Petroleum Economics and Management
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Module - 09
Fundamentals of Petroleum Resources
Lecture - 44
Price Leadership Dominant Firm Model - II

Hi everyone. Welcome back to our NPTEL course, Petroleum Economics and Management. I am your instructor, Dr. Anwesha Aditya. So, we are in module 9 of our course, where we are discussing the Fundamentals of Petroleum business. So, this is our lecture number 44 in our entire course, where we are discussing the Price Leadership Dominant Firm Model.

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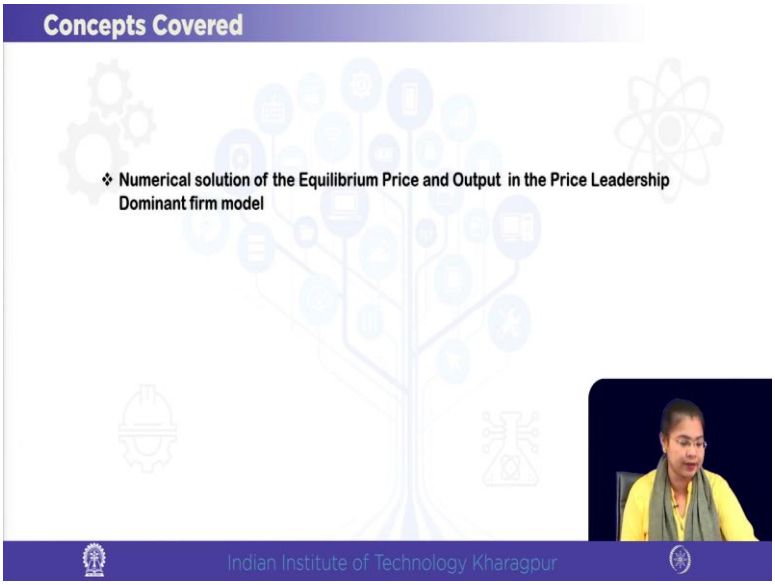

Now, if you remember, we have already discuss the market structure means, we are discussing the global petroleum industry market structure and that is how we have design the module 8th and module 9. In module 8, we have discussed about market structure, collusive oligopoly behaviour and why we need game theory to study oligopoly model.

In module 9, we have focused our attention to collusive behaviour and then we are studying the price leadership dominant firm model, because that will help us to study the

OPEC cartel market structure. So, in the previous lecture, we have already defined, we have discussed in detail the structure of the price leadership dominant firm model.

There is a leader firm, which enjoys a large market share and often it has a cost advantage, it is the relatively low cost producer, but it is not the monopolist. So, we have small firms, which act as competitive firms together and they are referred to as the fringe firms, ok. So, the large firm is the price maker and the small competitive firms are the price taker.

Now, we have already solved the model intuitively and we have also step by step did the graphical solution, which is very important. Now, in this particular lecture that we are going to discuss right now is we are going to solve the model, the price leadership dominant firm model numerically or algebraically, which is pretty easy, because once we know already the intuition, it will not take much time, it is very easy. So, you can see these two lectures module in this module are just interconnected.

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Because of time constraint, I could not bring the numerical solution in this particular lecture. So, you can listen to these two lectures at one go. So, we already know the structure, the large firm is now the price maker, ok. So, it maximizes its profit. So, how does it do so? So, the large firm or the leader firm, which has a large market share can maximize its profit by decide by it has to take into account what will be the output supplied by the remaining small firms, ok.

So, the first step in getting started is to derive the demand curve of the large firm, right. So, the large firm, the dominant firm it has the information regarding the market demand and it also knows the supply of the fringe firms. So, at each price the dominant firm has to see what will be the supply of the small firms together. So, see these small firms they individually supply very less amount.

So, they cannot influence the market price. So, that is why they take they behave like perfectly competitive firms and they take the price set by the dominant firms as given and they decide how much to supply. So, the dominant firm from its perspective has to take into account what will be the supply of the small firms. So, at each price the dominant firm has to derive the demand that it will be supplying.

So, that means, it has to take the difference between the market demand and the competitive supply to get its own demand. So, that is how if you remember we have graphically and intuitively solve the model in the previous lecture.

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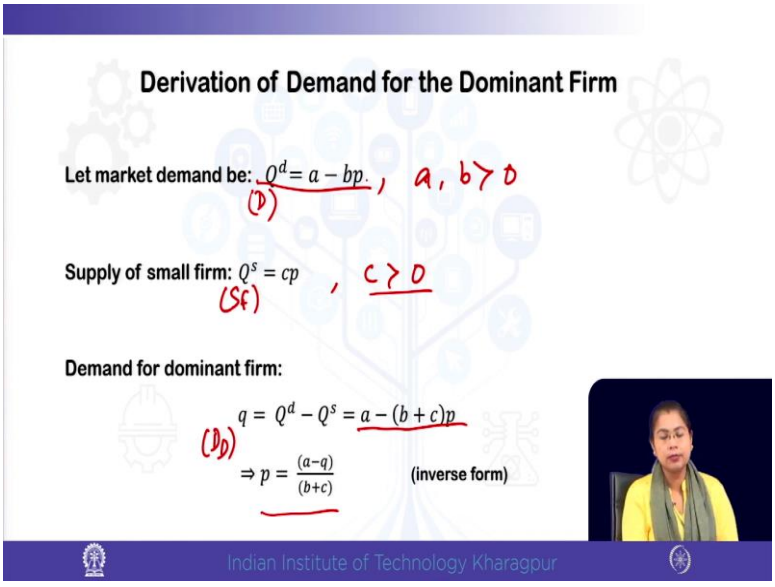

So, numerically the first step will be to derive the demand curve for the dominant firm. So, suppose we start with a standard market demand a Q^d is equal to a - bp where a and b are some positive constant, ok. So, a is the intercept term and b is the slope coefficient and these are positive constant means then you can easily understand that as long as b is positive the market demand is downward sloping.

So, that means, the market demand obeys the law of demand and that is how we have drawn the downward sloping market demand in our previous lecture. Then next comes the supply of the small firms which is Q^s is equal to cp where c is a positive constant. So, if Q^s is equal to cp, c is positive.

So, if c is positive then that means. So, we can write over here if c is positive. So, marginal cost is rising, ok. So, the law by law of demand the market demand is downward sloping and since c is positive. So, the law of supply also holds if you remember we have already drawn. So, Q^s is nothing but what we have denoted in that class as S_F the supply curve of the fringe firm, ok.

So, because F stands for the competitive fringe the small firms together, they do not have market power to influence the market price. So, they just take the price set by the dominant firm as given, ok. So, this is the S_F curve that we have discussed in the last class and it is upward rising law of supply so because marginal cost is increasing.

Now, the first step as I already mentioned is to plot the difference between the market demand and the supply of the fringe firm. So, here also numerically we do the same thing. So, the small q is basically what we have written in the previous class as D_D, right. So, for your understanding I am just denoting and this one in the previous lecture we have denoted as capital D only. So, D_D or here we have written small q is the gap between the market demand and the supply of the fringe firm.

So, now we have the functional firms. So, suppose instead of this a, b, c you will be in the exam for example, you will be given small problems with some exact values numerical values in place of a, b, c. So, you will be easily able to solve. So, first step is to take the difference between the total market demand and the supply of the small firms for all the prices and you get the demand function for the dominant firm or the leader firm. So, this is the demand function for the leader firm.

Now, see this we are representing in the inverse firm because the one we have plotted in the previous lecture we plot price on the vertical axis and quantity on the horizontal axis. That means, we work with the inverse form of the demand function. So, this is the inverse demand function for the leader firm.

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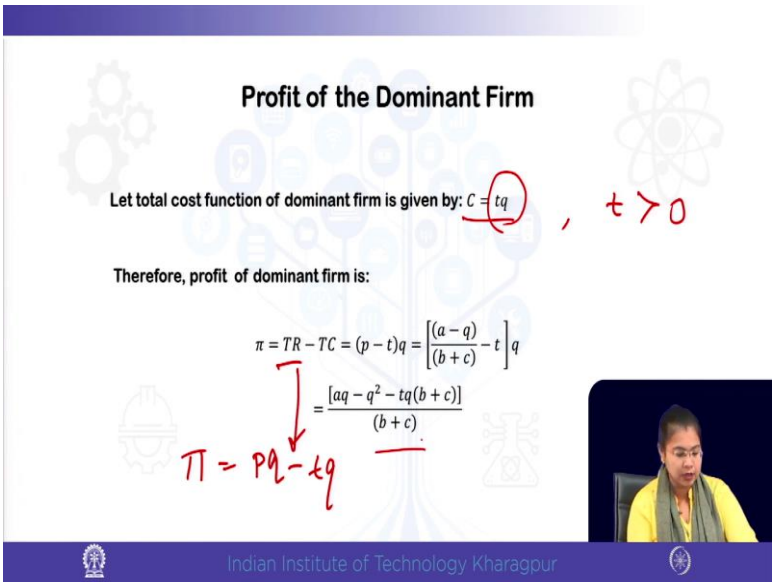

So, what is the next step? Next step is we know that the leader firm is a profit maximizer because it is maximizing its profit and it is then deciding how much to produce and what should be the price, ok. So, suppose this is the cost function. So, again you assume that t is positive. So, the marginal cost of the leader firm is increasing.

But if you remember when we plotted the supply function of the fringe firm S_F and the marginal cost of the dominant firm MC_D, we saw that MC_D lies much below S_F because the large firm the dominant firm has a cost advantage and also, we saw that these two are non-parallel. So, that means, as output increases the gap between the marginal cost of the two firms the leader firm and the small firms competitive fringe firms that accentuates.

So, that means, for larger level of output the leader firm has a greater cost advantage also. And if price falls too much the high cost firms or the competitive firms they are not able to sell. So, we have already graphically and intuitively explained the marginal compare the marginal cost of the two firms. Now, coming back to the solution of the model.

So, now we are finding out the equilibrium price or the market price and the quantity supplied by the dominant firm. So, first we have to write down the profit function. So, profit we have in many classes earlier, we have defined profit is the gap between total revenue and total cost. So, what is the total revenue? Total revenue is the value of the product.

So, price per unit price into the total output sold, ok. So, it is pq, q means which q the small q that the output of the dominant firm. So, we are denoting small q to refer to the output of the dominant firm. So, , total revenue is pq minus total cost. Total cost is see it is capital C which is we have referred to the capital C is written as tq.

So, here we are plotting we are putting in place of total revenue it is pq - tq, ok. So, this we can take q as common and we can write it as (p – t) q. Now, what we do? We have already derived in the previous slide you see we have already written the demand function of the dominant firm in the inverse form. So, we put this value of p which is a function of output and the parameters a, b, c in this profit function. So, this is our expression for the profit.

Now, what the firm is doing? The first order condition for the profit maximization is to maximize profit by choosing the quantity. So, we know that the dominant firm is the profit maximizer firm. So, if you remember the numerical sorry, the graphical and intuitive solution what we did after deriving the demand curve? We derived the marginal revenue curve and we found out the output Q_D which occurs at the point of intersection of MR_D and MC_D, right.

Because, while the firm is deciding whether to sell one more unit the firm will compare between the additional revenue that the firm can enjoy by selling one more unit and the additional cost incurred to produce and sell this extra unit. So, as long as the revenue is greater than cost the additional cost the firm will keep on producing. If the revenue falls below cost the firm will not produce.

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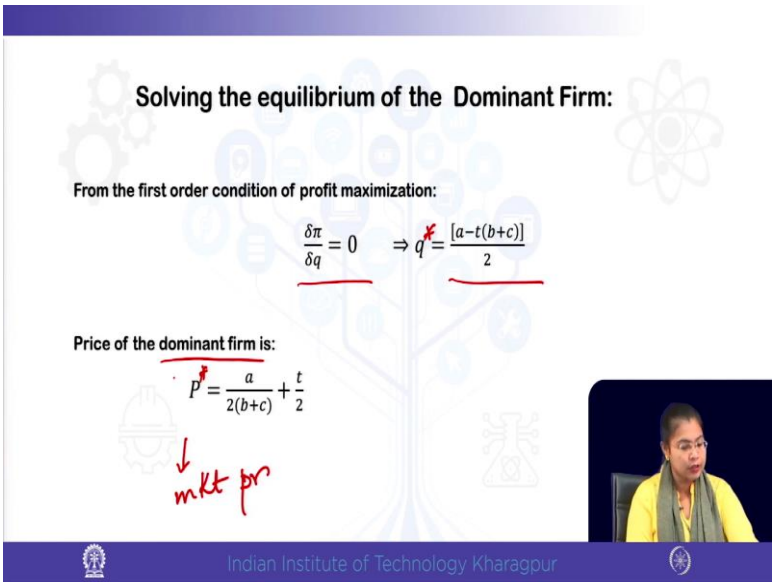

So, the firm will stop where the additional revenue obtained from the extra unit of quantities hold is exactly equal to the additional cost of producing that extra unit so where MR is equal to MC. So, that is how the firm maximizes profit. So, the first order condition is to set a maximized profit by choosing quantity. So, we write $\frac{\partial \pi}{\partial q} = 0$, ok. So, this was our profit function. So, first order condition with respect to and the other choice variable is quantity.

So, $\frac{\partial \pi}{\partial q} = 0$, ok. From here we can easily solve this output of the leader firm or the dominant firm. This was our expression of the profit function π . So, this we are differentiating with respect to q and we get the solution of q in this way. So, now the next step is what?

If you remember what we have done graphically, graphically we found out the output Q_D and we found out the price P* which corresponds to the output Q_D from the demand curve D_D; that means, the demand curve of the dominant firm. So, that means, this equilibrium output of you can denote it as q* this is the equilibrium output of the dominant firm.

These you can put back into the demand function inverse form of the demand function of the dominant firm. So, we can get the price P* let us say, ok. So, P* is the price of the dominant firm which is also the market price, right.

Because here the market price is determined by the leader firm because the small competitive firms, they take the price determined by the leader firm as given or the dominant firm price is the market price. So, this price P* is found this is the out price corresponding to the output q* given by the demand curve of the dominant firm.

So, this q* output is found from the first order profit maximizing condition $\frac{\partial \pi}{\partial q} = 0$. And we are getting this q* which we put back into the inverse form of the demand function of the dominant firm and we get the market price. If this is not only the price of the dominant firm this is also the market price.

So, we have to find out four things the market price, the output of the dominant firm and the output of the competitive fringe firm and the total output. So, we can see that we have already solved the first two; we have solved the market price and the output of the dominant firm.

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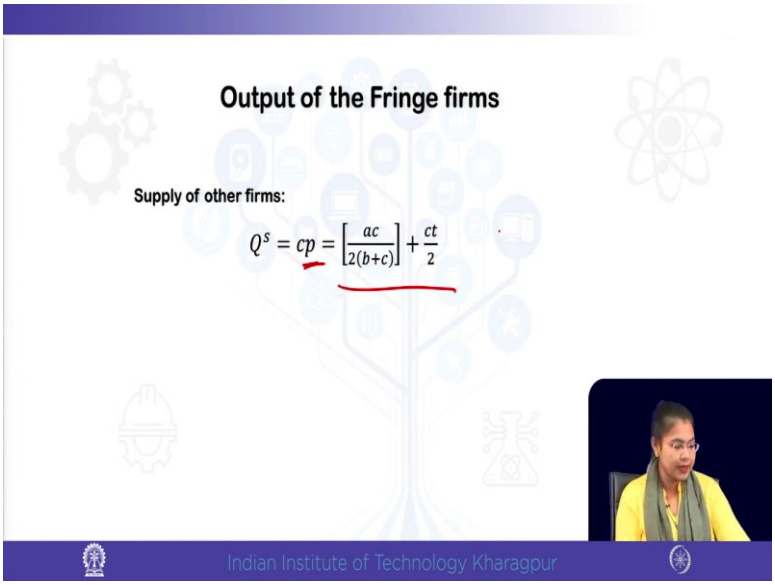

Now, what is the next step? Next step is to find out the supply of the competitive firms. So, the competitive firms they supply, they decide how much to supply from the market price which is the price set by the dominant firm. So, you see we were given the supply function form of the small firms which is $Q^s = cp$ and we have already solved the market price say P*.

So, there what we do we put the value of p in this supply function of the small firms S_F or Q^s. So, we can solve for the output of the small firms. So, here we are just doing it with these parameters in a generalized way we at we have not given any values. But suppose in exam you may be given small questions like this where you will be assigning some numerical values to a, b, c, t. So, you can solve the equilibrium price quantity combination, price for the market and the quantity for the small firm and the dominant firm in this way.

Now, the final step is what? We have to also get the total supply. So, what is the total supply? We know total supply in this structure is the sum of the supply of the leader firm and the competitive fringe firms. So, we can add this Q^s this value and this value q* to get the total supply. Other way can be we see we can also put the value of this means corresponding to this price we can also use the market demand because we started with the market demand, ok.

So, what else we can do? We can get the market total output in two ways either by adding the supply of the dominant firm that is q* and the supply of the fringe firm Q^s or what we can do? We can put this value of P* the market price add them in the market demand function. Because we are given the market demand function. That is how graphically and intuitively also we did that we can cross check the results.

So, we can put the value of P* in Q_D the market demand function and we can get the total market output, ok.

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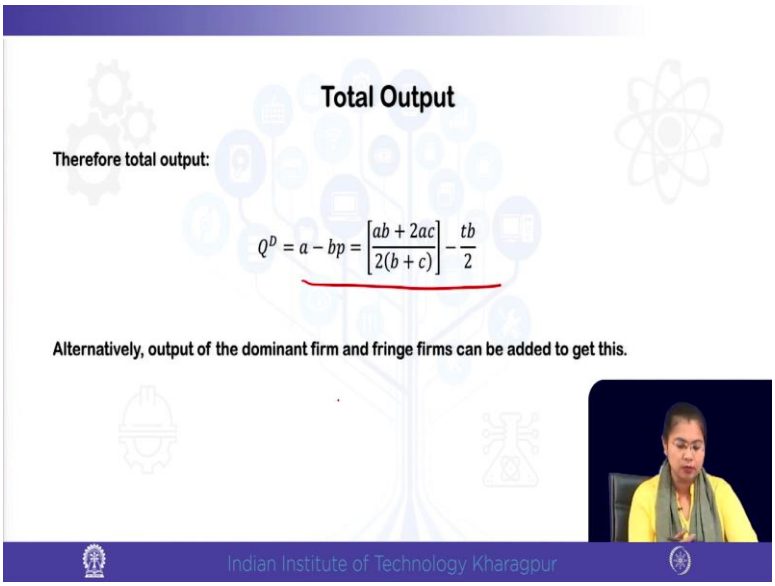

So, the total output is here you see we have plotted we have put the value of market price P* into the demand function or we can cross check the result by adding the output of the fringe firm and the dominant firm. So, I suggest you that you in the last step you cross check the result. Because if there is any error in calculation, any mistake then these two will not be equal.

So, if you have done it correctly. So, these two will be equal if you put the market price into the market demand function or you add the output of the dominant firm and the small firms to get the market the total supply. So, here you see we have done a generalized solution, but you can then do the you can solve the model using if you are given some particular values numerical values of the parameters a, b, c, t ok.

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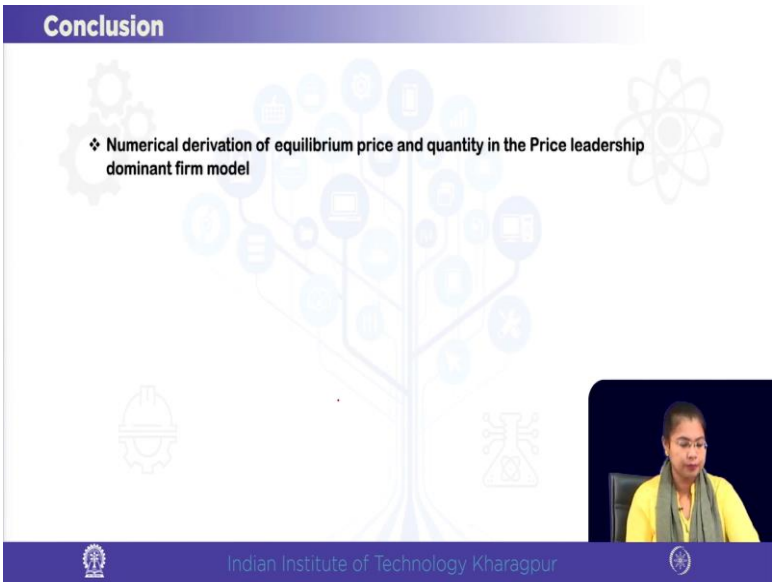

So, in today's class this particular lecture it is a continuation of our previous lectures. So, these two lectures are very interconnected. In the previous lecture we discussed we solved the price leadership dominant firm model graphically and intuitively and this particular lecture we have solved the model numerically.

So, what we have done in today's class? We were given the market demand function and the supply of the small firms the fringe firms. Then how we did? We started with deriving the demand function for the leader firm. Because here you see the leader firm it is the price maker.

So, how it will decide the price? The leader firm will maximize its profit. And how does it maximize profit? It maximizes profit by taking into account the quantity supplied by the remaining firms. So, that is why it starts, the leader firm starts by deriving its own demand which is the gap between the total demand and the supply of the small firms.

So, by this way we derived the market demand sorry, the demand curve of the dominant firm and then what we did? We were given the supply a marginal cost of the dominant firm. So, we wrote the profit function and we maximize the profit. Because this dominant firm is a profit maximizer.

So, we use the first order condition for profit maximization. So, we said $\frac{\partial \pi}{\partial q} = 0$ and we solved for the q*, small q* which is the output that the dominant firm, the leader firm

will supply and that is the profit maximizing output and corresponding to that output q* we put the value of q* into the demand function of the dominant firm and we got the price P star.

Now, that price is not only the price profit maximizing price of the dominant firm that was also the market price. And corresponding to the market price P* we solve the output of the fringe firm because we already started, we had the functional form of the marginal cost curve which is also the supply curve of the fringe firm.

So, we solve for the output of the competitive small firms and we can add the two the output of the dominant firm and the competitive small firms to get the total output. And we can cross check our result by putting the market price into the market demand function and we can solve for the total output and we compare.

So, I suggest that you solve the total output by adding the competitive output and the leaders output and you cross check the result by putting the market price into the demand function. So, your calculation will be error free. So, that is how we solve numerically the equilibrium price and quantity in the price leadership dominant firm model.

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So, we have mainly followed the book of Pindyck and Rubinfeld and the Perloff for the price leadership dominant firm model.

So, thank you very much. We look forward to meet you when we will be discussing the last lecture in module 9.