UNIT 11   COLLUSIVE OLIGOPOLY

Structure

11.0   OBJECTIVES

After going through this unit, you will be able to:

- understand the collusive oligopolistic market structure; and

- evaluate the prices and output determination in such markets.

11.1   INTRODUCTION

In the case of collusive oligopoly the competing firms collude in order to reduce the uncertainties cropping out of the inherent rivalries among them. The colluding firms are usually bound by agreements whereby they seek to maximise the joint profit of the group. OPEC is an example of such type of collusion. In the following discussion, we would analyse the behaviour of firm by considering ― Cartels, Mergers, Price Leadership and Basing-point Price System.

11.2   COLLUSIVE OLIGOPOLY

11.2.1   Cartels

Mainly, cartels are formed among the firms due to the uncertainty arising out of mutual interdependence. Typically, there can be two types of cartels, viz.,

a) cartels aiming at joint profit maximisation

b) cartels aiming at the sharing of markets

a)   Cartels Aiming at Joint Profit Maximisation

Often cartels are formed for maximising the industry profit. The situation is similar to that of a multi-plant monopolist. Generally, the firms appoint a central agent to which they delegate the authority to decide the total quantity to be produced and the price to be charge, to maximise the joint profit. It is the central agency, which allocates the output to be produced among the firms, and it distributes the joint profit. To be able to do this, the central agency must have an access to the cost conditions of the firms. This knowledge is crucial as allocation and distribution depend crucially on them.

To analyse let us consider two profit maximising firms A and B forming a cartel for joint profit maximisation. The cost conditions are represented in terms of the marginal and average cost curves (MC and AC respectively). Based on the individual MC curves of the two firms, we derive the aggregate MC curve (AMC) as the horizontal summation of MC_1 and MC_2. Given the market demand curve (DD_1), by equating MR with AMC, we can derive the industry output and the corresponding industry price as shown in Figure 11.1.
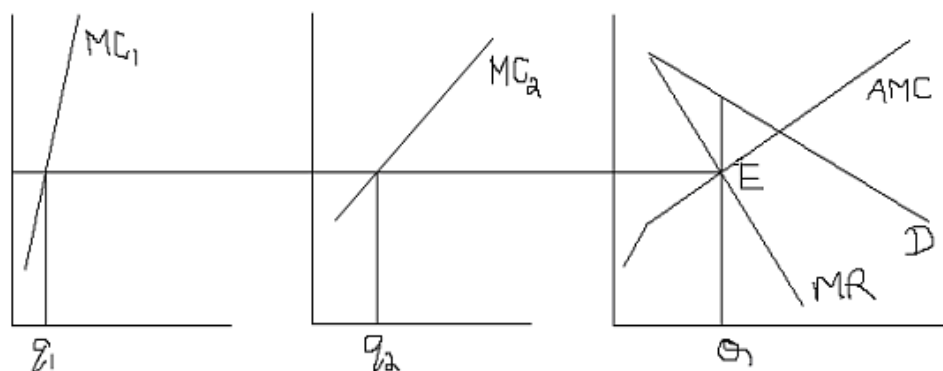

Fig. 11.1: Distribution of Output Among Firms

The individual output of each firm is obtained by drawing a line through the point E (where MR = AMC) and extending it back to the two adjoining figures whereby we get $MC_1 = MC_2 = AMC = MR$. Dropping perpendiculars from the point of intersection of the line $MC_1 = MC_2 = AMC = MR$ we get the output to be produced by each firm.

We find that the firm having the flatter MC, implying lesser per unit cost, produces the more output. But this by no way means that the firm with the flatter MC or the least cost gets a bigger share of the profit of the cartel.

Drawbacks in Cartels

There might arise situations when the joint profit maximisation of the firm may not be achieved. The main reasons could be the following:

1) Mistakes in the estimation of the market demand.

2) Mistakes in the estimation of the MC

3) Slow process of cartel negotiations

4) 'Stickiness' of the negotiated price

5) 'Bluffing' nature of the members

6) Existence of high-cost firm

7) Government interference

Mathematical Representation of Cartel Equilibrium

Supposing there are two firms in the market, joint profit maximisation implies that the firms maximise their respective profits i.e., maximise $\Pi = \Pi_1 + \Pi_2$.

Let $P = f(X) = f(X_1 + X_2)$ be the demand function and

$C_1 = f_1(X_1)$ and $C_2 = f_2(X_2)$ be the cost functions of the two firms. Then,

$\Pi_1 = R_1 - C_1$ and $\Pi_2 = R_2 - C_2$.

Therefore, $\Pi = \Pi_1 + \Pi_2 = R_1 - C_1 + R_2 - C_2 = R - C_1 - C_2$

The first order condition for profit maximisation requires that we differentiate Π with respect to X_1 and X_2 separately and set the derivatives equal to zero. So,

$\partial\Pi/\partial X_1 = \partial R/\partial X_1 - \partial C_1/\partial X_1 = 0$ and

$\partial\Pi/\partial X_2 = \partial R/\partial X_2 - \partial C_2/\partial X_2 = 0$

From the above equations, the optimality condition is,

$MR = MC_1 = MC_2$

That is, at the optimum, the marginal costs from each plant must be equal and such equality should again be equal to the marginal revenue. Otherwise, the firms would still have some incentive to reshuffle the level of output production from each plant.

The second order condition for joint profit maximisation requires that,

$\partial^2 R/\partial X^2 < \partial^2 C_1/\partial X^2_1$ and $\partial^2 R/\partial X^2 < \partial^2 C_2/\partial X^2_2$

This implies that for each plant, it should be such that once the profit maximising output level has been reached, any additional unit of output would have the MR falling at a faster rate than MC.

A Numerical Example

The market demand function $P = 100 - 0.5(X) = 100 - 0.5(X_1 + X_2)$

The cost functions of the two firms are $C_1 = 5X_1$ and $C_2 = 0.5X^2_2$. Then the total profit of the colluding firms is given by

$\Pi = \Pi_1 + \Pi_2$

$= P(X_1 + X_2) - C_1 - C_2$

$= [100 - 0.5(X_1 + X_2)](X_1 + X_2) - 5X_1 - 0.5\,X^2_2$

$= 95\,X_1 - 100X_2 - 0.5\,X^2_1 - X^2_2 - X_1X_2$

The first order condition for profit maximisation requires that,

$\partial\Pi/\,\partial X_1 = 95 - X_1 - X_2 = 0$

$\partial\Pi/\,\partial X_2 = 100 - X_1 - 2X_2 = 0$

Solving for X_1 and X_2 we get, $X_1 = 90$ and $X_2 = 5$

From the demand function, we get $P = 100 - 0.5(X_1 + X_2) = 52.5$

The maximum joint profit obtained is given by,

$\Pi = PX_1 - C_1 + PX_2 - C_2 = 52.5(90+5) - 5(90) - 0.5(5)^2 = 4525$

b) Market Sharing Cartels

This form of collusion is more popular. Here the firms agree to share the market but at the same time maintain a considerable degree of freedom regarding product differentiation, selling activities and other business decisions. There are two basic methods of sharing the market:(1) Non-price competition and (2) Quota system

1) Non-price competition

In this form of a 'loose' cartel, the member firms agree on a common price, at which each of them can sell any quantity demanded. The price is set by the process of bargaining, with the low-cost firms pressing for a lower price and the high-cost ones for a higher price. The agreed price must be such as to allow some profits to all the members. The firms agree

not to sell at a price below that decided by the cartel, but they are free to vary the style of their product and/or their selling activities. In other words, firms compete on a non-price basis.

2) Quota system

It is an agreement on the quantity that each member may sell at the agreed price(s), if the costs are identical, then the firms share the market equally among themselves. If costs differ, then the share of the market is decided by bargaining. The final quota of each firm depends on the level of it's cost as well as on it's bargaining skill. Most often adopted criteria for determining quotas are 'past-period sales' and 'productive capacity'. Another popular method of determining quota is that of geographical sharing of the market.

Check Your Progress 1

1) What is a cartel?

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2) What is the optimality condition? Explain.

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3) How is cartel agreement similar to the case of a multiplant monopolist?

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4) What is a market-sharing cartel?

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5) Briefly, explain (a) non- price competition and (b) quota system under market sharing cartel.

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11.2.2 Mergers

If firms in an oligopolistic industry cannot form a cartel or accept leadership, then they have another way out that will save them from any price war. That is to eliminate rivalry through merger. A *Merger* is the consolidation of two or more independent firms into a single firm. There are three kinds of mergers viz., (1) Horizontal (2) Vertical and (3) Conglomerate.

A Horizontal merger combines two firms that produce the same product in the same geographic market. Since the two are competitors, a merger reduces the number of firms in the market.

A Vertical merger combines two firms that previously had an actual or potential customer-supplier relationship. That is, the product of one firm is used as an input of the other. The most important motive of vertical merger is the security in the input markets, output markets or both. When an acquiring firm merges with a firm that distributes it's products through it's outlets then it is a *Downstream Integration*, and this is done to obtain security in the output market. If the acquiring firm merges with an input-supplying firm, then it is called an *Upstream Integration* and designed to obtain security in the input markets.

A conglomerate merger is neither horizontal nor vertical. These mergers have three motives: extending the market, expanding the product line and pure investment.

Check Your Progress 2

1) What is a merger?

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2) What are the different types of mergers? Briefly, explain each.

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11.2.3   Price Leadership

In this form of collusion, one firm sets the price and the rest follow. This helps to reduce the uncertainty about the competitors' reactions, even though the firms may have to depart from their profit maximising position. Price leadership is more widespread than cartels because it allows the members complete freedom regarding their product and selling activities. Such an arrangement is more acceptable to the followers than a complete cartel, which requires the surrendering of all freedom of action to the central agency.

There are various forms of price leadership. The most common types are:

1) Price leadership by a low-cost firm

2) Price leadership by a large (dominant) firm

3) Barometric price leadership.

In this kind of a setup, the leader sets it's price according to the marginalistic principle (MR = MC) and the followers merely act as price takers. Generally, therefore the followers do not end up maximising profit. If they do so then it is by sheer coincidence and not an outcome of their independent decision.

Low-Cost Price Leader Model

Let us consider a duopoly (firms A and B) selling a homogeneous product at different costs. Let us also assume that firm A is the price leader. The firms may have equal market as shown in Figure 11.2 (shown by a common market demand curve) or unequal market as shown in Figure 11.3 (represented by two different market demand curves). We would consider the case when the firms have unequal costs.
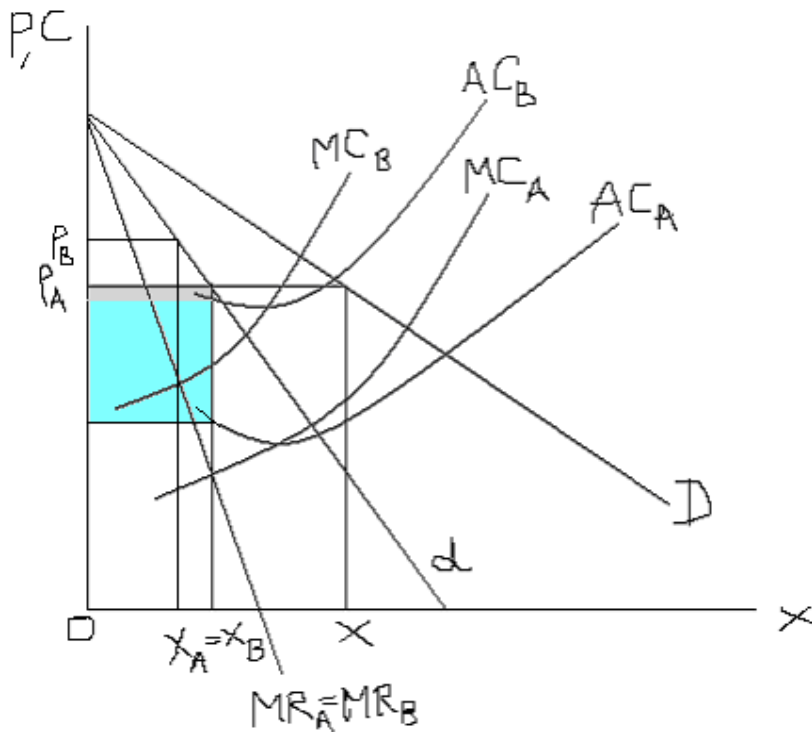

Fig. 11.2: Firms with a Common Market Demand Curve

In Figure 11.2, the different cost structures are represented by the two marginal cost curves MC_A and MC_B with $MC_A < MC_B$. Both the firms face the same market demand curve d so the aggregate demand curve D is given by the horizontal summation of each duopolist's. Firm A being the leader equates MR_A with MC_A and arrives at the price OP_A. Firm B would accept the price even though it is not the profit-maximising price for her. The profit-maximising price for B is OP_B. With this kind of an arrangement, firm B does make some profit. Firm A's profit is given by the shaded area. Finally, we see that the two firms produce the same level of output.
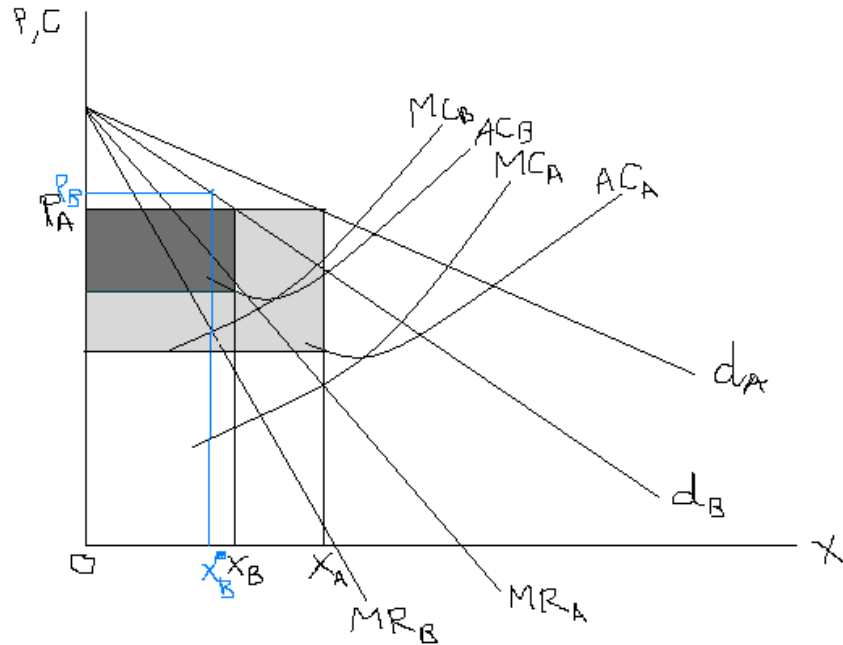
Fig. 11.3 : Firms with Individual Market Demand Curves d_A and d_B

In Figure 11.3, the only difference is that the firms face different market demand curves d_A and d_B and the output levels are different for the two firms but the price charged is the same. The profit earned by the leader is higher than that of the follower.

The firm with the lowest cost will charge a price P_A and this price will be followed by the high cost firm B, although at P_A it does not maximise profit. In fact the follower could earn a higher profit by charging P_B and producing X_B.

However, it prefers to follow the leader in order to avoid any price war. Otherwise, if a price war ensues, then price may fall so much as not to cover the average cost.

Even though the follower has an incentive to comply with the leader in terms of price, the firms must also enter a share-of-the-market agreement. Otherwise, the follower may not produce the stipulated amount of output required to maintain the price in the market and the leader may be pushed away from the profit maximising position.

Mathematical Representation

Let us assume that there are only two firms in the industry.

The market demand function is given by, $P = a - b(X)$; $X = X_1 + X_2$ where X_1 and X_2 are the output of firm 1 and 2 respectively.

The cost functions of the two firms are given by $C_1 = f_1(X_1)$ and $C_2 = f_2(X_2)$ respectively and $C_1 < C_2$.

The leader (firm 1, as it is the low cost one) assumes that the rival firm would produce an equal amount of output such that $X_1 = X_2$

Therefore, the demand function of the leader becomes $P = a - 2b(X_1)$

The profit function of the low cost leader is given by:

$\Pi_1 = PX_1 - C_1 = (a - 2bX_1) X_1 - C_1$

Differentiating partially with respect to X_1 and setting the derivative equal to zero yields,

$\partial\Pi_1/\partial X_1 = a - 4bX_1 - \partial C_1/\partial X_1 = 0$

or, $a - 4bX_1 = \partial C_1/\partial X_1$

i.e., MR = MC

Solving this equation, we get the equilibrium value of X_1, after checking for the second order condition that $\partial^2 R_1/\partial X^2_1 < \partial^2 C_1/\partial X^2_1$.

From the demand function, we can find out the equilibrium price level of the firm. The follower firm will accept the equilibrium price achieved by the leader.

Model of the Dominant Firm

In this case, it is assumed that there is a large dominant firm, which has a considerable share of the total market, and some smaller firms each having a small market share. It is assumed also that the dominant leader knows the MC curves of the smaller firms. The leader adds these curves horizontally to arrive at the total supply by the small firms at each price. Or, we can think of the leader at best to have a fair idea from the past as to how much the small firms can sell at every price level. With this knowledge, the leader can obtain her own demand curve. This is illustrated in Figures 11.4 and 11.5 below.

At each price, the demand for leader is the difference between total demand D at that price and total supply S_1. Accordingly, we can derive d_L. The profit maximising output level is determined by setting MR = MC, whereby output is Ox and price is OP. The other small firms would also sell at P, following the leader, and selling output, which does not maximise profit. There has to be some kind of an agreement among the firms regarding the market share, else the followers may not sell the amount required to maintain the profit maximising level of price.
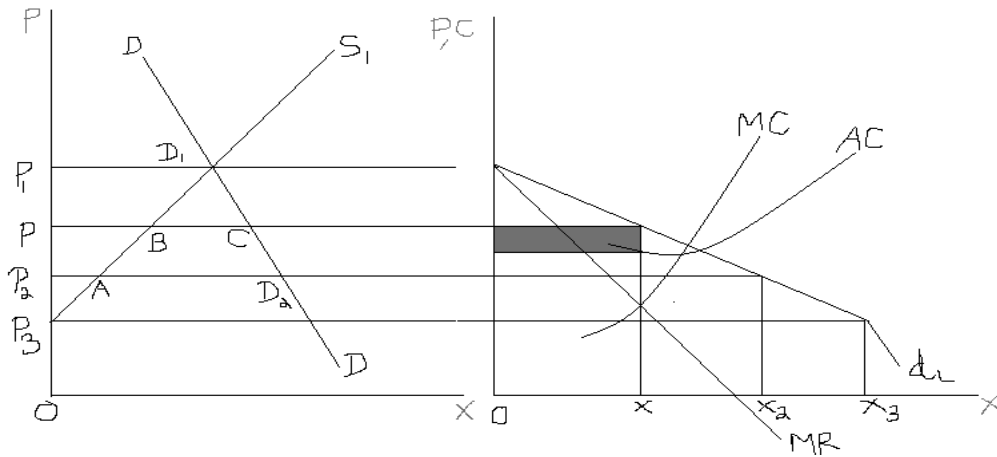

Fig. 11.4: Market Demand Curve   Fig. 11.5: Demand Curve of the Leader

At price OP, PB gives the small firms supply and BC the leader's supply. At price OP_3, AD_2 gives the leader's supply.

Mathematical Representation

In this model, the dominant firm knows the MC curves of the small firms. By adding these curves horizontally, it obtains the supply curve S_1 of the small firms as a function of price. Let us assume that $S = 0.2P$

The dominant firm knows the market demand $D = 50 - 0.3P$

The dominant firm derives its own demand curve at any price as the difference (say X)

i.e., $X = D - S = 50 - 0.3P - 0.2P = 50 - 0.1P$

or, $P = 100 - 2X$

Let the cost function of the dominant firm be $C = 2X$

Thus, profit function of the dominant firm is given by,

$\Pi = PX - 2X = (100 - 2X)X - 2X = 98X - 2X^2$

Differentiating partially with respect to X and setting the derivatives equal to zero we get,

$\partial \Pi / \partial X = 98 - 4X = 0,$

  or, $X = 24.5$

The leader will set the price $P = 100 - 2X = 100 - 2(24.5) = 51$ and this will be the equilibrium price in the market.

The total quantity demanded in the market will be $D = 50 - 0.3P = 34.7$

This total demand is covered in the market with the leader producing

$X = 24.5$ units and the small firms producing $S = 0.2P = 0.2(51) = 10.2$ units.

Barometric Price Leader Model

In this model, it is formally or informally agreed that all firms will follow the changes of the price of a firm, which is considered to have a good knowledge of the prevailing conditions in the market and can forecast better than the others on the future developments in the market. The firm chosen as the leader is considered as the barometer, reflecting the changes in economic environment. The barometric firm may be neither a low-cost nor a large firm. Usually it is a firm, which from past behaviour has established the reputation of a good forecaster of economic changes.

Check Your Progress 3

1) What is a price leadership form of collusion? What are the different forms of such a collusion?

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2) Briefly, describe how a low cost price leader arrives at the equilibrium price, if the firms face (a) a common market demand curve (b) different market demand curves. Give diagrams.

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3) Briefly describe how a dominant firm arrives at the equilibrium price.
   Give diagram.

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4) What is barometric price leadership?

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11.2.4 Basing-point Price System

Basing-point pricing has been adopted often in practice by oligopolists producing a homogeneous product whose transportation costs are relatively higher and whose production requires a large plant, if full economies of scale (minimum production costs) are to be realised. We would consider two kinds of basing-point pricing — single basing-point and multiple basing-point system.

Single Basing-point System

In this collusive pricing model, the oligopolists agree on a common place as the basing-point, and all the firms set the price as the production price (mill price) at the basing-point plus the transport cost from the basing-point to the place of destination. This is shown in the following Figure 11.6.
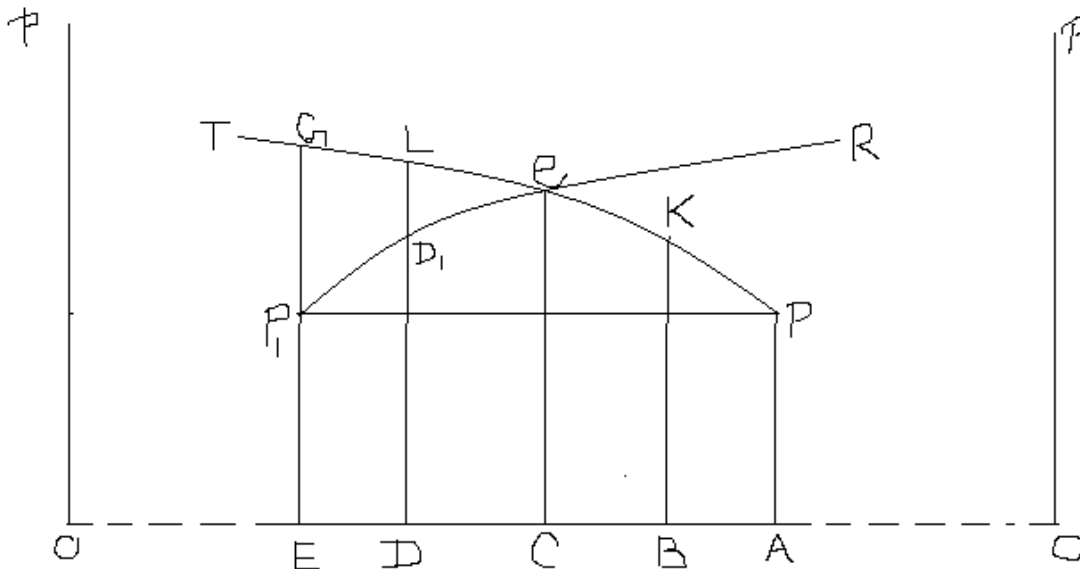

Fig. 11.6: Pricing Under Basing-point Strategy

Let town A be the basing-point for all oligopolists located anywhere. The basing-point production price = AP. Delivered price increases as the distance from the basing-point increases. Let us assume that the delivered prices change as shown by curve PT in Figure 11.6. These prices are the same for all the oligopolists.

Therefore, a firm located in town E will quote the price EG to its local customers, DL to customers in town D, BK to buyers located in town B.

If the production price (mill price) is, in town E, the same as in the basing-point A, the firm in E will be realising excess profits by selling to buyers located between E and C. For example, if the firm in E sells to a buyer located in D, the firm will be making an excess profit equal to D_1L per unit of output, since its freight costs are given by the P_1R curve. Such excess profits are called 'phantom freights'. The firm in E may expand its sales beyond point e in the territory-market of firms located at A, if its marginal costs are less than its mill price EP_1 minus the freight it will have to cover.

i.e., $MC \leq EP_1 -$ freight cost

or, $MC +$ freight cost $\leq EP_1$ (mill price), so that the oligopolist is still making some profit.

The oligopolists may find it profitable to sell in each other's territory-markets. This is known as *cross-hauling*.

Multiple Basing-point System

The excess profits ('phantom freight' gains) realised by the firms selling at the basing-point price to buyers located at places where this price is higher than their production costs plus transportation cost, may be reduced under a system of multiple basing pricing. In such a system, several places are agreed as basing points. The delivered price of all oligopolists will be the same for buyers located in a certain place and will be the lowest possible delivered price. This is illustrated in the Figure 11.7.

To illustrate the multiple Basing-point system assume that the locations A and E are both agreed as basing-points. The delivered price of firms in location A are those on the curve PT (same as in Figure 11.6). The delivered prices of firms in location E are those on the curve P_1R. Only at the point of intersection of PT and P_1R (i.e., point e) will the delivered prices be identical for firms located in E and A. To the left of e the delivered price of firm in A are higher than those of firms located in E; thus for buyers located to the left of e the delivered prices quoted by all sellers will be the (lower) prices of curve P_1e. To the right of point e the delivered prices of firms in A are lower, and these will be quoted by all firms to the buyers. In this way, the relevant delivered prices for buyers located between E and A are on the segments P_1e (of P_1R) and eP (on PT). A firm located in A will charge the delivered price on P_1e to buyers located between E and C, without gaining any 'phantom freight'. If this firm wants to sell to buyers located further than C, it will have to cover itself part of the freight. This would not at all be profitable because beyond e, prices are low for firm A and the price charged will not cover the freight charge.
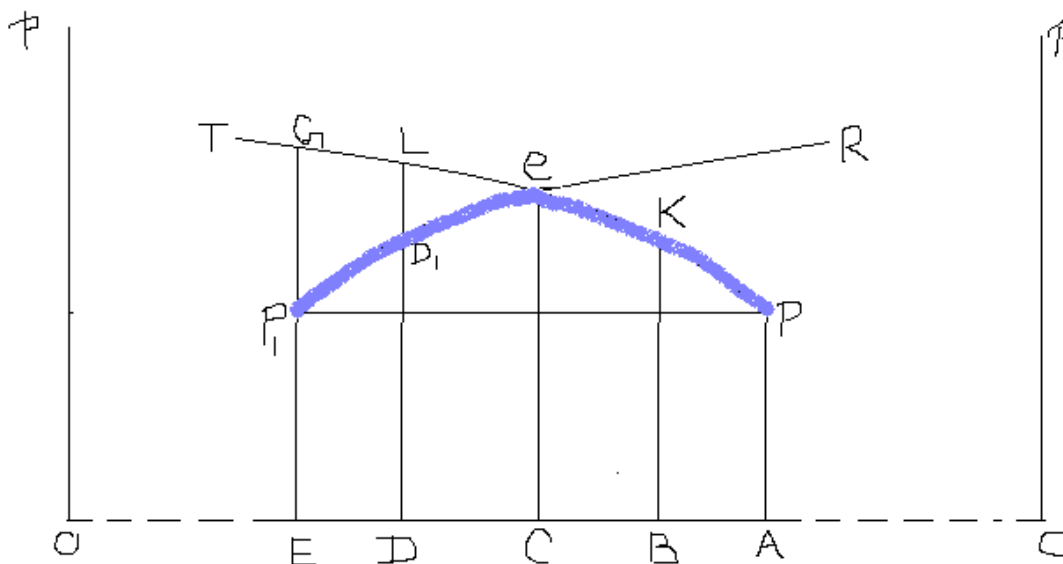
Fig. 11.7: Pricing under Multiple Basing-point

Only the firms between the basing points will have 'phantom frieghts', given that they can produce at the same mill price as firms in A or E. For example, a firm located in D will charge the delivered price Coe to buyers located at C, and will receive 'phantom freight' equal to ae, as per the freight curve is represented by the curve D_2R. A firm located at C and selling to local customers will receive a greater phantom price (equal to eb) given the two basing-point pricing arrangement. This is illustrated in Figure 11.8
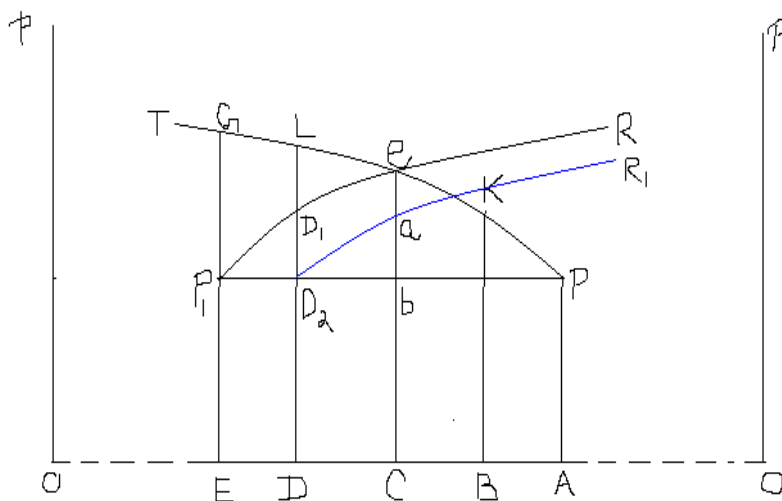

Fig. 11.8: Pricing with Phantom Freight

As the number of basing-point increases, the phantom freights are gradually eliminated. In the limit, if sellers were located next to each other and there were as many basing points as sellers, all would quote the same price $EP_1 =$ AP, which is the lowest of delivered prices of all sellers. This is shown in Figure 11.9. In the figure, let us suppose that B, C and D are all basing-points. Therefore, as before the price to be charged by the oligopolists would be the lower of the prices charged by each. This is shown by the bold line. Now as the number of basing-points increases the price line will fall further and finally coincide with the mill price $AP = EP_1$.
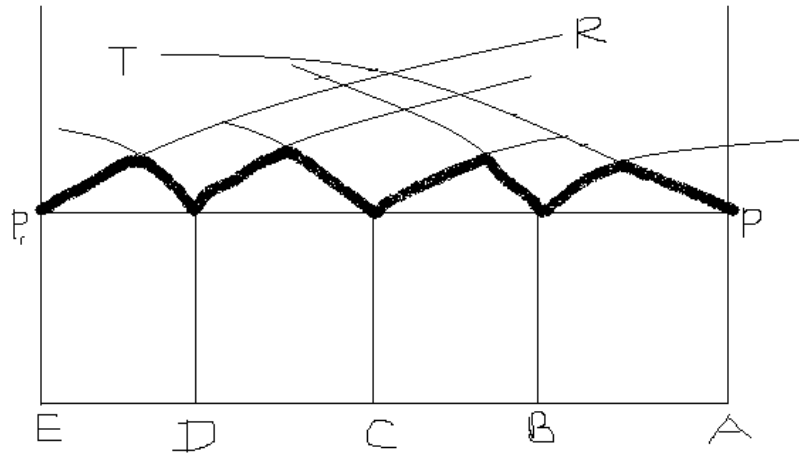
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Fig. 11.9: Elimination Process of Phantom Freight

Check Your Progress 4

1) What is a single point basing system?

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2) What is a multiple point basing system?

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4) Explain with a diagram what happens to the market price if there are multiple basing points.

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11.3 LET US SUM UP

The competing firms in an oligopolistic market enter into a collusion to reduce the inherent uncertainties. In this unit, we have mainly focused on how the firms arrive at the equilibrium market price and output.

There are various forms of collusion, viz., cartel, merger, price leadership and basing-point system of price fixing. In a cartel, the firms seek to maximise the joint profit with the help of a central agency. In a merger, the firms merge together as one. Accordingly, we can have horizontal mergers, vertical mergers or conglomerate mergers. Under price leadership, a particular firm

with certain characteristics is chosen as the leader to determine the market price at which the others would produce and sell. In the basing-point price system, the oligopolists agree on a common place as the basing-point, and all the firms set the price as the production price (mill price) at the basing-point plus the transport cost from that point to the place of destination. Under this category, we have single point and multiple point pricing. In the former case, the firms have a single location as the basing-point and in the latter, the firms have more than one basing-point.

11.4   KEY WORDS

Basing-point Price System: The oligopolists agree on a common place as the basing point, as per which the firms set their price.

Cartel: An agreement whereby oligopolists (competing firms) decide to collude and produce.

Merger: A consolidation of two or more independent firms into a single firm

Price Leadership: A particular firm from among the colluding members acting as a price setter.

11.5   SOME USEFUL BOOKS

Koutsoyiannis, A. (1979), *Modern Microeconomics*, Second edition, London: Macmillian.

G.S. Maddala and E. Miller (1989), *Microeconomics: Theory and Applications*, McGrow-Hill, New Delhi.

Henderson, Henderson & Richard E. Quandt (2003), *Microeconomic Theory: Mathematical Approach*, Tata McGraw-Hill Publishing Company Limited, New Delhi.

11.6   ANSWERS OR HINTS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) An agreement whereby competing firms decide to collude and produce**.** Generally, the firms appoint a central agent to which they delegate the authority to decide the total quantity to be produced, the price to be charged and the output to be produced among the firms and to distribute the joint profit.

2) The reshuffling of output across the firms would go on until the marginal costs of each firms is equated to the marginal revenue.

3) Hint: The optimality condition is similar to that of a multiplant monopolist. A multiplant monopolist allocates the amount of output to be produced at each plant based on the cost condition of each of the plants. Hence, the plant with the least cost gets to produce the most.

4) The colluding firms decide to share the market.

5) a)   Hint: non- price competition- member firms agree on a common price

   b)   Hint: quota system – the firms share the market equally among themselves

Check Your Progress 2

1) Hint: A merger is the consolidation of two or more independent firms into a single firm

2) Horizontal mergers – A horizontal merger combines two firms that produce the same product in the same geographic market

   Vertical mergers – A vertical merger combines two firms that previously had an actual or potential customer-supplier relationship

   Conglomerate merger – These mergers have three motives: extending the market, expanding the product line and pure investment.

Check Your Progress 3

1) Hint: In this form of collusion, one firm sets the price and the rest follow.

   There are various forms of price leadership. The most common types are:
   Price leadership by a low-cost firm
   Price leadership by a large (dominant) firm
   Barometric price leadership.

2) Hint: Suppose 2 firms A, B and A is the low cost firm.

   Firm A equates MR with its MC and arrives at the profit-maximising price. Next, firm B accepts the price and sells at that even though the price may not be profit maximising. With a common market demand curve, the two firms end up sharing the market.

   Firm A equates MR with its MC and arrives at the profit-maximising price. Next, firm B accepts the price and sells at that even though the price may not be profit maximising. The amount of output to be produced is obtained from the respective demand curves of the two firms.

3) Hint: The leader is assumed to know the cost functions of each of the colluding firms and also the demand function. From the cost functions, it derives the market supply curve. Given the market demand curve, the leader then with the help of market demand and supply decides upon it's own supply into the market. The market price is determined by the leader by equating it's MR and MC.

4) Hint: In this model it is formally or informally a firm is chosen as the barometric leader which is considered to have a good knowledge of the prevailing conditions in the market and is a better forecaster than the others about the future developments in the market. The chosen firm is considered to be a barometer, reflecting the changes in economic environment.

Check Your Progress 4

1) Hint: The oligopolists agree on a common place as the basing-point. All the firms then set the price as the production price (mill price) at the basing-point plus the transport cost from the basing-point to the place of destination.

2) Hint: It is the same as above except that here are more than one basing-points.

3) Hint: The market price comes down due to reduced cross hauling.

11.7 EXERCISES

1) The demand function $P = 100 - 0.5(X)$, $C_1 = 10X_1$ and $C_2 = 0.25X^2_2$. Find the joint profit, the output produced by each firm under collusion. If the firms act as monopolists without considering the presence of the other, then find the individual profits. Compare the profits.

2) In a joint profit maximising cartel if there are two firms 1 and 2, what happens to the direction of output production, if

   a) $MC_1 > MC_2 = MR$

   b) $MC_2 > MC_1 = MR$

   c) $MC_1 = MC_2 > MR$

3) What is the difference between a joint profit maximising cartel and a market-sharing cartel?

4) Assume that the market demand function is given by $P = 105 - 2.5X$, where $X = X_1 + X_2$.

The cost function of the two firms is given by:

$C_1 = 5X_1$ and $C_2 = 15X_2$

Find the equilibrium output, price and maximum profit level.