Study Material
Economics

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Course Information

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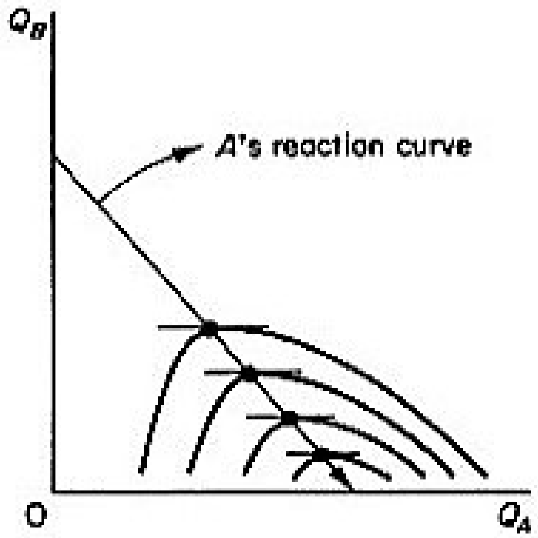
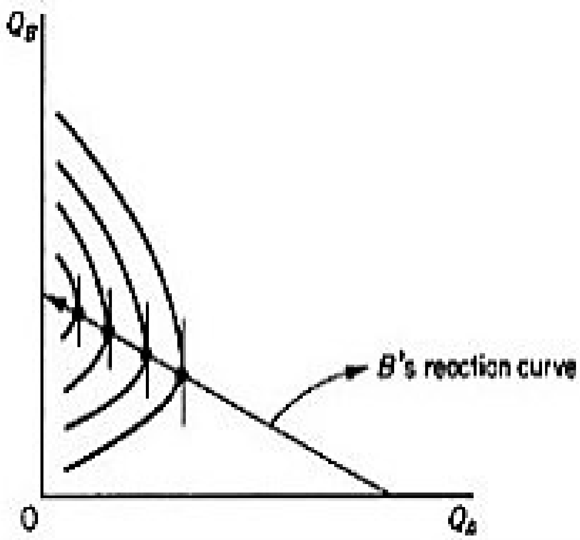
Lecture 1: Oligopoly

The *reaction curves* approach is a more powerful method to analyse oligopolistic market because it doesn't require the assumptions of identical costs, costless production and identical demands. This approach is based on the *Stackelberg's indifference curve analysis* which introduces the concept of *isoprofit curves* for competing producers.

An *isoprofit* curve for Firm-A is a string of points showing different levels of output by Firm-A and its rival Firm-B which yields the same level of profit to Firm-A (see Figure 1a). Similarly, an *isoprofit* curve for Firm-B is a string of the points showing different levels of output by Firm-B and its rival which yields the same level of profit to Firm-B (see Figure 1b).



(a) Isoprofit graph for Firm-A



(b) Isoprofit graph for Firm-B

Figure 1: Isoprofit maps

The properties of *isoprofit curves* (IP) are:

1. IPs for firms are concave to the axes along which we measure the output of corresponding firm. The Figure 2 shows an *isoprofit* curve of Firm-A which is concave to the horizontal axis Q_A. This shape shows how Firm-A can react to Firm-B's output decisions so as to retain a given level of profit.

   Suppose that Firm-B decides to produce the level of output B_1. A line parallel to the horizontal axis through B1 intersects the *isoprofit* curve Π_{A1} at points h and g. This shows that Firm-A will earn same profit by producing either A_h or A_g corresponding to points h and g. Assume that Firm-A reacts by producing higher production A_g. If now Firm-B increases its output to B_2, Firm-A will reduce its output, otherwise excess production will reduce market price and hence,

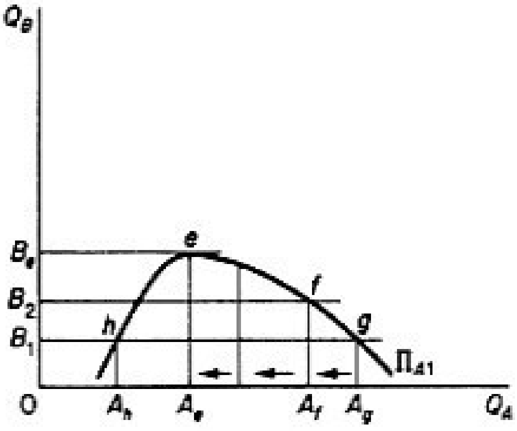


Figure 2

the profit of Firm-A. Thus, Firm-A will reduce its output in response to increase in the output of Firm-B. This will go on up to a certain point e as shown in Figure 2.

As Firm-A reduces its output, its cost will also change but its net profit , Π=R-C, will remain at the same level because of market elasticity or decreasing cost arising from a better utilisation of Firm-A's plants. Consider point h, if Firm-B decides to increase its output from B_1, Firm-A will react by increasing its output as well. Like before, Firm-A's profit will remain the same because of market elasticity and decrease its costs due to better utilisation of its plants.

2. Further the *isoprofit* curve is from the axes, lower is the profit and vice versa. Consider Figure 3, suppose that Firm-B decides to produce B_4. Firm-A can react by increasing or decreasing or keeping its output level at A_e.

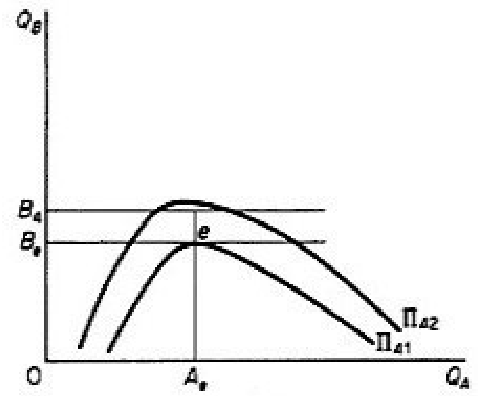
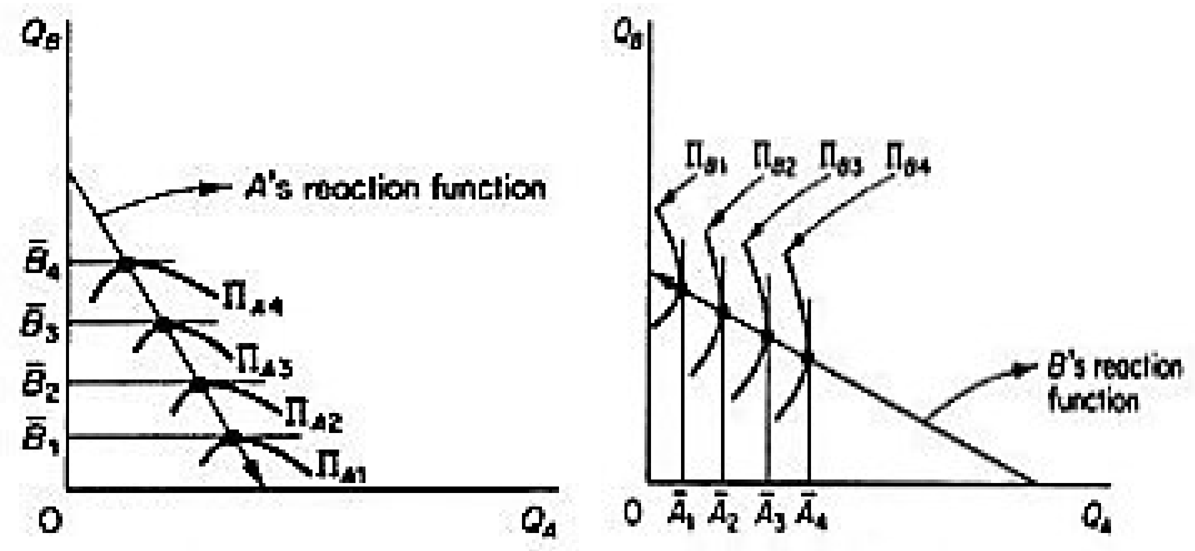


Figure 3

If Firm-A retains its output at a constant while Firm-B increases its output, market price will fall. As a result, both revenue and profit of Firm-A will decrease if cost of production does not change. If Firm-A increases its production beyond A_e (Figure 3) while Firm-B increases its output, both revenue and profit of Firm-A will decrease due to the inelasticity of demand or increasing cost of production. If Firm-A decreases it's production below A_e, its profit will fall because of elasticity of demand or increasing cost of production. Thus, Firm-A will earn lower levels of profit, no matter what it's reaction is, when Firm-B increases its output beyond B_e. Thus, in Figure 3, the *isoprofit* curve Π_{A2} represents lower profit than Π_{A1}.

3. For Firm-A, the highest points of successive *isoprofit curves* lie to the left of each other. Firm-A's *reaction curve* is shown in Figure 4a. If we join the highest points of the *isoprofit curves* we obtain Firm-A's *reaction curve*. *Reaction curve* is defined as the locus of points representing highest profits that Firm-A can attain, given the different levels of the output of its rival, Firm-B. lt is so called because it shows reaction of Firm-A to Firm-B's decision to increase or decrease production.



(a) (b)

Figure 4

Firm-B's *isoprofit curves* are concave to the Q_B axis. The highest points of the *isoprofit curves* of B lie to the right of each preceding curves as we move further away from the Q_B axis. If we join these highest points, we obtain Firm-B's reaction curve (see Figure 4b).

Cournot's equilibrium is determined by the intersection of *reaction curves* of two firms (see Figure 5). It is a stable equilibrium, provided that Firm-A's reaction curve is steeper than Firm-B's reaction curve.

If Firm-A decides to produce A_1, firm B will react by producing B_1 given *Cournot's* assumption that Firm-A will keep its quantity fixed at A_1. However, Firm-A reacts

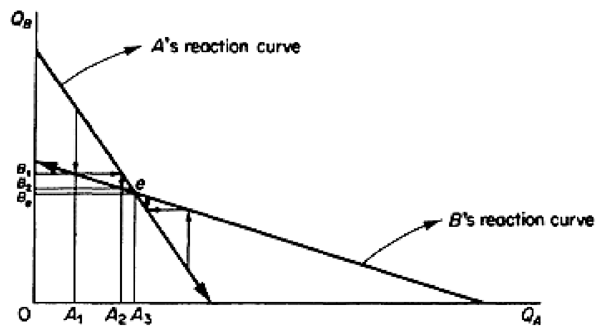


Figure 5

by producing higher quantity A_2 on the assumption that Firm-B will stay at the level B_1. Now, Firm-B reacts by producing its output at B_2. This adjustment will continue till the point e is reached. Thus, e is a stable equilibrium but is also suboptimal. At point e each firm maximises its own profit but the joint profit of the industry is not maximised (see Figure 6).

EE' is similar to *Edgeworth's contract curve* which is the locus of the points of tangency of the two firm's *isoprofit curves.* The points on the *contract curve* are optimal because points off this curve imply a lower profit for one or both firms, i.e. less industry profits as compared to points on the curve.

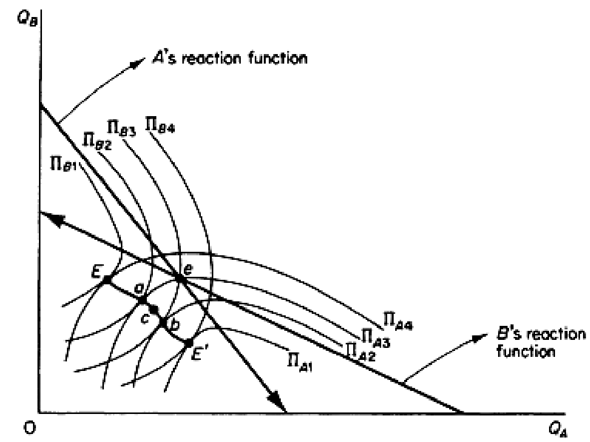


Figure 6: *EE'* is Edgeworth's contract curve

At point a, Firm-A would continue to have same profit Π_{A3} while Firm-B have a higher profit ($\Pi_{B2} > \Pi_{B3}$). Again at any intermediate point between a and b, namely c both Firms will earn higher profits.

QUESTION: Why would competing firms choose a suboptimal equilibrium e?
ANSWER: The *Cournot* pattern of firm's behaviour implies that the firms do not learn from their past experiences, each expecting the other to remain at a given position.

Assume that the market demand facing the duopolists is

$$X = a^* + b^*P$$

or

$$P = a + bX \qquad b < 0$$

Given that $X = X_1 + X_2$

$$\frac{\partial X}{\partial X_1} = \frac{\partial X}{\partial X_2} = 1$$

and the MRs of the duopolists need not be the same. Actually if the duopolists are of unequal size the one with the larger output will have the smaller MR.

Proof:

$$R_i = pX_i$$

$$p = a + b(X_1 + X_2) = f(X_1, X_2)$$

Thus

$$\frac{\partial R_i}{\partial X_i} = p + X_i \frac{\partial P}{\partial X_i}$$

But

$$\frac{\partial P}{\partial X_1} = \frac{\partial P}{\partial X_2} = \frac{\partial P}{\partial X} = b$$

Therefore

$$\frac{\partial R_i}{\partial X_i} = P + X_i \frac{\partial P}{\partial X} = P + (X_i)(b)$$

Given that $P > 0$ while $b < 0$, it is clear that the larger X_i is, the smaller the MR will be.

The two duopolists have different costs

$$C_1 = f_1(X_1) \quad \text{and} \quad C_2 = f_2(X_2)$$

The first duopolist maximises his profit by assuming X_2 constant, irrespective of his own decisions, while the second duopolist maximises his profit by assuming that X_1 will remain constant.

The first-order condition for maximum profits of each duopolist is

$$\left.\begin{aligned}\frac{\partial \Pi_1}{\partial X_1} = \frac{\partial R_1}{\partial X_1} - \frac{\partial C_1}{\partial X_1} = 0 \\ \frac{\partial \Pi_2}{\partial X_2} = \frac{\partial R_2}{\partial X_2} - \frac{\partial C_2}{\partial X_2} = 0\end{aligned}\right\} \tag{9.1}$$

Rearranging we have

$$\left.\begin{aligned}\frac{\partial R_1}{\partial X_1} = \frac{\partial C_1}{\partial X_1} \\ \frac{\partial R_2}{\partial X_2} = \frac{\partial C_2}{\partial X_2}\end{aligned}\right\} \tag{9.2}$$

Solving the first equation of (9.2) for X_1 we obtain X_1 as a function of X_2, that is, we obtain the reaction curve of firm *A*. It expresses the output which *A* must produce in order to maximise his profit for any given amount X_2 of his rival.

Solving the second equation of (9.2) for X_2 we obtain X_2 as a function of X_1, that is, we obtain the reaction function of firm *B*.

If we solve the two equations simultaneously we obtain the Cournot equilibrium, the values of X_1 and X_2 which satisfy both equations; this is the point of intersection of the two reaction curves.

The second-order condition for equilibrium requires that

$$\frac{\partial^2 \Pi_i}{\partial X_i^2} = \frac{\partial^2 R_i}{\partial X_i^2} - \frac{\partial^2 C_i}{\partial X_i^2} < 0 \qquad (i = 1, 2)$$

or

$$\frac{\partial^2 R_i}{\partial X_i^2} < \frac{\partial^2 C_i}{\partial X_i^2}$$

Each duopolist's *MR* must be increasing less rapidly than his *MC*, that is, the *MC* must cut the *MR* from below, for both duopolists.

Here ends *Cournot* Duopoly Model.

Lecture 2: *Stackelberg* Duopoly Model

This model is an extension of *Cournot's* Model and was developed by Heinrich von Stackelberg in 1939. In this model, it is assumed that one duopolist is sufficiently sophisticated to recognise that its competitor acts on as per *Cournot's* assumptions. Thus, the wiser duopolist can determine the *reaction curve* of his rival and incorporate it in his own profit function, which he then tries to maximise like a monopolist.

Assume that the *isoprofit curves* and the reaction functions of the duopolists are those depicted in Figure 7. If Firm-A is the sophisticated duopolist, it will assume that it's rival will act on the basis of its own *reaction curve.* Then it will choose its own output at a level that maximises its own profit. This is point a in Figure 7 which shows the lowest possible *isoprofit* i.e. the highest possible profit Firm-A can earn given Firm-B's*reaction curve.* Then, Firm-A acting as a monopolist will produce X_A, and Firm-B will react by producing X_B according to its *reaction curve.*

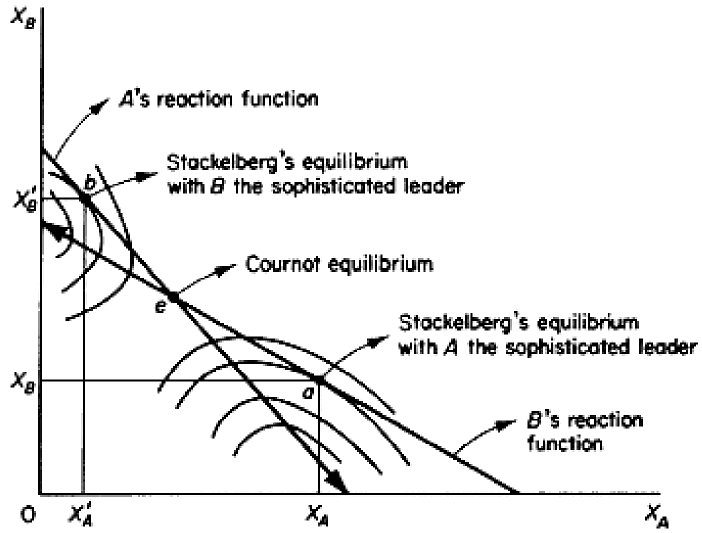


Figure 7

The sophisticated oligopolist becomes the leader and its rival becomes the follower. Compared to *Cournot's* equilibrium, Firm-A is better off and its rival Firm-B is worse off because the former is producing nearer to its axis and the later is producing further from its own axis. If Firm-B is sophisticated oligopolist, it will choose X'_B corresponding to point b on Firm-A's reaction curve. Firm-B will be leader now and Firm-A becomes follower. Now Firm-B has the higher profit and its rival Firm-A has the lower profit in comparison to *Cournot's* equilibrium. It means if only one firm is sophisticated, it will emerge as the leader and since it's rival is follower, there will be stable equilibrium.

If both are sophisticated, both will want to act as leaders to earn a greater profit. In this situation, market becomes unstable. There will either be a price war until one of the firm surrenders and agrees to act as a follower. Or a collusion between the firms may happen. In this case, both firms will abandon their reaction functions and move to a point closer to or on the *Edgeworth's contract curve* and both will have higher profit.

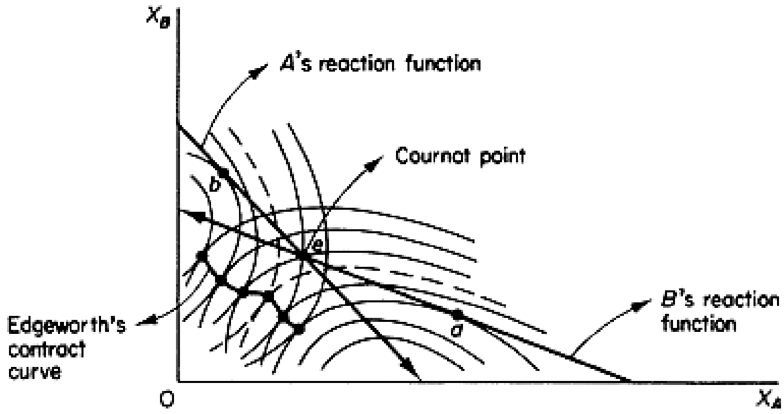


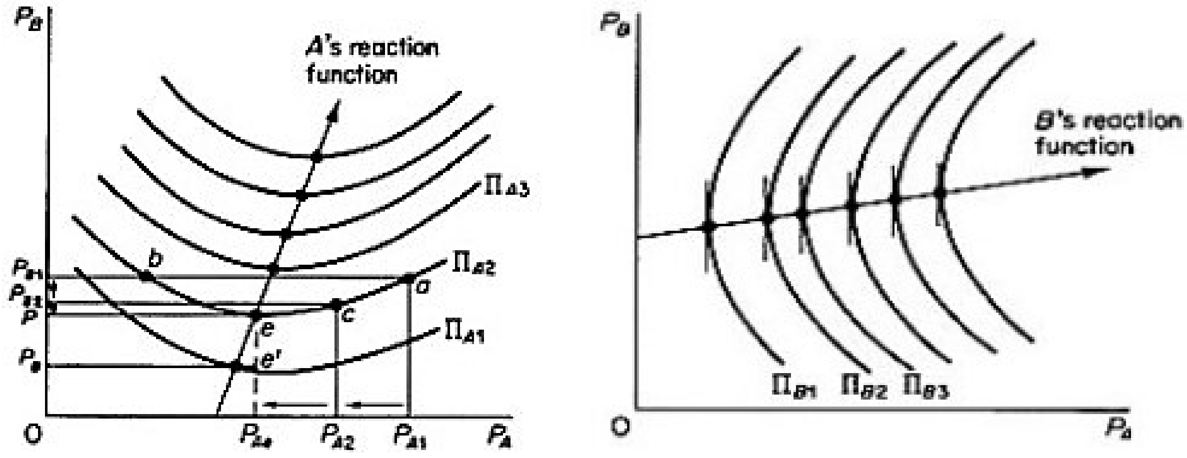
Figure 8

If the final' equilibrium lies on the *Edgeworth's contract curve* the joint profit of the industry are maximised (see Figure 8). This model shows that a collusive agreement becomes advantageous to both duopolists.

Stackelberg's model ends here.

Lecture 3: *Bertrand* Duopoly Model

This model differs from that of *Cournot's* in the assumption that each firm expects that his rival will keep its price constant, irrespective of its own decision about pricing. Thus, each firm faces the same market demand. In this model, the *reaction curves* are derived from *isoprofit* maps which are convex to the axes and on which prices of the duopolists are measured.



(a) (b)

Figure 9

Each *isoprofit curve* (see Figure 9a and 9b) for a firm represents the same level of profit that each firm would accrue from various levels of prices charged by it and its rival.

The shape of *isoprofit curve* for Firm-A (see Figure 9a) shows that it must lower it's price up to the point e to match the reduction of product price of its competitors so as to maintain the level of its profit at Π_{A2}. However, if Firm-B continues to cut its prices, Firm-A will be unable to retain its profits, even if it continues to keep unchanged price at P_{Ae}. If Firm-B cuts its price at P_B, Firm-A will be in the lower *isoprofit curve* Π_{A2} which indicates lower profits. The reduction of profits of Firm-A is due to the fall in price, and the increase in output beyond the optimum level of utilisation of the plants which, in turn, increases costs. Thus, lower the *isoprofit*, lower is the level of profits. The *reaction curves* of Firm-B can be derived in a similar way.

For any price charged by Firm-B there will be a unique price of Firm-A which maximises the latter's profit. This unique profit-maximising price is determined at the lowest point on the highest attainable *isoprofit curve* of Firm-A. The lowest point of the *isoprofit curves* lie to the right of each other because as Firm-A moves to a higher level of profit, it gains some of the customers of Firm-B when the latter increases its price, even if Firm-A also raises it's price. If we join the lowest points of the successive *isoprofit curves* we obtain the reaction curve of Firm-A.

Bertrand Duopoly Model leads to a stable equilibrium at e (see Figure 10). It is stable because any departure from it, sets in motion forces which will lead back to point e where

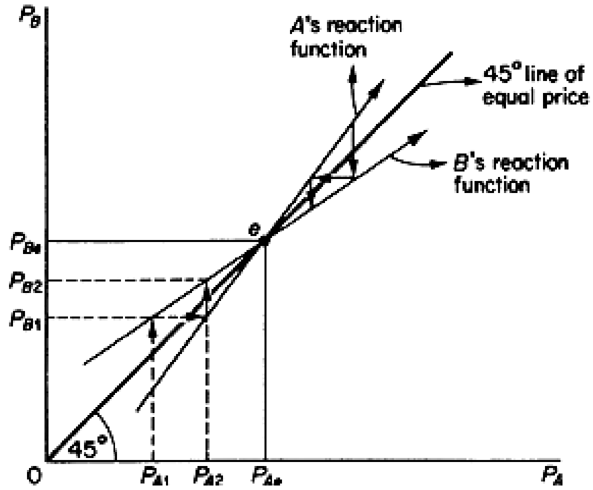


Figure 10

the price charged by Firm-A and Firm-B are P_{Ae} and P_{Be}. It will be stable if Firm-A's reaction function is steeper than that of Firm-B. If Firm-A charges a lower price P_{A1}, then Firm-B will charge P_{B2} . Firm-A will react to this decision of its rival by charging a higher price, P_{A2}. Firm-B will react by increasing its price and so on, until point e is reached, when the market will be in equilibrium. Similarly, if Firm-A charges price higher than P_{Ae}, competitive price cut takes place till equilibrium e is reached.

Lecture 4: *Sweezy's* kinked demand curve model

P. Sweezy published an article in which he introduced the kinked demand curve as a tool for the determination of equilibrium in the oligopolist of markets. The demand curve of an oligopolist has a kink (point E in Figure 11) reflecting its behavioural pattern.

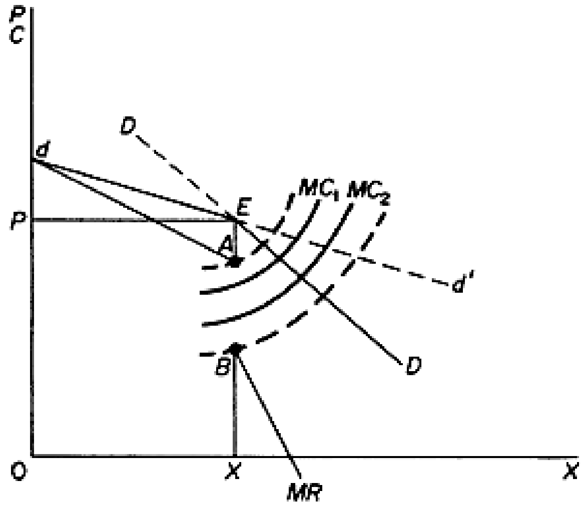


Figure 11

The upper section of the kinked demand curve has a high price elasticity than the lower part. Due to the kink in demand curve of oligopolist, its *MR* curve is discontinuous at the level of output corresponding to the kink. *MR* has two segments, dA corresponds to the upper part of the demand curve and the segment starting from B corresponds to the lower part of the kinked demand curve. The equilibrium for any firm is defined by the position of kink since at any point on the left of the kink *MC* is below *MR*, while to the right of the kink *MC* is larger than *MR*.

Thus, total profit is maximised at the point of kink. Here, equilibrium is not ensured by the intersection of *MC* and *MR* curves. In fact, *MC* passes through the disconnected segment AB. Although marginalistic calculation is behind 'kink-equilibrium', the kink demand curve is a manifestation of the breakdown of basic marginalistic rule (MC=MR). The discontinuity of *MR* curve implies that there is a range within which a cost may change without affecting the equilibrium price and quantity. Thus, the kink can explain why price and output will not change despite changes in cost. Greater the difference of elasticities of the upper and lower parts of the kinked demand curve, wider the discontinuity in *MR* curve and wider the range of cost condition compatible with the equilibrium price and output. In an exceptional case, rise in cost is associated with the rise in price, for example, imposition of sales tax. It affects all firms equally. In that case, the point of kink shifts upward to the left, and equilibrium is established at a higher price and lower output (see Figure 12).

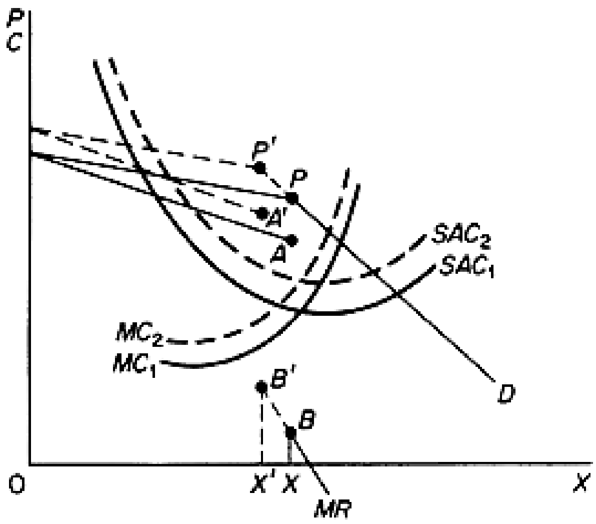


Figure 12

The independently running firms may move closer to a point of joint profit maximisation. In case of kinked demand curve, shift of market demands in upwards or downwards directions will affect the volume of output but not the level of price, so long as the cost curve passes through the range of discontinuity of the new *MR* curve (see Figure 13).

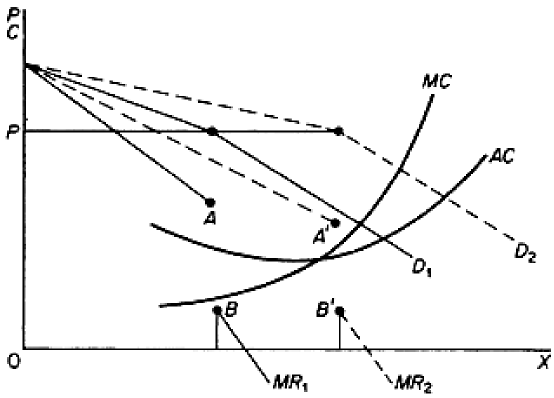


Figure 13

Here ends *Sweezy's* kinked demand curve model.