Petroleum Economics and Management
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Module - 09
Fundamentals of Petroleum Business
Lecture - 43
Price Leadership Dominant Firm Model - I

Hi everyone. Welcome to the NPTEL course, Petroleum Economics and Management and I am your instructor, Dr. Anwesha Aditya. So, we are in module 9 of our course, where in today's class it will be lecture 43 of our course, we will be discussing about the Price Leadership Dominant Firm Model.

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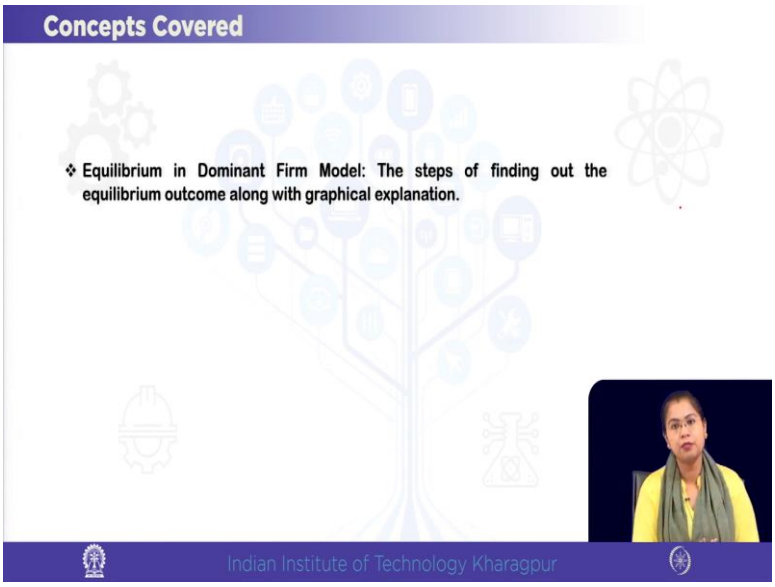

We have already detailed out the motivation of inclusion of our each of the modules and we have already discussed why we have included module 8 and 9. And, those two are very interconnected. So, in module 8 we have studied different types of market structure and we focused on oligopoly how it is different. And, we also studied some basic of game theory because we study oligopoly in a game theoretic framework.

Now, we have come to module 9, where we are focusing on the collusive oligopoly because the global petroleum industry is a typical example of a cartel and price leadership model. So, we know that OPEC is the leader firm in the world oil market, but

there are non-OPEC suppliers also. So, we will be we have already studied about OPEC, the structure of OPEC, the views of the literature, we have handed lot of empirical data.

Now, time has come where we will be studying theoretically the market structure of OPEC. Now, for that we have already discussed the collusive oligopoly, what are the examples, what are the incentives. And we have classified different types of collusive oligopoly like the price signalling model, the low-cost price leadership, the dominant firm price leadership and biometric price leadership and of course, cartel.

So, we will be focusing on the price leadership dominant firm model and cartel for our purpose. So, today's like this particular lecture is devoted towards finding out the equilibrium in the price leadership dominant firm model. Because in the doing so, we can also explain the equilibrium, price quantity means how that is determined by the OPEC and the CIPEC cartel. Because, our focus is on OPEC, but then we will be also comparing OPEC with other type of cartel like the copper cartel which is the CIPEC cartel.

So, we will be discussing the OPEC versus CIPEC and what are the conditions for a successful cartel. But, before that we will be studying the price leadership dominant firm model because that will help us to study the OPEC price output decision ok and of course, the non-OPEC supply decision also. So, in today's lecture we are just focusing on getting the equilibrium in the price leadership dominant firm model. What are the steps of finding out the equilibrium outcome that we will be discussing with the graphical exposition.

So, you see the lectures are very much interrelated. So, all the lectures in module 9 are just interconnected with one another. So, in today's this particular lecture I will be discussing the step-by-step derivation of the equilibrium, price and output. So, what is the market price, what will be the output supplied by the dominant firm, what will be the output supplied by the follower firms and what will be the total supply ok.

And, in the next lecture what we will be doing? Will be solving the model mathematically or numerically ok, how to find out all these variables, the market price and the total output which is the sum of the leader firms output and the small firms output; we will be doing that numerically ok.

And finally, we will be studying the OPEC cartel and then we will compare it with other not so successful cartel. So, to get the conditions for a successful cartel. So, these two particular lectures, lecture number 43, 44 are very much interconnected. In 43, we are doing the model intuitively and graphically in 44, we will be doing it numerically or mathematically.

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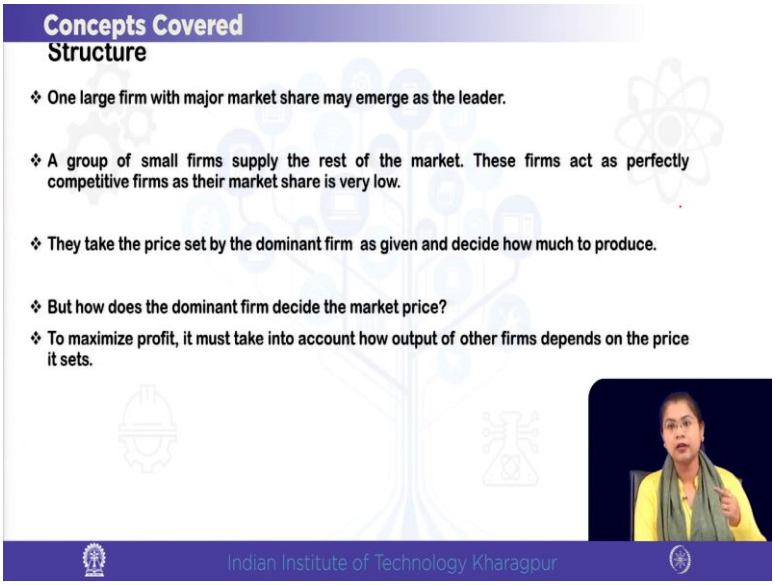

So, we have already discussed the market structure, I mean what do we mean by a price leadership dominant firm model. In price leadership dominant firm model as you can see easily that the name suggest that there is one large firm with majority of market share and that can act as the leader firm. But it is not the monopolist because it cannot alone supply the all the market demand. So, there will be there will be some small firms apart from the leader firm ok.

So, we can consider these small firms as a group of small firms which are often referred to as fringe firms ok. And, and these fringe firms they individually sell very insignificant proportion of the total market supply. So, these firms together they act as perfectly competitive firm, because their individual market share is very low. So, what happens they behave like a price taker? So, they take the price set by the dominant firm as given. Now, with you should note that the market price here is the price set by the dominant firm.

So, the dominant firm maximizes its profit by setting the price ok and the small firms which are the remaining firms, the rest of the firms which we are referring to as the fringe firm, they take the price set by the dominant firm as given just like in perfect competition.

But the difference is that in perfect competition, the market price is determined with the interaction of demand, a market demand and market supply. But here the market price is determined from the profit maximization behavior of the leader firm or the dominant firm.

And, the small firms take this leader firm's price as the market price to be given and they decide how much to sell. So, we will be deriving the total output which will be a sum of leaders output and the follower firms or the fringe firm output. Now, the question is how does the dominant firm decide the profit maximizing price which is also the market price? So, to maximize profit the leader firm or the dominant firm must consider how output of the remaining firms or the follower firms can depend on the price that it is setting.

Why? Because you see it is a collusive means it is an oligopoly market structure its collusive, but it is oligopoly. In oligopoly at each stage, you have to think about what the rival is doing, just like we doing game theory. Remember, we defined environment of the game, we also made rationality and intelligence as means common knowledge right, environment is also a common knowledge.

So, here are also the same thing means for each price that the dominant firm is setting; so, it has to see what how the small firms will respond. So, while maximizing profit, the dominant firm, the leader firm should take into account how output of other firm depends on the price it sets ok. And, often this leader firm knows about the cost structure of the small firm.

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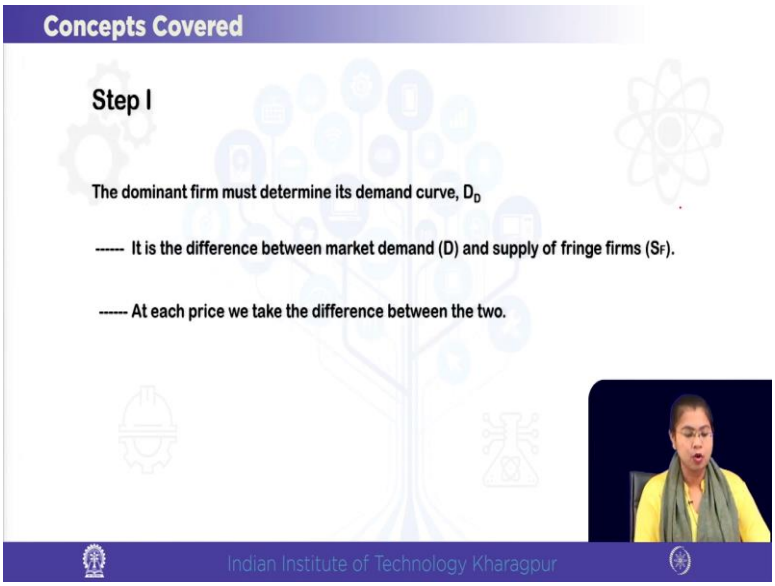

So, it is the leaders it has the leadership position, it has a large share of the market and often we have also discussed that one type of price leadership occurs if the firm, the leader firm has a significant cost advantage. So, that means, it is a low-cost producer. So, it can produce more means even if the market price is not very high, it can supply. So, it is a low-cost firm.

So, it can also since it has a large share of market, it earns profit and it can reinvest its profit, it can come up with new products. But, at the same time what happens since it can reinvest its profit. So, it can also devote fund towards market research and it will be in a better position to know about the cost structure of the small firms ok. So, in this way what the dominant firm will do? The first step of finding out the equilibrium is to find out the demand curve of the dominant firm.

So, the dominant firm knows the market demand as well as it knows the supply or the marginal cost of the small firms ok. So, what will be its demand? So, it will supply the gap between the total demand and the small firms supply. So, small firm supply means the sum of all individual small firm supply. So, there are we are assuming that apart from the leader firm or the large firm, there are some small firms.

So, the small firms they together we are referring to them as the fringe firm. So, the supply of the small firms for different prices, the large firm, the dominant firm can collect the data on that and the dominant firm suppose also knows about the market

demand. So, because it has the fund to do market research so, it is in a better position to know about the market demand as well as the supply of the fringe firm.

So, what it will do to maximize profit? It should first get its demand. So, what will be the demand of the dominant firm? So, the demand for the dominant firm will be total demand minus the supply of the small firm, because this excess demand means the small firms are able to supply only a very small amount and suppose this is the demand. So, this gap will be supplied by the large firm or the leader firm or the dominant firm.

So, the first step for getting started is the dominant firm deciding its own demand which is the difference between market demand and the competitive supply ok, that we are describing as S_F. See, the notation for the supply of the fringe firm is S_F and the total market demand is capital D. So, for each price we take the difference between the two. So, at each price we know the demand at each price we also know the supply.

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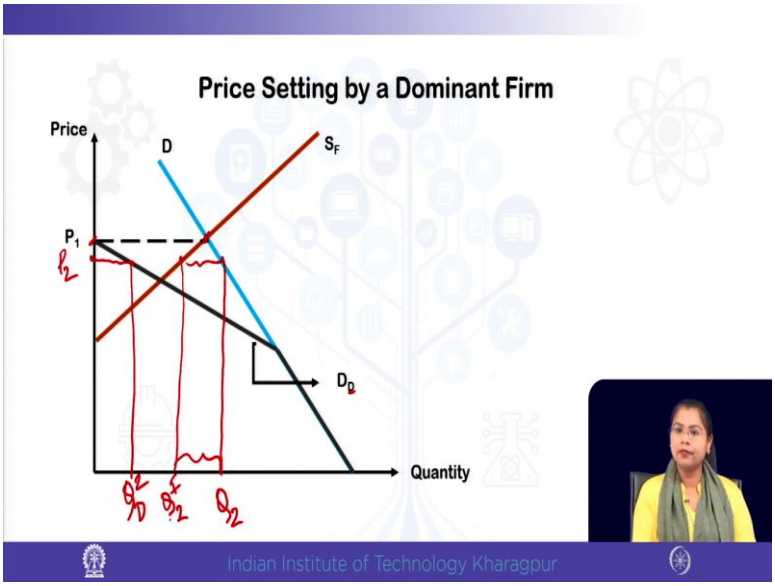

So, what the dominant firm does? It takes the difference between the two and plot this its demand for different prices and we get the means demand for the dominant firm. So, here we are doing it graphically first and then in the next lecture we will be solving it numerically.

But, once we know the steps intuitively, we understand it is very easy. So, for your easy understanding we are representing it step by step. If I show the figure entirely at one go then you will be able to understand. So, step by step we are plotting here.

So, price as usual we already know, the price comes in the vertical axis and the quantity on the horizontal axis. Then, we plot the market demand ok. So, this is the downer sloping line here you can see, capital D is the market demand which is downward sloping. So, we know that law of demand holds unless otherwise mentioned. So, we always empirically see mostly that as price increases quantity demanded fall. So, its inverse relationship between price and quantity demanded is the law of demand.

So, we are plotting the demand curve, market demand curve which obeys the law of demand. Next, we also plot the competitive supply or the supply of the fringe firm small firm which we are denoting by S_F. So, S stands for supply and the subscript F, F stands for fringe firms ok.

Now, this supply curve is upward rising for reasons we have already studied that the by law of supply, the producer can sell more when price increases. So, there is a positive relationship between price and quantity supply because as price increases, it has greater incentive to sell right.

Because, cost of production also increases if you are producing more and more and see this competitive firms, these small firms they behave like perfectly competitive firms. And, this is also their marginal cost. If you remember in when we discussed the basic of microeconomic demand and supply.

I mentioned that we can get economically meaningful supply curve only under perfect competition and that supply curve is nothing, but the marginal cost curve ok. In other markets in imperfectly competitive market, we cannot draw economically meaningful supply curve.

Why? Because, how do you define a supply curve? It is the unique relationship between price and quantity supplied. But, this unique relationship between price and quantity supplied may not hold in other types of market, let us say in monopoly. The monopoly has all the market power. So, for different prices, it can charge different quantities.

Suppose, there is a change in demand, it can say different quantities. We cannot say definitely what the monopolist will supply ok.

So, that is why this unique relationship between price and quantity supplied is often cannot be obtained in other types of imperfectly competitive markets. So, when you refer to supply curve, basically we mean the supply curve correspond to the perfectly competitive market.

And this supply curve is nothing, but we can show that this is the marginal cost curve right. Because, you know if you remember the inverse firm of the supply also, we defined. So, in the inverse firm how do we define the supply curve? So, for each quantity what will be the minimum supply price; that means, there should be a particular cost or producing the good.

If the price the producer gets in the market is falls below the minimum price which is required to put the product in the market, the producer would not be willing to supply the market supply the product in the market. So, it is the locus between the different minimum supply price for different quantities ok. So, this is basically the marginal cost curve also which is the supply curve of the fringe firm. Now, the first step as I mentioned is to get the gap between the total market demand and the supply of the fringe firm.

So, for each price the dominant firm plots the difference between the two and we get the demand curve of the dominant firm which is denoted as D_D. So, D stands for demand and the subscript D here stands for you see the subscript D stands for the dominant firm. So, only D is the demand curve for the total market and D_D is the dominant firms demand curve. So, you see if we take the price P_1. So, P_1 is a very high price where we see that the market demand intersects the supply of the fringe firm; that means, what?

The entire market demand can be supplied by the fringe firms that means; they are the demand for the dominant firm is 0. So, that means, the demand curve for the dominant firm starts with the vertical intercept at P_1. So, the demand for the dominant firm is 0 because at price P_1 or any price above that the these fringe firms can supply the entire market ok. Because, we can see over here that at price P_1 that the demand curve of the total market cuts the supply curve of the fringe firm.

So, the fringe firms together they can supply, if price increases very much, they can supply the entire market. So, the dominant firm is not supplying anything. So, the dominant firms demand curve starts from the vertical intercept at P_1. After that what we do? We take the difference, after that you consider any price let us say here, you consider this price say for example, P_2 and you take the difference between D and S_F ok. So, this is the difference at price P_2.

See at price P_2, we can draw over here say this is the Q_2^F is the supply of the fringe firm and this is the total market demand say Q_2. So, this amount Q_2 minus Q_2^F cannot be supplied by the fringe firms. So, what happens this amount will be now supplied by the dominant firm right. So, here if we plot this amount Q_2^F Q_2. So, you see we get one price quantity combination ok. Suppose, this is Q_D^2 ok. So that means, at corresponding to the price P2, Q_D^2 is the Q_D^2 is the demand for the dominant firm which is basically nothing, but the difference between the total market demand and the supply of the fringe firm. Because, at price P_2 the fringe firm can at most supply the output Q_2^F which is less than the total market demand. So that means, this rest of the supply means the rest of the demand is excess demand amount Q_2 to Q_2^F , this can be supplied by the dominant firm.

So, in this way we can get different price quantity combination by plotting the gap between the market demand and the competitive supply. And, if we plot this price quantity combination, we get the locus of the demand curve which is nothing, but the demand curve of the dominant firm ok. So, I hope this is clear and hence I am removing these parts.

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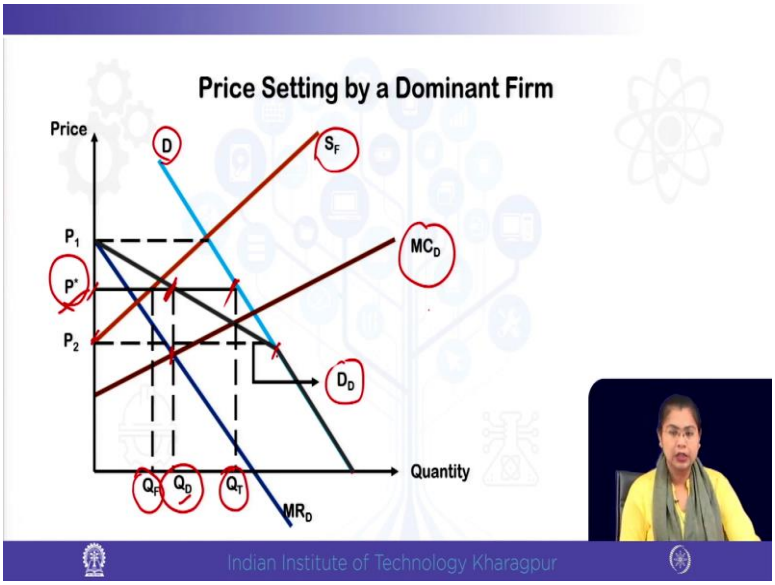

So, in this way we plot for each price and we get the market demand. Now, you can see you can take another example say consider the price P_2 ok. So, you see at this price P_2, what happens? At this price P_2, the supply the competitive supply becomes 0. You consider any price P_2 or less than that, the small firms are not able to supply. See the small firms do not have that cost advantage that the dominant firm enjoys. So, they are relatively high cost.

So, if price falls below a certain level, they will not be able to supply ok. So, at price P_2 now again if we see the small firm, the fringe firms, they are not able to sell because they are the relative high-cost producers. So, if price falls below a certain level, they are not able to cover their marginal cost. So, for any price less than equal to P_2, the supply of the small firms they fall to 0.

So, you see that the vertical intercept of the S_F curve starts from the price P_2. So, that means, that price P_2 what happens? At price P_2, the total market demand will be now served by the dominant firm. So, now you can see, you can understand the reason why this demand curve for the market demand curve I we have used two colors right. So, that means, for any price below P_2, the market demand is now same as the dominant firms demand because the fringe firms cannot supply anything ok.

Now, obviously, this dominant firm has a leadership position and we have earlier also discussed that one of the reason can be, it can be a low cost producer. So, if price falls

below a certain extent, it will be able to sell, but not the small firms which are relatively high cost. So, we can see now that above the price P_1, the dominant firm is not supplying anything.

So, the dominant firm demand curve starts from the price P_1. So, for any price below P_1, the dominant firms demand curve is the gap between the total market demand and competitive supply. But then if we come to a very low price like P_2 then the small firms are not able to supply anything because P_2 is the vertical intercept of the S_F curve.

So, there we see that the dominant firms demand curve D_D, you can see that it coincides with the market demand ok. So, for any price less than equal to P_2, the market demand entire market will be served by the dominant firm. Obviously, we will see that the profit maximizing price will not be like that, but it will be able to supply ok.

So, for any price between P_1 to P_2, now what we are doing? We are plotting the gap between the capital D and S_F curve to get the D_D curve ok and below price P_2 D_D coincides with D. So, this is a very important step which we have already covered.

Now, let us go for the next steps. So, what will be the next step? Now, that the dominant firm has already derived with demand curve because it is a profit maximizing firm. So, it has to take into account what will be the output for the rival firms, means not the rivals here the small firms, the other firms in the market for different prices it sells. And, it gathers data on market demand and the competitive supply and it plots the gap between the two and then we get the market demand for the means the demand curve for the dominant firm.

Now, corresponding to the demand curve, we can also draw the marginal revenue curve. Now, remember we have already studied how to derive the marginal revenue, we have defined marginal revenue. So, that is the addition to revenue when a firm sells one more unit, because in economics we are often interested to see what is happening at the margin. And, the profit maximizing decision is taken by equating marginal revenue and marginal cost.

That means, if a firm sells one more unit what will happen to the change in revenue and change in cost. Because, if the firm wants to sell one more unit, it will earn extra revenue, but at the same time to sell and produce one more unit, the firm has to also

incur cost. So, the cost will change for the extra unit and that is known as the marginal cost and the addition to total revenue is the marginal revenue.

So, it is important that we derived these curves and we already know the shape of the MR curve. If the demand curve is downward sloping, MR is also downward sloping. So, please refer to your lectures when we discussed about the relationship between price demand curve, a marginal revenue, the relationship between revenue and price elasticity.

So, I am not again elaborating on how to derive the MR curve and means the slope of the MR curve, we have discussed it already ok. So, corresponding to D_2, we are plotting the MR curve which is also downward sloping and it lies everywhere below the market demand for reasons we have earlier discussed. Next step is to plot the marginal cost of the dominant firm or the leader firm. So, which is denoted here as MC_D and that is upward rising because the marginal cost is rising.

So, if the dominant firm or the leader firm wants to produce more and more output, the incremental cost or the change in cost is also increasing. So, hence we plot the marginal cost curve. Now, you see as I was telling you that one of the reason for a firm to be a leader firm or dominant firm is that it can be a low cost producer.

So, we can easily see over here that MC_D lies below S_F right. So, S_F is what? S_F is the competitive supply which is also the which can be interpreted as the marginal cost of the fringe firms right. Because, the marginal in the competitive market, the supply curve is nothing, but the marginal cost curve, just now I mentioned. We have already interpreted the inverse supply function ok. So, that means, this S_F is the marginal cost of the fringe firms whereas, the MC_D is the marginal cost of the dominant firm.

So, we can see that for any output MC_D lies much below S_F. So, that actually means leads to a cost advantage of the leader firm and that is why you see if price falls below the price level P_2. So, then the competitive firms are not able to supply, but the dominant firm will be able to supply because it is the relatively low-cost producer. And one thing you can also notice over here that S_F and MC_D these are not parallel; that means, the cost advantage for larger level of output is more.

So, that means, what as we increasing the output level, the gap between S_F and MC_D, it is getting accentuated, we can see it is not parallel. So, that means, as the firms are the

output is increasing, the cost for the extra cost for the fringe firms, it is increasing at a faster rate than the marginal cost of the dominant firm.

Hence, the gap between MC_D and S_F, S_F it is not parallel, it is also getting accentuated with increase in output level. So, that is one of the reason for the dominant firm to have a leadership position, it is arising from the cost advantage. So, if due to market conditions a demand side shock, if market price falls to a lower extent so, that then the small firms are out of business.

But, the dominant firm with its low-cost production capacity or its advantage, it will be able to supply ok. Now, we have depicted the structure, we have depicted the demand and cost side of the total market means consisting of both the leader firm and the small firms. Now, time has come to find out the market price and the profit maximizing quantity.

As we have already know now the market price is actually the price set by the leader firm or the dominant firm. And, we know I just now mentioned that how the profit maximizing price and quantity is set. So, by equating the marginal revenue and marginal cost.

We will be also doing it mathematically in our next lecture from the we can see you will write the profit function and we will be using the first order condition to maximize profit. Now, intuitively what happens? Just now I mentioned that if a firm is willing to produce one more unit, the firm will compare the addition to revenue from selling that extra unit and the addition to cost.

So, if the two are equal MR is equal to MC_D. So, the firm will stop because for any output less than the profit maximizing output, we can see if you look at any output which is less than this point of intersection then MR will be greater than MC. So, that means, if the firm increases output what will happen? The addition to total revenue is still greater than the addition to total cost. So, a rational profit maximizing firm will not stop.

Now, if the firm produces any output beyond the point of intersection of MR_D and MC_D, then we can see that marginal cost is increasing and MR starts falling. So, rational firm will not go to that output level because then profits will fall ok. So, the firm being the profit maximizer, it wants to maximize the gap between total revenue and total cost and

that will be occurring when MR_D is equal to MC_D ok. So, the next step over here is to find out the profit maximizing price.

So, first we set the we get the output Q_D which is obtained at the point of intersection of MR_D and MC_D. So, corresponding to this output Q_D which is the equilibrium output for the dominant firm, we can get the price from the dominant firm's demand curve. So, this is the price P*. So, P* is the price which maximizes the profit of the dominant firm. So, how we are getting? First, we are getting the quantity equilibrium output supplied by the dominant firm which occurs at the point of intersection of MR_D and MC_D.

Now, corresponding to this quantity Q_D from this demand curve D_D, where this Q_D cuts the demand curve D_D corresponding to this output from the demand curve D_D, we are getting the price P* which is not only the profit maximizing price of the leader firm or the dominant firm, it is also the market price. So, in the next step what we do? As we already mentioned intuitively the steps, the competitive firms they are price takers. So, we can see this P* price is formed by the dominant firm.

So, the dominant firm is the price maker and the competitive firms they take the market price that is the price set by the dominant firm as given. So, these small firms, they decide their how much to supply corresponding to this price. So, where this price P* cuts the S_F line, we can get the supply of the fringe firm which is Q_F.

So, Q_F is the total supply, considering the supply of all the company means the small firms. So, this is the total supply. So, there are 10 small firms for example, I am telling. So, Q_F is the total supply of the fringe firms ok.

So, you see we are just a step to reach to get the total supply. So, what do you do? You can now proceed in both ways, you can add. So, as at price P*, that is the market price which is also the profit maximizing price of the dominant firm, we can add the output of the dominant firm or the leader firm and the competitive supply. So, if you add Q_D and Q_F, you get the total output. You can also cross check, you can also see from you have the market demand right.

This D is the market demand. So, you can also get the output corresponding to the market demand at the price P* ok, because there is only one price. So, the profit maximizing price of the dominant firm is also the market price. So, corresponding to the

price P*, what will be the total demand? So, that you can get because you have the total demand. So, from the total demand, you can see that this output will be output Q_D which will be same, if you add Q_D and Q_F.

So, adding Q_D and Q_F also you can get Q_T or; that means, total output or from the price P*, you can also use the demand function and you can get the output Q_T. See, the leader firm cannot go beyond the market demand right, it is also constrained by market demand. If you remember, we discussed in case of monopoly also; a monopoly can maximize profit either by choosing price or by choosing quantity, not both simultaneously, but the outcome will be same ok.

And, and the price equilibrium price quantity combination will be same. Because, when the monopolist is maximizing profit subject means choosing quantity, then price will be subject to the market demand. So, the monopoly is also constrained by market demand or the monopolist can also maximize profit by choosing price, then output is from the market demand. And, in case of monopoly the market demand is same as the individual demand, because monopolist is the single supplier.

Here the dominant firm is not the single supplier, but dominant firm has a leadership position because you can see that MC_D lies everywhere below S_F. So, if price falls below P_2, the small firms are not able to sell, but the large firm the dominant firm can sell, but it is the price setter. So, for any price if price falls to a lower extent, then market demand is same as the dominant firms demand curve.

But, above this price P_2, we get the market demands difference with the competitive supply to derive the dominant firms demand curve. Then, we got the marginal revenue of the dominant firm and we equated and the marginal cost and marginal revenue to get the quantity supplied by the dominant firm. And, from the dominant firms demand curve, we got the profit maximizing price which is also the market price and from that market price, we can derive how much the small firms will supply.

So, we get the output Q_F and we add Q_F and Q_D to get the total output Q_T and you can also cross check your results. Suppose, you are in exam you are given some demand function and the supply function and the marginal cost equation and you are asked to find out this Q_D, Q_F and P*.

So, I will suggest you that you do both the ways, you get the total output Q_T by adding Q_F and Q_D or you can also find out the total output Q_T from means what is the output corresponding to the price P* from the market demand D, because both will be same.

So, you can cross check your result, you can be sure that there is no error in the calculation ok. So, this is intuitively and graphically how we derived the equilibrium price or the market price and the equilibrium quantities. The three quantities we are getting here, one is the quantity supplied by the dominant firm, the other is the supply of the fringe firm and the total market output that is the sum of the output of the leader firm and the fringe firms.

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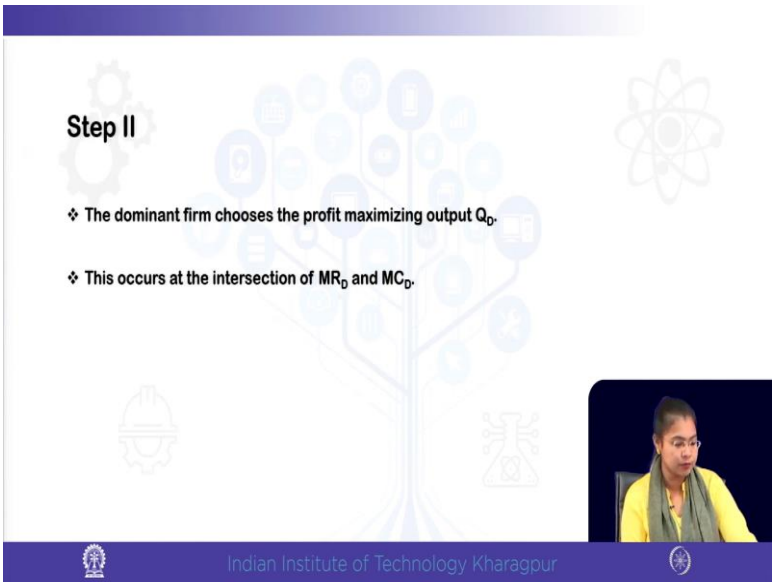

So, these are the steps that we have already discussed. So, I am not repeating the steps, you can go through the steps.

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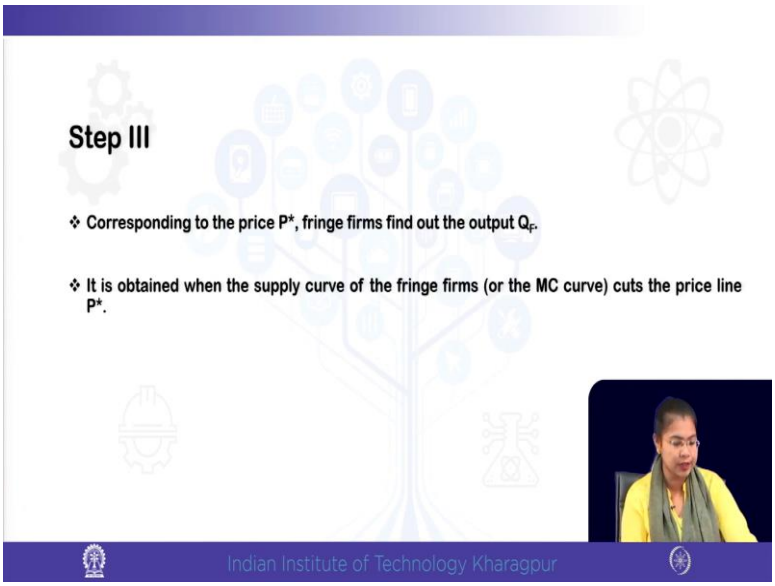

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So, we have basically discussed all these.

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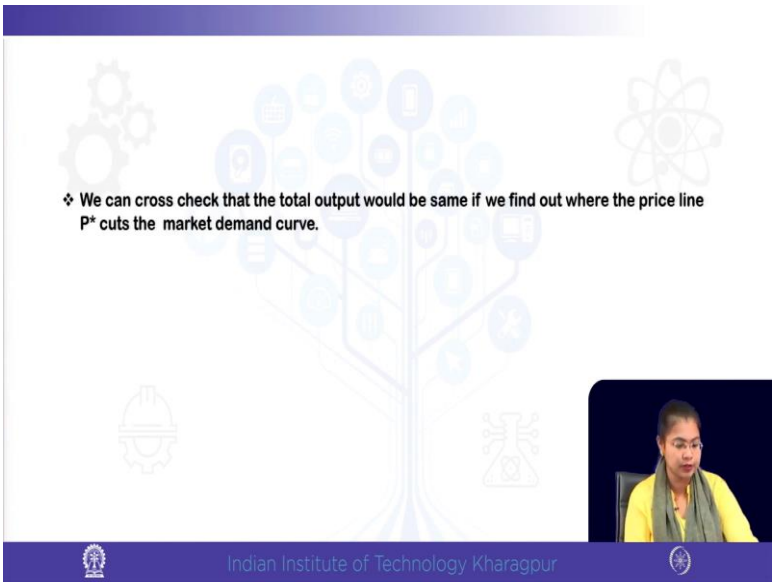

So, I am not repeating the slides.

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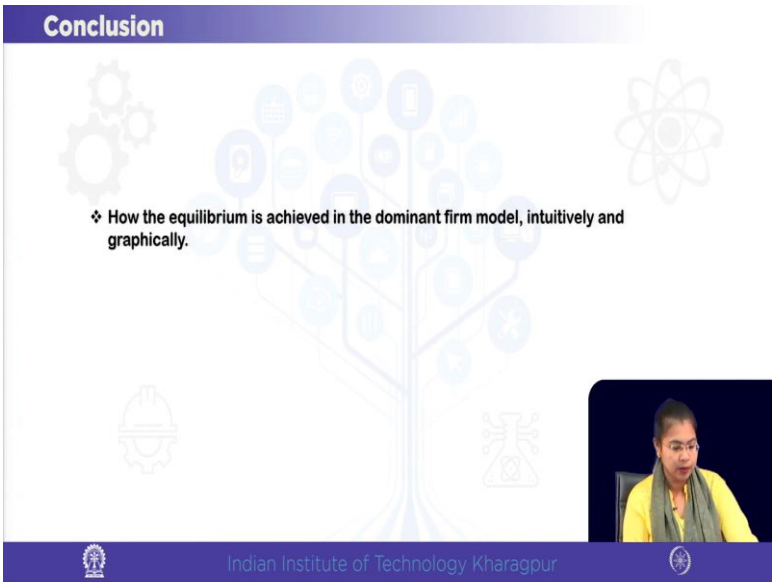

So, what we have done in today's class? We have intuitively and graphically explained, we started with the structure of the price leadership dominant firm model. So, one firm has a cost leadership position, it supplies a large share, but there are some small firms also which act as competitive firms, they take the price set by the leader firm as given. So, what we have done in today's class? We have found out how the leader firm decides the market price.

So, the leader firm decides the market price, first step is to get the demand curve of the dominant firm. So, the leader firm like this is an oligopoly model; so, in oligopoly the firms have to take into account each other's decision.

So, the leader firm while deciding about its own profit maximizing price quantity combination, it has to take into account what will be the supply of the competitive firms for different prices. So, by taking the difference between the total market demand and the supply of the small firms, the dominant firm derives its own demand curve.

Then, corresponding to the demand curve we can get the marginal revenue curve and by equating marginal revenue and marginal cost, we found out the output of the dominant firm, the market price of the which is set by the leader firm is also the market price.

And, then we find out the total supply of the fringe firm and total market output. So, this is what we discussed intuitively and graphically. So, understanding the steps intuitively is very important. Then, in the next class which will be a continuation of this class, we will be solving the model numerically.

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So, we have followed the two standard state textbook, mainly we have followed Pindyck and Rubinfeld for this part.

Thank you very much. See you in the next class, when we will be discussing the model numerically.