UNIT 7  PERFECT COMPETITION

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7.0  OBJECTIVES

After going through this unit, you will be able to:
- understand the market structure under perfect competition;
- the short-run and long-run equilibrium of the firm; and
- derive the price and output determination in such a market.

7.1  INTRODUCTION

A perfectly competitive market is assumed to have the following characteristics:

1) There are numerous buyers and sellers in the market, such that no single agent has the power to affect the market price. Thus, both the parties are price-takers.
2) The products sold in the market are identical.
3) There is perfect information among the buyers regarding price and output.
4) Any firm can enter the industry without incurring a cost. The resources can also freely move across the sectors. In other words, there is no entry barrier.

Each firm in this model is a profit maximiser. As the firms are price takers in the market, their decision variable is executed through output. Being price takers, they face an infinitely elastic market demand curve and can sell unlimited amount of output at that price.

7.2.1  Short-run Equilibrium of Firm

As the firms under perfect competition are all identical, we can consider any one firm to represent the rest.

Let \( q \) = quantity of output produced by the firm
Price and Output Determination – I

\[ C(q) = \text{cost function} \]
\[ p = \text{price per unit of the product} \]
\[ \Pi = \text{profit.} \]

Given these variables, the profit function of the firm would be,

\[ \Pi = TR - TC = pq - C(q) \]

and to maximise it we differentiate \( \Pi \) with respect to \( q \) and set the derivative equal to zero,

\[ \frac{\partial \Pi}{\partial q} = p - \frac{\partial C}{\partial q} = 0 \]

or, \( p = MC \) (the marginal cost)

Under perfect competition, a firm would produce up to that level of output where \( p \) equals \( MC \). As the marginal revenue (MR) is equal to \( p \), we have \( P = MC = MR \) at the profit maximising level of output.

Diagrammatically we can represent these conditions as follows:

![Diagram](image_url)

**Fig. 7.1: Short-run Equilibrium of Firm**

In the diagram, AC represents the short-run average cost curve of the firm and MC the marginal cost. MC intersects AC at the latter’s minimum point. Given the price, \( p \), MR and AR curves are given by the horizontal price line. The equilibrium point of the firm is the point where the MC curve cuts the price line. Dropping a perpendicular from the intersection point to the horizontal axis, we get the equilibrium output \( q^* \). The shaded region represents the profit accruing to the firm with \( q^* \) level of output.

**Short-run profit maximisation**

The point of intersection of MR and MC gives the stable equilibrium point. For any point other than \( q^* \) the firm would go back to the equilibrium output level. For a \( q < q^* \), MC < MR, so that \( q \) would rise and for any \( q > q^* \), MC > MR, \( q \) would fall.

In the short-run, the firm would make a profit given by the shaded area. This will be true for all the firms, because the firms are all identical.
Check Your Progress 1

1) What kind of a demand curve does a firm under perfect competition face?
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2) What is the short-run equilibrium condition for a firm under perfect competition?
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3) Prove that for a given price, \( p = AR = MR \).
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7.2.2 Supply Curve of Firm and Industry

For a given price, the firm will produce only that much of output where MR = MC. Therefore, MC curve lying above the average variable cost (AVC) would give the supply curve of the firm. The portion of MC lying below the AVC would not represent the supply curve because in that region the firm would shut down. The reason for it is shown with the help of the following proof:

Suppose \( p < AVC \)

\[ \Rightarrow pq < (AVC)q \]

\[ \Rightarrow TR < TVC \]

\[ \Rightarrow TR < TC - TFC \]

\[ \Rightarrow TC - TR > TFC \]

\[ \Rightarrow \] the loss incurred by the firm is greater than the total fixed cost, so that if the firm shuts down, it will have to incur only the fixed cost.

Supply Curve of the Firm

Diagrammatically, the supply curve of the firm would be given by the rising part of the MC curve lying above the AVC curve. Below the AVC curve the supply curve would coincide with the vertical axis. Therefore, the supply curve would be broken one as shown in Figure 7.2.
Mathematical Representation

Let the cost function of the $i^{th}$ firm be $C = C_i(q_i)$

The marginal cost, $MC = \frac{\partial C_i}{\partial q_i} = C'_i(q_i)$

Given the market price ($p$) the supply function of the firm is given by,

$$S_i = S_i(p) \text{ for } p \geq \text{min } AVC$$

$$= 0 \text{ for } p < \text{min } AVC$$

The aggregate supply function or the supply function of the industry is given by

$$S = \sum S_i(p) = S(p)$$

Check Your Progress 2

1) What gives the supply curve of the firm?

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2) Why do we consider the portion of the MC above the AVC curve to represent the supply curve of the firm?

Supply Curve of Industry

The industry supply can be obtained by summation of the supply of all the firms. Therefore, the industry supply would be,

\[ S = \sum q_i(p) \text{ over all } N \text{ firms, where } i = 1,2,\ldots N \]

If the firms are all identical then \( q_i(p) \) is the same for all. Assuming \( q_i = q \), total industry supply would be \( S = Nq \)

![Fig.7. 3: Supply Curve of the Industry](image)

The industry supply curve \( S \) implies the summation of all the individual supply curves of the existing firms in the market.

A Numerical Example

Let the total cost curve be \( C_i = 0.1q_i^3 - 2q_i^2 + 15q + 10 \)
Then, \( MC_i = 0.3q_i^2 - 4q_i + 15 \)
Setting \( MC_i = p \), we have,
\[ p = 0.3q_i^2 - 4q_i + 15 \]
This is a quadratic equation in \( q_i \), therefore,
\[ q_i = \frac{[4 + (10+1.2p)]/0.6}{[4- (10+1.2p )]/0.6} \]
The individual firm’s supply function is relevant for all $p \geq \text{minimum AVC}$.

The AVC function is $\text{AVC}_i = 0.1q_i^2 - 2q_i + 15$

The minimum point on the AVC is located by taking derivative with respect to $q_i$ and setting the derivative equal to zero, as shown below.

$$\frac{d (\text{AVC}_i)}{dq_i} = 0.2q_i - 2 = 0$$

Therefore, $q_i = 10$.

Substituting $q_i = 10$ in the AVC function we get,

minimum AVC = 5.

Therefore, the firm supply function is

$$S_i = \left[ \frac{4 \pm (1.2p - 2)}{0.6} \right] \quad \text{for } p \geq 5$$

$$= 0 \quad \text{for } p < 5$$

If the industry consists of 100 identical firms, the aggregate supply function is

$$S = 100 \times \left[ \frac{4 \pm (1.2p - 2)}{0.6} \right] \quad \text{for } p \geq 5$$

$$= 0 \quad \text{for } p < 5$$

At a price of 22.5, the aggregate supply would be 1500 units.

### 7.2.3 Short-run Equilibrium of Industry

Given the industry demand and supply curves, the equilibrium price and output in the market will be determined at their point of equality. Assuming the market demand curve to be linear and downward sloping, the equilibrium condition is represented in the following figure.

![Fig.7. 4: Industry Equilibrium](image)
Perfect Competition

The equilibrium price and output in the industry are shown as $p^*$ and $Q^*$ respectively.

Check Your Progress 3

1) Is there a difference between the demand curve faced by the firm and industry? Give reasons.

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7.2.4 Long-run Equilibrium of Firm and Industry

In the long-run, all the inputs available to the firms are variable, so that the concept of fixed cost is absent and the total cost (TC) equals the total variable cost (TVC). Therefore, we need only to deal with the long-run average cost ($LAC = \frac{LTC}{q}$). We assume the LAC to be U-shaped exhibiting the fact that at the low levels of output, the cost is falling and beyond a point, it rises.

We have stated above that a perfectly competitive market is characterised by free entry and exit of the firms. As in the short-run, the firms are making profits, there will be entry of new firms in the market. As a result, the industry supply would go up and price would fall. This would continue until the profits are driven down to zero.

Such a process is described in the following diagram.

In Figure 7.5, at price $P_1$, the firm is producing an output $q_1$ whereby it is making a profit shown by the shaded area. At price, $P_1$, the industry output is $Q_1$. As the existing firms are making profit, there will be entry into the market. As a result, the total supply in the market would go up and the price in market would fall. If at the new price the firms are still making some profit, then there will be further entry and market supply would go up. Consequently, the price would go down further level. This process would
continue until the price falls to such a level that all profits are eliminated. From the diagram, the shaded area ceases to exist. This price is \( P_2 \), where \( P = MC = AC \) and therefore profit is zero.

The zero profit scenario faced by the firms means that the economic profit is zero implying that the firms earn no more than they would elsewhere. In other words, the firms are breaking even at price \( P_2 \).

At \( P_2 \), as the firms are earning zero profit, there is no incentive for other firms to enter the industry. Hence, price \( P_2 \) would represent an equilibrium price level with \( Q_2 \) as the equilibrium output. With that the long-run equilibrium is characterised by a situation where the economic profits for the firms are zero.

**Firm at the Long-run: Choice of Plant and the Adjustment Process**

In the long-run, an entrepreneur can adjust the plant size. She has the scope to choose the optimal plant size, which would minimise the cost. The adjustment process is illustrated with the help of the following diagram.

![Fig. 7.6: Long-run Adjustments in Plants for a Firm](image)

Let the market price be \( OP \). The firm has a plant size whose costs are represented by short-run average cost (SAC1) and short-run marginal cost (SMC1). With this plant size, the short-run equilibrium occurs at a point where the firm produces \( oq_1 \) amount of output. The firm makes a loss because the price line lies below the SAC1 curve. In such a situation, the firm has two options: to go out of business or to construct a plant of more suitable size.

In the long-run, the firm has the option of increasing the plant size so that it would construct a larger plant represented by SAC2 and SMC2 in the diagram. At the price \( OP \), the firm with this new plant size would produce \( Oq_2 \) amount of output, which would give it some profit. With perfect knowledge about the future, the firm would decide to use the plant represented by SAC4 that gives it the most profit.

The long-run adjustment process and the choice of plant for the firm are shown in the figure below.
Suppose initially price is OP1 and the firm has only the plant 3 represented by SAC3. Setting \( P = SMC \), it produces Oq3 and earns some profit because OP3 > SAC3. As the firm is earning some profit, new ones would be attracted into the industry. As a result, the supply in it would go up from OQ3 to OQ1 and price would fall from OP3 to OP1. Consequently, the supply curve would shift from S3 to S1.

At price OP1, the representative firm is making a loss because OP1 < SAC1. Therefore, the existing firms would start moving out of the industry. As a result, the supply in the market would fall and the supply curve would shift backward from S1. Given the market demand curve DD, as the supply curve shifts, the price would fall.

Suppose the price settles at OP2. At this price, \( P_2 = SMC_2 = SAC_2 \) so that the representative firm faces neither a loss nor a gain. The new firms neither would have any incentive to enter the market nor would the existing firms want to leave the industry. Hence, this would be the equilibrium situation with OP2 price and OQ2 output in the industry. The corresponding equilibrium output for the firm is Oq2.

**Check Your Progress 4**

1) Describe the long-run equilibrium condition of the firm and industry.

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2) Which characteristic of the perfectly competitive market is responsible for the long-run equilibrium condition of $p = \text{min LAC}$?

3) Which plant does a firm choose in the long-run?

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### 7.3 LET US SUM UP

The perfectly competitive market is characterised by the presence of many buyers and many sellers with both the parties being mere price takers, presence of perfect knowledge, homogeneous product and free entry and exit from the market.

Under such of a setting a firm faces a horizontal demand curve and decides to sell whatever it can at the given market price. Being a profit maximiser, the firm in the short-run, chooses to sell that amount of output for which the $p = MC$. As long as $p > \text{min AVC}$, the firm earns supernormal profit by producing and selling in the market.

In the long-run due to free entry and exit from the market, the long-run equilibrium for the firm occurs at the minimum point of LAC, whereby $p = \text{min LAC}$ and thereby the supernormal profits are swept out. In the long-run, therefore, the firms just break even due to the phenomenon of free entry and exit from the market.

### 7.4 KEY WORDS

**Price-takers:** This means that the agents in the market take prices as given. They have no power to influence the market price.

**Free Entry and Exit:** This implies that any new firm is free to set up production in the market if it wishes to, and any existing firm can stop production and leave the industry.

**Homogeneous Product:** The product of one seller is identical to that of the other.

**Perfect Knowledge:** Consumers know the prices, producers know the costs and workers know the wage rate.

**Zero Profit:** It means that the firms are covering only their total costs. These total costs are economic costs. In other words, firms are just able to cover their...
Perfect Competition

full opportunity cost. It implies that all factors of production are earning what they could in their best use.

**Pure Competition:** A market structure slightly less stringent than perfect competition. Pure competition requires only a large number of traders and a homogeneous commodity.

### 7.5 SOME USEFUL BOOKS


### 7.6 ANSWERS OR HINTS TO CHECK YOUR PROGRESS

**Check Your Progress 1**

1) A typical firm under perfect competition faces a horizontal demand curve. So that at the given price, p, the firm can sell whatever amount it wishes to sell.

2) The short-run equilibrium condition is given by \( p = MC = MR = AR \)

3) Total Revenue (\( TR \)) = \( pq \), therefore Average Revenue (\( AR \)) = \( TR/q = pq/q = p \). Marginal Revenue (\( MR \)) = \( TR/q = p \). Thus, \( p = AR = MR \).

**Check Your Progress 2**

1) The rising part of the MC curve is the supply curve of the firm.

2) In the short-run the total cost of production consists of the variable as well as the fixed cost. If price falls below AVC, then for unit cost the revenue earned (which is price, \( p \)) is unable to cover the variable cost. If the producer shuts down, then one has to incur only the fixed cost. Otherwise, her loss would include both that from the variable cost as well as from the fixed cost. Being a profit maximiser the producer would never produce an output when \( p < AVC \). Therefore, the supply is zero for \( p < AVC \).

**Check Your Progress 3**

1) Yes. The demand curve that the firm faces is a horizontal straight line, whereas the demand curve of the industry is downward sloping. The firm is a price taker in the market so that it has to take as given whatever price is determined by the market and sell whatever amount it wants to in the market. This is not so for the industry as a whole.

**Check Your Progress 4**

1) In the long-run equilibrium condition is given by \( SAC = SMC = \min LAC = LMC = p \)

2) The free entry and exit assumption

3) The firm in the long-run eventually chooses that plant which is operated efficiently
7.7 EXERCISES

1) The long-run cost function for each firm that supplies Q is \( C = q^3 - 4q^2 + 8q \). Firms will enter the industry if profits are positive and leave if profits are negative. Describe industry’s long-run supply function. Assume that the corresponding demand function is \( D = 2000 - 100p \). Determine the equilibrium price, aggregate quantity and number of firms.

2) Construct a short-run supply function for an entrepreneur whose short-run cost function is
\[
C = 0.04q^3 - 0.8q^2 + 10q + 5.
\]

3) Construct an effective supply curve for an industry, which has two sources of supply: domestic production with the supply function
\[
S = 20 + 8p
\]
and an unlimited supply of imports at a fixed price of Rs. 20.

4) Discuss the assumptions of perfectly competitive market.

5) Assume that the total cost functions of representative firms in the two categories are
\[
\begin{align*}
C_1 &= 0.04q_1^3 - 0.8q_1^2 + 10q_1 \\
C_2 &= 0.04q_2^3 - 0.8q_2^2 + 20q_2
\end{align*}
\]
Assuming that there are 50 firms in each category, if the demand curve is given by \( D = -100p + 2050 \). Find the supply curve of firm and industry, equilibrium price, quantity, profits of the firms and the industry. How much output would the high cost firm produce?

Hints To Exercises

1) Firms will have a profit maximum of 0 if \( p = MC = AC \), which occurs at the minimum point of the AC curve.
\[
AC = q^2 - 4q + 8 \text{ and it reaches a minimum at } q = 2. \text{ So at that point } p = 4.
\]
The long-run supply function is horizontal and the amount supplied is 2n where n is the number of the firms. At \( p = 4 \), the quantity demanded is 1600. Hence, 1600 = 2n and n = 800.

2) \( AVC = 0.04q^2 - 0.8q + 10 \)
Its minimum point is found by setting the derivative equal to zero. So,
\[
d (AVC)/dq = 0.08q - 0.8
\]
or, \( q = 10 \). At this point, \( AVC = 6 \) and \( MC = 0.12q^2 - 1.6q + 10 \). Substitute \( p = MC \), multiply through out by 12.5 and solve for
\[
q = \{20 +/- 5 \sqrt{(3p - 14)}\}/3.
\]
The positive branch gives output at which MC is increasing, hence
\[
S = 0 \quad \text{if } p < 6
\]
\[
= \{20 +/- 5 (3p - 14)\}/3 \quad \text{if } p \geq 6
\]

3) The entire supply will come from domestic sources as long as its price is less than 20. When price reaches 20, domestic supply is 180. Thereafter the supply curve is horizontal. Domestic supply remains at 180, price remains at 20 and imports = \( (q - 180) \)
\[
\{20 +/- 5 (3p - 14)\}/3.
\]

4) Do it yourself.