Unit 5.3: Perfect Competition

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1 Market Structures

Economists usually talk about four market structures. From most competitive to least competitive, they are: perfect competition, monopolistic competition, oligopoly and monopoly. Perfectly competitive and monopolistically competitive markets both have large numbers of buyers and sellers; the difference is that all firms sell an identical product in a perfectly competitive market, whereas monopolistic competition features product differentiation. An oligopoly is a market where a few large firms control a significant part of the market. A monopoly is a market with one seller.

The table below summarizes the economics of the outcomes of various market structures.

Market	Pricing	Price and Marginal Cost	Entry	Long-Run Profit
Perfect Competition	Price taker	$P = MC$	Yes	No
Monopolistic Competition	Price maker	$P > MC$	Yes	No
Oligopoly	Price maker	$P > MC$	Barriers	? (various models)
Monopoly	Price maker	$P > MC$	No	Yes

Perfectly competitive firms are price-takers, meaning that they accept the market price as fixed. In this case, we say that the firm has *no market power*. In the other three market structures, firms choose the price that they charge. In this case, we say that the firm has *market power*. Notice that lack of market power implies that firms charge a price equal to the marginal cost of production. Market power implies that firms mark up price above marginal cost. Even though there are many sellers in a monopolistically competitive market, they still exercise some market power because the products are differentiated.

An important point is that market power does *not* guarantee long-run profit. No matter how much price-setting market power a firm has, if there is free entry of new firms in the long-run, then positive profits cannot persist permanently. Firms exercise market power in monopolistically competitive markets but, because of easy entry of new firms, long-run profit is not possible.

2 Price Taking

Perfect competition features many sellers selling an identical product, in addition to easy entry and exit in the long-run. Since there are a large number of sellers all selling an identical product, each firm has no price-setting power. We say that the firm is a price-taker. Each individual firm has no influence on the market price. In other words, regardless of how much output the firm sells (or none at all), the market price is still the same. No single firm is large enough to influence the market price through its own output. As a result, each firm's demand curve is horizontal, as shown in figure 1.

The positive way of looking at this is that the firm can sell as much output as it wants at a given market price; in contrast, a firm with market power must lower the price in order to sell more output. The negative way of looking at this is that the firm can't raise price at all. If a single firm charges a price even slightly above market price, it will sell nothing since there are a large number of firms selling an identical product at the market price. On the other hand, the firm has no reason to lower price either since it can sell as much as it wants at the market price.

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Market
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q

Figure 1: Perfectly competitive firm is a price taker

3   Profit

Profit is equal to the revenue that the firm earns minus its costs.

$$\Pi = TR - TC$$

For *accounting profit*, TC includes only explicit costs like wages that are actually paid out. For *economic profit*, TC includes both explicit costs and implicit costs. Recall that implicit costs represent the value of something sacrificed, but with no direct payment made. The largest implicit cost for most firms is the holding cost of capital – a firm that has a large amount of money tied up in capital equipment could have rented out the equipment or invested the money it has tied up; the firm sacrifices potential earnings by holding capital. Other potential implicit costs might include things like the value of the owner's time that could have been used doing other things or the foregone rent on a building that the firm owns but could have rented out.

In any case, we will always be dealing with economic profit, meaning that TC includes both explicit and implicit costs. Note that economic profit is always lower than accounting profit since economic profit deducts more costs than accounting profit.

We think about the firm's profit-maximizing decision in two stages.

1. If the firm produces, what is the profit-maximizing output q^*?

2. Should the firm produce or shut down?

What makes the perfectly competitive case simple is that the firm chooses only its output level. Firms with market power also choose their price.

4   Profit-Maximizing Output

Consider a perfectly competitive firm with cost function $TC = 100 + q^2$. The market price is $P = 50$. The firm's profit function is:

$$\Pi = TR - TC = 50q - (100 + q^2)$$

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To find the level of q that the firm should produce to maximize profit, differentiate the profit function with respect to q and set the first derivative equal to zero.

$$\frac{d\Pi}{dq} = 50 - 2q = 0$$
$$50 = 2q$$
$$q = 25$$

This firm should produce $q = 25$ units of output to maximize profit. Substituting this back into the profit function gives the level of profit that the firm earns.

In general, since $\Pi = TR - TC$, the first-order condition for profit maximization gives:

$$\frac{d\Pi}{dq} = \frac{dTR}{dq} - \frac{dTC}{dq} = 0$$
$$MR - MC = 0$$
$$MR = MC$$

So the $MR = MC$ condition familiar from principles courses is just the first-order condition for profit maximization. Intuitively, if $MR > MC$, then the firm should raise output since a marginal unit gives the firm more additional revenue than the additional cost of producing it, thus raising the firm's profit. Conversely, if $MR < MC$, then the firm should cut back its output since the marginal unit cost more to make than the additional revenue generated. Profit is maximized exactly where $MR = MC$.

Now $TR = Pq$. What is simple about the perfectly competitive case is that P is constant from the perspective of a single firm maximizing profit. Each individual firm cannot influence the market price. Thus, *for a perfect competitor*, marginal revenue is equal to price.

$$MR = \frac{dTR}{dq} = P$$

This is only true for a perfect competitor. Intuitively, since a firm can sell as many units of output as it wants to sell at the market price, the marginal revenue from selling one more unit of output is always constant at the market price. For a firm with market power, it is *not* true that marginal revenue equals price. The problem is that, in that case, the price P is not constant, since the firm's choice of q will affect P when the firm has market power.

Since the profit-maximizing condition is $MR = MC$ and $P = MR$ for a perfect competitor, we can alternatively write the profit-maximizing condition as $P = MC$ for the perfectly competitive case.

5   Supply Function

The *supply function* describes the output that the firm produces at various price levels P. Since firms maximize profit, the supply function just comes from the profit maximizing condition. Using the example from earlier,

$$\Pi = TR - TC$$
$$= Pq - (100 + q^2)$$

Maximizing profit:

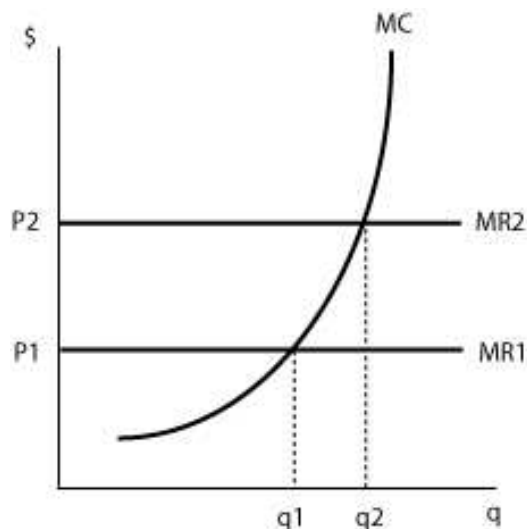Figure 2: The supply curve coincides with the marginal cost curve

$$\frac{d\Pi}{dq} = P - 2q = 0$$
$$P = 2q$$
$$q = \frac{P}{2}$$

From the second-to-last line, it is easy to see that the supply function is just $P = MC$. But this makes sense since this is how a perfectly competitive firm chooses output to maximize profit.

Graphically, the firm's supply curve *is* the marginal cost curve. See figure 2. At price P_1 (with corresponding marginal revenue curve is MR_1), the firm produces where $MR = MC$ at q_1. When price rises to P_2, the firm maximizes profit by producing q_2 units of output. The marginal cost curve thus maps out the level of output that the firm produces at various prices.

6   Shut-Down Decision

A firm should continue producing in the short-run as long as its total revenue is greater than its *variable* costs. The firm should shut down if its total revenue is less than its *variable* costs.

Notice that, even if revenue is lower than total costs (meaning that the firm is earning a loss), the firm should still stay open in the short-run as long as its revenue covers the *variable* costs. For example, consider a firm with total revenue of $TR = 5000$, variable costs of $TVC = 4000$ and fixed costs of $TFC = 3000$. By operating, the firm loses $2000, since $TR = 5000$ and $TC = 7000$. However, by shutting down, the firm would actually earn a loss of $3000 in the short run since it has to pay its fixed costs; fixed costs have to be paid in the short-run regardless of the firm's output. Since the firm earns enough revenue to cover its variable costs and offset part of the loss from its fixed costs, it should stay open. If it shut down in the short run, it would earn a loss equal to *all* of the fixed costs.

Even more simply, fixed costs do not factor into short-run decision making since they are sunk and therefore unrecoverable.

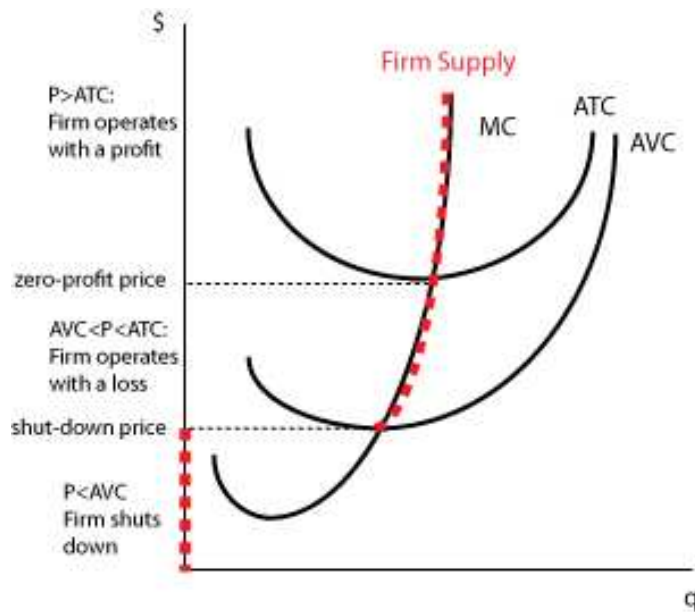Technically, the short-run shut down condition is to shut down whenever:

Figure 3: Perfectly competitive decision-making for various prices

$$TR < TVC$$

Dividing through both sides by q, the shut down condition can be expressed as:

$$\frac{TR}{q} < \frac{TVC}{q}$$
$$P < AVC$$

With this in mind, we need to slightly modify our earlier derivation of the supply curve. The firm's supply curve is equal to its marginal cost curve *as long as price is higher than AVC*. However, if price falls lower than AVC, then the firm shuts down in the short run and so its supply falls to zero.

Figure 3 summarizes. For $P > ATC$, the firm produces and earns a profit since the price it receives per unit exceeds its cost per unit. $P = ATC$ is known as the *zero-profit price* since the price that the firm receives per unit is exactly equal to its cost of making each unit. Whenever operating, the firm produces at $P = MC$ to maximize profit; this is the supply function.

For $AVC < P < ATC$, the firm continues to operate in the short run at a loss since, as discussed above, the loss would be even greater if the firm were to shut down. When price falls below AVC, the firm shuts down and produces no output.

7   Short-Run Market Equilibrium

Consider a market where 46 firms are in operation in the short run. Each firm's cost function is $TC = 100 + q^2$. The *market* demand function is $Q^D = 1000 - 2P$. Notice the distinction between q, indicating output of a single firm and Q, indicating market output. While the *market* demand curve is downward sloping, each firm's individual demand curve is horizontal at the market price since firms are price-takers.

To calculate short-run market equilibrium, first find each firm's supply function. Since profit is:

$$\Pi = TR - TC$$
$$= Pq - (100 + q^2)$$

Each firm maximizes profit:

$$\frac{d\Pi}{dq} = P - 2q = 0$$
$$P = 2q$$
$$q^S = \frac{P}{2}$$

This is *each firm's* supply function. Now, the market supply Q^S consists of 46 firms each producing q^S:

$$Q^S = 46q^S$$
$$= 46\left(\frac{P}{2}\right)$$
$$= 23P$$

Short-run market equilibrium occurs where market supply and market demand are equal:

$$Q^D = Q^S$$
$$1000 - 2P = 23P$$
$$P = 40$$

Substituting this back into either the market demand or the market supply function gives $Q = 920$. Now, since $P = 40$, each firm produces output of $q^S = \frac{P}{2} = 20$. We can calculate the profit earned by each firm in short run market equilibrium:

$$\Pi = TR - TC$$
$$= Pq - (100 + q^2)$$
$$= 40 * 20 - (100 + 20^2)$$
$$= 300$$

Figure 4 shows the short-run equilibrium. The market graph is pictured on the left. The equilibrium is $Q = 920$ and $P = 40$. A typical firm is shown on the right. Each firm accepts the market price $P = 40$ as fixed and produces where $P = MC$ at $q = 20$ units of output. The green rectangle displays the profit earned by each firm. Profit per-unit is the difference between the firm's price and its cost per unit. Multiplying this across all $q = 20$ units that the firm produces gives total profit $\Pi = 300$.

8   Long-Run Adjustment

The situation above will not persist in the long-run because firms are earning profits. Since entry is easy in a perfectly competitive market, any time there are positive profits, new firms will enter. This entry continues
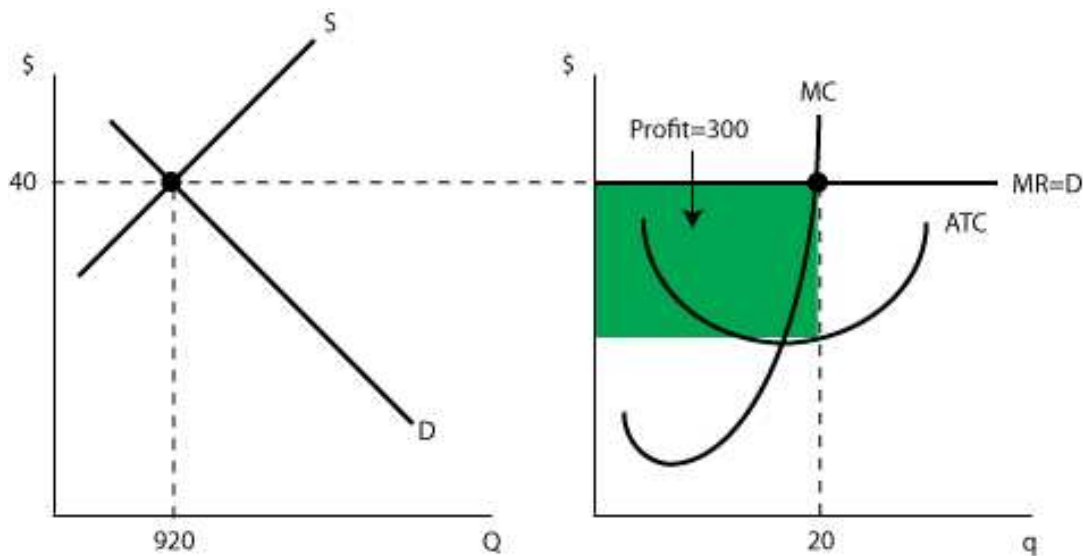
Figure 4: Short-run market equilibrium

until profits fall to zero. Conversely, any time firms are earning losses in a competitive market, exit will continue until zero profit is restored.

Note when we say that firms earn zero profit in long-run equilibrium, we mean zero *economic* profit. For example, consider a firm with revenues of $TR = \$50,000$, explicit costs of \$30,000 and implicit costs of \$20,000. This firm earns zero *economic* profit after considering both the explicit costs and the implicit costs. However, notice that the firm earns an *accounting* profit equal to \$20,000. Another way of stating that the firm earns zero economic profit is to say that it earns exactly enough accounting profit to cover its implicit costs. Since implicit costs represent the next-best use of the firm's resources, what this means is that the firm earns exactly enough profit to prevent it from wanting to switch to the some other use of its resources – but no more profit than this. This level of profit is known as a *normal profit*. Any profits above the normal level are referred to as *excess* profits.

So a more precise statement is that free entry and exit ensure that *excess* profits are zero in the long run.

9   Long-Run Equilibrium

Firms earn zero profit in long run market equilibrium, so the first step is to find the zero-profit level of output for each firm. Recall from figure 3 that the zero-profit level of output is where $MC = ATC$. For the firm we have been considering, $TC = 100 + q^2$ so $MC = 2q$ and $ATC = \frac{100}{q} + q$. Thus, the zero-profit level of output is:

$$MC = ATC$$
$$2q = \frac{100}{q} + q$$
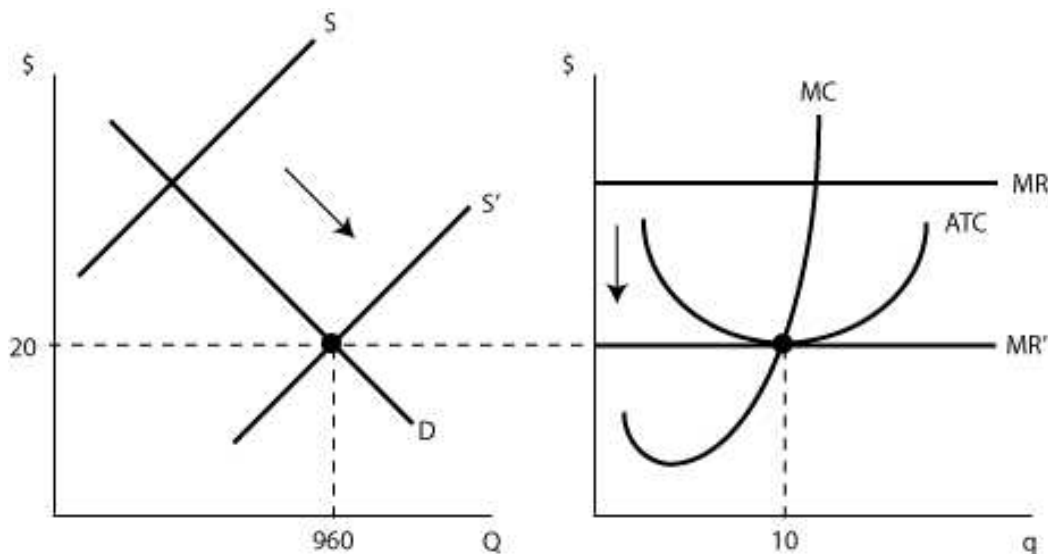$$q = \frac{100}{q}$$
$$q^2 = 100$$
$$q = 10$$

Figure 5: Long-run market equilibrium

Since $P = MC$, the corresponding zero-profit price for our example is:

$$
\begin{aligned}
P &= MC \\
&= 2q \\
&= 2(10) \\
&= 20
\end{aligned}
$$

Then the total *market* demand, using the market demand equation from our example, is:

$$
\begin{aligned}
Q^D &= 1000 - 2P \\
&= 1000 - 2(20) \\
&= 960
\end{aligned}
$$

Also, we can say that since total market output is $Q = 960$ and each firm produces $q = 10$ units of output in long-run equilibrium, then there must be 96 firms in operation in this industry in long run equilibrium.

Figure 5 shows the transition from short-run equilibrium to long-run equilibrium. Entry of new firms shifts the market supply curve right, lowering the market price all the way to the zero-profit price $P = 20$. Taking this new, lower, price as given, each firm produces $q = 10$ units of output where $P = MC$.

10   Long-Run Supply

Short-run changes in the market may cause profit or loss, but entry and exit will always bring the price back to the zero-profit level in the long run.

Consider figure 6. The zero-profit price is P_0, where price is equal to the average cost of production ATC. Suppose that the market is initially in long-run equilibrium, but that demand rises from D to D'. The price will rise to P_1 in the short-run, causing the firms to earn short-run profit. The profit does not last forever, however. In the long-run, the existence of excess profits induces new firms to enter the market. Eventually,
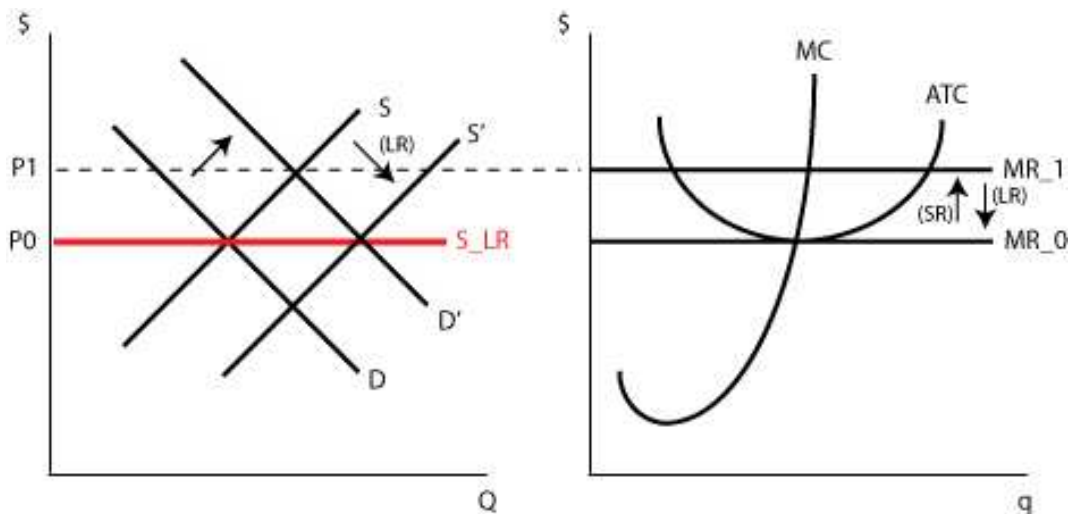
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Figure 6: Long-run supply

the supply curve will rise to S' because of the newly entering firms, restoring the zero-profit price P_0. Each firm's output q returns to the initial level, although market output Q rises because of newly entering firms.

Notice that, no matter the level of Q, price always returns to the zero-profit level of P_0 in the long-run because of entry and exit. In other words, the long-run supply curve is horizontal at the zero-profit price.

This argument implies that, no matter what level of output Q is to be supplied, it is always supplied at the zero-profit price of P_0 in the long-run, which generates a horizontal long-run supply curve. Nevertheless, there are various reasons that long-run supply might slope upwards. That is, it might be that supplying a higher level of output raises the market price. Why might this be?

- **Limited entry**: If there is some limit to entry by new firms (e.g. government regulation), then as market demand rises, n cannot increase. In this case, output by each firm q rises and so the price must increase in order to induce each firm to supply more output.

- **Nonconstant input costs**: At the market level, it is possible that as output rises, demand for firm inputs rises noticeably and so input costs rise. This means that firms' costs rise and so the zero-profit price rises as well.

- **Nonidentical firms**: Suppose that firms do not have identical costs. If the lowest-cost firms enter first then, in order to raise output, less efficient firms join the market and so the market price has to rise in order to induce these new firms to enter. Note that the initial entrants will earn some excess profit. In this case, long-run equilibrium requires only that *marginal* entrants not be able to earn profit. Long-run equilibrium implies that new firms have no incentive to enter. It is possible for established, more efficient firms to earn profit as long as newer, less efficient firms, could not earn economic profits by entering.

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