**Managerial Economics**
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**Lecture - 64**
**Oligopoly (Contd…)**

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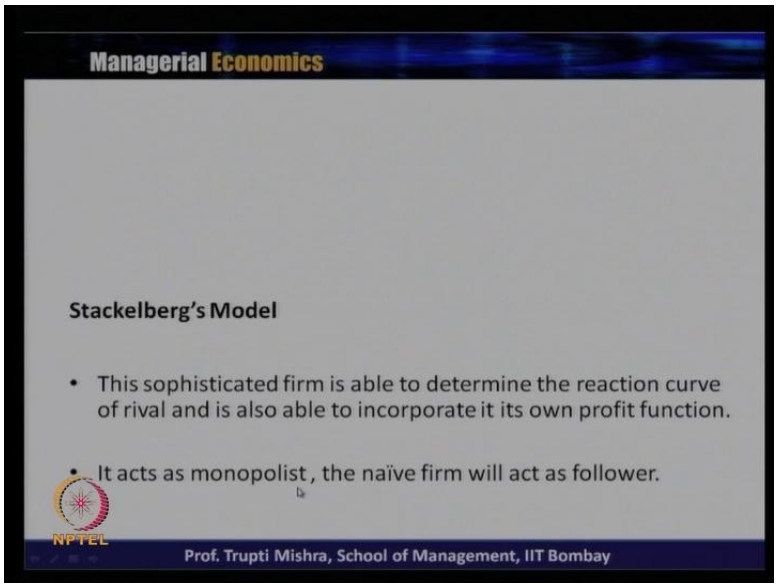


Then, we will take the case of another non-collusive model, that is generally known as the Stackelberg's model and this is the extension of the Cournot model and this is popularly known as the Leader Follower model. Here, one player is sufficiently sophisticated to recognize that the rivals firms act according to Cournot's assumption.

So, here one player, they feel that they recognize that rival firms, what is the rival firms reaction and what assumption they are taking when they are finding, when they are revising their output plan. So, this sophisticated firm, when they recognize that what will be the rivals plan or what is the reaction curve of the rival, they also able to incorporate that in their own profit function because they know now what the reaction curve function of the rival is. They act as monopolist; the naive firm will act as follower.

So, here how is it different from the Cournot's model? In case of Cournot model, when the firm, they were deciding about the output plan, they were not considering the reaction function of the other firm, but in case of this Stackelberg model, they consider this reaction. At least one of the firm who is sophisticated enough to understand or identify the reaction function of the other firm and they incorporate that in the profit function and that firm who

has identified this, they generally act as the leader and the other firms act as follower. That is why it is also known as the leader follower model, this typical Stackelberg model. Both the firm is in equilibrium because they are maximizing the profit before going into this equilibrium. We will see that ideally graphically how they reach to this equilibrium.

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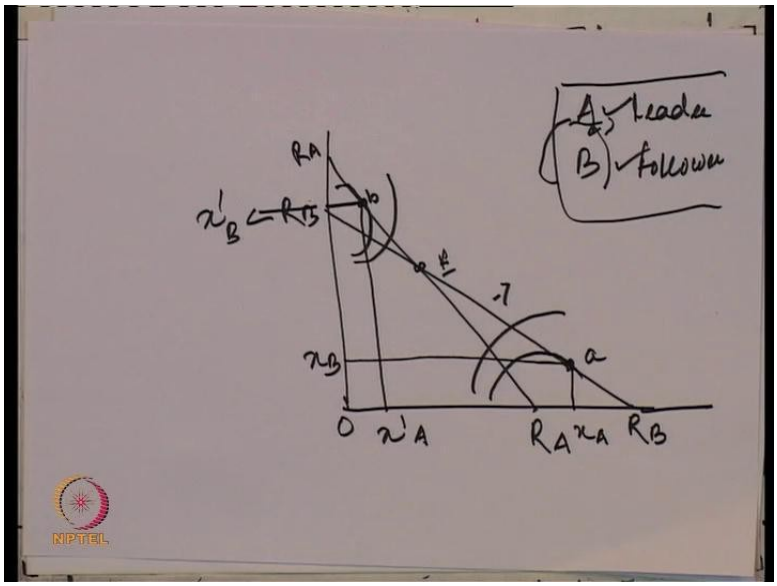


So, this is the reaction curve of firm A and this is the reaction curve function of firm B. Now, this is the point where both the, so this is the profit and this is another profit for B. So, this is x does B and this is x does A. Similarly, this is the profit function for A. No, this is profit function of B. So, this also is profit function of A. This is A and this is B. So, R B is the firm B reaction function, R A is the firm A reaction function. Now, corresponding to this, here we have $x_A$ and here we have $x_B$ and E is the equilibrium output.

Now, let assume that A is firm. A is sophisticated enough and they operate in typically this R A, R A E R A because their reaction curve function and they will produce A which is profit maximizing because the is profit curve which also is the reaction curve function. Now, in this case, A will produce $o\,x_A$and B will produce $o\,x_B$. In this case, A is the leader and B is the follower. Now, suppose we will take the turn. We will suppose B is the sophisticated firm over here, what is the reaction function approach? The reaction function is again R B Eis the reaction function. Reaction function for firm B is its equilibrium at the point B. So, B will produce $ox_B$does and firm A will produce $ox'_A$.

So, if you look at whoever sophisticated, they are producing more who is the leader. Whoever is not a sophistic their follower, they are generally paying. They are producing less like in

case. In the first case, B is producing less and A is producing more and in the second case, B is producing more since B is the leader and A is producing less. Now, till the time the situation in one of them is leader, the other is follower or the reverse may happen that B is the leader and A is the follower. They will just the output will change because they are sophisticated.

Now, what happens when both of them they becomes sophisticated? Price war will continue. What is the outcome? Price war will continue, but price war is also not when if you sell for the oligopoly that also they know. So, initially when both of them they will be trying to sophistic, the sophisticated, they will be trying to be the leader in the market. Initially, price war will continue, but when they realize that price war is not going to benefit them, rather price war is going to benefit the consumer, they will stop over there. They will stabilize price over there and then, finally they get into the cartel.

So, Stackelberg model says what? Stackelberg model says that it is always profitable if one of them is leader and the other follower. Still the time the follower is also getting their share of profit and their share of output, but the question is that it will not continue for long run because if one firm is getting more profit because he knows that what is the reaction pattern of other firm, the other firms will also try to do it that in the long run and eventually, both of them were trying to be leader. That will lead to the price war and finally, it is a cartel. So, the end outcome, when you think about the end outcome of a Stackelberg model, still it is not determined fully that what should be the end outcome and where they should stop.

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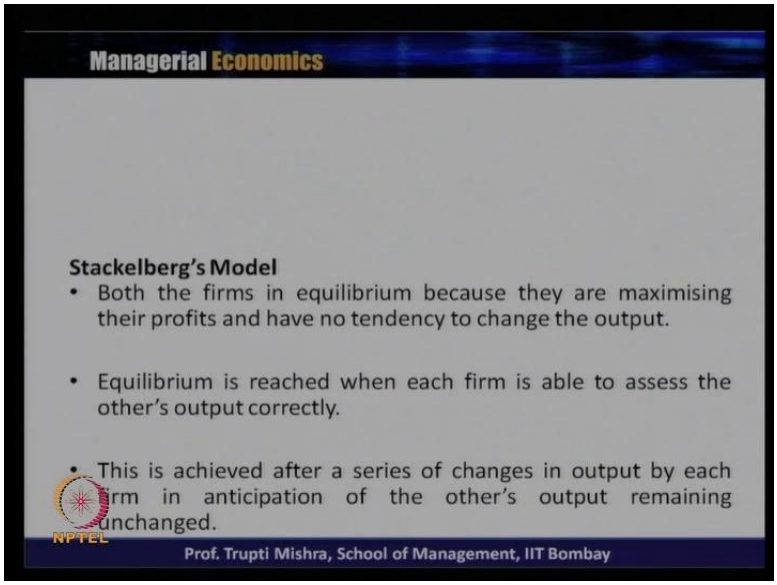

So, when it comes to monopoly's, both this typically both the firms in equilibrium because they are maximizing their profit and have no tendency to change the output. Typically, in the graph if you have seen at the point E and equilibrium is reached when each firm is able to asses to other output correctly and this is achieved after a series of change in the output by each firm in the anticipation of other outputs remaining unchanged like in the previous case. In case of Cournot model, we are discussing the action reaction pattern of both the firms. Finally, take them to the equilibrium and something happen. In case of Stackelberg model also, equilibrium is reached when each firm is able to assess the other's output correctly and this is not happened once. This generally happens after the action reaction pattern and in the anticipation that the other's output is remaining unchanged. Then, before going into the next model, we will just take a small numerical to understand this Stackelberg model.

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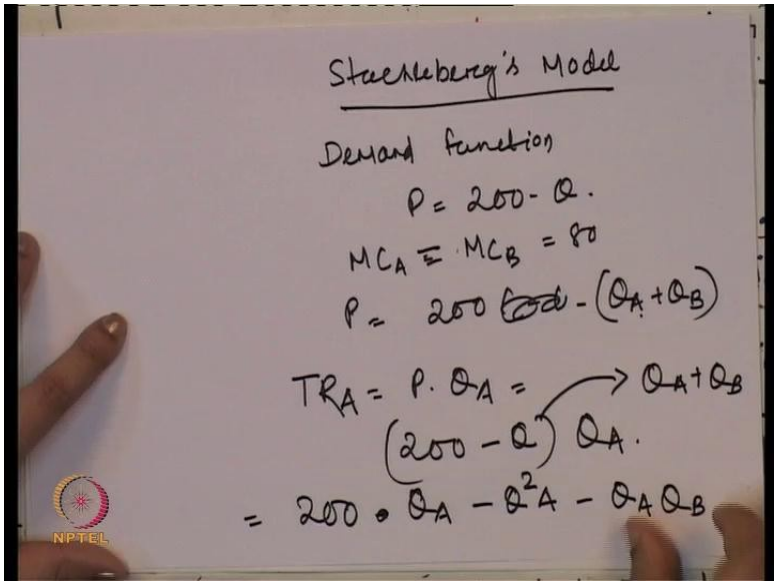


So, we have a demand function. This $P=200-Q$. Then, cost is fixed. $MC_A=MC_B=80$. So, P also we can say, this is $P=200-(Q_A+Q_B)$. What will be the revenue function of A? So, total revenue of A is $PQ_A$. So, this is $TR_A=(200-Q)Q_A w$. This is no minus here. $TR_A=200Q_A-Q_A^2-Q_AQ_B$ because this $Q=Q_A+Q_B$.

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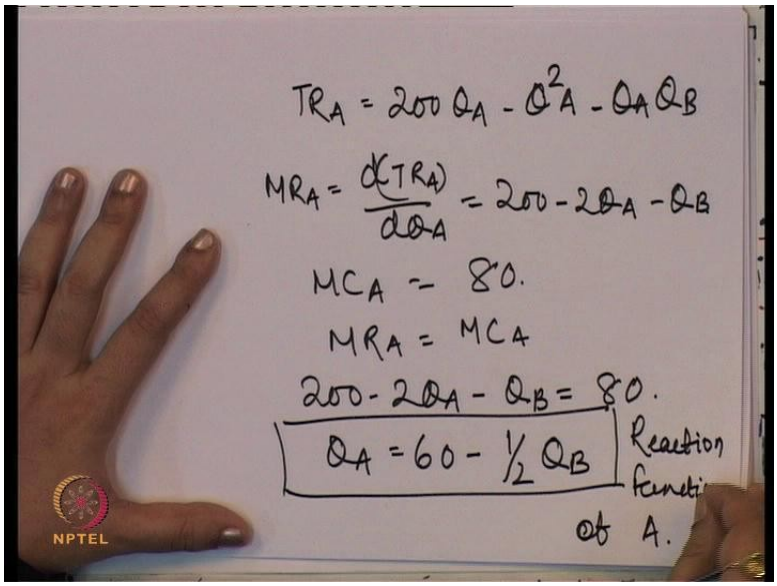


So, total revenue of A is $TR_A = 200 Q_A - Q_A^2 - Q_A Q_B$ and for marginal revenue of A, this is $MR_A = \frac{dTR_A}{dQ_A}$. So, this is $200 - 2Q_A - Q_B$. Marginal cost of A is equal to 80. So, if marginal profit maximizing rule says that marginal revenue of A should be equal to marginal cost of A, so $200 - 2Q_A - Q_B = 80$. So, $Q_A = 60 - \frac{1}{2} Q_B$ and this is generally the reaction function of A.

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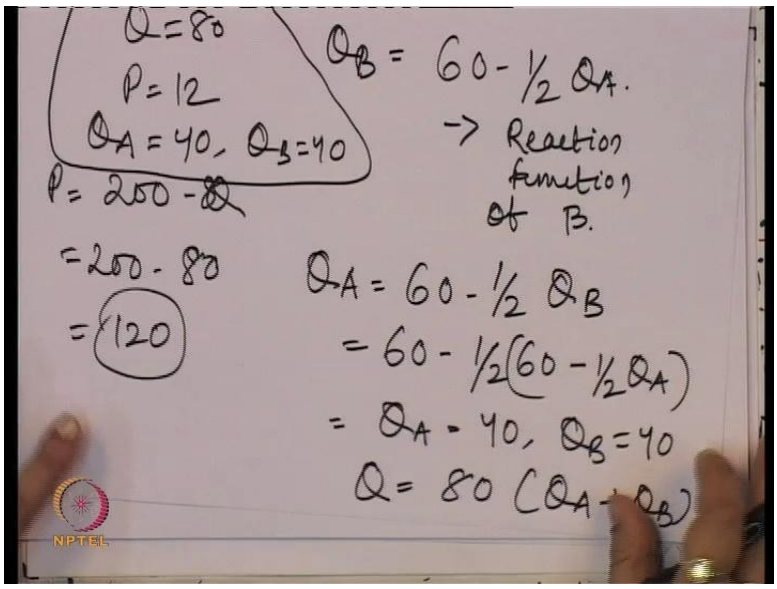

Similarly, for B we can find out $Q_B$ is equal to I am not just getting into the detail of the derivation. So, $Q_B = 60 - \frac{1}{2}Q_A$. This is the reaction function of this is the reaction function of B. So, now to solve the value of Q and $Q_B$, we can just put the value of $Q_A$ in equation of $Q_B$ or $Q_B$ in equation of Q A. So, $Q_A = 60 - \frac{1}{2}Q_B$. So, $Q_B = 60 - \frac{1}{2}Q_A$, this is the value of $Q_B$. So, simplifying this, we will get Q A is equal to 40 and $Q_B$ also equal to 40. So, $Q_A$ is equal to 40, $Q_B$ is equal to 40 and Q has to be equal to 80. Since, it is $Q = Q_A + Q_B$ and price is equal to $P = 200 - Q = 200 - 80 = 120$. So, Q is equal to 80, P is equal to 120, $Q_A$ is equal to 40 and $Q_B$ is equal to 40 with this demand function and cost using the Stackelberg model.

Then generally, how to solve this numerical or how to find out profit maximizing level of output for both the firms? Using the profit maximizing rule, we need to find out the reaction curve function for both the firms, that is for firm 1 and firm 2. From there, we can solve the value of output that is $Q_A$, $Q_B$ or $Q_1$, $Q_2$. Just porting the value of the others and that gives us the total output in the market and also the output specific to the firm.

So, here typically the reaction function, generally we say that this is the reaction function approach through which generally we get the individual firms output and the total market output. Then, we will get into the discussion of Kinked demand curve model. Kinked demand curve model is also one form of the non-collusive oligopoly model, where it assumes that there is no cooperation or no collusion among the firm. In case of a kinked demand curve model and this model generally explains us that why the price is rigid for the firms and at least in the oligopoly's market, why it changes very slowly over time.

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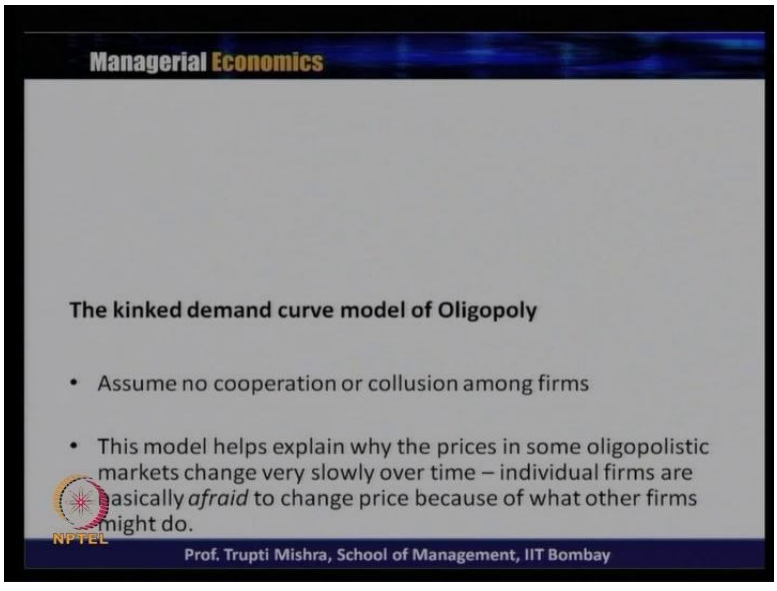

So, individual firms basically afraid to change their price because of what other firms might do. So, if one firm change the possibility that the other firm may not do change and that is the reason they afraid to the change the price and that is the reason in case of oligopoly market may be decreasing price is not so slow, but increasing price is slow because the others may not follow to this.

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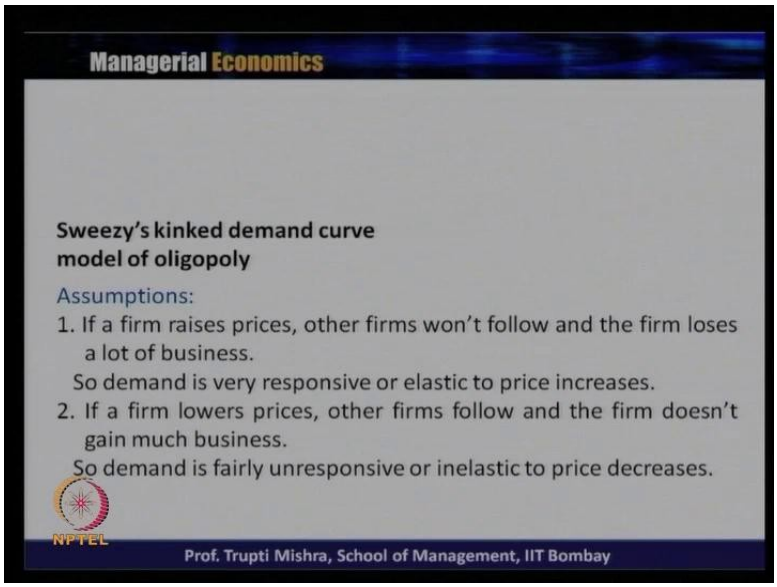


There are certain assumptions we take in order to understand the kinked demand curve model. The first one is if a firm raises price, other firm would not follow and firm looses a lot of business. So, whenever there is an increase in the price, the other firm will not follow it automatically and that is why that firm who has raised the price, they generally lose lot of business. So, demand is very responsive or elastic to price increase and if a firm lowers the price, other firm follows, but the firm does not gain much business.

So, in these cases, if you look at if this part of the demand curve is inelastic because whenever one firm lower the price, the other firm also lower the price in order to get more market share or more demand. That is why in this case, the change in the price which is not affecting the quantity demand of the firm much and that is why we get inelastic demand curve. So, demand is very responsive or elastic to increase in the price and demand fairly unresponsive and inelastic to price decrease.

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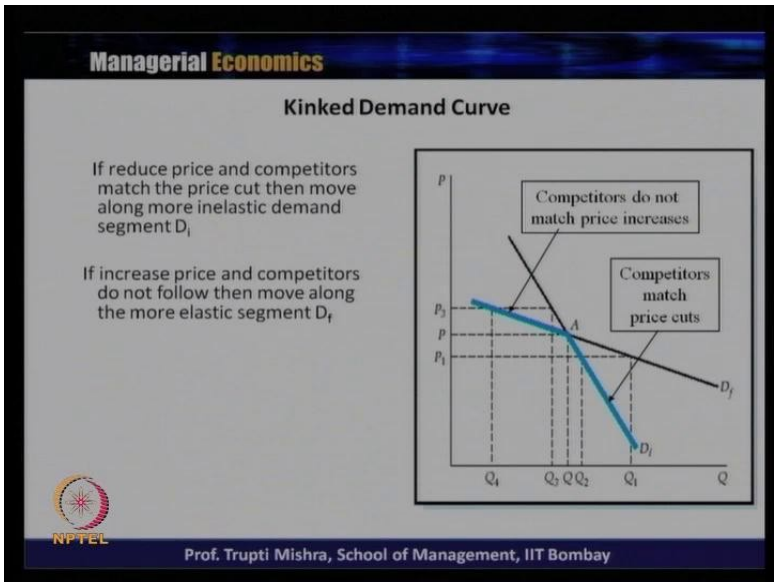


So, if you look at this graph, if you reduce price and competitor match the price, typically if you look at, now we are getting two set of the demand curve. One is the elastic demand curve and other is the inelastic demand curve. If we reduce price and competitor match the price, then move alone that inelastic demand curve that is segment D i and if increase in the price and competitor is not following that, then we get in the segment of the elastic.

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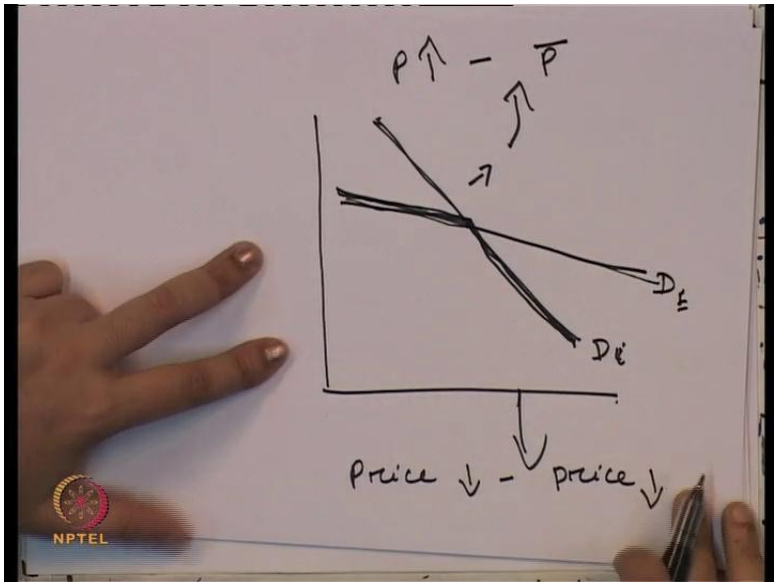


So, we have two kind of demand curve. Now, one we have inelastic demand curve and we have elastic demand curve. So, this inelastic demand curve is when price decreases, other firm also decreases the price and elastic is the basis is that whenever there is an increase in the price, other firm keep the price constant. So, ideally what will be the demand curve for the

firm? There are two segments. One segment of the elastic demand curve and one segment of the inelastic demand curve. So, this segment of the elastic demand curve because of the fact that whenever there is an increase in the price, the competitor they are not matching to it and this part of the demand curve is one whenever the price got happens, the other firms or the competitor also decreasing the price.

So, increase in the price, competitor price remains constant. Decrease in the price, the competitor also decreasing the price. That is why the demand curve of the firm has two segments. One is the elastic segment with respect to increase in the price and other is the inelastic segment that is with respect to decrease in the price. Remember that decrease in the price is generally followed by the competitor, but increase in the price is not followed by the competitor and that is why, we get two separate segments in the demand curve. One is the elastic segment and other is the inelastic segment.

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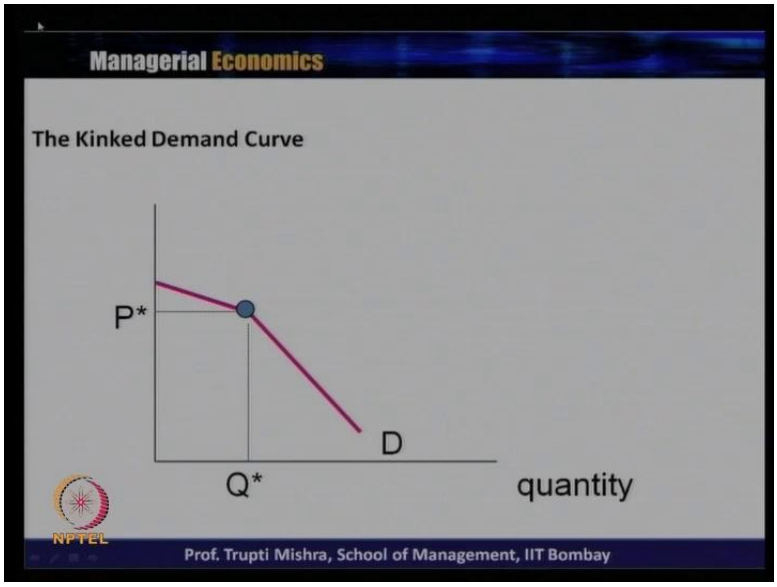


So, this is generally the shape of the kinked demand curve, where the upper portion is elastic and the lower portion is inelastic. The upper portion comes from the elastic demand curve and in this segment, whenever there is an increase in the price because increase in the price, the competitor they are not going to follow it and the downward segment is the part of the inelastic segment, where whenever there is decrease in the price, competitor generally follows this.

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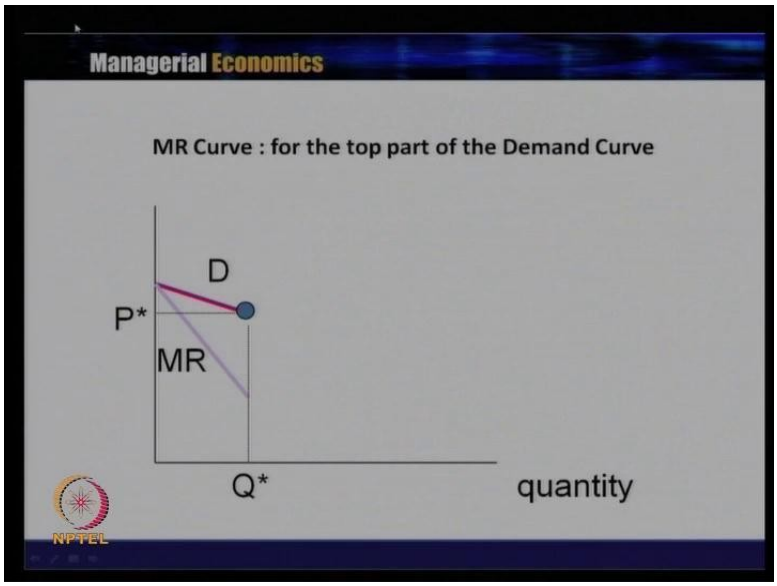


Now, how we get this marginal revenue curve here? We get this is the first case. This is the, we also get two marginal revenue curves here because since, we have two demand curves; we have two marginal revenue curves. The first segment of the marginal revenue curve comes from the top part of the demand curve which is the elastic demand curve. So, here this marginal revenue curve is with respect to the elastic segment of the demand curve.

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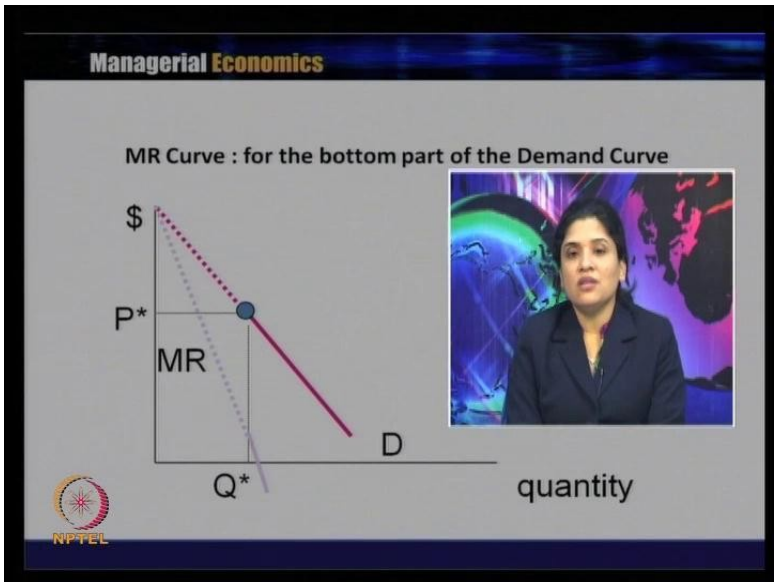


Then, we will see what the marginal revenue curve for the bottom segment is and for the marginal revenue curve or the bottom segment is again, it is a part of the inelastic demand curve. So, if you will find, there are two marginal revenue curves with respect to two demand curve because it is one demand curve, but it has two segments. One is the elastic segment and

other one is the inelastic segment. So, one marginal revenue curve with respect to the elastic segment and the other marginal revenue curve with respect to the inelastic segment.

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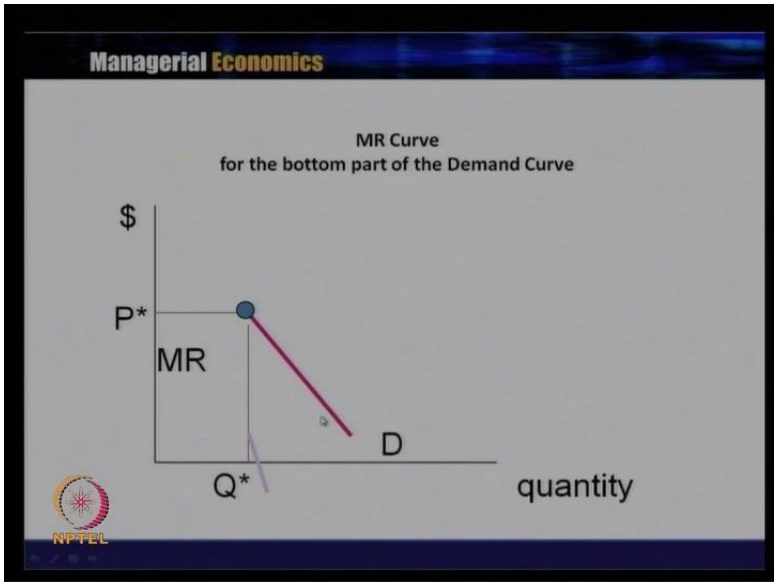


So, this is for the bottom part of the demand curve and previously, it was the top part for the demand curve. So, this is inelastic part of the demand curve.

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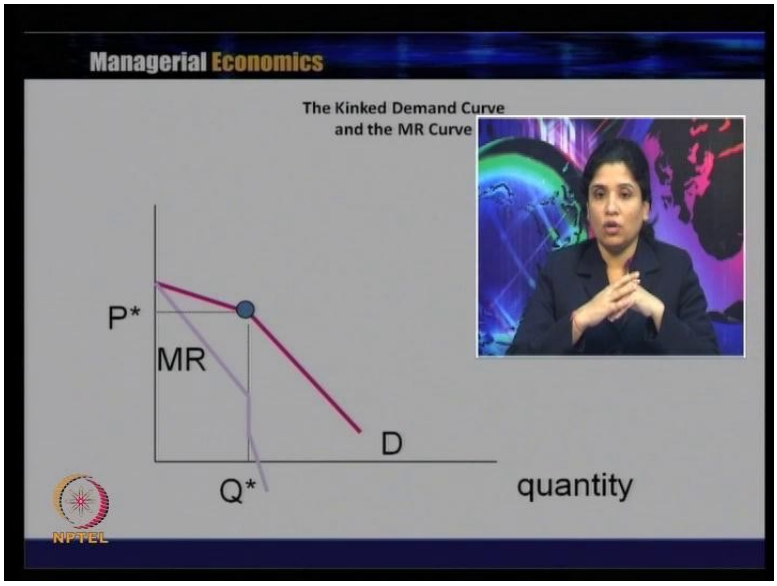


So, this is generally the kinked demand curve and we have two marginal revenue curve. If you notice, here there is a gap between the two marginal revenue curves. Why there is a gap between two marginal revenue curves? Because our demand curve has kinked and at the point of the kinked, we have not able to decide which one is a marginal revenue curve.

So, if you look at demand curve is generally known as a kinked demand curve because it is kinked between the two segment of the demand curve, that is between the elastic segment and inelastic segment of the demand curve. Corresponding to the elastic segment, we have one marginal revenue curve and corresponding to the inelastic segment, we have another marginal revenue curve. At the corresponding to the point of kink, there is a gap between the marginal revenue curve 1 and marginal revenue curve 2. So, that is why in case of a kink demand curve, there is a gap between the marginal revenue curve 1 and marginal revenue curve 2.

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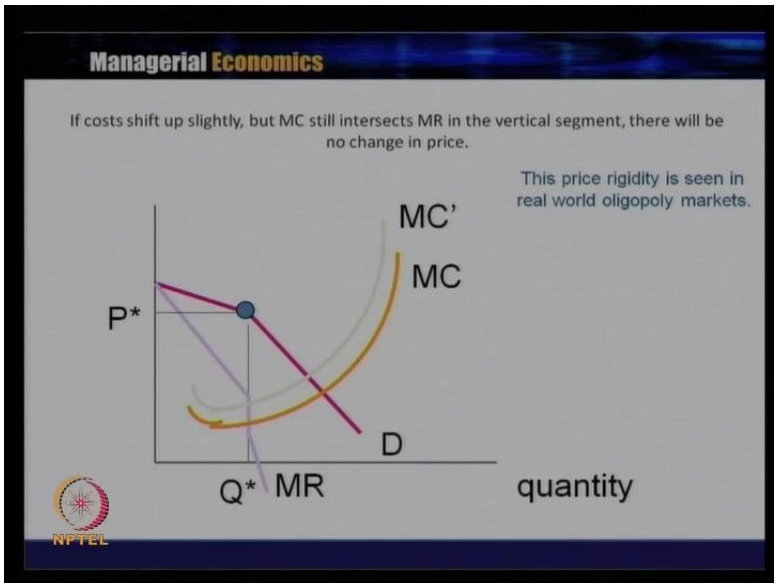


Now, the question comes how the marginal cost should be because we need to get the equality between the marginal revenue and marginal cost to get the profit maximizing level of output. The marginal cost should cut which segment of the marginal revenue curve? Whether the segment related to the elastic demand curve or whether the segment related to the inelastic demand curve.

So, marginal cost generally intersect the marginal revenue curve in the gap, in the vertical segment, in the gap between the marginal revenue 1 and marginal revenue 2 and whenever there is an increase in the marginal cost, if the cost shift up slightly, but marginal cost still intersect the marginal revenue in the vertical segment. There will be no change in the price because if any point of time if marginal cost goes to marginal revenue 1, that is elastic segment or to the inelastic segment, still it will not considered as for the whole demand curve, whole kink demand curve. That is why, we will find that there is price rigidity and this is the outcome of the price rigidity that we get two levels of marginal revenue curves and the

marginal cost curve is not going for the marginal revenue 1 or marginal revenue 2, rather it is in the gap.

So, even if there is an increase in the cost till the firm is not changing the price because if it is changing the price, again it may lead to a situation that the other firm will not follow it and they will get into the loss.

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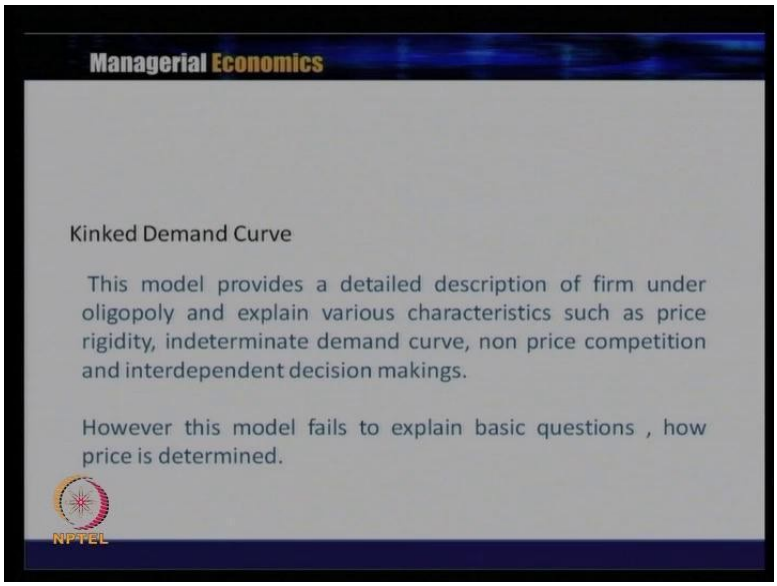


So, Kinked demand model, generally it provides the explanation, detailed description of firm under oligopoly and it explains the various characteristics, such as price rigidity, why there is an indeterminate demand curve, non-price competition and independent decision making, but this model fails to explain a basic question that how price is determined because it is really forgiven when the price decided in the gap in the vertical segment between marginal revenue 1 and marginal revenue 2. That is why this model is criticized on the ground that it fails to explain the basic question of any model that how the price and output is determined because we have a kinked demand curve and we have a two level of marginal revenue curve that is marginal revenue 1 and marginal revenue 2.

So, we will just take a numerical to understand that when you take a numerical, when you take a real production function, when we take a demand function cost function, whether we get the gap between the marginal revenue 1 and marginal revenue 2 with respect to two different demand, and whether the marginal cost also pass through the vertical segment or the gap between the marginal revenue 1 and marginal revenue 2.

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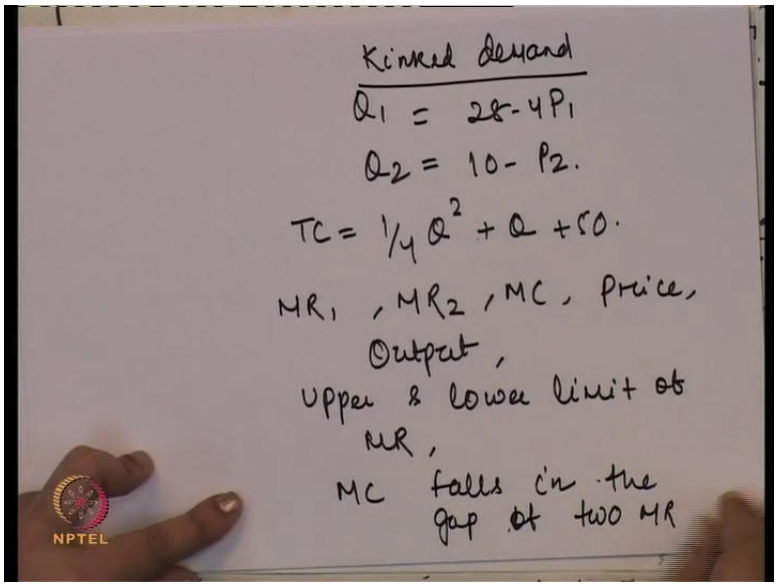


So, we will take two demand functions. We will take a $Q_1$ and we will take $Q_2$. So, we have two demand functions. One is $Q_1 = 28 - 4P_1$ and second is $Q_2 = 10 - P_2$. We will take a total cost function, that is $TC = \frac{1}{4}Q^2 + Q + 50$ and we need to find out the marginal revenue for both the firms, marginal cost price output and we need to see what is the upper and lower limit of M R because that will tell us whether there is a vertical segment or gap between marginal revenue or not and whether M C falls in the gap of M R or not.

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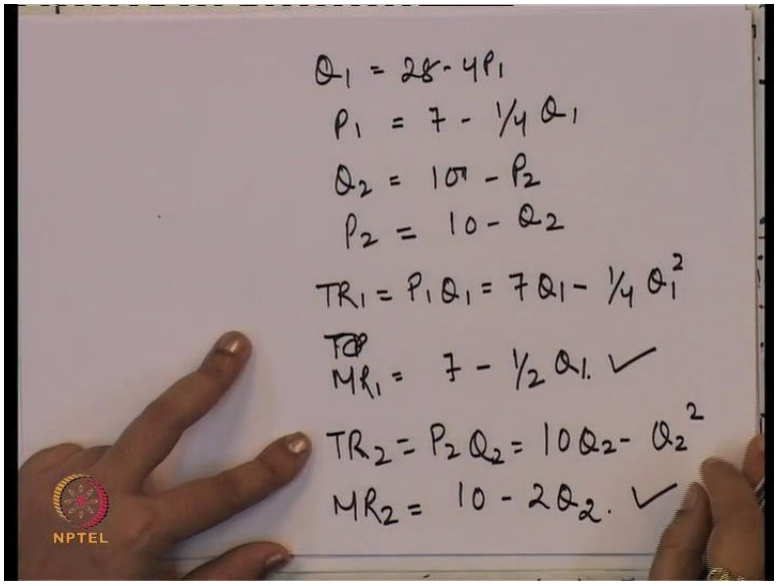

So, to start with, we will find out, since we have $Q_1=28-4P_1$, we will find $P_1=7-\frac{1}{4}Q_1$. $Q_2=10-P_2$. So, $P_2=10-Q_2$. Total revenue 1 is $TR_1=P_1Q_1$. So, that comes to $TR_1=7Q_1-\frac{1}{4}Q_1^2$ and corresponding to this, we will get the marginal revenue 1 that is $MR_1=7-\frac{1}{2}Q_1$. Similarly, total revenue 2 is $TR_2=P_2Q_2$. So, this is $TR_1=10Q_2-Q_2^2$. Marginal revenue 2 is $MR_1=10-2Q_2$.

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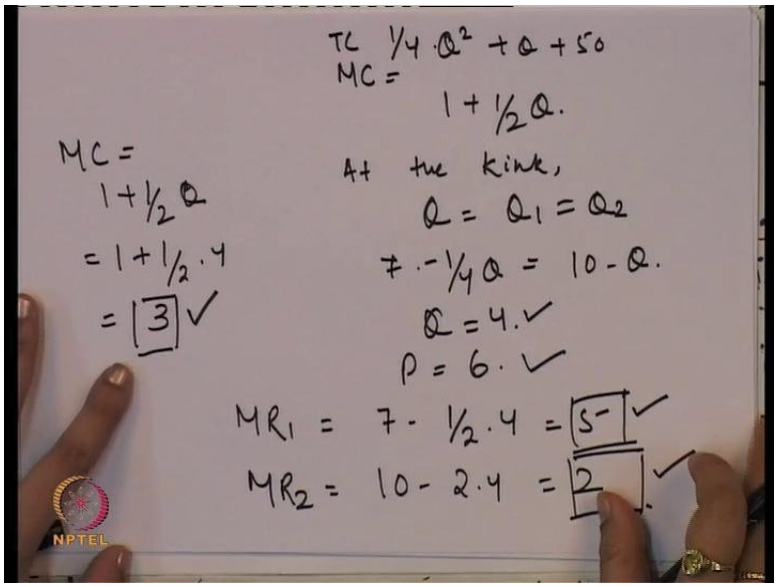


We now have marginal revenue 1 and we have now marginal revenue 2. We will find out the marginal cost from our total cost function. So, total cost function is $TC=\frac{1}{4}Q^2+Q+50$. So, marginal cost will come as $MC=1+\frac{1}{2}Q$ and if you look at the kink, at the point of kink, both the demand curve should intersect. To get this intersection, we have to do is equal to $Q=Q_1=Q_2$. So, $7-\frac{1}{4}Q=10Q$. So, Q is equal to 4 and P is equal to 6.

So, taking the value of Q and P, marginal revenue 1 is equal to $MR_1=7-\frac{1}{2}Q_1=5$that is equal to 5. Marginal revenue 2 is equal to $MR_1=10-2Q_2=2$. So, that is 2. So, marginal revenue 1 is 5. Marginal revenue 2 is 2. Now, we need to find out M C. So, M C is equal to 1 plus half Q. So, this comes to 1 plus half multiplied by 4. So, this comes to 3. So, we can say

that Q is equal to 4. This is the output. P is equal to 6. We have a first segment of M R is equal to 5. The value of second segment of M R is equal to 2 and M C is equal to 3. So, we can also prove that the M C falls in the gap of 2 level of M R that is marginal revenue 1 and marginal revenue 2.

So, today we discussed about typically in this session, we discussed about the Cournot model, Stackelberg model and Kinked demand curve model and all these 3 models are part of non-collusive oligopoly model. In the next session, we will discuss about the collusive oligopoly model, typically the cartels and the price leadership model.