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## REVENUE AND PROFIT MAXIMIZATION OF A COMPETITIVE FIRM

Every producer/firm wants to get money by selling the product it has produced. Revenue or turnover is money that a firm/producer receives from its normal business activities, usually from the sale of goods and services to customers. The firm wants to recover its cost of production from the revenue it earns. In fact the firm wants to create simply of revenue over cost as well. How does a competitive firm achieve its goal of profit maximization is the topic of discussion here. The analysis is only meant for a competitive firm.



### OBJECTIVES

After completing this lesson, you will be able to:

- understand the concept of total revenue (TR); average revenue (AR) and marginal revenue (MR);
- distinguish between super normal profit, normal profit, and loss; and
- explain producers equilibrium of a competitive firm by using TR and TC approach as well MR and MC approach.

### 23.1 CONCEPT OF REVENUE

Revenue (sometimes called sales) refers to all the money a Firm/producer takes in from doing what it does – whether making goods or providing services. Total revenue of a firm is defined as the total sales proceeds in the market. The firm sales different quantities of the product to its customers at the prevailing market price. So the total revenue can be calculated by multiplying price with quantity. Symbolically

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#### Notes

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$$TR = PXQ$$

where TR = Total revenue

P = Price

Q = Quantity.

#### Average Revenue (AR)

AR is defined as the ratio of total revenue to quantity of the product. Symbolically,

$$AR = \frac{TR}{Q}$$

Put

$$TR = P \times Q$$

i.e.

$$AR = \frac{P \times Q}{Q}$$

or

$$AR = P$$

Average revenue is also known as the price of the product. In other words AR is the revenue per unit of the product sold by the firm.

#### Marginal revenue (MR)

Marginal revenue is defined as the increase in the total revenue due to an extra unit of the commodity sold by the firm in the market. In other words MR is the addition to TR as a result of the additional unit of the good sold. Symbolically,

$$MR = \frac{\Delta TR}{\Delta Q}$$

where  $\Delta$  stands for change in.

Under perfect competition (refer to Lesson 22- “Forms of Market”), the price of the product is given as the product is homogeneous. So the TR of a firm can increase or decrease depending on the quantity it sells. If the quantity decreases TR will decrease and if quantity increases TR will also increase. See the Table below to know the behaviour of TR of a firm under perfect competition.

**Table 23.1: TR, AR and MR of a competitive Firm**

Price	Quantity	TR	MR	AR
10	0	0	0	0
10	1	10	10	10
10	2	20	10	10
10	3	30	10	10
10	4	40	10	10

## Revenue and Profit Maximization of a Competitive Firm

As given in the table the price of the commodity is given at ` 10. It remains at 10 whatever quantity is sold. Now when quantity is 1,  $TR = 10 \times 1 = 10$ . When quantity increase to 2,  $TR = 10 \times 2 = 20$ . When quantity further increases to 3 and 4,  $TR$  increases to 30 and 40 respectively. This shows that under perfect competition, the total revenue of a firm increases due to increase in quantity given the price of the commodity in the market. Similarly, in the reverse way, if quantity falls from 4 to 3  $TR$  decreases from 40 to 30 and so on.

Another point to be learnt about  $TR$  is that, it increases at a constant rate. Starting from 10,  $TR$  increases to 20, 30, 40 at a constant rate of 10 given the price and increase in each unit of quantity.

Coming to  $AR$ , since  $AR = \frac{TR}{Q}$  or price, you may club them as a single column in the table instead of showing them separately. We have only given them in this table for the purpose of calculating  $AR$  and to show that it is same as price.

In the table, you can see that  $MR$  is also 10 at each point. In the beginning,  $MR$  is shown as 10 and  $TR = 10$ . It means that  $TR$  has increased from 0 to 10 when quantity has increased from 0 to 1. When quantity increases from 1 to 2,  $TR$  increase from 10 to 20. So  $\Delta TR = 20 - 10 = 10$  and  $\Delta Q = 2 - 1 = 1$ . So  $MR$

at the 2nd quantity or 2nd unit of the commodity is given as  $\frac{\Delta TR}{\Delta Q} =$

$\frac{20-10}{2-1} = \frac{10}{1} = 10$ . Similarly when quantity increases from 2 to 3,  $TR$  increases

from 20 to 30. So  $MR$  at 3rd unit of the good is given as  $\frac{30-20}{3-2} = \frac{10}{1} = 10$ . and

so on.  $MR$  shows the manner in which  $TR$  is increasing as a result of one unit increase in the quantity of the good. So  $MR$  is measured between two quantities.

### Relationship between $AR$ and $MR$ and $TR$

From the table above we can easily state the relationship between  $AR$ ,  $MR$  and  $TR$  of the firm under perfect competition as follows.

1. Since price or  $AR$  is given under perfect competition and is constant throughout,  $AR$  and  $MR$  are always equal. i.e.  $AR = MR$  for competitive firm.
2. Between  $MR$  and  $TR$ , it can be said that  $MR$  is the rate of change of  $TR$ . In other words, the value of  $MR$  at any quantity gives the value at which  $TR$  has increased above its previous unit.

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### Diagrammatic Presentation

We can give the diagrams of  $TR$ ,  $AR$  and  $MR$  as given in Fig. 23.1 below.

Take,  $TR$  first. In order to draw the diagram of  $TR$ , take the values of  $TR$  (as given the table) on the vertical axis and the different values of quantity ( $Q$ ) on the horizontal axis. Plot each combination of  $Q$  and  $TR$  and join these combinations to get  $TR$  curve. Here  $TR$  is a straight line through the origin as shown in the diagram.

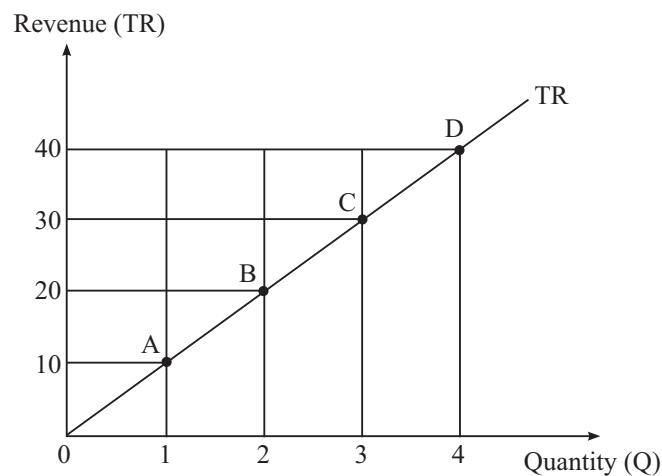


Fig. 23.1

As given in the diagram, the combination of  $Q = 1$  and  $TR = 10$  is plotted at point A. Point B shows  $Q = 2$ ,  $TR = 20$ , point C shows  $Q = 3$ ,  $TR = 30$  and point D shows  $Q = 4$  and  $TR = 40$ . Join 0, A, B, C and D to get  $TR$ .

The diagram for  $AR$  and  $MR$  for a firm under perfect competition is a horizontal line as shown in the diagram Fig. 23.2 below.

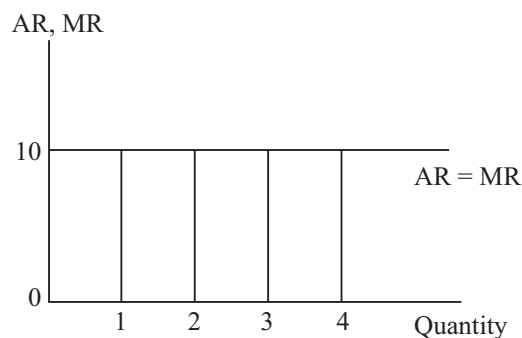


Fig. 23.2

In the table it is given that  $AR = MR = 10$  at each quantity sold. So AR and MR start from 10 on the vertical axis which measures them. Then it becomes a horizontal line as there is no change in AR and MR with increase in quantity.



### INTEXT QUESTIONS 23.1

1. Define TR, AR and MR symbolically.
2. If price is `5 and quantity sold increases from 6 to 7, find out TR, AR and MR?

Where  $P = \text{price}$ ,  $Q = \text{Quantity}$ ,

$\Delta = \text{increase in}$ .

### 23.2 VARIOUS CONCEPTS OF PROFIT

Profit is defined as the difference of total revenue (TR) over total cost (TC) of the firm.

So profit =  $TR - TC$ . Economists often distinguish between super normal profit and normal profit. Super normal profit is defined as the surplus of total, revenue over total cost. This means total revenue is greater than total cost. In other words if the difference between total revenue and total cost is positive or greater than zero, then we can say that the firm is earning super normal profit.

**Example:** A firm sells 5 units of a good at price 10. Its total cost of production is 40. Does supernormal profit exist, and how much?

**Ans:**  $TR = 5 \times 10 = 50$

$TC = 40$

$TR - TC = 50 - 40 = 10$

Since  $10 > 0$  i.e.  $TR - TC$  is positive, there is super normal profit which is equal to 10.

If we want to find out whether super normal profit exists at each unit of the output or at each quantity of the output then we must compare revenue and cost at each quantity.

You know that revenue per unit of the good is called average revenue (AR).

Similarly, cost per unit of the good is called average cost (AC). If  $AR - AC$  is positive or  $AR > AC$  then there will be super normal profit. You can use price instead of AR also.



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### Normal profit

When total revenue equals total cost, the difference between them becomes zero. Such a situation is called normal profit or zero profit. So normal profit means

$$TR - TC = 0 \text{ or } TR = TC.$$

This also means that  $AR$  or  $P$  equals  $AC$  if we divide quantity. i.e.  $\frac{TR}{Q} = \frac{TC}{Q}$ .

or  $AR = AC$

Loss

When the firm's total cost exceeds total revenue, i.e.  $TC > TR$  the firm incurs loss. In other words loss of the firm implies that its  $TR$  is less than  $TC$ . At the unit level, loss means  $AR$  or  $P$  is less than  $AC$  ( $AR < AC$ ). In a situation of loss the firm is not able to recover its cost of production after selling the product.



### INTEXT QUESTIONS 23.2

1. The average cost of a firm is 10. It sold 10 units at a price of 10. What type of profit did the firm earn?
2. If  $TR > TC$ , then there is normal profit. True or false
3. If  $TR = TC$ , then there is super normal profit. True or false.
4. If  $AR < AC$ , then there is loss. True or false

### 23.3 PROFIT MAXIMIZATION OF A COMPETITIVE FIRM

The major objective of a firm is to maximize profit. To attain this we can explain two different approaches.

1.  $TR$  and  $TC$  approach
2.  $MR$  and  $MC$  approach

#### TR and TC approach

As we know that profit is the difference between total revenue and total cost, profit maximization through this approach states that the firm should produce that quantity of output at which the difference between total revenue and total cost is the maximum ( $TR - TC$  is maximum).

This can be explained by using the following table. [Recall the lesson on cost you have studied earlier].

Table 23.2: Profit maximization of a firm: TR and TC approach

Q	TR	TC	TR-TC = Profit
1	10	15	-5
2	20	20	0
3	30	22	8
4	40	25	15 (TR - TC is maximum.)
5	50	40	10
6	60	60	0
7	70	85	-15



Notes

As shown in the table, the TR of a competitive firm is increasing at a constant rate of 10. It starts from 0 when quantity is 0, Then with in each unit increase in the quantity TR is increasing by 10 i.e. when  $Q = 1$ ,  $TR = 10$ .

When  $Q = 2$ ,  $TR = 20$  and so on. On the otherhand TC of the firm is 15 even if  $Q = 0$ . This is because of presence of fixed cost as already told in the lesson on cost. TC slowly increases in the beginning and then increases fast with increase in quantity of output. At  $Q = 1$ ,  $TC = 15$ , then at  $Q = 2$ ,  $TC = 20$  which is an increase of 5. When  $Q = 3$ ,  $TC = 22$  which is an increase of 2 i.e. less than the previous unit. After this TC increases faster which you can easily verify.

Now look at the column on profit, marked as  $TR - TC$ . At  $Q = 1$ ,  $TR - TC = -5$ . This means that there is loss at this level of output because  $TC > TR$ . So the firm must increase output. At  $Q = 2$ ,  $TR = TC$  so that  $TR - TC = 0$ . Here the firm is able to recover the cost. At  $Q = 3$ ,  $TR - TC = 8$  and at  $Q = 4$ ,  $TR - TC = 15$ . At  $Q = 5$ ,  $TR - TC = 10$  which has fallen from the previous level of 15. At  $Q = 6$ ,  $TR - TC$  falls to 0 and then at  $Q = 7$ ,  $TR - TC$  is again negative at  $-15$  indicating loss. From this it is clear that at  $Q = 4$ ,  $TR - TC$  is maximum at 15. So firm must produce 4 units to maximize profit because here the difference between  $TR$  and  $TC$  is maximum.

### Diagrammatic Presentation

We can show the profit maximization process in a suitable diagram given as fig. 23.3.

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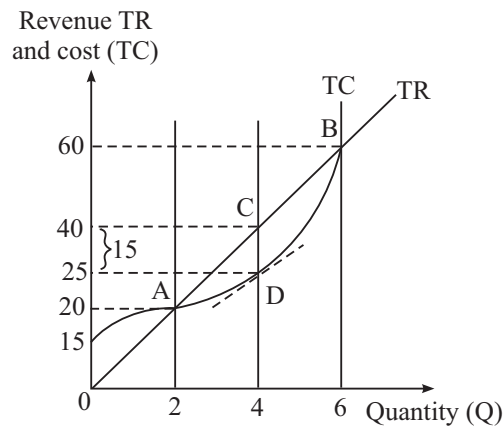


Fig. 23.3

In the diagram revenue and cost are measured on vertical axis. Quantity measured on horizontal axis. The TR is a straight line through the origin.

The TC curve starts from 15 on vertical axis and then rises like an inverse 'S' shaped curve as shown in the lesson on cost. From quantity 0 to 1 there is loss as  $TC > TR$  here. At  $Q = 2$ ,  $TR = TC$ . This is shown as TR and TC curves meeting at point A. At  $Q = 4$ ,  $TR = 40$ , (which corresponds to) point C on TR curve. At the same level of  $Q = 4$ , point C and TC is 25, corresponding to point D. The distance CD is the maximum difference between TR and TC. Then at  $Q = 6$ ,  $TR = TC$  again and after that TC curve is above TR curve indicating loss. So at  $Q = 4$ , profit is maximized.

According to this Method, the profits of a firm can be estimated by calculating Marginal Revenue (It is the change in total Revenues by selling of additional Unit of Output) and Marginal cost (it is the addition to the total cost/Total variable cost by producing one additional unit of Output) at different levels of Output the profit of a firm will be maximum at that level of output which MC is equal to MR.

$$MC = MR$$

or  $MR - MC = 0$

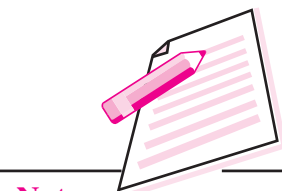
MR and MC Equality approach to firm's Equilibrium is based on two conditions.

- First order necessary condition. The Firm's MC must be equal to its MR at the equilibrium level of Output.
- Second order or sufficient condition. At the equilibrium level of Output the MC should be rising i.e. the MC curve should have positive slope or MC curve intersects MR curve from below.



**Table 23.3:** Profit maximization through MC and MR Approach

Q	MR	MC	MR – MC	Total
1	5	8	–3	–0 loss
2	5	5	0	0
3	5	2	3	0
4	5	3	2	5 Profit
5	5	4	1	6
6	5	5	–0	
7	5	7	–2	0 loss



Notes

In the table quantity Q is increasing from 1 to 7. Marginal revenue (MR) is constant at 5 since the firm is under perfect competition (already told in the section on revenue). The marginal cost (MC) starts at 8 and then falls and increases to 5 and continues falling to 4 at Q = 5. After that MC rises to 5 at Q = 6 and then further rises to 7 at Q = 7.

From the behaviour of MR and MC, you can see that initially between Q = 0 to 1,  $MC > MR$ . As  $MC = 8$  and  $MR = 5$ . At Q = 1,  $MC = MR = 5$ . Then between Q = 2 to Q = 6 MC lies below MR. Then again at Q = 6, MC rises to be equal to MR at 5. We can say that initially when  $MC > MR$  there is loss. So the firm must increase output. Then when  $MC = MR$  at Q = 2 there was no profit and no loss. But after that between Q = 3 to Q = 5, MC lies below MR. This is the zone of profit. For example at Q = 3,  $MR - MC = 5 - 2 = 3$ . At Q = 4,  $MR - MC = 5 - 3 = 2$ . At Q = 5,  $MR - MC = 5 - 4 = 1$ . At Q = 6,  $MR - MC = 5 - 5 = 0$ . i.e. We can say that profit starts at from 0 at Q = 2 to 3 at Q = 3, 2 at Q = 4, 1 at Q = 5 and 0 at Q = 6. Adding all these we get total profit to be  $0 + 3 + 2 + 1 + 0 = 6$ , when Q = 6. After that at Q = 7, there is loss again. So profit is maximized at Q = 6. In the table it is clearly shown that  $MR = MC$  at two points, one when Q = 2 and then when Q = 6. However at Q = 2, profit was not maximum as the firm had loss earlier at Q = 1 with MC more than MR at the time. But at Q = 6,  $MC = MR$ , but total profit is already maximum as indicated by the fact that MC was less than MR when they become equal. Also after that MC exceeds MR creating loss. Hence at Q = 6, both the conditions of profit maximization are satisfied.

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### Diagrammatic presentation

The above table can be presented diagrammatically in fig. 23.4.

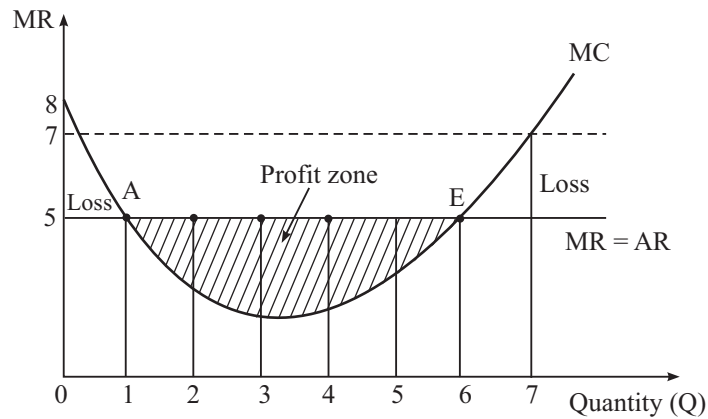


Fig. 23.4

In the diagram MR and MC are measured on vertical axis. Quantity is measured on horizontal axis. MR is horizontal at S. It is also same as AR as said earlier. MC is a 'u' shaped curve starting from see that initially when  $Q = 1$ , MC is above MR indication loss. Other  $MC = Z$ ,  $MC = MR$ , at point A. Here MC units MR from above. MC lies below MR so profit stands from point A when  $Q = 2$ . Profits are napped as long as MC is less than MR and till they are equal at point when  $Q = 6$ . At point, E,  $MC = MR$  and MC is less than MR when they become equal. Diagrammatically it means that MC cuts MR from below. So "E" is the point of profit maximization which satisfies both the conditions.



### INTEXT QUESTIONS 23.3

- Maximum profit implies that  $MC$  is above  $MR$  after both are equal.  
True or false.
- At quantity 2,  $TR = TC$ . After that  $TC$  lies below  $TR$  and again they become equal at quantity. 6. Do you firm agree that profit maximizing output lies between these two quantities.  
Yes/No.



### WHAT YOU HAVE LEARNT

- Total revenue ( $TR$ ) is the total sales proceeds of the firm.  $TR = \text{Price} \times \text{Quantity}$ .

- $AR = \frac{TR}{Q}$  and  $MR = \frac{\Delta TR}{\Delta Q}$ .
- $AR$  and  $MR$  are equal under perfect competition.
- Super normal profit refers to a situation when  $TR > TC$  or  $AR > AC$ .
- Normal profit implies that  $TR = TC$  or  $AR = AC$ . It is also called zero profit.
- Loss implies that  $TR < TC$  or  $AR < AC$ .
- Profit maximizing output is that output where  $TR - TC$  is maximum as per  $TR$  and  $TC$  approach.
- As per  $MR$  and  $MC$  approach, profit maximizing condition are
  - (i)  $MC = MR$
  - (ii)  $MC$  must be less than  $MR$  before they are equal.



Notes



**TERMINAL EXERCISE**

1. Define total revenue, average revenue and marginal revenue. Give their relationship.
2. Fill TR, AR and MR column.
 

P	Q	TR	AR	MR
	20	4		
	20	5		
	20	6		
3. Distinguish between super normal and normal profit.
4. Write a short note on loss of a firm by giving numerical example?
5. Explain the profit maximization principle by using TR and TC approach. Give suitable diagram.
6. Explain profit maximization conditions of a competitive firm by using suitable diagram?
7. Construct an imaginary table show the profit maximization output by using TR and TC approach?
8. Construct an imaginary shown the profit maximizing output of a competitive firm by using  $MR$  and  $MC$  approach?

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### ANSWERS TO INTEXT QUESTIONS

#### 23.1

1.  $TR = P \times Q$ ,  $AR = \frac{TR}{Q}$ ,  $MR = \frac{\Delta TR}{\Delta Q}$

2.

	P	Q	TR	AR	MR
	5	6	30	5	5
	5	7	35	5	5

#### 23.2

1. Normal profit or zero profit.
2. False
3. False
4. True.

#### 23.3

1. True
2. Yes.