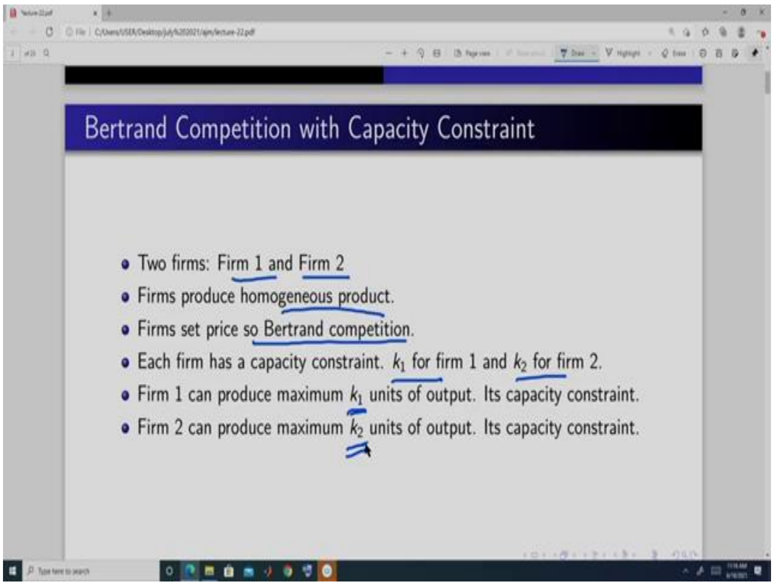
Introduction to Market Structures
Professor. Amarjyoti Mahanta
Department of Humanities and Social Sciences
Indian Institute of Technology, Guwahati
Lecture No. 30
Bertrand Competition with capacity constraint

Hello, everyone. Welcome to my course Introduction to Market Structures.

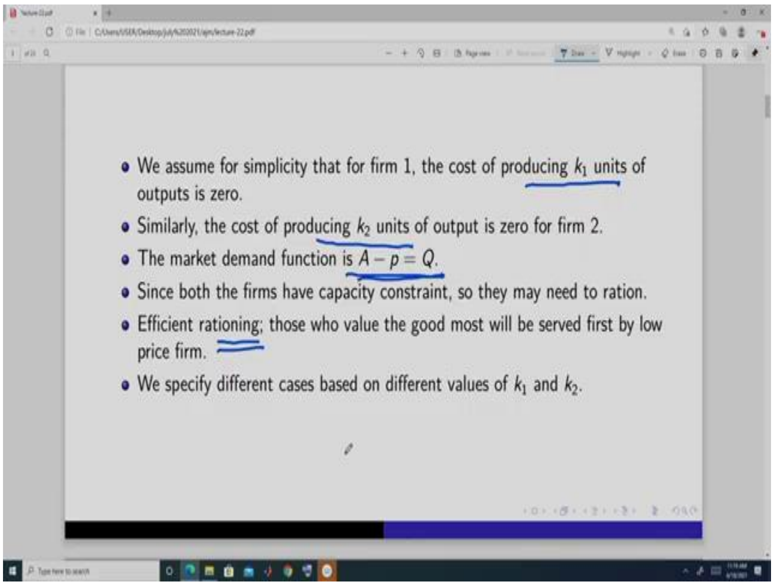
(Refer Slide Time: 0:54)



We were doing Bertrand competition with capacity constraints. So, and we have proved only find the pure strategy Nash equilibrium in case one and we will continue. So, our model is this we have two firms, firm 1 and firm 2, both produces homogeneous product that means they produce similar product, whether you buy from firm 1 or firm 2 it does not matter.

Again each firms sets price on their choice variable is price so it is a Bertrand competition. And what we do, we introduce capacity constraints. So, firm 1 capacity is k1 and k2 for firm 2. So, capacity here means that firm 1 can produce maximum k1 units of output and firm 2 can produce k2 units of output.

(Refer Slide Time: 1:50)



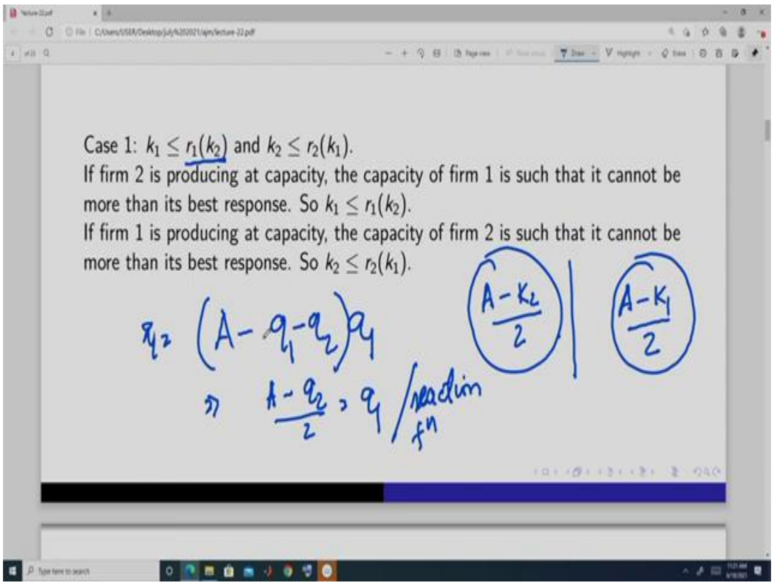
And for simplicity we assume that the cost of producing output is 0. So, till k1 there is no cost of production for firm 1 and it cannot produce more than k1. Similarly, for firm 2 there is no cost of production till k2 units of output and it cannot produce beyond k2, okay. So, this is the structure of the firm. And the market demand is this- A-p=Q. So, it is a linear straight line which is downward sloping, okay.

So, since both the firms have capacity constraint, so they may need to ration. What do we mean by ration? So, suppose the demand is 10 units and each firm can produce suppose firm 1 can produce 5 units, firm 2 can produce suppose 3 units. So, they can produce only 8 units, but the demand is 10. So, 2 person or 2 units cannot be met, cannot be supplied. Now, who is going to forego among the buyers or among the demanders, consumers, who is going to forgo this amount. So, that is the rationing. So, the firm use a method to ration.

Unlike suppose each individual demand 1 unit and suppose there are 10 individuals who demands 1 units and firm 1 can produce 5 units and firm 2 can produce suppose 3 units, so two person they cannot be supplied. So, who are going to be these two persons, right? So, here in this module we use efficient rationing. Efficient rationing means that one who value the goods most is going to get it.

So, it means that that if I am willing to pay more, I will get that good fast. And if my willingness to pay is less, I will get it later or I may not get it, okay. So, the firm which sets the lowest price they sells to the consumers whose willingness to pay is high, okay.

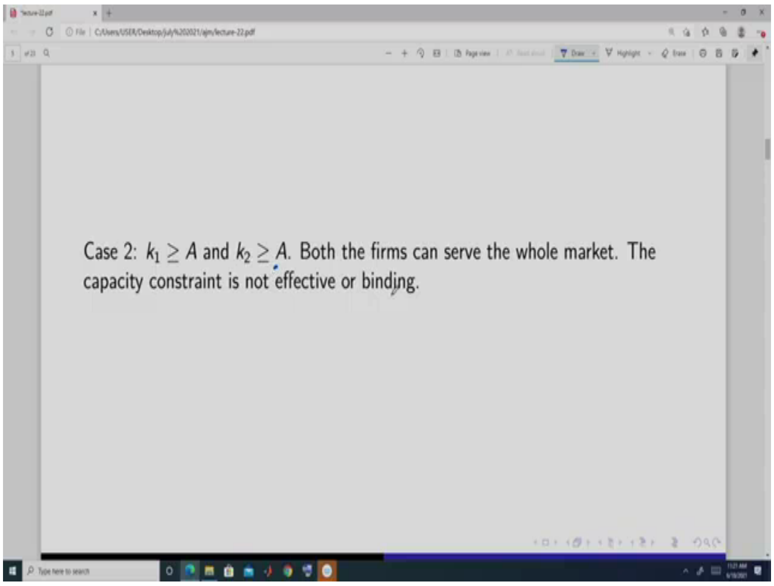
(Refer Slide Time: 4:08)



So, we specify different cases and we have done it like in case 1, it is suppose the capacity of firm 1, k1 is less than this amount-$r_1(k_2)$. What is this amount? This is the best response. Suppose firm 1, firm 2 produces k2 unit, what is the Cournot best response amount of output of firm 1 this is given by this. So, this is r1k. So, in this case, if we want to derive, so suppose our Cournot output of firm 1, output of firm 2 and, so this is the profit of firm 1-$\pi_1 = (A - q_1 - q_2)q_1$. Suppose q1 is less than equal to k1 and q2 is also less than equal to k2. So, here, in this case we get this to be, so this is the reaction function-$\frac{A-q_2}{2} = q_1$, Cournot reaction function.

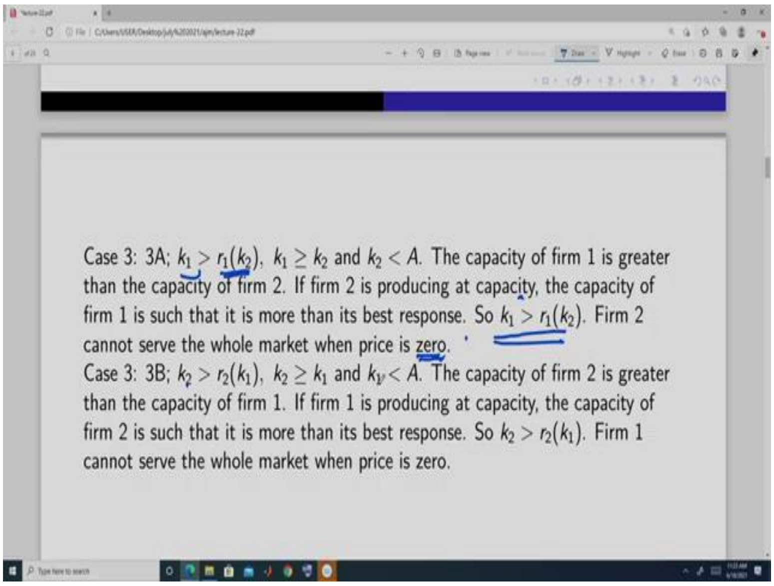
Now, k2, q2 the maximum it can take is k2. So, suppose firm 2 produces at its capacity then what is the best response for firm 1, this amount-$\frac{A-k_2}{2}$. So, here it says that the capacity of firm 1 given a capacity of firm 2 is less than equal to this amount. Similarly, for firm 2 we will get a reaction function like this-$\frac{A-k_1}{2}$. So, k2, if k1 is fixed k2 is such that it is less than equal to this amount-$\frac{A-k_1}{2}$, okay and we have found pure strategy Nash equilibrium in this case in the previous lecture.

(Refer Slide Time: 5:58)



Next in case 2, we have suppose both the firms can produce more than its, more than the size of the market. Their capacity is more than the size of the market. Size of the market here is A, because if the price is 0 what is the maximum output demanded in the market and that is A. So, the maximum output that is going to be demanded in this market is A and both the firms can supply A units. So, actually the capacity constraint is not at all binding in this case, okay. It is more. So, both the firms can produce. So, we will also solve this today.

(Refer Slide Time: 6:39)

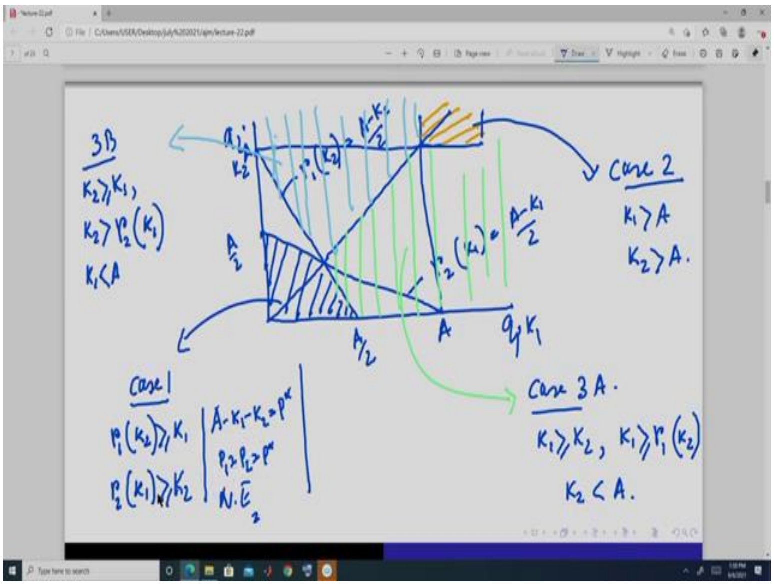


Next case is this, case 3A, where capacity of firm 1 is greater than this amount, (k_2), okay. In the case 1 it was less than this, but capacity of firm 1 is greater than the capacity of firm 2 and capacity of firm 2 is always less than A, but capacity of firm 1 can be greater than A. So, this is 3A. And 3B, so it means the capacity of firm 1 is greater than the capacity of firm 2. If firm 2 is producing at capacity, the capacity of firm 1 is such that it is more than its best response.

So, that is why it is this. Best response here it means the reaction function, Cournot reaction function that we have already done in the Cournot section that we dealt with. And also I have derived it explicitly in the last class. And firm 2 cannot serve the whole market when the price is 0, okay.

Similarly, this case 3, again 3B is just the opposite of this that is k2 is greater than equal to r2k1 that is if firm 1 is producing at its capacity k1 then the best response for firm 2 is given by this amount-$r_2(k_1)$ based on the reaction function. So, capacity of firm 2 is always greater than this. And this k2 is greater than equal to k1 and k1 is less than A, okay. So, when the price is 0, firm 1 cannot supply the whole market, okay.

(Refer Slide Time: 8:28)

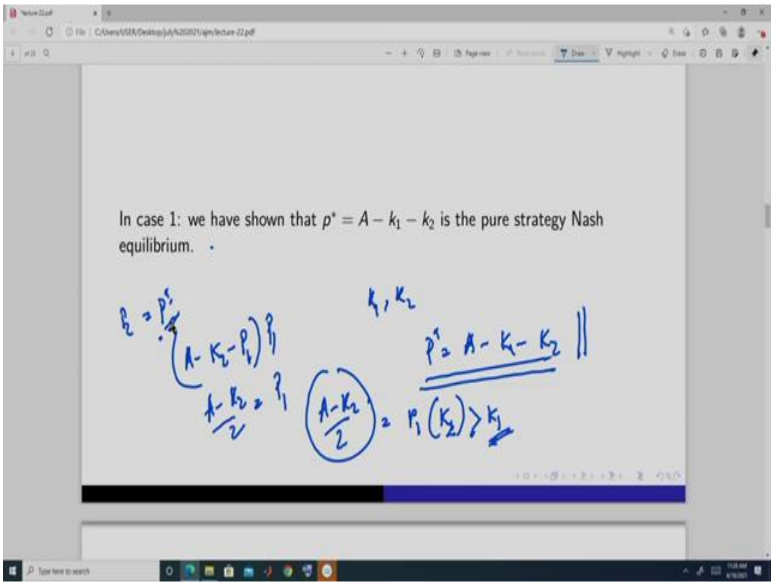


Okay, now, so in the diagram we can show it in this way. So, in this axis q1, q2 and capacity of firm 1, capacity of firm 2, so this is the reaction function of firm 1 given a capacity of firm 2. This is the reaction function of firm 2 given a capacity of firm 1 and this is we have shown already. And we have already proved the case 1 and the case 1 is this region. This is case 1 and here we have got the r1 this is greater than equal to k1, this-case $1 - r_1(K_2) \geq K_1, r_2(K_1) \geq K_2$. And here in this case we have shown the p star and p1 is equal to p2. So, this is the, this we have shown.

And this point is A, this is A by 2, this is A by 2, this point is A. And this region is case 2, case 2 where capacity of firm 1 is greater than A and capacity of firm 2 is greater than A, **okay** this whole region. And this region, this green region, this is case 3A, where we get, this is 3A where capacity of firm 1 is greater than equal to capacity of firm 2 and capacity of firm 1 is greater than equal to the optimal Cournot optimal output given a capacity of firm 2 and capacity of firm 2 is strictly less than A.

And this region, this light blue, this region is actually 3B. This is 3B. And here we get capacity of firm 2 is greater than equal to capacity of firm 1 and the capacity of firm 2 is greater than the Cournot optimal output of firm 2 given a capacity of firm 1 that is k1 and k1 is strictly less than A. So, these are the possible cases. And we have already shown, this case.

(Refer Slide Time: 13:27)

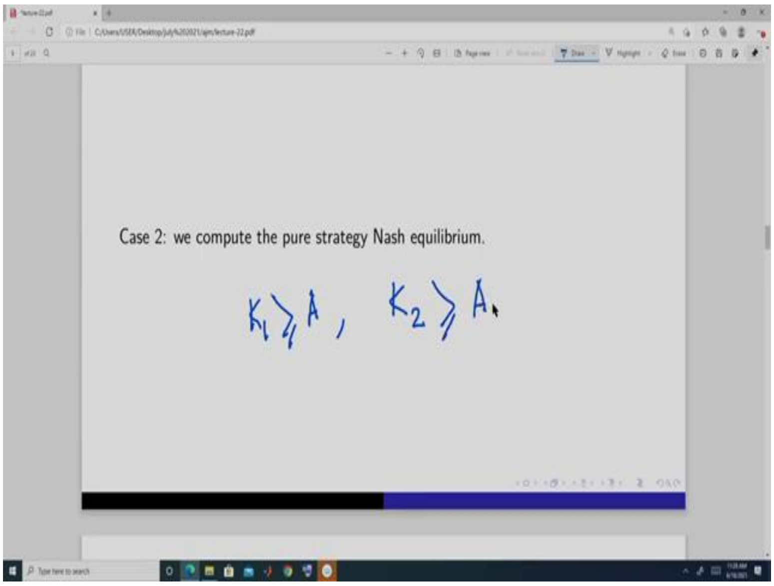


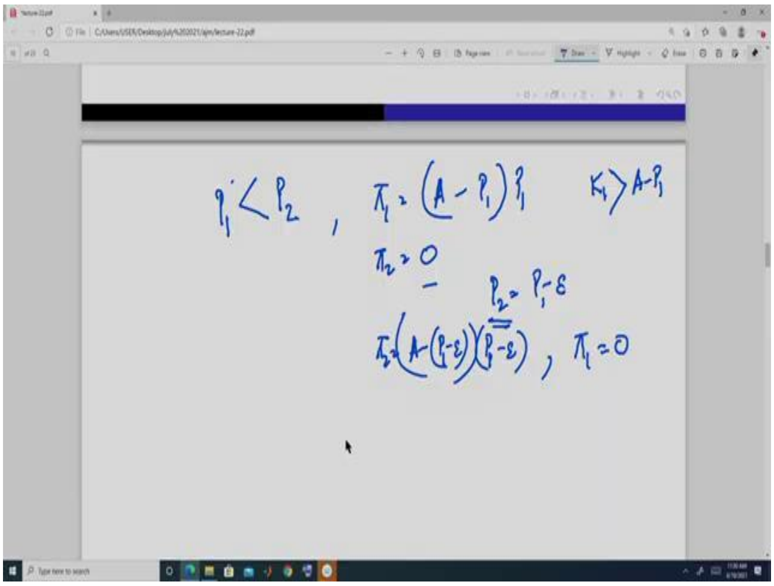
Now, in case 1 we have shown that firm 1 and firm 2 produces at capacity k1 and k2 and the price that we get if both of them produces that capacity is this p star and so this is the unique pure strategy Nash equilibrium in case 1 and we have shown this, okay. Next, we, how do we have got it, we have simply solved one problem that suppose firm 2 set this price p2 is equal to suppose this, okay.

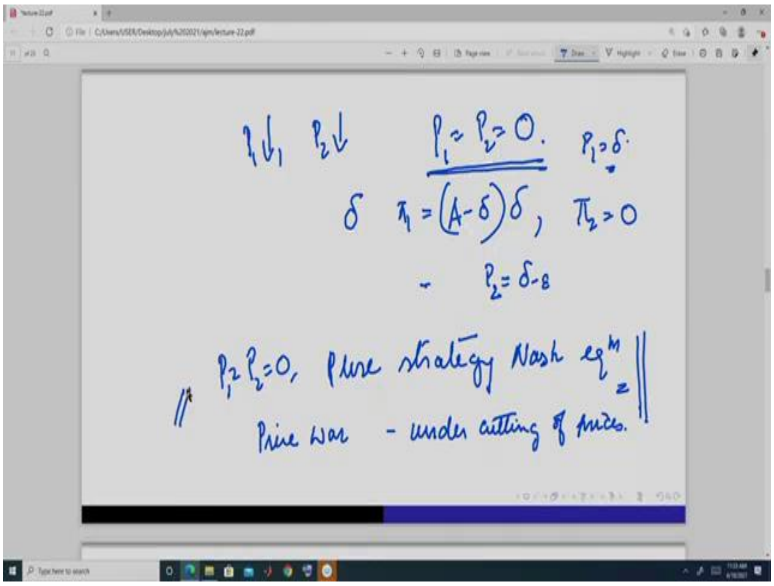
Now, firm 1 suppose wants to be the monopolist in this. So, firm 1's demand curve will be, it will be this-$(A - K_2 - P_1)P_1$. So, it will be, price will be this-$\frac{A-K_2}{2} = P_1$. When we plug in this price quantity, it is this. This is what? This is actually this-$r_1(K_2)$. So, k1 is less than this-$r_1(K_2)$, right? So, it means what? It wants to produce this much, it wants to set a price p1 such that it produces this much amount, okay. But that will give it maximum, higher profit, but it cannot produce this much.

So, the nearest that it is possible to produce is k1, and when it produces k1 then the price it gets is the p star. So, that is why p star is this. And similarly, we can argue it for the case of firm 2 and we get this as the pure strategy Nash equilibrium, okay.

(Refer Slide Time: 15:26)







Next, here in this case, in case 2, capacity of firm 1 is greater than equal to A and capacity of firm 2 is greater than equal to A. Suppose firm 1 produces set of price which is p1 and suppose this is less than the price of firm 2. Firm 2 sets a price p2. Then profit of firm 1 is going to be this-$\pi_1 = (A - P_1)P_1$. Now, this is the demand. And we know k1 is always greater than this- $A - P_1$. So, firm 1 is not facing any constraint regarding the output that is the capacity constraint. Profit of firm 2 is 0, because firm 1 is supplying to all the buyers and so no one is going to buy from firm 2. So, firm 2 here is going to do what?

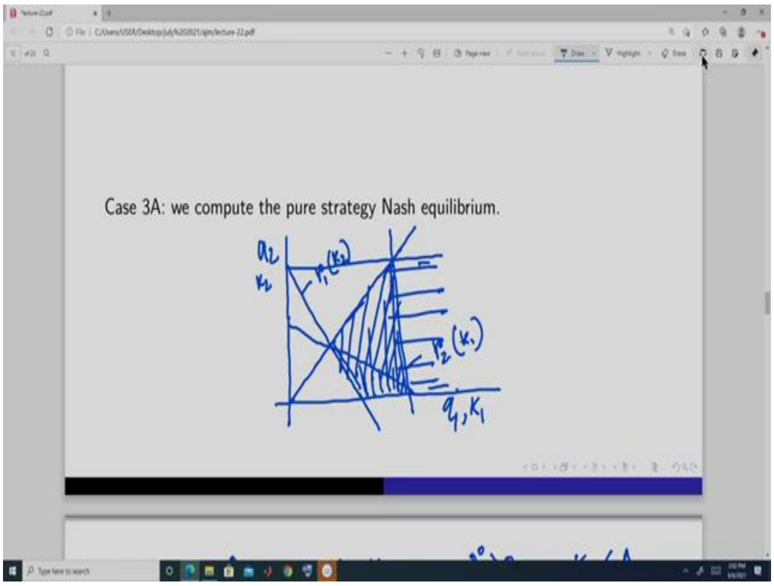
So, p2 best response is p1 small amount that is epsilon amount and this is this-$P_2 = P_1 - \varepsilon$. So, here when p2 is this then the profit of firm 2 is this-$\pi_2 = (A - (P_1 - \varepsilon))(P_1 - \varepsilon)$and profit of firm 1 is 0, because p1 is greater than p1 minus epsilon. So, what is happening? Firm 1, firm 2 is undercutting the price of firm 1. So, like this it will go on happening. So, price will go down. There is going to be continuous competition and each firm is going to undercut the price. So, finally, p1 is going to fall and similarly p2 is also going to fall.

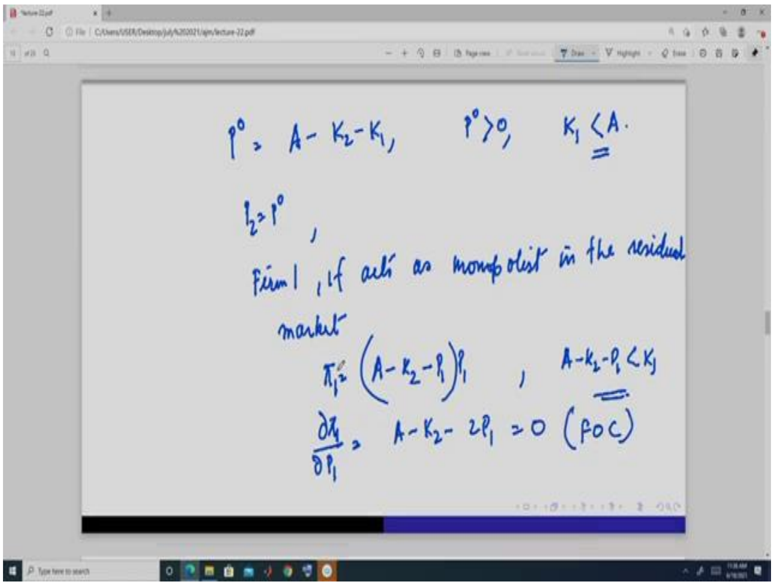
So, what, it can go till what level. It can go till p1 is equal to p2 is equal to 0. So, any positive price suppose takes up some delta as a positive price, what is the demand at delta, this- $(A–\delta)\delta$. Delta is a very small positive amount suppose. Suppose its profit is this- $(A–\delta)\delta$ and p2 profit of this is this. So, what will happen? Again it will be price of, so p2 is delta minus epsilon amount. So, like this it will go on. So, any price greater than this p is equal to 0 is cannot be sustained. So, there is going to be someone who is going to undercut that price.

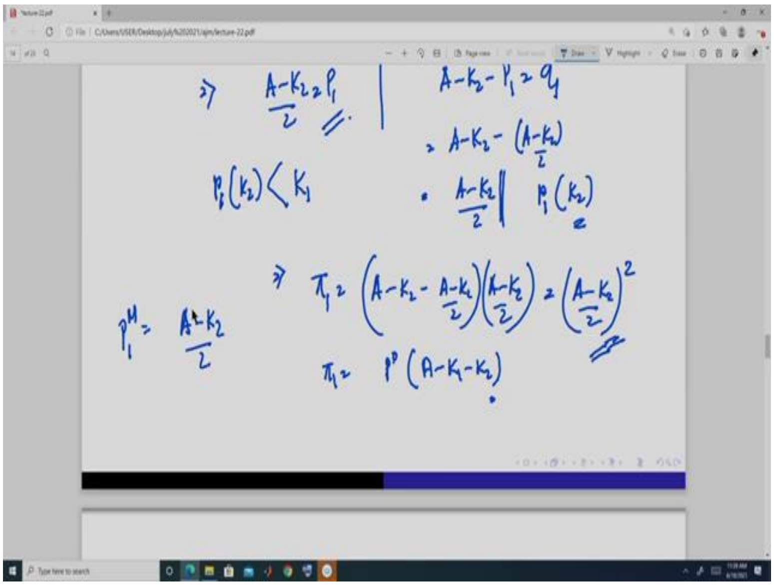
So, here pure strategy Nash equilibrium is p1 is this is the pure strategy Nash equilibrium. So, there is going to be continuous something called price war or undercutting of prices. So, finally, price goes down to 0 level, okay. So, in case 2 we get that the price is equal to 0. So, this is also obvious from the case that we have done in the first case when Bertrand competition between two firms and they have the same marginal cost and 0 fixed cost.

Now, there they have a positive marginal cost and that is the constant marginal cost. So, there the pure strategy Nash equilibrium is price of both the firms is equal to the constant marginal cost. So, same here, here the marginal cost is 0. So, the pure strategy Nash equilibrium is at that level of price that is price is equal to 0, okay. So, this proof and that proof is same. We get this.

(Refer Slide Time: 19:55)







Next one is a slightly complicated one. And here we compute the pure strategy Nash equilibrium for case 3A. So, we have already seen that case 3A is this. Here and this is the reaction function of firm 1, reaction function of firm 2 this and so this region is, all these region is case 3A, but when A is, when k is less than A, so it is only this portion. And this is the whole all this region is 3CA and we will prove the pure strategy Nash equilibrium here.

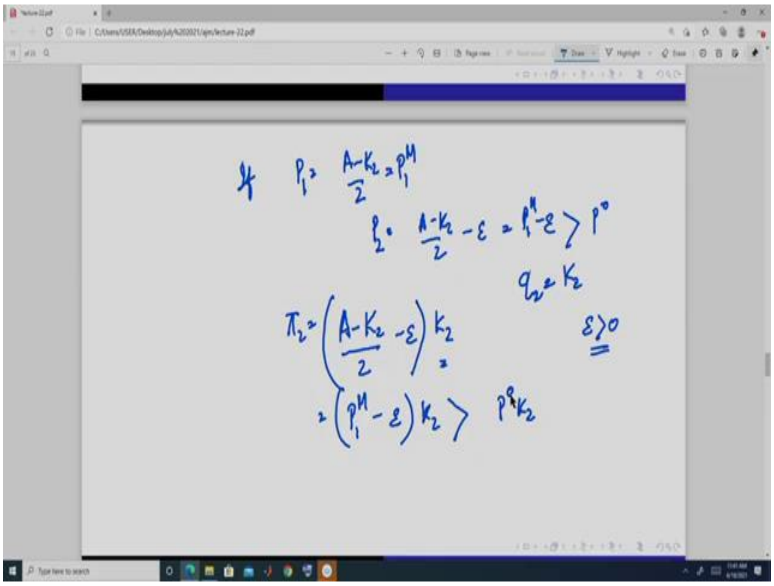
So, now, suppose we have a price p naught and the price is this-$P^0 = A - K_2 - K_1$. So, we get p naught to be a positive when k1 is less than A, okay. It has to be less than A. So, when k1, the capacity of firm 1 is less than A, so it is only this, this portion. It is only this portion, this region. Although CA includes all this, but if we take A less than, k1 less than A it is only this portion, but for this also it will, we will not see any difference.

Now, in this situation suppose firm 2 set this price p1, firm 1, if acts as monopolist in the residual market, if it acts as a monopolist in the residual market what is going to happen? Suppose, so it maximizes its profit this with respect to p1, because firms are setting the price and this is equal to this which is equal to here first order condition- $A - K_2 - 2P_1 = 0$and this gives us this-$\frac{A-K_2}{2} = P_1$, right?

Now, this is the demand curve faced by the firm 1- $A - K_2 - P_1 = q_1$and since it acts as a monopolist in this and this price is this-$A - K_2 - \frac{A-K_2}{2}$. So, we get this. So, again we know this is what, this is the reaction function of firm 1. So, since this is the reaction function and we are given, this is greater, so we are given k1 is greater than this. So, firm 1 can supply this amount, right?

And so here profit of firm 1 is this-$\pi_2 = \left(A - K_2 - \frac{A-K_2}{2}\right) A - K_2$ if we plug it in here and this is equal to this-$\left(\frac{A-K_2}{2}\right)^2$. This when firm 2 is producing k2 the best response for firm 1 is to produce this much and it is doing it here. So, this, even if we are, this is actually the Cournot outcome, right? So, it is based on the Cournot reaction function. So, this profit is definitely greater than the profit that firm 1 gets if it sets the price p naught this-$P^0 = A - K_2 - K_1$. So, firm 1 will set this price when firm 2 sets p naught. And let us call this price p1 and because it acts as a monopolist in the residual market, so this-$P_1^M = \frac{A-K_2}{2}$.

(Refer Slide Time: 26.25)



Now, if firm 1 sets this price if p1 is, so then it means it is acting as a residual, is acting as a monopolist in the residual market. So, then and price of p2 is this, firm 2 is this. So, firm 2 this is not a best response. What it will do? It will set a price p2 is equal to actually is equal to some epsilon amount which is greater than p naught and it is selling q2 is equal to k2, okay.

So, the profit of firm 2 is now-$\pi_2 = \left(\frac{A-K_2}{2} - \varepsilon\right) K_2 = (P_1^m - \varepsilon)K_2$, where epsilon, this is an epsilon amount which is positive and it is a very small number, okay so that they call sell k2 amount. So, this is definitely going to be greater than selling p naught k2 because this is greater than, this is less than this amount-$(P_1^m - \varepsilon)K_2 > P^0K_2$, okay. So, firm 2 is best response is this.

(Refer Slide Time: 28:08)

p_1^l, $\quad p_1^l K_1 = \left(\frac{A-K_2}{2}\right)^2$, $\quad K_1 < A$.

$$p_1^l = \left(\frac{A-K_2}{2}\right)^2 \frac{1}{K_1} \qquad K_1 \geq A$$

$$p_1^l = \left(\frac{A-K_2}{2}\right)^2 \frac{1}{q_1}$$

$$p_1^l < \left(\frac{A-K_2}{2}\right) = p_1^M, \quad p_1^l = \left(\frac{A-K_2}{2}\right)\left(\frac{A-K_2}{2}\right)\frac{1}{K_1}$$

$$\left(\frac{A-K_2}{2}\right)\frac{1}{K_1} < 1 \qquad \frac{A-K_2}{2} < K_1$$

p_1^M, p_1^l. $\quad p_1^M = p_1$, $\quad p_2 = \left(\frac{A-K_2}{2} - \varepsilon\right)$

K_2.

$$p_1 = \left(\frac{A-K_2}{2} - \varepsilon - \delta\right)$$

$- K_1$

p_1^M, p_1^l. $\quad p_1^M = p_1$, $\quad p_2 = \left(\frac{A-K_2}{2} - \varepsilon\right)$

K_2.

$$p_1 = \left(\frac{A-K_2}{2} - \varepsilon - \delta\right)$$

$- K_1$

$$\pi_1 = \left(\frac{A-K_2}{2} - \varepsilon - \delta\right) K_1 > \left(\frac{A-K_2}{2}\right)^2$$

At p_1^l, $p_1^l K_1 = \left(\frac{A-K_2}{2}\right)^2$

$$\frac{A-K_2}{2} > \left(\frac{A-K_2}{2} - \varepsilon - \delta\right) > p_1^l$$

$p_1 \downarrow$, $p_2 \downarrow$.

$p_1 = p_1^l$

, $p_1 = p_1^H$ it will fall till $p_1 = p_1^l$

$p_2 = p_1^l - \varepsilon$, K_2

Firm 1 again acts as monopolist in the residual market.

$p_1 < p_1^l$, $\pi_1 = p_1 K_1$

$\pi_1 = p_1 K_1 < \left(\frac{A-K_2}{2}\right)^2$

At p_1^l, $p_1^l K_1 = \left(\frac{A-K_2}{2}\right)^2$

$\pi_1 = \left(\frac{A-K_2}{2}\right)^2$

$p_2 = \left(\frac{A-K_2}{2} - \varepsilon\right)$.

Firm 1, $p_1 = \left(\frac{A-K_2}{2} - \varepsilon - \delta\right)$

p_1^H, p_1^l

$p_1^H \downarrow \to p_1^l$

$p^H \leftarrow$

Edgeworth cycle.

Price war so prices fall to p_1^l

Again price rises to p_1^H after $p_1 = p_1^l$

Now, let us find another price and this price is suppose p1l. And this price is such that p1l into k1 is this- $P_1^l K_1 = \left(\frac{A-K_2}{2}\right)^2$. So, suppose firm 1 is selling up to its capacity, so, okay this k1 has to be less than A and it is setting a price which is a positive price and the profit is equal to this- $\left(\frac{A-K_2}{2}\right)^2$ when it acts as a monopolist in the residual market. So, this price is actually we can write it in this form and it is this, okay. Now, if suppose k1 is very high and suppose k1 is greater than equal to A, then p1l you can think as some quantity q such that their product and this is equal to this-$P_1^l = \left(\frac{A-K_2}{2}\right)^2 \frac{1}{q_1}$, okay.

Now, here, the interesting thing here is this is actually less than this which is-$P_1^l < \left(\frac{A-K_2}{2}\right) = p_1^M$. Why, because p1l is equal to-$\left(\frac{A-K_2}{2}\right)\left(\frac{A-K_2}{2}\right)\frac{1}{k_1}$. Now, here this number- $\left(\frac{A-K_2}{2}\right)\frac{1}{k_1}$is less than 1, because of the condition that we get this, okay. So, that is why pl is less than. And in this case we will take this p1l and q in such a way that p1l is less than this price, okay. So, now we have two price p1m and p1l. Now, we know that when p1m is set by firm 1 then firm 2 set a price which is this- $\left(\frac{A-K_2}{2} - \varepsilon\right)$and it sells up to its capacity.

Now, firm 1 can also set a price p1 which is equal to minus epsilon minus suppose some small amount delta, okay and it sells an amount up to its capacity k1. So, here in this case profit of firm 1 is going to be this-$\left(\frac{A-K_2}{2} - \varepsilon - \delta\right) K_1$. Now, this is going to be greater than, because at p1l profit p1l into k1 is equal to this much amount, right? and this price A1 minus this, this is greater than p1l and this is less than this-$\frac{A-K_2}{2} > \left(\frac{A-K_2}{2} - \varepsilon - \delta\right) > P_1^l$. So, what happens, firm 1 is also going to undercut the price.

As firm 1 undercuts, so firm 2 also undercuts and so prices of p1 is going to fall, price of firm 2 is also going to fall and it is going to go falling till p1 is equal to p1l. So, the price of firm 1 starting from p1l it will fall till p1 is equal to p1l, okay. So, at p1 now suppose p2 is to sell it can slightly reduce its price which is small amount and sell k2 units of output.

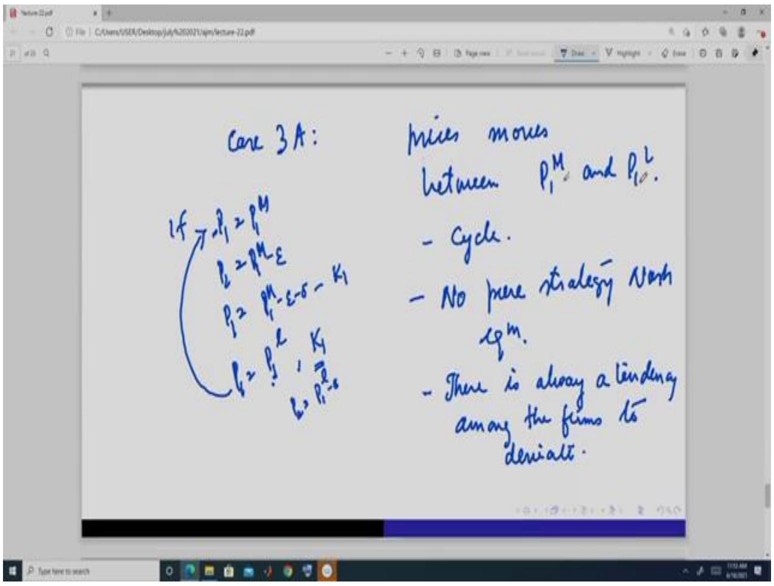
Now, here firm 1 is not going to act like this. Here firm 1, because if it sets a price which is less than this, then profit of firm 1 is going to be this and this profit is going to be less than this amount- i.e. $\pi_1 = P_1 K_1 < \left(\frac{A-K_2}{2}\right)^2$, because at p1l we know p1l k1 is equal to A minus this-

$\left(\frac{A-K_2}{2}\right)^2$. So, firm 1 here in this case firm 1 again acts as monopolist in the residual market, okay. So, in this case profit of firm 1 is again going to be like this-$\left(\frac{A-K_2}{2}\right)^2$.

Now, firm 2 can gain if this is the price then firm 2 is again going to set a price like this-$\frac{A-K_2}{2} - \varepsilon$. Now, if firm 2 sets a price like this, then again firm 1, is going to set p1 which is equal to delta very small amount, so like this. And then there is going to be price war. So, prices fall to p1l then at this again price rises to p1m after p1 is equal to this. So, what is happening? So, there is going to be some kind of a cycle and this cycle is going to be between p1m and p1l. So, price will oscillate between this.

So, from here it will move to p1l by falling, so price will fall and it will reach this and then from here it will start move to this and then again, so it will be like this. So, this is called Edgeworth cycle, okay. Edgeworth is a great economist and he first discovered this cycle, okay. But he did not use any game theory to discover this, because at that time game theory was not there, but he talked about this price competition like, okay. So, and we get this kind of cycle in this situation in case 3A.

(Refer Slide Time: 36:47)

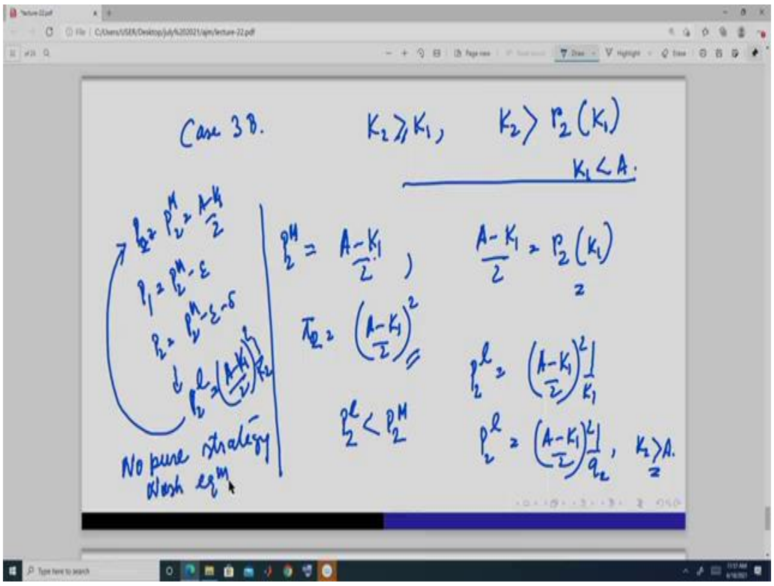


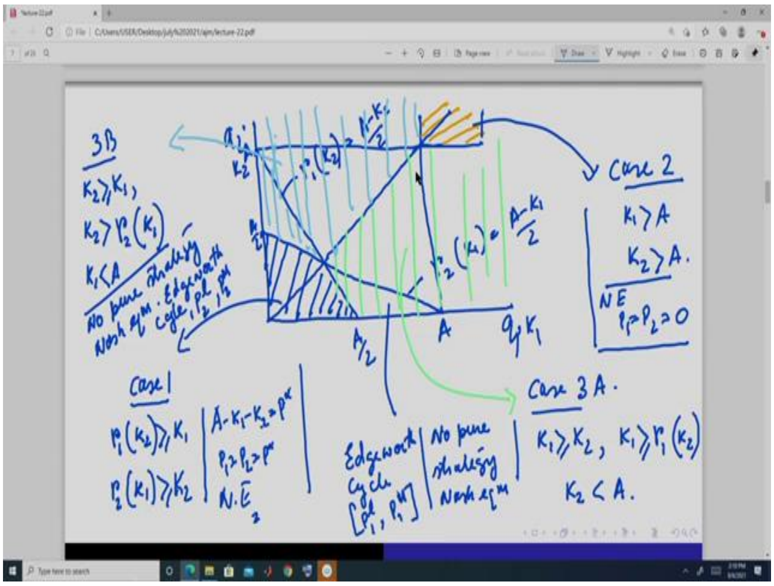
So, in case 3A what do we get, we get that the prices moves between p1m and p1l and there is a cycle, so no pure strategy Nash equilibrium, because there is always the tendency among the firms to deviate, right. So, if p1 is equal to p1m then p2 is equal to p1m epsilon, then p1 is a again a small amount delta, like this it will go on and it will fall till p1 is equal to p1l and when, after this it is again is going to be like this.

When firm 1 sets this price, it is selling k1 units. So, firm 2 it is going to slightly reduce the price, because at this price both the firms cannot sell up to its capacity. So, by slightly reducing the price, it can sell up to his capacity. So, p2 here is going to be this minus a very small amount and then it can sell up to its capacity, so then firm 1 is not going to go below this price. So, it will set this.

Now, when firm 1 set this price, firm 2 is never going to set this price, because p1l minus epsilon is less than p1m minus epsilon. So, firm 1, firm 2 will set this price. So, when firm 2 sets this price, firm 1 since we have this price, we know by slightly reducing it can sell up to its capacity. So, here again it will sell up to its capacity like this. It will go on cycling, okay. So, in case 3 we have no pure strategy and the price will oscillate or you can see cycle between p1m and p1l.

(Refer Slide Time: 39:32)





Now, we talk about the case 3, again, case 3B. So, here it is this-$K_2 \geq K_1$. Okay, Now, in this case, again, so capacity of firm 2 is greater than A. So, we will have p2m which is like this-$P_2^M = \frac{A-K_1}{2}$, because we can derive this. So, this is, so at this place because the reaction function of, is this and when it wants to produce this much or act as this much, so if firm 1 is already producing k1 units so the market demand is going to be this price only, right? as we have already got, right. So, this is, okay.

Now, similarly again, so here profit of firm 2 is this-$\left(\frac{A-K_1}{2}\right)^2$. Now, based on this we can derive one another price this- $P_2^l = \left(\frac{A-K_1}{2}\right)^2 \frac{1}{K_1}$ which is or and this p2l is less than m or we can find another price p2l which is like this if k2 is greater than A in this case. Now, here again we know the price is going to oscillate between these two price. So, firm 2 first set a price like this p2 is equal to, p2 is suppose pm2 and that is, then p1 is going to be p2m minus epsilon. Then firm 2's price is going to be epsilon minus some delta and like this price will fall and it will reach this, like this-$P_2^l = \left(\frac{A-K_1}{2}\right)^2 \frac{1}{K_1}$.

And after that it will again rise to this, because firm 2 is never going to reduce a price below p2l, because if it is better to act as a monopolist in the residual market because the profit is same here if price is p2l and the price is, if it acts a monopolist in the residual market. So, again when it acts as a monopolist in the residual market firm 1 is not going to reduce the price but it will set a price slightly less than p2m. And then again there is going to be price war, same argument. And based on that, we get that there is again no pure strategy Nash equilibrium.

So, what do we get? So, if you look at this diagram, so we got that in case of 3A we shown that in this region we have, so here we have no pure strategy Nash equilibrium. And instead what do we get, we get that there is, the price will, there is a something called Edgeworth cycle and price cycles between p1l and p1m in this range, okay. And in this 3AB we again got there is, it is same as this case, but only the thing is it is the capacity of firm 2 is greater. So, again here, there is no pure strategy Nash equilibrium. And what we get that the, there is Edgeworth cycle and price will oscillate or cycle between p2l and p2m, okay.

So, for all this reason we have no pure strategy Nash equilibrium, in this region also no pure strategy Nash. Here we have got there is a unique pure strategy Nash equilibrium and that is Nash equilibrium is p1 is equal to p2 it is equal to 0. So, in case 2, we get this outcome. We have shown that. And we have already shown that the in case 1 we have unique pure strategy Nash equilibrium and it is a positive pure strategy Nash equilibrium, price is positive. It takes a positive value and this is p star, where at p star the market demand is such that the firm 1 and firm 2 sales up to its capacity. Firm 1 sales k1 unit, firm 2 sales k2 unit.

But in this two region, in this portion and in this portion we found no pure strategy Nash equilibrium. There actually exists a mix strategy Nash equilibrium, but we are not going to do that, okay. So, now, here you may be this portion is also in the 3B, so I missed it. So, this whole portion is in 3B and this whole portion is in 3A.

So, in Bertrand competition with capacity constraint we see that when the capacity lies within certain range, then we find pure strategy Nash equilibrium. And if the capacity is sufficiently big that is each firm can supply or can meet the demand of the whole market that is the whole market, the maximum demand that can be there in this market is A units, so if each firm can meet this A units, then there is a pure strategy Nash equilibrium and the price is equal to 0.

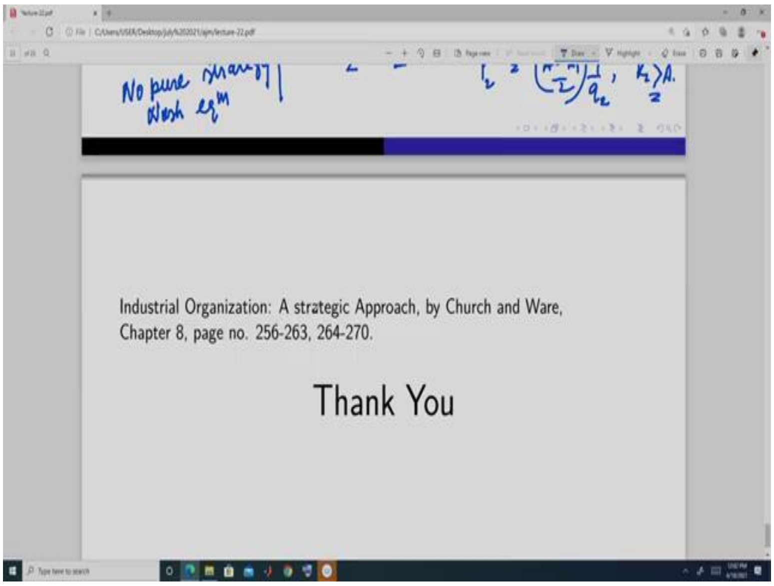
But if the capacities are in the intermediate region between these two and suppose the capacity of firm 1 is greater than capacity of firm 2 and it lies within these two case then which is the case 3A then we find no pure strategy Nash equilibrium. And when the capacity of firm 2 is greater than the capacity of firm 1 and it lies within these range that is 3B then also we find no pure strategy Nash equilibrium.

And in this situation we find that there is a cycle and the cycle is in case 3A price will start from, if the price started from p1m that is the monopoly price in the residual market, it will move down till p1l. And when it reaches p1l it again it will move to p1m. So, like this there is going to be a price changes in the price by each firm. They will charging different prices.

Now, in 3B again we will have p2l and p2m and the price will cycle between these two. So, it will oscillate between these two. So, if the price starts from p2m then there is going to be a price war and it will come down to p2l. And then again price will rise and it will rise to p2m. So, like that it is going to cycle.

So, with this I end the portion on capacity constraint in Bertrand competition. So, with this I conclude the Bertrand with capacity constraint, okay. Now, actually, I had allotted three lectures on this Bertrand competition with capacity constraint, but I could complete it within two lectures. So, the next lecture I will allot it to one more topic in Bertrand competition and it is a very interesting. So, we will introduce decreasing returns to scale in Bertrand competition and we will see what kind of results we get. So, thank you very much.

(Refer Slide Time: 50:17)



And for this reason you can go through this book Industrial Organization, A Strategic Approach by Church and Ware and these are the specific page numbers of the chapter 8, okay. Thank you.