would quickly forsake Margate for London.

If he compares economic profits, however, he will reach precisely the opposite conclusion. In Margate, his economic profit is zero once we account for the opportunity cost of his labour. (He could have earned £800/mo as a supermarket assistant, exactly the amount of his accounting profit.) To calculate what his economic profits would be in London, we must deduct from his £12,000/mo accounting profits not only the £800 monthly opportunity cost of his labour, but also the opportunity cost of his land. Few locations on earth command higher land prices than Knightsbridge. Suppose we conservatively estimate that Cullen's land would sell for £100,000,000 in today's real estate market, and suppose that the interest rate is 0.1 per cent/mo. The opportunity cost of devoting the land to a miniature golf course will then be $(0.001) \times (£100{,}000{,}000) = £100{,}000$/mo, which makes his monthly economic profit in London equal to $£12{,}000 - £800 - £100{,}000 = -£88{,}800$. Thus, if we assign any reasonable value to the opportunity cost of his land, it will obviously be better for Cullen to sell or rent it to someone else and remain in Margate. The reason London real estate is so expensive is that people can build luxury apartments on it and charge high rents to a multitude of tenants. To build a miniature golf course in Knightsbridge would be like wearing diamonds on the soles of your shoes. ◆

EXERCISE 12.1 In Example 12.1, how low would the monthly interest rate have to be before Cullen should relocate to London?

Let us turn now to the assumption of profit maximization. To predict what any entity—a firm, person, committee or government—will do under specific conditions, some sort of assumption must be made about its goals. After all, if we know where people want to go, it is much easier to predict what they will do to get there. Economists assume that the goal of firms is to maximize economic profit; then they try to discover what specific behaviours promote that goal.

Numerous challenges have been raised to the profit-maximization assumption. Some critics say the firm's goal is to maximize its chances of survival; others believe that it wants to maximize total sales or total revenues; and some even claim that firms do not try to maximize anything at all.

One reason for such scepticism is that examples abound in which the managers of firms appear unqualified to take the kinds of actions required for maximizing profit. It is important to understand, however, that the assumption of profit maximization is not refuted by the existence of incompetent managers. On the contrary, a case can be made that, even in a world in which the actions of firms are initially random, a long-run tendency for profit-maximizing behaviour will eventually dominate.[1]

The argument is analogous to Charles Darwin's theory of evolution by natural selection, and it goes roughly as follows. First, in a world of random action, some firms will, purely by chance, come much closer than others to profit-maximizing behaviour. The former firms will have greater surplus revenues at their disposal, which will enable them to grow faster than their rivals. The other side of this coin is that firms whose behaviour deviates most sharply from profit maximization are the ones most likely to go bankrupt. In the animal kingdom, food is an essential resource for survival, and profit plays a parallel role in the competitive marketplace. Those firms with the highest profits are often considerably more likely to survive. The evolutionary argument concludes that, over long periods of time, behaviour will tend toward profit maximization purely as a result of selection pressures in the competitive environment.

But the forces in support of profit maximization are not limited to the unintentional pressures of natural selection. They also include the actions of people who are very consciously pursuing their own interests. Bankers and other moneylenders, for example, are eager to keep their risks to a minimum, and for this reason, they prefer to do business with highly profitable firms. In addition to having more internal resources, such firms thus have easier access to external sources of capital to finance their growth. Another important force supporting profit-maximizing behaviour is the threat of an outside takeover. The price of shares of stock in a firm is based on the firm's profitability (more on this point in Chapter 16), with the result that shares of stock of a non-profit-maximizing firm will often sell for much less than their potential value. This creates an opportunity for an outsider to buy the stock at a bargain price and then drive its price upward by altering the firm's behaviour.

Another pressure in favour of profit maximization is that the owners of many firms compensate their managers in part by giving them a share of the firm's profits. This provides a clear financial incentive for managers to enhance profitability whenever opportunities arise for them to do so.

Let us note, finally, that the assumption of profit maximization does not imply that firms conduct their operations in the most efficient conceivable manner at all times. In the world we live in there are not only many intelligent, competent managers, but also a multitude who possess neither of these attributes. Needless to say, not every task can be assigned to the most competent person in the universe. In a sensible world, the most important tasks will be carried out by the best managers, the less important tasks by less competent ones. So the mere fact that we often observe firms doing silly things does not establish that they are not maximizing profits. To maximize profits means simply to do the best one can under the circumstances, and that will sometimes mean having to muddle along with uninspired managers.

Taken as a whole, the foregoing observations lend support to the assumption of profit maximization. We might even say that they place the burden of proof on those who insist that firms do not maximize profits. But they obviously do not establish conclusively that firms always pursue profit at the expense of all other goals. This remains an empirical question, and in the chapters to come we will see some evidence that firms sometimes fall short. Even so, the assumption of profit maximization is a good place to begin our analysis of firm behaviour, and there is no question but that it provides useful insights into how firms respond to changes in input or product prices, taxes and other important features of their operating environments.

THE FOUR CONDITIONS FOR PERFECT COMPETITION

To predict how much output a competitive firm will produce, economists have developed the *theory of perfect competition*. Four conditions define the existence of a perfectly competitive market. Let us consider each of them in turn.

1. **Firms Sell a Standardized Product** In a perfectly competitive market, the product sold by one firm is assumed to be a perfect substitute for the product sold by any other. Interpreted

[1]See, for example, Armen Alchian, 'Uncertainty, Evolution, and Economic Theory', *Journal of Political Economy*, 1950.

literally, this is a condition that is rarely if ever satisfied. Connoisseurs of fine wines, for example, insist that they can tell the difference between wines made from the same variety of grape grown on estates only a few hundred metres apart. It is also difficult to speak of a market for even such a simple commodity as shirts, because shirts come in so many different styles and quality levels. If we define the market sufficiently narrowly, however, it is sometimes possible to achieve a reasonable degree of similarity among the products produced by competing firms. For instance, 'French spring wheat' may not be exactly the same on different farms, but it is close enough that most buyers do not care very much which farm the wheat comes from.

Glow Images

Few product markets fully satisfy the conditions required for perfect competition, but the markets for many agricultural products come close.

2. **Firms are Price Takers** This means that the individual firm treats the market price of the product as given. More specifically, it must believe that the market price will not be affected by how much output it produces. This condition is likely to be satisfied when the market is served by a large number of firms, each one of which produces a negligible fraction of total industry output. But a large number of firms are not always necessary for price-taking behaviour. Even with only two firms in the market, for example, each may behave as a price taker if it believes that other firms stand ready to enter its market at a moment's notice.

3. **Free Entry and Exit, with Perfectly Mobile Factors of Production in the Long-Run** One implication of this condition is that if a firm perceives a profitable business opportunity at a given time and location, it will be able to hire the factors of production required to take advantage of it. Similarly, if its current venture no longer appears attractive in relation to alternative business ventures, it is free to discharge its factors of production, which will then move to industries in which opportunities are stronger. Of course, no one believes that resources are perfectly mobile. Labour, in particular, is not likely to satisfy this condition. People buy homes, make friends, enrol their children in schools, and establish a host of other commitments that make it difficult to move from one place to another. Nonetheless, the perfect mobility assumption is often reasonably well satisfied in practice, especially if we take into account that it is not always necessary for labour to move geographically in order for it to be mobile in an economic sense. Indeed, the firm can often move to the worker, as happens when textile companies outsource to India or the Far East.

4. **Firms and Consumers Have Perfect Information** A firm has no reason to leave its current industry if it has no way of knowing about the existence of more profitable opportunities elsewhere. Similarly, a consumer has no motive to switch from a high-priced product to a lower-priced one of identical quality unless she knows about the existence of the latter. Here too the required condition is never satisfied in a literal sense. The world is sufficiently complex that there will inevitably be relevant features of it hidden from view. As a practical matter, the assumption of perfect information is usually interpreted to mean that people can acquire most of the information that is most relevant to their choices without great difficulty. Even this more limited condition will fail in many cases. As we saw in Chapter 9, people often have the relevant information right at their fingertips and yet fail to make sensible use of it. These observations notwithstanding, we will see that the state of knowledge is often sufficient to provide a reasonable approximation to the perfect information condition.

Few if any markets satisfy all of these four conditions in full. Perfect competition is, therefore, an idealized concept. Many markets do, however, come close to satisfying all the conditions. Cloud computing provides one example. This product is relatively homogenous—all a cloud does is essentially store and process your files. There is a strong element of price taking behaviour—if Google, IBM, Amazon or Microsoft attempt to increase prices, for example, they are likely to lose a lot of customers. There is free entry and exit—anyone can set up a cloud. And finally, firms and consumers have perfect information—prices are easily available on the internet. To be sure, the four properties are only approximately satisfied. For instance, some customers will be loyal to Google even if its prices are higher than those of Microsoft. The model of perfect competition can still, though, give useful insight.

To further assess whether the assumptions underlying the model of perfect competition are hopelessly restrictive, it is useful to compare them to the assumptions that underlie the physicist's model of objects in motion. If you have taken a high school or college physics course, then you know (or once knew) that a force applied to an object on a frictionless surface causes that object to accelerate at a rate inversely proportional to its mass. Thus, a given force applied to a 10-kilogram object will cause that object to accelerate at twice the rate we observe when the same force is applied to a 20-kilogram object.

To illustrate this theory, physics teachers show us films of what happens when various forces are applied to a hockey puck atop a large surface of dry ice. These physicists understand perfectly well that there is an easily measured amount of friction between the puck and the dry ice. But they are also aware that the friction levels are so low that the model still provides reasonably accurate predictions.

In the kinds of situation we are most likely to encounter in practice, friction is seldom as low as between a puck and a dry ice surface. This will be painfully apparent to you, for example, if you have just taken a spill from your Harley Sportster motorcycle on an asphalt road. But even here the physicist's laws of motion apply, and we can make adjustments for friction in order to estimate just how far a fallen rider will slide. And even where the model cannot be calibrated precisely, it tells us that the rider will slide farther the faster he was going when he fell, and that he will slide farther if the pavement is wet or covered with sand or gravel than if it is clean and dry.

With the economic model of perfect competition, the issues are similar. In some markets, most notably those for agricultural products, the four conditions come close to being satisfied. The predictions of the competitive model in these cases are in many ways as precise as those of the physicist's model applied to the puck on dry ice. In other markets, such as those for laptops or earth-moving equipment, at least some of the conditions are not even approximately satisfied. But even in these cases, the competitive model can tell us something useful if we interpret it with care.

ECONOMIC NATURALIST 12.1

Why are eBay, Alibaba and Amazon marketplaces good for consumers?

As discussed in Chapter 7, consumers often have to search for information about the price of products. Someone, for instance, looking to buy a new mobile phone may simply be unaware of how cheap or expensive her preferred model of phone will be. We saw that this lack of information could result in her paying significantly more for the phone than she needed to. Sellers, of course, can profit from this.

The internet has transformed the ease with which consumers can search for price information. Within seconds a person can gather as much information as would have taken hours if not days only 10 years ago. No longer do we have to search the high street, shop by shop, or ring up suppliers, one by one, for information. Online marketplaces like eBay, Amazon and Alibaba take things one step further in actively bringing together buyers and sellers.

Online marketplaces have had the effect of making the market for many products closer to the ideal of perfect competition. Clearly they mean that consumers have access to much more information. This, in turn, means sellers have less power to set price because cheaper alternatives are easier to find. Online marketplaces have also made entry and exit freer. A seller no longer needs a shopfront or fancy advertising. She just needs a good reputation on an online marketplace.

We shall see shortly that perfect competition is advantageous for consumers. It is no surprise, therefore, that consumers have embraced online marketplaces. ■

THE SHORT-RUN CONDITION FOR PROFIT MAXIMIZATION

The first question we want our model of competitive firm behaviour to be able to answer is, 'How does a firm choose its output level in the short-run?' Under the assumption that the firm's goal is to maximize economic profit, it will choose that level of output for which the difference between total revenue and total cost is largest.

Consider a firm with the short-run total cost curve labelled TC in the top panel in Figure 12.1. Like many of the firms we discussed in Chapter 11, this firm experiences first increasing, then decreasing, returns to its variable input, which produces the familiar pattern of curvature in its total cost curve. Suppose this firm can sell its output at a price of P_0 = €18/unit. Its total revenue per week will then be €18/unit of output times the number of units of output sold each week. For example, if the firm sells no output, it earns zero total revenue; if it sells 10 units of output per week, it earns €180/wk; if it sells 20 units/wk, it earns €360/wk; and so on. So for the perfectly competitive firm, which can sell as much or as little output as it chooses at a constant market price, total revenue is exactly proportional to output. For the firm in this example, the total revenue curve is the line labelled TR in the top panel in Figure 12.1. It is a ray whose slope is equal to the product price, $P_0 = 18$.

The bottom panel in Figure 12.1 plots the difference between TR and TC, which is the curve labelled Π_Q, the notation traditionally used in economics to represent economic profit. Here, Π_Q is positive for output levels between $Q = 4.7$ and $Q = 8.7$, and reaches a maximum at $Q = 7.4$. For output levels less than 4.7 or greater than 8.7, the firm is earning economic losses, which is simply another way of saying that its economic profits are negative for those values of Q.

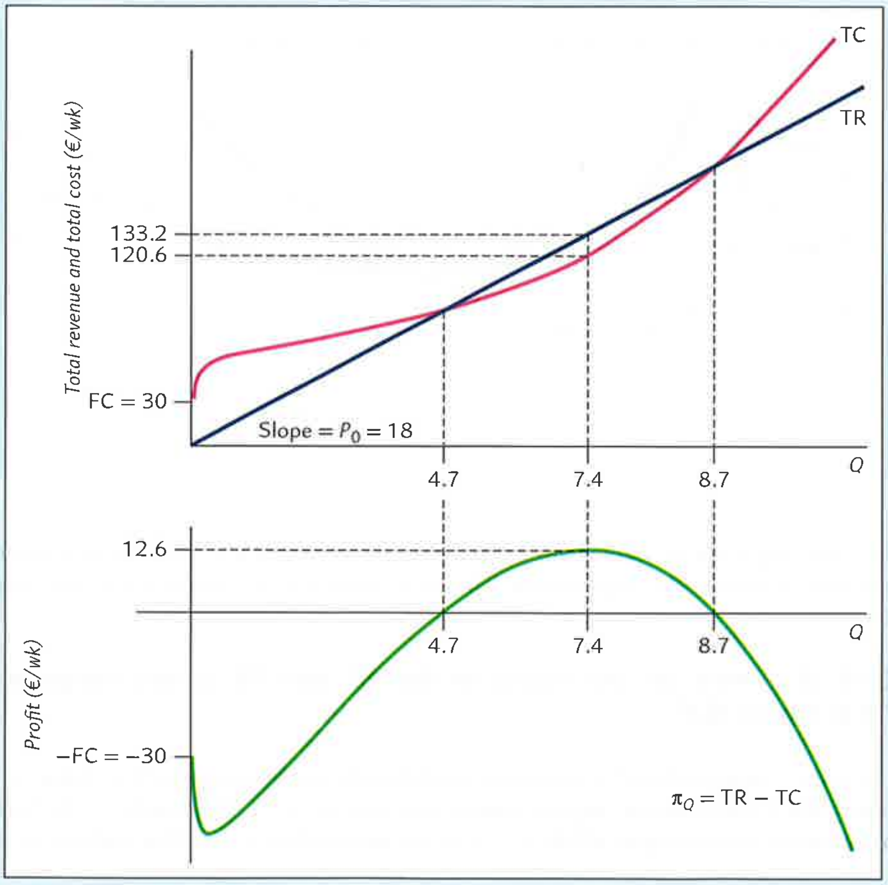


FIGURE 12.1
Revenue, Cost and Economic Profit
The total revenue curve is the ray labelled TR in the top panel. The difference between it and total cost (TC in the top panel) is economic profit (Π_Q in the bottom panel). At $Q = 0$, $\Pi_Q = -FC = -30$. Economic profit reaches a maximum (€12.60/wk) for $Q = 7.4$.

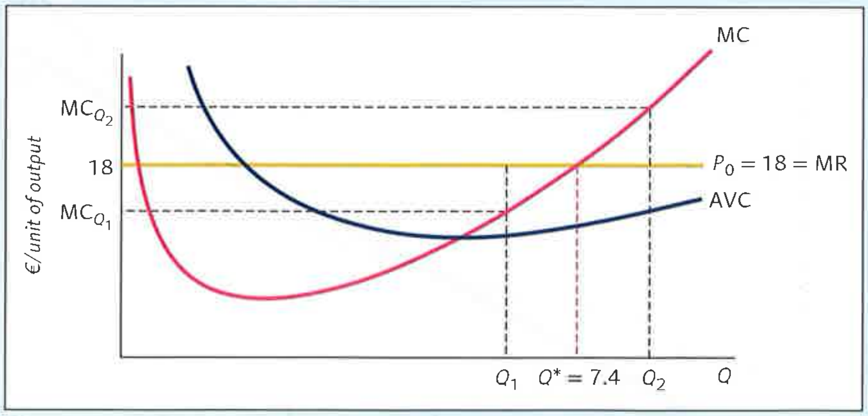
In the bottom panel in Figure 12.1, note also that the vertical intercept of the profit curve is equal to −€30/wk, the negative of the firm's fixed cost. When the firm produces no output, it earns no revenue and incurs no variable cost but must still pay its fixed costs, so its profit when $Q = 0$ is simply −FC. If there were no positive output level for which the firm could earn higher profit than −FC, its best option would be to produce zero output in the short-run.

The maximum profit point can also be characterized in terms of the relationship between output price and short-run marginal cost. Output price, which is equal to the slope of the total revenue curve, is also called **marginal revenue (MR)**.[2] Marginal revenue is formally defined as *the change in revenue that occurs when the sale of output changes by 1 unit*. In the cost–benefit language of Chapter 1, MR is the benefit to the firm of selling an additional unit of output. If the firm wants to maximize its profit, it must weigh this benefit against the cost of selling an extra unit of output, which is its marginal cost.

marginal revenue (MR) the change in total revenue that occurs as a result of a 1-unit change in sales.

The short-run marginal and average variable cost curves that correspond to the TC curve in Figure 12.1 are shown in Figure 12.2, where we again suppose that the firm can sell its output at a price of P_0 = €18/unit. To maximize its economic profit, the firm should follow this rule: provided P_0 is larger than the minimum value of AVC (more on the reason for this condition below), *the firm should produce a level of output for which marginal revenue, $P_0 = 18$, is equal to marginal cost on the rising portion of the MC curve.* For the particular cost curves shown in Figure 12.2, $P_0 = 18$ is indeed larger than the minimum value of AVC, and is equal to marginal cost at the quantity level $Q^* = 7.4$. The requirement that marginal revenue intersect marginal cost on the rising portion of marginal cost implies that marginal revenue intersects marginal cost from above. Thus marginal revenue lies below marginal cost past this point of intersection, and the firm has no incentive to expand output beyond this point (additional units would reduce profits).

FIGURE 12.2
The Profit-Maximizing Output Level in the Short-run
A necessary condition for profit maximization is that price equals marginal cost on the rising portion of the marginal cost curve. Here, this happens at the output level $Q^* = 7.4$.



As the following exercise demonstrates, the definitions of MR and MC tell us something about the relative values of the slopes of the TR and TC curves at the maximum-profit point in Figure 12.1.

EXERCISE 12.2 How do the slopes of the TC and TR curves compare at $Q = 7.4$ in Figure 12.1?

Why is 'price = marginal cost' a necessary condition for profit maximization? Suppose we picked some other level of output, say, Q_1, that is less than $Q^* = 7.4$. The benefit to the firm of selling an additional unit of output will be P_0 = €18 (its marginal revenue). The addition to total

[2]As we will see in the next chapter, output price and marginal revenue are *not* the same for a monopolist.

cost of producing an extra unit of output at Q_1 will be its marginal cost at the level of output, MC_{Q_1}, which in Figure 12.2 is clearly less than €18. It follows that for any level of output on the rising portion of the MC curve to the left of $Q^* = 7.4$, the benefit of expanding (as measured by marginal revenue) will be greater than the cost of expanding (as measured by marginal cost). This amounts to saying that profit will increase when we expand output from Q_1.

Now consider any level of output to the right of $Q^* = 7.4$, such as Q_2. At Q_2, the benefit of contracting output by 1 unit will be the resulting cost savings, which is marginal cost at that level of output, namely, MC_{Q_2}. (Note here that we are using the term 'benefit' to refer to the avoidance of a cost.) The cost to the firm of contracting output by 1 unit will be its marginal revenue, $P_0 = 18$, the loss in total revenue when it sells 1 unit less. (Here, not getting a benefit is a cost.) Since $MC_{Q_2} >$ €18, the firm will save more than it loses when it contracts output by 1 unit. It follows that for any output level greater than $Q^* = 7.4$, the firm's profit will grow when it contracts output. The only output level at which the firm cannot earn higher profit by either expanding or contracting is $Q^* = 7.4$, the level for which the cost of any move is exactly equal to its benefit.[3]

The Shutdown Condition

Recall that the rule for short-run profit maximization is to set price equal to marginal cost, provided price exceeds the minimum value of average variable cost. Why must price be greater than the minimum point of the AVC curve? The answer is that unless this condition is met, the firm will do better to shut down—that is, to produce no output—in the short-run. To see why, note that the firm's *average revenue (AR)* per unit of output sold is simply the price at which it sells its product. (When price is constant for all levels of output, average revenue and marginal revenue are the same.)[4] If average revenue is less than average variable cost, the firm is taking a loss on each unit of output it sells. The firm's total revenue (average revenue times quantity) will be less than its total variable cost (AVC times quantity), and this means that it would do better by not producing any output at all. Shutting down in this context means simply to produce zero output in the short-run. The firm will resume production if price again rises above the minimum value of AVC, the trigger point for its **shutdown condition**.

shutdown condition if price falls below the minimum of average variable cost, the firm should shut down in the short-run.

As we saw in Figure 12.1, a firm that produces zero output will earn economic profit equal to the negative of its fixed costs. If the price of its product is less than the minimum value of its average variable costs, it would have even greater economic losses if it produced a positive level of output.

The two rules—(1) that price must equal marginal cost on a rising portion of the marginal cost curve and (2) that price must exceed the minimum value of the average variable cost curve—together define the short-run supply curve of the perfectly competitive firm. The firm's supply curve tells how much output the firm wants to produce at various prices. As shown by the heavy red locus in Figure 12.3, it is the rising portion of the short-run marginal cost curve that lies above the minimum value of the average variable cost curve (which is €12/unit of output in this example). Below $P = 12$, the supply curve coincides with the vertical axis, indicating that

[3]The firm's problem is to maximize $\Pi = PQ - TC_Q$, where TC_Q *is the short-run total cost of producing Q units of output. The first-order condition for a maximum is given by*

$$\frac{d\Pi}{dQ} = P - \frac{dTC_Q}{dQ} = P - MC_Q = 0$$

which gives the condition $P = MC_Q$. The second-order condition for a maximum is given by

$$\frac{d^2\Pi}{dQ^2} = \frac{-dMC_Q}{dQ} < 0$$

or

$$\frac{dMC_Q}{dQ} > 0$$

which tells us why we must be at a point on the rising portion of the marginal cost curve.

[4]Note that $AR = TR/Q = PQ/Q = P$.

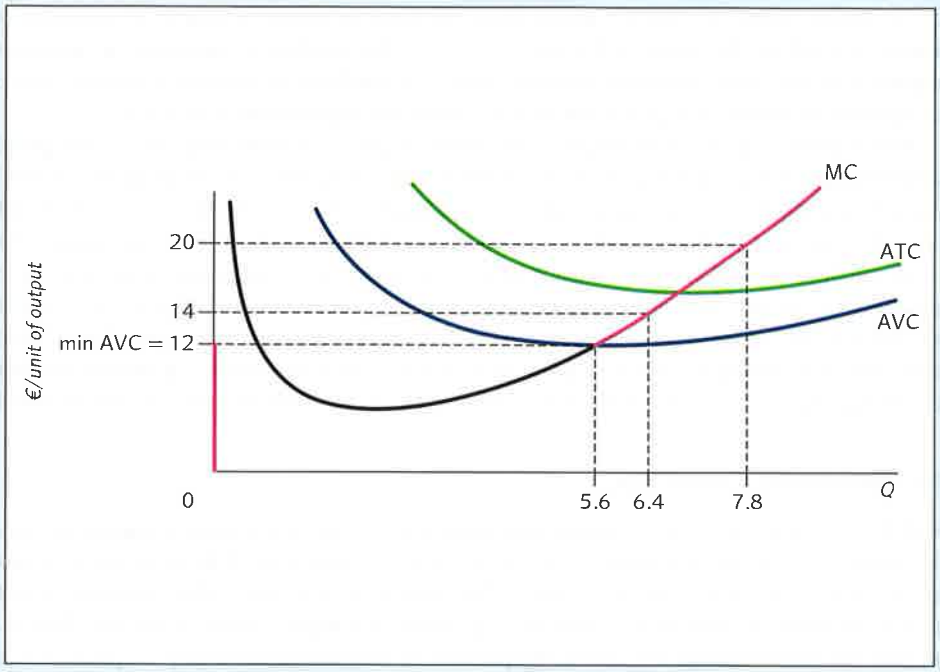


FIGURE 12.3
The Short-Run Supply Curve of a Perfectly Competitive Firm
When price lies below the minimum value of average variable cost (here, €12/unit of output), the firm will make losses at every level of output, and will keep its losses to a minimum by producing zero. For prices above min AVC, the firm will supply that level of output for which P = MC on the rising portion of its MC curve.

the firm supplies zero output when price is less than min AVC. For prices above 12, the firm will supply the output level for which P = MC. Thus, prices of 14 and 20 will cause this firm to supply 6.4 and 7.8 units of output, respectively. The competitive firm acts here as both a price taker and a profit maximizer: taking the market price as given, it chooses the level of output that maximizes economic profit at that price.

Note in Figure 12.3 that the firm supplies positive output whenever price exceeds min AVC, and recall that average variable cost is less than average total cost, the difference being average fixed cost. It follows that no matter how small AFC is, there will be a range of prices that lie between the AVC and ATC curves. For any price in this range, the firm supplies the level of output for which P = MC, which means that it will lose money because P is less than ATC. For example, the firm whose cost curves are shown in Figure 12.3 cannot cover all its costs at a price of €14. Even so, its best option is to supply 6.4 units of output per week, because it would lose even more money if it were to shut down. Being able to cover variable costs does not assure the firm of a positive level of economic profit. But it is sufficient to induce the firm to supply output in the short-run.

Note also in Figure 12.3 that the firm's short-run supply curve is upward sloping. This is because the relevant portion of the firm's short-run marginal cost curve is upward sloping, which, in turn, is a direct consequence of the law of diminishing returns.

ECONOMIC NATURALIST 12.2

Why do North Sea oil operations continue at a loss?

In 2013 the oil price hit a high of €83 per barrel. By 2015 it was down to €40. Such a steep fall in the price of oil clearly has big implications for oil and gas extraction. At a price of €55 it is estimated that a large proportion (maybe up to a half) of extraction in the North Sea is unprofitable. So, is it time to shut down operations?

Oil extraction involves large fixed costs, carrying out surveys, building oil rigs, laying pipes, etc. Variable costs are much smaller. Indeed, even oil workers are typically on long-term contracts meaning that their wages cannot be cut in the short-run. If the price of oil exceeds average variable cost then it is optimal to continue extraction. So, in the short-run North Sea oil extraction is set to continue. Whether oil companies will make long-term investment in new surveys, rigs, pipes and workers is less clear.

THE SHORT-RUN COMPETITIVE INDUSTRY SUPPLY

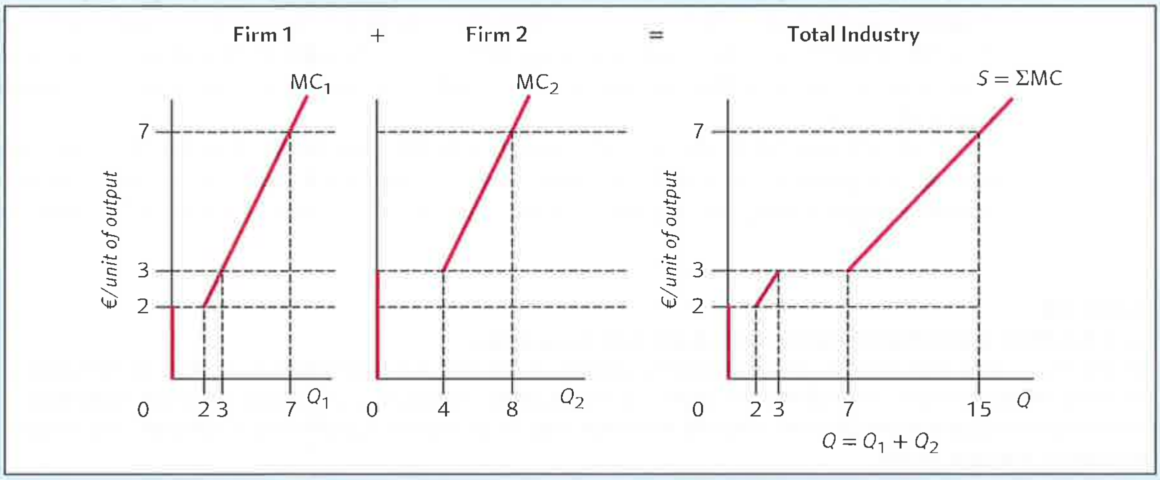
The short-run supply curve for a competitive industry is generated in a manner analogous to the one we used to generate the market demand curve in Chapter 6. In this case we simply announce a price and then add together the amounts each firm wishes to supply at that price. The resulting sum is industry supply at that price. Additional points on the industry supply curve are generated by pairing other prices with the sums of individual firm supplies at those prices.

Figure 12.4 illustrates the procedure for one of the simplest cases, an industry consisting of only two firms. At a price of €2/unit of output, only firm 1 (left panel) wishes to supply any output, and so its offering, $Q_1 = 2$ units of output per week, constitutes the entire industry supply at $P = 2$ (right panel). At $P = 3$, firm 2 enters the market (centre panel) with an offering of $Q_2 = 4$. Added to firm 1's offering at $P = 3$—namely, $Q_1 = 3$—the resulting industry supply at $P = 3$ is $Q = 7$ (right panel). In like fashion, we see that industry supply at $P = 7$ is $Q = 7 + 8 = 15$. In Chapter 6, we saw that the market demand curve is the horizontal summation of the individual consumer demand curves. Here, we see that the market supply curve is the horizontal summation of the individual firm supply curves.

FIGURE 12.4

The Short-Run Competitive Industry Supply Curve

To get the industry supply curve (right panel), we simply add the individual firm supply curves (left and centre panels) horizontally.



The horizontal summation of an individual firm's supplies into industry supply has a simple form when the firms in the industry are all identical. Suppose n firms each have supply curve $P = c + dQ_i$. To add up the quantities for the n firms into industry supply, we rearrange the firm supply curve $P = c + dQ_i$ to express quantity alone on one side: $Q_i = -(c/d) + (1/d)P$. Then industry supply is the sum of the quantities supplied Q_i by each of the n firms,

$$Q = nQ_i = n\left(-\frac{c}{d} + \frac{1}{d}P\right) = -\frac{nc}{d} + \frac{n}{d}P$$

We can then rearrange industry supply $Q = -(nc/d) + (n/d)P$ to get it back in the form of price alone on one side: $P = c + (d/n)Q$. The intuition is that each unit supplied by the industry is $1/n$ unit for each firm to supply. These calculations suggest a general rule for constructing the industry supply curve when firms are identical. If we have n individual firm supply curves $P = c + dQ_i$, then the industry supply curve is $P = c + (d/n)Q$.

EXAMPLE 12.2 Suppose an industry has 200 firms, each with supply curve $P = 100 + 1{,}000Q_i$. What is the industry supply curve?

First, we need to rearrange the representative firm supply curve $P = 100 + 1{,}000Q$ to have quantity alone on one side:

$$Q_i = -\frac{1}{10} + \frac{1}{1{,}000}P$$

Then we multiply by the number of firms $n = 200$:

$$Q = nQ_i = 200Q_i = 200\left(-\frac{1}{10} + \frac{1}{1{,}000}P\right) = -20 + \frac{1}{5}P$$

Finally, we rearrange the industry supply curve $Q = -20 + (\frac{1}{5})P$ to have price alone on one side, $P = 100 + 5Q$, to return to the slope-intercept form. ◆

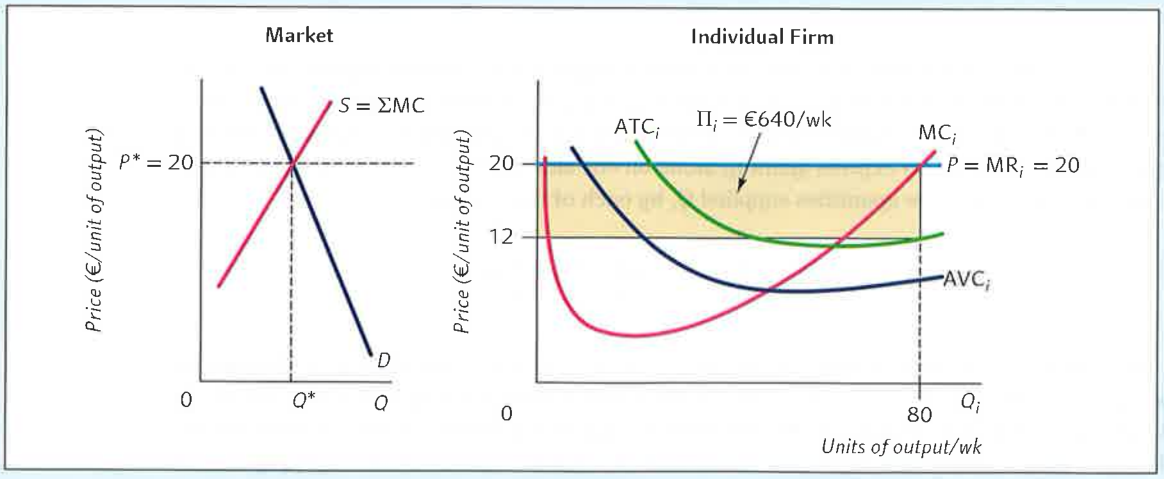
EXERCISE 12.3 Suppose an industry has 30 firms, each with supply curve $P = 20 + 90Q_i$. What is the industry supply curve?

SHORT-RUN COMPETITIVE EQUILIBRIUM

The individual competitive firm must choose the most profitable level of output to produce in response to a given price. But where does that price come from? As we saw in Chapter 2, it comes from the intersection of the supply and demand curves for the product. Recall that at the equilibrium price sellers are selling the quantity they wish to sell and buyers are buying the quantity they wish to buy.

In the left panel in Figure 12.5, the curve labelled D is the market demand curve for a product sold in a perfectly competitive industry. The curve labelled S is the corresponding short-run industry supply curve, the horizontal summation of the relevant portions of the individual

FIGURE 12.5
Short-Run Price and Output Determination under Pure Competition
The short-run supply and demand curves intersect to determine the short-run equilibrium price, $P^* = 20$ (left panel). The firm's demand curve is a horizontal line at $P^* = 20$ (right panel). Taking $P^* = 20$ as given, the firm maximizes economic profit by producing $Q_i^* = 80$ units/wk, for which it earns an economic profit of $\Pi_i = €640$/wk (the shaded rectangle in the right panel).



short-run marginal cost curves.[5] These two curves intersect to establish the short-run competitive equilibrium price, here denoted $P^* = €20$/unit of output. $P^* = 20$, in turn, is the price on which individual firms base their output decisions.

The conditions confronting a typical firm are shown in the right panel in Figure 12.5. The demand curve facing this firm is a horizontal line at $P^* = 20$. This means that it can sell as much or as little as it chooses at the market price of €20/unit. Put another way, any single firm can sell as much as it wants to without affecting the market price. If a firm charged more than €20, it would sell no output at all because buyers would switch to a competing firm that sells for €20. A firm could charge less than €20, of course, but would have no motive to do so if its objective were to maximize economic profit, since it can already sell as much as it wants to at €20. The result is that even though the market demand curve is downward sloping, the demand curve facing the individual firm is perfectly elastic. (Recall from the definition of price elasticity in Chapter 6 that a horizontal demand curve has infinite price elasticity, which is what 'perfectly elastic' means.)

In the right panel in Figure 12.5, the representative firm maximizes its profit by equating $P^* = €20$/unit to marginal cost at an output level of $Q_1^* = 80$ units/wk. At that output level its total revenue is $P^*Q_1^* = €1{,}600$/wk and its total costs are $\text{ATC}_{Q_i^*}\, Q_1^* =$ (€12/unit) (80 units/wk) = €960/wk. Its economic profit is the difference between total revenue and total cost, €1,600/wk – €960/wk = €640/wk, and is represented by the shaded rectangle denoted Π_i. Equivalently, profits can be calculated as the difference between price (€20/unit) and average total cost (€12/unit) times the quantity sold (80 units/week).

Recall that the opportunity cost of resources owned by the firm constitutes part of the cost included in its average total cost curve. This is why we say that total revenues over and above total costs constitute economic profit. If the firm's revenue were exactly equal to its total cost, it would earn only a normal profit—which is to say, zero economic profit. This happens when price is equal to average total cost. Thus, price equal to the minimum of average total cost can be called the breakeven point—the lowest price at which the firm will not suffer negative profits in the short-run.

The situation portrayed in Figure 12.5 and Table 12.1 is one in which the short-run equilibrium price enables the firm to make a positive economic profit. Another possibility is that the short-run supply and demand curves will intersect at an equilibrium price that is sufficiently high to induce firms to supply output, but not high enough to enable them to cover all their costs. This situation is shown in Figure 12.6 and Table 12.1. In the left panel, supply and demand intersect at a price $P^* = €10$/unit of output, which lies above the minimum value of the AVC curve of the firm shown in the right panel, but below that firm's ATC curve at the profit-maximizing level of output, $Q_1^* = 60$ units of output per week. The result is that the firm makes an economic loss of $P^*Q_1^* - \text{ATC}_{Q_i^*} Q_i^* = -€120$/wk. This loss is shown in the right panel in Figure 12.6 by the shaded rectangle labelled Π_i. Note that this loss is less than –TFC, the value of economic profit when output is zero. Thus it makes sense to produce even when economic profit falls below zero in the short-run.

TABLE 12.1
Economic Profits versus Economic Losses

Q	ATC	MC	$\Pi(P = 20)$	$\Pi(P = 10)$
40	14	6	240	–160
60	12	10	480	–120
80	12	20	640	–160
100	15	31	500	–500

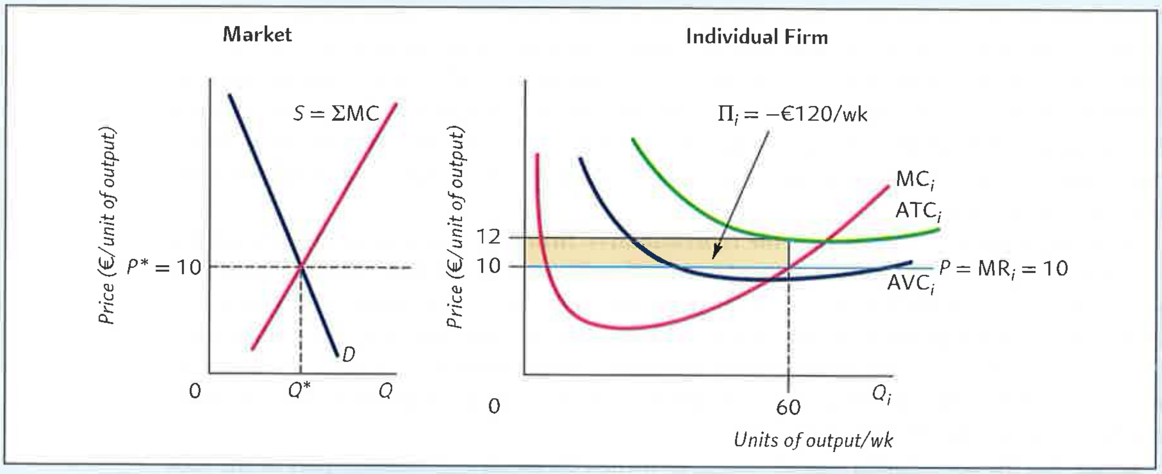
At a price of 20, the firm earns economic profits, but at a price of 10, it suffers economic losses.

[5]Here, the 'relevant portions' are those that lie above the respective values of min AVC.

FIGURE 12.6

A Short-Run Equilibrium Price that Results in Economic Losses

The short-run supply and demand curves sometimes intersect to produce an equilibrium price $P^* = €10$/unit of output (left panel) that lies below the minimum value of the ATC curve for the typical firm (right panel), but above the minimum point of its AVC curve. At the profit-maximizing level of output, $Q_i^* = 60$ units/wk, the firm earns an economic loss of $\Pi_i = -€120$/wk.



EXERCISE 12.4 **If the short-run marginal and average variable cost curves for a competitive firm are given by MC = 2*Q* and AVC = *Q*, how many units of output will the firm produce at a market price of *P* = 12? At what level of fixed cost will this firm earn zero economic profit?**

THE EFFICIENCY OF SHORT-RUN COMPETITIVE EQUILIBRIUM

One of the most attractive features of competitive markets is the fact that they result in **allocative efficiency**, which means that they fully exploit the possibilities for mutual gains through exchange. This also implies that competitive markets lead to **Pareto efficient** outcomes where it is only possible to make one person better off at the expense of another (see Chapter 2). To illustrate, let us consider the short-run equilibrium pictured in the left panel of Figure 12.7, and suppose that the cost curves pictured in the right panel are the same for each of 1,000 firms in the industry.

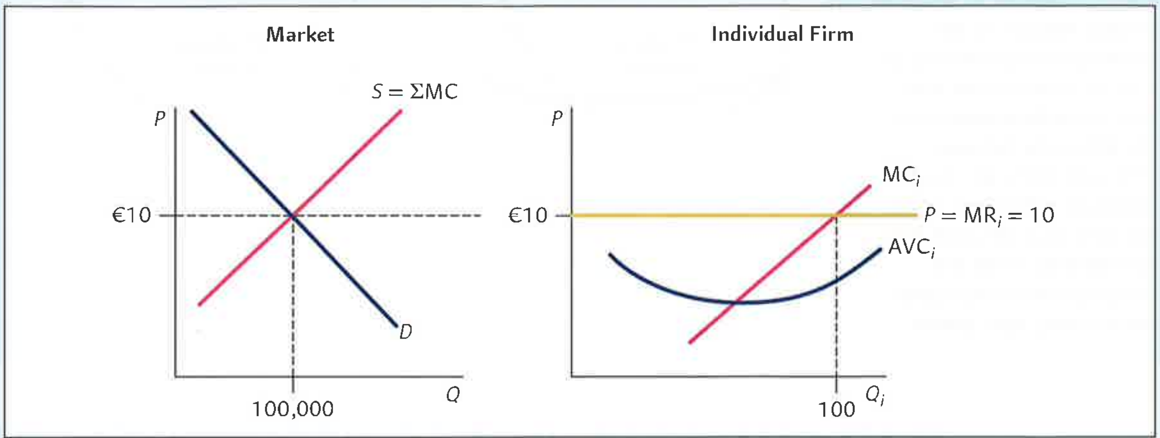
allocative efficiency a condition in which all possible gains from exchange are realized.

Pareto efficient an outcome where it is not possible to make some person better off without harming another person.

In a competitive market in the short-run, consumers give firms money, which firms use to buy variable inputs to produce the output that goes to consumers. To say that the competitive equilibrium leaves no room for further mutually beneficial exchange is the same thing as saying that there is no way for any producer and consumer to agree to a private transaction at any price other than €10. Of course, consumers would gladly pay less than €10 for an additional unit of output. But since €10 is equal to the value of the resources required to produce another unit (MC_i in the right panel of Figure 12.7), no firm would be willing to respond. Firms, for their part, would gladly produce an extra unit of output if the price were higher than €10. But with 100,000 units of output already in the market, there are no consumers left who are willing to pay more than €10 (left panel of Figure 12.7).

At the short-run competitive equilibrium price and quantity, the value of the resources used to produce the last unit of output (as measured by short-run marginal cost) is exactly equal to the value of that unit of output to consumers (as measured by the price they are

FIGURE 12.7
Short-Run Competitive Equilibrium Is Efficient
At the equilibrium price and quantity, the value of the additional resources required to make the last unit of output produced by each firm (MC in the right panel) is exactly equal to the value of the last unit of output to buyers (the demand price in the left panel). This means that further mutually beneficial trades do not exist.



willing to pay for it). Firms may wish that prices were higher, and consumers may complain that prices are too high already. But the two parties have no incentive to trade at any price other than the equilibrium price.

PRODUCER SURPLUS

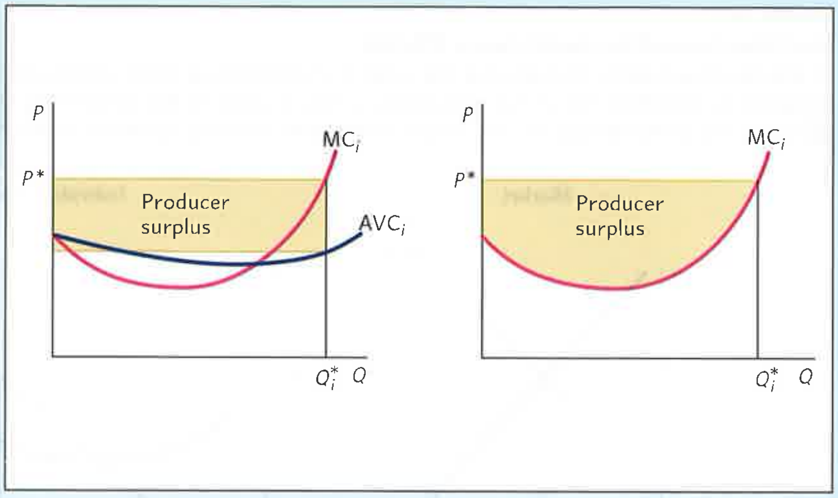
To say that a competitive market is efficient is to say that it maximizes the net benefits to its participants. In policy analysis, it is often useful to estimate the actual amount by which people and firms gain from their participation in specific markets. Suppose, for example, that the government of a developing country knows it can open up new markets for seafood by building a road from its coast to an interior region. If its goal is to use the country's resources as efficiently as possible, its decision about whether to build the road will depend on whether the benefits people and firms reap from these new markets exceed the cost of building the road.

In Chapter 6 we discussed the concept of consumer surplus as a measure of the benefit to the consumer of engaging in a market exchange. An analogous measure exists for producers. Economists call it **producer surplus**, and it measures how much better off the firm is as a result of having supplied its profit-maximizing level of output. It may seem tempting to say that the firm's producer surplus is simply its economic profit, but surplus and profit often differ. To see why, first recall that in the short-run if the firm produces nothing, it will sustain a loss equal to its fixed cost. If the price exceeds the minimum value of AVC, however, it can do better by supplying a positive level of output. How much better? The firm's gain compared with the alternative of producing nothing is the difference between total revenue and total variable cost at the output level where $P = \text{MC}$. Now recall that economic profit is the difference between total revenue and total cost and that total cost differs from variable cost by fixed cost; it follows that producer surplus is the sum of economic profit and fixed cost.[6] Diagrammatically, it is the area of the shaded rectangle shown in the left panel in Figure 12.8. In the short-run, producer surplus is thus larger than economic profit, because the firm would lose more than its economic profit if it were prevented from participating in the market. In the long-run, all costs are variable. So producer surplus is the same as economic profit in the long-run.

producer surplus the euro amount by which a firm benefits by producing a profit-maximizing level of output.

[6]If $\Pi = \text{TR} - \text{TC}$ and $\text{TC} = \text{VC} + \text{FC}$, then producer surplus $= \text{TR} - \text{VC} = \text{TR} - \text{TC} + \text{FC} = \Pi + \text{FC}$.

FIGURE 12.8
Two Equivalent Measures of Producer Surplus
The difference between total revenue and total variable cost is a measure of producer surplus, the gain to the producer from producing Q_i^* units of output rather than zero. It can be measured as the difference between $P^*Q_i^*$ and $AVC_{Q_i^*}Q_i^*$ (shaded rectangle, left panel), or as the difference between $P^*Q_i^*$ and the area under the marginal cost curve (upper shaded area, right panel).

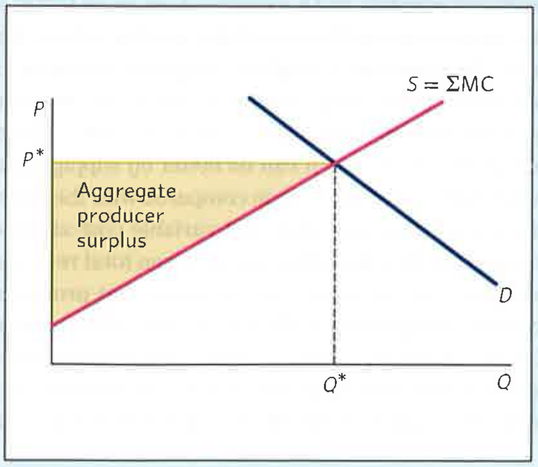


The right panel in Figure 12.8 shows an equivalent way of representing producer surplus. The alternative measure makes use of the fact that variable cost at any level of output is equal to the area under the marginal cost curve (below the shaded area in the right panel). To see why this is so, note that the variable cost of producing 1 unit of output is equal to marginal cost at 1 unit, MC_1; VC for 2 units is the sum of MC_1 and MC_2, and so on, so that $VC_Q = MC_1 + MC_2 + \cdots + MC_Q$, which is just the area under the MC curve. Hence the difference between the total revenue and total variable cost may also be expressed as the upper shaded area in the right panel in Figure 12.8.

Which of the two ways of measuring producer surplus is most useful will depend on the specific context at hand. If we are interested in the change in an existing producer surplus, the method shown in the right panel in Figure 12.8 will usually be easiest to work with. But when we want to measure total producer surplus, it will often be easier to calculate the surplus by using the method shown in the left panel.

To measure aggregate producer surplus for a market, we simply add the producer surplus for each firm that participates. In cases where each firm's marginal cost curve is upward sloping for the bulk of its range, aggregate producer surplus will be well approximated by the area between the supply curve and the equilibrium price line, P^*, as shown in Figure 12.9.

FIGURE 12.9
Aggregate Producer Surplus When Individual Marginal Cost Curves Are Upward Sloping Throughout
For any quantity, the supply curve measures the minimum price at which firms would be willing to supply it. The difference between the market price and the supply price is the marginal contribution to aggregate producer surplus at that output level. Adding these marginal contributions up to the equilibrium quantity Q^*, we get the shaded area, which is aggregate producer surplus.



Recall from Chapter 6 that a rough approximation of consumer surplus is given by the area between the consumer's demand curve and the equilibrium price line.[7] An approximation of consumer surplus for the market as a whole is given by the area between the demand curve and the equilibrium price line, as indicated by the shaded upper triangle in Figure 12.10. The total benefits from exchange in the marketplace may be measured by the sum of consumer and producer surpluses.

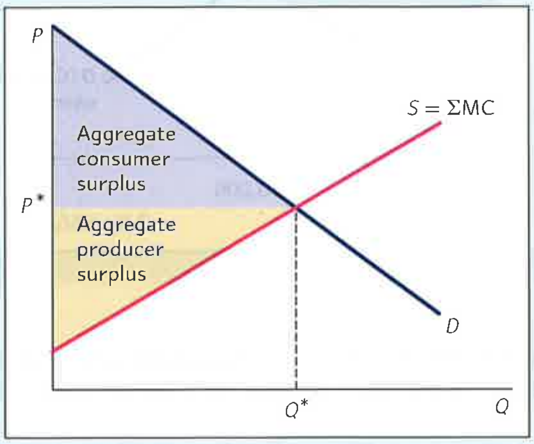


FIGURE 12.10
The Total Benefit from Exchange in a Market
The sum of aggregate producer surplus (shaded lower triangle) and consumer surplus (shaded upper triangle) measures the total benefit from exchange.

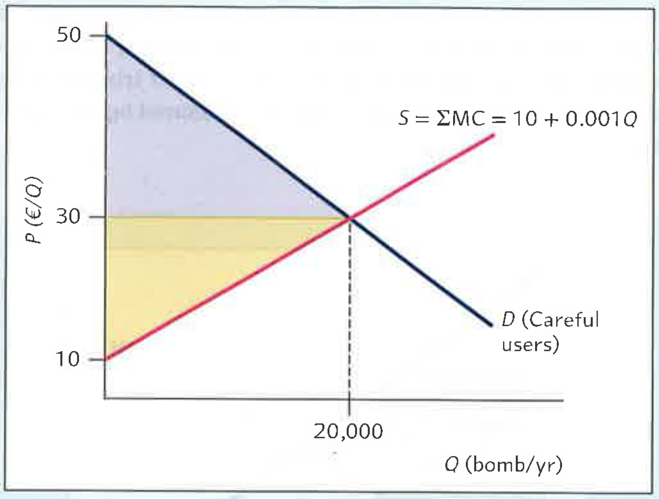
EXAMPLE 12.3 **Suppose there are two types of users of fireworks: careless and careful. Careful users never get hurt, but careless ones sometimes injure not only themselves, but also innocent bystanders. The short-run marginal cost curves of each of the 1,000 firms in the fireworks industry are given by MC = 10 + Q, where Q is measured in number of cherry bombs per year and MC is measured in euros per cherry bomb. The demand curve for fireworks by careful users is given by $P = 50 - 0.001Q$. Legislators would like to continue to permit careful users to enjoy fireworks. But since it is impractical to distinguish between the two types of users, they have decided to outlaw fireworks altogether. How much better off would consumers and producers be if legislators had the means to effect a partial ban?**

If the entire fireworks market is banned completely, the total of consumer and producer surplus will be zero. So to measure the benefits of a partial ban, we need to find the sum of consumer and producer surplus for a fireworks market restricted to careful users. To generate the supply curve for this market, we simply add the marginal cost curves of the individual firms horizontally, which results in the curve labelled S in Figure 12.11. The demand curve for careful users would intersect S at an equilibrium price of €30 and an equilibrium quantity of 20,000 bombs/yr.

By outlawing the sale of fireworks altogether, legislators eliminate producer and consumer surplus values given by the areas of the two shaded triangles in Figure 12.11, which add to €400,000/yr. In the language of cost–benefit analysis, this is the cost imposed on producers and careful users. The benefit of the ban is whatever value the public assigns to the injuries prevented (net of the cost of denying careless users the right to continue). It is obviously no simple matter to put a monetary value on the pain and suffering associated with fingers blown off by cherry bombs. In Chapter 15, we will discuss how at least rough estimates have been attempted

[7]Recall that this measure of consumer surplus is most accurate when income effects are small.

FIGURE 12.11
Producer and Consumer Surplus in a Market Consisting of Careful Fireworks Users
The upper shaded triangle is consumer surplus (€200,000/yr). The lower shaded triangle is producer surplus (€200,000/yr). The total benefit of keeping this market open is the sum of the two, or €400,000/yr.



in similar situations. But even in the absence of a formal quantitative measure of the value of injuries prevented, the public can ask itself whether the forgone surplus of €400,000/yr is a reasonable price to pay.

Many countries ban the private use of fireworks—Australia, Ireland, and most states in the US. Some countries have hardly any restrictions on private use—the UK and France. Whether or not this reflects differences in the estimated value of injuries prevented or of the proportion of careless users we leave for you to judge. ◆

EXERCISE 12.5 What would the sum of consumer and producer surplus be in Example 12.3 if the demand curve for careful users were instead given by $P = 30 - 0.001Q$?

ADJUSTMENTS IN THE LONG-RUN

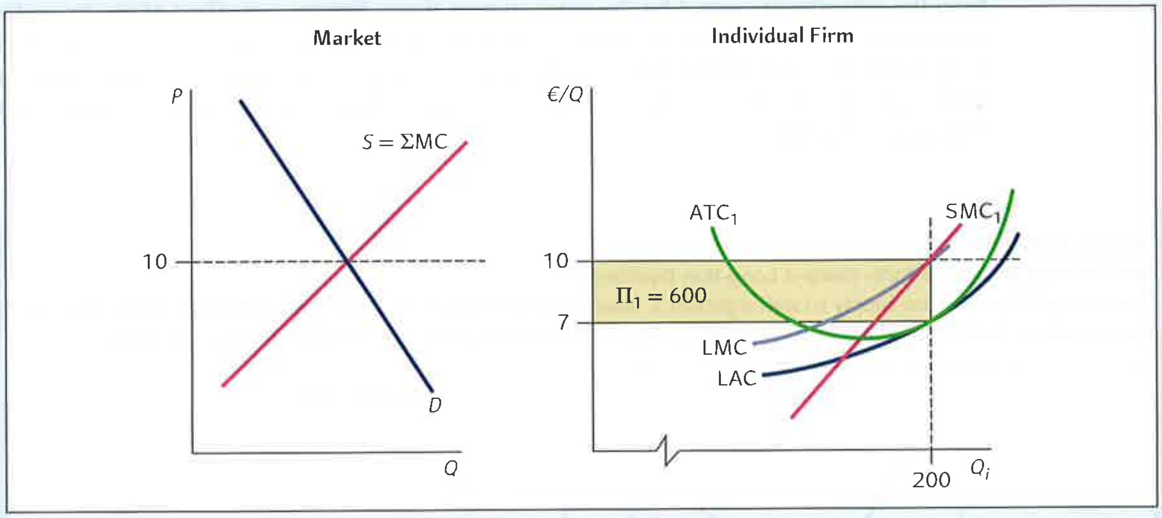
The firm's objective in the long-run is the same as in the short-run: to earn the highest economic profit it can. But, there are two things the firm can do in the long-run that it cannot do in the short-run. (1) It can change fixed inputs. This will change its short-run marginal costs and, therefore, will change its short-run supply curve. (2) The firm can leave the industry or decide to enter a new industry. This will change the industry supply curve.

To illustrate, suppose that industry supply and demand intersect at the price level $P = 10$, as shown in the left panel in Figure 12.12. The cost curves for a representative firm are shown in the right panel in Figure 12.12. At $Q = 200$, the price of €10/unit of output exceeds ATC_1, with the result that the firm earns economic profit of €600 each time period. This profit is indicated by the shaded rectangle.

The situation depicted in Figure 12.12 is inherently unstable. The reason is that positive economic profit creates an incentive for outsiders to enter the industry. Recall that the average total cost curves already include the opportunity cost of the capital that a firm requires to do business. This means that an outsider can buy everything needed to duplicate the operations of one of the existing firms in the industry, and in the process earn an economic profit of €600 each time period.

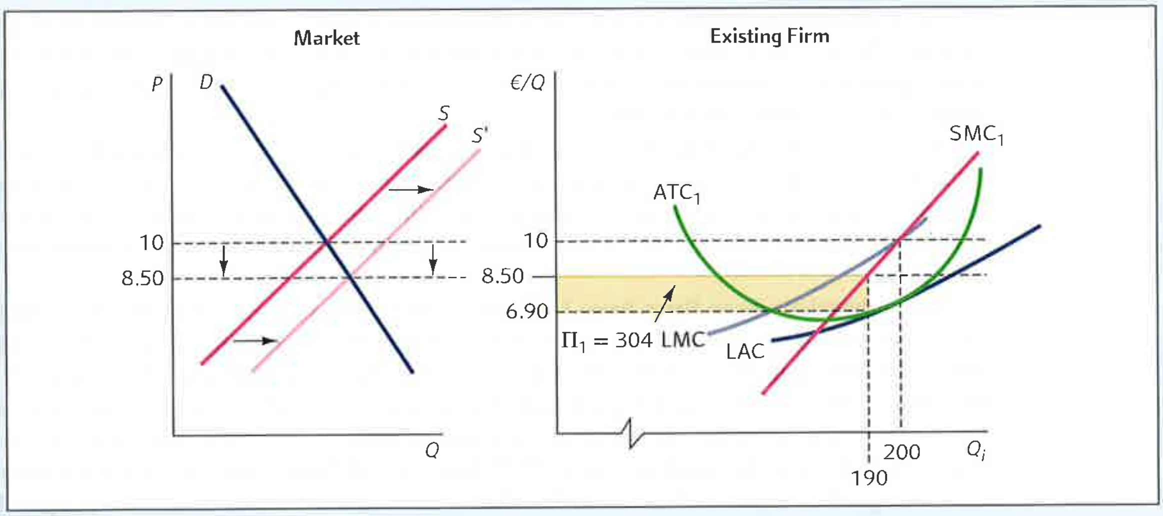
So, let us suppose that at least one new firm enters the industry. As shown in the left-hand panel of Figure 12.13, this will cause a rightward shift in the industry supply curve. In this

FIGURE 12.12
A Price Level that Generates Economic Profit
At the price level $P = €10$/unit, the firm has adjusted its plant size so that $SMC_1 = LMC = 10$. At the profit-maximizing level of output, $Q = 200$, the firm earns an economic profit equal to €600 each time period, indicated by the area of the shaded rectangle.



particular case, the new supply schedule, S', intersects the demand schedule at $P = 8.50$. At a price of €8.50 the existing firm, given its short-run supply curve, will reduce output. We can see in the right-hand panel of Figure 12.13 that it reduces output from 200 to 190. This has the effect of slightly reducing average total cost. Profit though still falls from €600 to €304 per time period.

FIGURE 12.13
First Step along the Path toward Long-Run Equilibrium
Entry of new firms causes supply to shift rightward, lowering price from €10 to €8.50. This lowers the profit of existing firms in the industry.

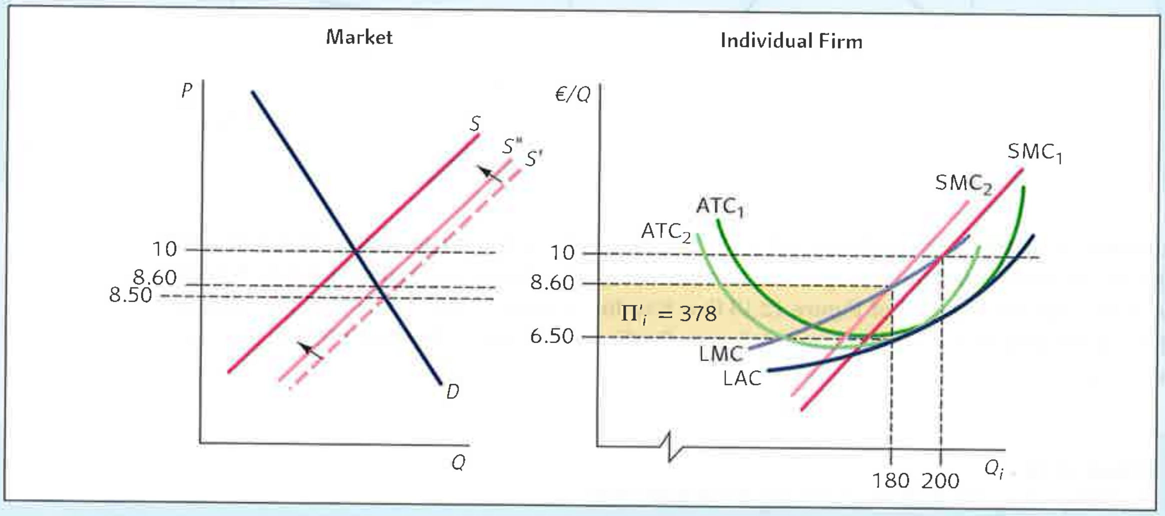


The situation depicted in Figure 12.13 is still inherently unstable. The reason this time is that the old firm is not employing the optimal quantity of fixed inputs. At an output of 190 the firm would want to employ less capital stock than it did when producing 200. As the firm readjusts its capital stock downwards we get new short-run cost curves ATC_2 and SMC_2 in Figure 12.14. Note that as the SMC curve shifts to the left so does the industry supply curve. In terms of its effect on the industry supply curve, this adjustment thus works in the opposite direction from the adjustment caused by the entry of new firms. But the *net* effect of the two adjustments must be to shift industry supply to the right. If it were not, price would not have fallen in the first place, and there would have been no reason for existing firms to reduce their capital stocks. The net effect, in this case, leaves us with industry supply curve S'' and an equilibrium price of €8.60.

FIGURE 12.14

Second Step along the Path toward Long-Run Equilibrium

Entry of new firms causes supply to shift rightward, lowering price from 10 to 8.60. The lower price causes existing firms to adjust their capital stocks downward, giving rise to the new short-run cost curves ATC_2 and SMC_2.



After adjusting its capital stock the firm has lowered output to 180 but increased profit from €304 to €378 per time period. Profits are higher because the firm has readjusted its capital stock to the optimal level. Profits are still lower, however, following the entry of the new firm than before, when they were €600 per time period.

Even after the adjustments described above take place, new and existing firms in the industry continue to earn positive economic profits. The new profit level is lower than before, but still acts as an incentive for additional entry into the industry. Further entry sets off yet another round of adjustment, as the continuing fall in price renders existing capital stocks too large.

For industries whose firms have U-shaped long-run average cost curves, entry, falling prices and capital stock adjustment will continue until these two conditions are met: (1) price reaches the minimum point on the LAC curve (P^* in the right panel in Figure 12.15), and (2) all firms have moved to the capital stock size that gives rise to a short-run average total cost curve that is tangent to the LAC curve at its minimum point (ATC^* in the right panel in Figure 12.15). Note in the right panel in Figure 12.15 that once all firms have reached this position, economic profit for each will be zero. The short-run marginal cost curve in the right panel is like the short-run marginal cost curve of all other firms in the industry, and when these curves are added horizontally, we get the industry supply curve shown in the left panel, which

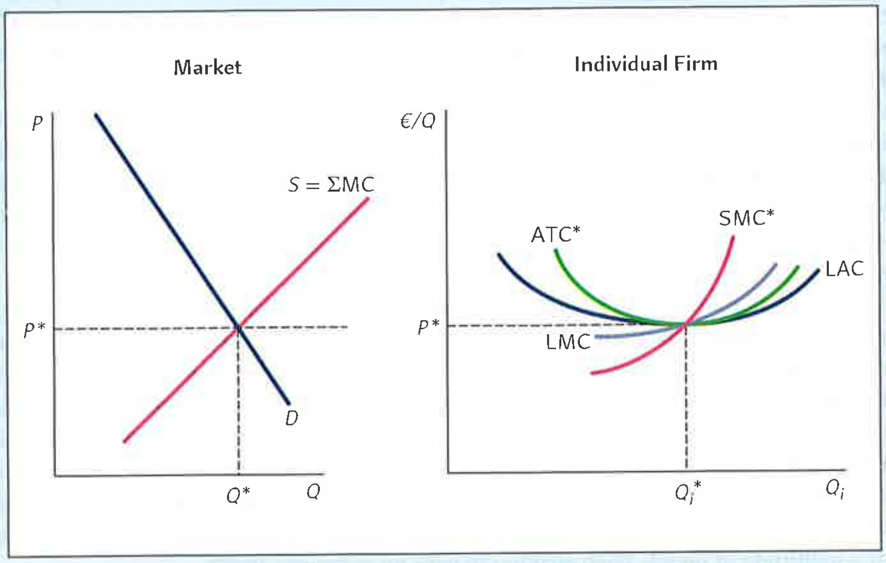


FIGURE 12.15
The Long-Run Equilibrium under Perfect Competition
If price starts above P^*, entry keeps occurring and capital stocks of existing firms keep adjusting until the rightward movement of the industry supply curve causes price to fall to P^*. At P^*, the profit-maximizing level of output for each firm is Q_i^*, the output level for which $P^* = \text{SMC}^* = \text{LMC} = \text{ATC}^* = \text{LAC}$. Economic profits of all firms are equal to zero.

intersects the market demand curve at the long-run equilibrium price of P^*. This is the long-run competitive equilibrium position for the industry. Once it is reached, there will be no further incentive for new firms to enter the industry, because existing firms will all be earning an economic profit of zero.

In discussing the movement toward long-run competitive equilibrium, we began with an initial situation in which price was above the minimum value of long-run average cost and existing firms were all earning an economic profit. Suppose we had instead started with a situation in which price was below the minimum value of LAC. In that case, existing firms would be earning negative economic profits (that is, economic losses), which would be an incentive for some of them to leave the industry. The exodus would shift the supply curve leftward, causing an increase in price and movements by existing firms to adjust their capital stocks upward. This process would continue until all firms have once again settled into the long-run equilibrium position portrayed in the right panel in Figure 12.15.

THE INVISIBLE HAND

As Adam Smith saw clearly more than two centuries ago, it is the invisible hand of the self-interest motive—in particular, the carrot of economic profit or the stick of economic losses—that drives competitive industries to their respective long-run equilibrium positions. And his crucial insight (as discussed in Chapter 3) was a recognition that, even though no firm consciously intends to promote the general social welfare, there are some remarkably attractive features of long-run competitive equilibrium. Thus, as Smith described the actions of an industrialist,

> he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain; and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest, he frequently promotes that of the society more effectually than when he really intends to promote it.[8]

[8]Adam Smith, *The Wealth of Nations*, Chapter 2, http://www.online-literature.com/view.php/wealth_nations/24?term=invisible%20hand.

In what sense is the long-run equilibrium in competitive markets attractive from the perspective of society as a whole? For one thing, price is equal to marginal cost, both long-run and short-run, which means that the equilibrium is allocative efficient in the sense previously discussed—the last unit of output consumed is worth exactly the same to the buyer as the resources required to produce it. Moreover, price is equal to the minimum point on the long-run average cost curve, which means that there is no less costly way of producing the product. Perfectly competitive markets, therefore, result in Pareto efficiency (as we shall discuss in full in Chapter 17). Finally, all producers earn only a normal rate of profit, which is the opportunity cost of the resources they have invested in their firms. The public pays not a cent more than what it cost the firms to serve them.

Even more remarkable than these efficiency properties is the sheer volume of activity that is coordinated by the market mechanism. If you want to buy fresh bread first thing in the morning then few of us need to travel far for the pleasure. You do not need to pre-order, or wait while the bread is made. You simply turn up at your nearest bakery, enjoy the smell of fresh bread and make your choice. Similarly the local supermarket, butcher or fishmonger will have your choice of pasta, fresh meat or fish. Within minutes you can go online and transfer money to a relative's bank account. On only a few hours' notice, several airlines stand ready to carry you around the world. All this activity, and much, much more, takes place without any central coordination at all, the result of a multitude of people each striving to earn an economic profit.

In controlled economies, resources are allocated not by markets but by central planning committees. Because of natural limits on the amount of information such committees can process, they are unable to specify in exact detail the characteristics of the goods called for by their plans. Workers and managers in controlled economies are therefore often able to interpret their production orders in self-serving ways. A famous Russian cartoon, for example, shows the response of the manager of a roofing nail factory who was called on by the plan to deliver 10,000 pounds of roofing nails for the month of August. He alertly discovered that the easiest way to fulfil his quota was to produce a single 10,000-pound nail.

Whatever other faults it may have, the market system cannot be accused of producing products that people do not want to buy. In the market system, the consumer is sovereign, and firms that fail to provide what consumers want face economic extinction.[9] The question of whether central plans are more efficient than market incentives was a hotly debated issue for most of the twentieth century. But no longer. Before their demise in the late 1980s, controlled economies all over the globe introduced market-like incentives in a desperate attempt to revive their lagging production totals.

This is not to say that competitive markets lead to the best possible outcome in every instance. On the contrary, in later chapters we will see that market systems fall short in a variety of ways. Moreover, the efficiency claims on behalf of competitive allocations are conditional on the initial distribution of resources among members of society. Markets are efficient at producing what people demand in the marketplace, and what gets produced depends on how much income specific people have. If you do not believe that the underlying distribution of resources is fair, there is no compelling reason for you to approve of the pattern of goods and services served up by competitive markets. But one need not take a naively optimistic view of the competitive process to appreciate its truly awesome power to draw order from complexity.

ECONOMIC NATURALIST 12.3

Why does an airline ticket from London to Frankfurt cost only €10?

After the Second World War the airline industry in Europe was very heavily regulated. National governments have rights over airspace and they used this to restrict which airlines could operate. Moreover, national airlines were typically government owned. In short, the airline history was a heavily controlled market.

Through the 1970s and 1980s competition in the industry, slowly but surely, increased as governments lowered restrictions. British Airways was privatized in 1987. And finally, in the

[9]The late Harvard economist John Kenneth Galbraith challenged this view. We will consider his arguments in Chapter 13.

1990s came an official EU policy to deregulate the industry. This removed all restrictions on flights within the EU. Since then, many national airlines have been privatized, or part-privatized. The latest trend is competition between airports. All this has made the airline industry much more competitive than it was before.

So, what are the consequences of this liberalization? Fares are dramatically lower, passenger numbers are far higher, and the possibilities for travel within Europe have expanded enormously. Airlines such as Ryanair and easyJet have transformed the market. Even the old national carriers like British Airways, Lufthansa, KLM and Air France have adapted to the increased competition, become more efficient and maintained a substantial presence in the market.

Today, if you want to fly from London to Frankfurt, you have at least four airports to choose from in London and two in Frankfurt. And there are at least 10 airlines offering to take you. It is because of such competition that you can get a ticket for only €10. ■

THE LONG-RUN COMPETITIVE INDUSTRY SUPPLY CURVE

We saw that the short-run supply curve for a perfectly competitive industry is the horizontal summation of the short-run marginal cost curves of its individual firms. But the corresponding long-run supply curve for a competitive industry is not the horizontal summation of the long-run marginal cost curves of individual firms. Our task is to derive the long-run supply curve for competitive industries operating under a variety of different cost conditions.

Long-Run Supply Curve with U-Shaped LAC Curves

What does the long-run supply curve look like in an industry in which all firms have identical U-shaped long-run average cost (LAC) curves? Suppose, in particular, that these LAC curves are like the one labelled LAC_i in the right panel in Figure 12.16. Suppose the demand curve facing the industry is initially the one labelled D_1 in the left panel. Given this demand curve, the industry will be in long-run equilibrium when each firm installs the capital stock that gives rise to the short-run marginal cost curve labelled SMC_i in the right panel. The number of firms in the industry will adjust so that the short-run supply curve, denoted S_{SR} in the left panel, intersects D_1 at a price equal to the minimum value of LAC_i. (If there were more firms than that or fewer, each would be making either an economic loss or a profit.)

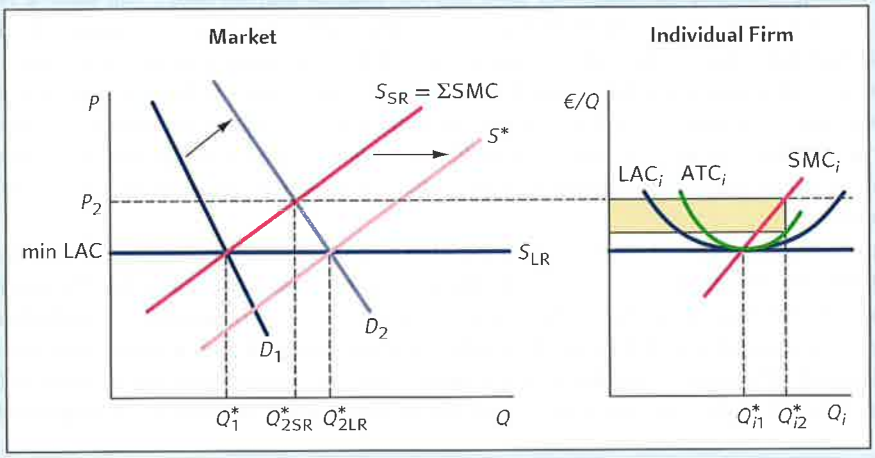


FIGURE 12.16
The Long-Run Competitive Industry Supply Curve
When firms are free to enter or leave the market, price cannot depart from the minimum value of the LAC curve in the long-run. If input prices are unaffected by changes in industry output, the long-run supply curve is S_{LR}, a horizontal line at the minimum value of LAC.

Now suppose demand shifts rightward from D_1 to D_2, intersecting the short-run industry supply curve at the price P_2. The short-run effect will be for each firm to increase its output from Q_{i1}^* to Q_{i2}^*, which will lead to an economic profit measured by the shaded rectangle in the right panel in Figure 12.16. With the passage of time, these profits will lure additional firms into the industry until the rightward supply shift (to S^* in the left panel) again results in a price of min LAC. The long-run response to an increase in demand, then, is to increase industry output by increasing the number of firms in the industry. As long as the expansion of industry output does not cause the prices of capital, labour and other inputs to rise, there will be no long-run increase in the price of the product.[10]

If demand had shifted to the left from D_1, a parallel story would have unfolded: price would have fallen in the short-run, firms would have adjusted their offerings, and the resulting economic losses would have induced some firms to leave the industry. The exodus would shift industry supply to the left until price had again risen to min LAC. Here, again, the long-run response to a shift in demand is accommodated by a change in the number of firms. With U-shaped LAC curves, there is no tendency for a fall in demand to produce a long-run decline in price.

In summary, the long-run supply curve for a competitive industry with U-shaped LAC curves and constant input prices is a horizontal line at the minimum value of the LAC curve. In the long-run, all the adjustment to variations in demand occurs not through changing prices but through variations in the number of firms serving the market. Following possibly substantial deviations in the short-run, price shows a persistent tendency to gravitate to the minimum value of long-run average cost.

THE ELASTICITY OF SUPPLY

In Chapter 6 we defined the price elasticity of demand as a measure of the responsiveness of the quantity demanded to variations in price. An analogous concept exists for measuring the responsiveness of the quantity supplied to variations in price. Naturally, it is called the **price elasticity of supply**. Suppose we are at a point (Q, P) on the industry supply curve shown in Figure 12.18, where a change in price of ΔP gives rise to a change of ΔQ in the quantity supplied. The price elasticity of supply, denoted ε^S, is then given by[12]

price elasticity of supply the percentage change in quantity supplied that occurs in response to a 1 per cent change in product price.

$$\varepsilon^S = \frac{\Delta Q}{\Delta P}\frac{P}{Q} \tag{12.1}$$

As in the case of elasticity of demand, supply elasticity has a simple interpretation in terms of the geometry of the industry supply curve. When ΔP is small, the ratio $\Delta P/\Delta Q$ is the slope of the supply curve, which means that the ratio $\Delta Q/\Delta P$ is the reciprocal of that slope. Thus the price elasticity of supply may be interpreted as the product of the ratio of price to quantity and the reciprocal of the slope of the supply curve:

$$\varepsilon^s = \frac{P}{Q}\frac{1}{\text{slope}} \tag{12.2}$$

[12]In calculus terms, supply elasticity is defined by

$$\varepsilon^s = \frac{P}{Q}\frac{dQ}{dP}$$

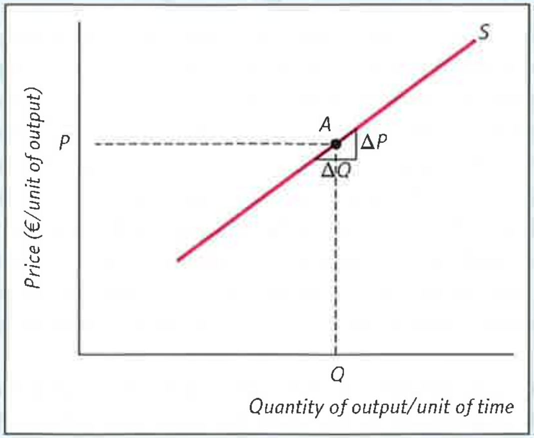


FIGURE 12.18

The Elasticity of Supply

At point A, the elasticity of supply is given by $\varepsilon^S = (\Delta Q/\Delta P)(P/Q)$. Because the short-run supply curve is always upward sloping, the short-run elasticity of supply will always be positive. In the long-run, elasticity of supply can be positive, zero or negative.

Because of the law of diminishing returns, the short-run competitive industry supply curve will always be upward sloping, which means that the short-run elasticity of supply will always be positive. For industries with a horizontal long-run supply curve, the long-run elasticity of supply is infinite. Output can be expanded indefinitely without a change in price. Because of pecuniary economies and diseconomies, long-run competitive industry supply curves may also be either downward or upward sloping in specific cases. The corresponding long-run elasticities of supply in these cases will be either negative or positive.

As noted earlier, most industries employ only a relatively small share of the total volume of inputs traded in the marketplace, which means that modest variations in industry output should have no significant effect on input prices in most industries. In practical applications of the competitive model, therefore, most economists adopt the working hypothesis that long-run supply curves are horizontal. Of course, this hypothesis can always be modified when there is evidence that pecuniary economies or diseconomies are important.