Foundation Course in Managerial Economics
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Lecture - 39
Oligopoly – Game Theory (Contd.)

Hello and welcome back to our discussion on oligopoly. We have looked at possible oligopoly model where we have looked at the traditional marginal cost, marginal revenue curves, what profit maximization would mean to a oligopolistic firm and we have looked at kinked demand curve and then we went on to understand a little about game theory because we said that in case of oligopoly it is more like a game for every individual firm where the firm has to keep not only a constant watch on its own demand and cost but also a constant watch on the price and quantity movements of its rivals.

And that is the reason that it is more like a game where the oligopolistic firm has to constantly make its own strategy or action plan to respond against different moves of its rivals. So we looked at the typical very traditional game of prisoner's dilemma which shows that why the 2 prisoners or why 2 individuals can settle on a less than optimum situation because of self-interest, they are driven by self-interest and so the choices that they make ultimately put them in a situation where they are not earning the maximum that they could have.

So this we started with game theory. Let us take a few more examples and see what are the situations, how the situations can change. Is there any possibility that the firms could actually stay put at a monopolistic situation. Is it possible for the firms to successfully collude? So we will see take a few examples and look at various possibilities.

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Vodafone and Airtel example relook as a Game

- Each firm's objective is to maximize profit
- They collude and decide to produce the monopolistic output together and charge the monopoly price
- So each produces 30 units and get a profit of ₹900
- If one breaks the agreement and produces 40, he gets ₹1000 and the other gets ₹750
- If both break the agreement, each gets ₹800
- What is each firm's dominant strategy
- What is the Nash Equilibrium?

So going back to our Vodafone and Airtel example, we look at the example, we relook at the example as a game. So now to quickly go through the example once more. Each firm's objective is to maximize profit. They collude and decide to produce the monopolistic output together and charge the monopoly price.

So each produces 30 units and gets a profit of 900 Rs. If one breaks the agreement and produces 40, he gets 1000 Rs and the other gets 750. If both break the agreement, each gets 800 Rs. So what is each firm's dominant strategy and what is the Nash Equilibrium? That is what we are interested in and let us look at the same problem as a game and try to draw the payoff matrix for this example.

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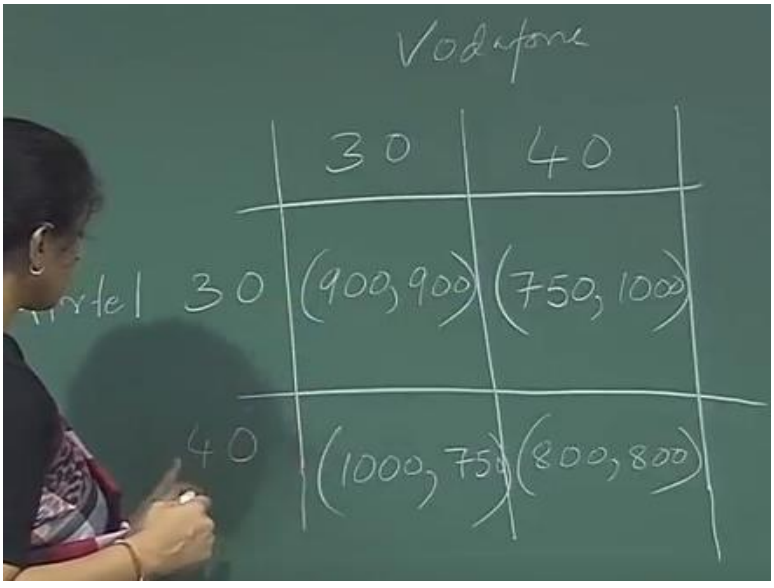

So we have Vodafone here and we have Airtel here and what are the choices that they can make? So they have colluded and they have decided they know, each of them knows that if they stick to the monopoly price and if they stick to the monopoly quantity of 30 units each that is the total output of 60 units in the market in that case each can earn a profit of 900 Rs.

So one option for them is to stick to the agreement and keep producing 30 units each. So that is one of the options; keep producing 30 units each. Now the other option is since price is now fixed each of the firms could be tempted to produce a little more. So if he produces a little more then he gets a bigger share of the market and ends up getting a higher profit.

So that is another choice. Say for example they can choose to produce 40 units each. So the other option is to produce 40 units each and then what is the, what does the payoff matrix look like then? So if each of them produces 30 units then the payoff matrix has profit of 900 for each firm.

If each of them ends up producing 40 units, both are producing 40 units so that the total output in the economy, in the market goes up to 80 units, in that case profit drops to 800 and 800 each. Now if Vodafone decides that I am going to produce 40 units and Airtel decides I am going to produce, Airtel continues to produce 30 units in that case Airtel is going to get a profit of 750 because now it is producing less and Vodafone is producing more and hence Vodafone gets a profit of 1000 Rs.

And the opposite happens when Airtel basically defaults on the agreement and produce 40 units and Vodafone sticks to the agreement and produces 30 units. In that case Airtel is going to get 1000 Rs and Vodafone gets 750. So this is what the payoff matrix actually looks like. So if we try to think about the decision making process of each of the firms in the framework of a game then the payoff matrix looks like this.

So since this is the payoff matrix how do they decide? So Vodafone decides that I have a choice either to produce 30 or 40. What should I do if Airtel has produced 30? So if Airtel has produced 30 it makes sense for me to produce 40 because in that case I will be getting a higher profit. What happens if Airtel has produced 40?

What happens if I cannot trust Airtel and Airtel actually ends up producing more. So what happens in that case, what should I do, what should my strategy be? So in case of, so the Vodafone now sees, looks at the payoff in both the cases and sees that if Airtel produces 40 I will be worse off if I continue to produce 30 and I should better be producing 40 so that I am at least I am at least getting 800 Rs which is same as what Airtel is going to get.

So in both the situations no matter what the decision of Airtel is, it makes sense for Vodafone to produce 40 units and same is the case for Airtel. Hence 40 units is the dominant strategy for each of the firms. So each of the firms it makes sense to produce 40 units and so this ends up becoming the Nash Equilibrium for both. So this is the Nash Equilibrium for both the firms. So this is how we look at the decision making in the framework of a game.

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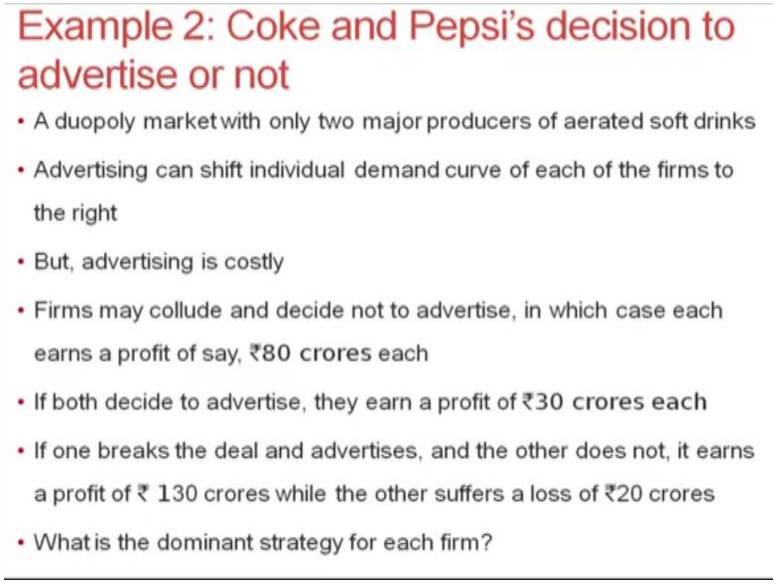

Let us move on to another example, let us take up another example where basically it is a duopoly situation, it is a duopoly market with only 2 major producers of aerated soft drinks. That is we have the Coke and the Pepsi. They are the only ones who are supplying aerated soft drinks to this market and they have to make a, take a decision of whether to advertise or not.

So we have already spoken a quite a lot about advertisement, advertising, the pros and cons of advertising from the point of view of the firm also and we have seen that it is possible for the firms to attract a larger amount of customers to themselves by just advertise through just by advertising.

So it is a kind of product differentiation a notional differentiation that the firms are able to create in the minds of the customers. So now the but at the same time advertising can turn out to be really costly for the both the firms so it is the decision that how much I am going to gain by advertising because my demand is going to go up against how much am I going to lose because my cost is also going to go up because I will be spending so much money on advertising.

So each of the firms knows that they would have been better off if none of them advertised. So if none of the firms advertise in a market then no one needs to spend anything, so the demand is basically continues to be the same for everyone so there is no possibility of one firm poaching on the customers of other firms just to advertisement.

So this is the decision that the since there are only 2 firms in the industry it is one could imagine that the 2 firms would collude or cooperate and say that see it is costly for both of us so let us not advertise. So let us see what happens. So advertising can shift individual demand curve of each of the firms to the right but advertising is costly.

Firms may collude and decide not to advertise in which case each earns a profit of say 80 crore rupees each. So let us assume that this is the amount they earn each of the firm is earning if they are not advertising at all. Now if both decide to advertise, they earn a profit of Rs 30 crores each.

Why has the profit gone down? Because it is costly for both the firms and since both the firms are advertising so the impact on demand for both the firms is probably cancelling out and the net result is that both are incurring higher cost without much increase in demand for both the firms.

Now what happens if they decide that let us advertise and then one firm basically breaks the agreement and goes on to advertise.

In that case what is going to happen in the market is although the firm which is actually breaking the agreement his demand is going to go up because he has advertised and the other firm has not advertised so he gets to he successfully is able to attract a lot of customers of the other firm which is not advertising.

So in that case since the other firm's customer base falls that is his demand curve shrinks and the demand curve of the firm that is advertising shifts to the right the firm the advertising firm gets a high profit of say 30 crores, while the firm which has not advertised he suffers a loss of say 20 crores, I am sorry it is it would not be 30, it should be 130 because now the profit is very high; he, it is earning a high profit.

So these are the so if one breaks the so if one firm breaks the deal and advertises and the other does not, it earns a profit of 130 crores while the other suffers a loss of 20 crores. So what is the dominant strategy for each firm in this case? So again let us look at the payoff matrix for each of the firms.

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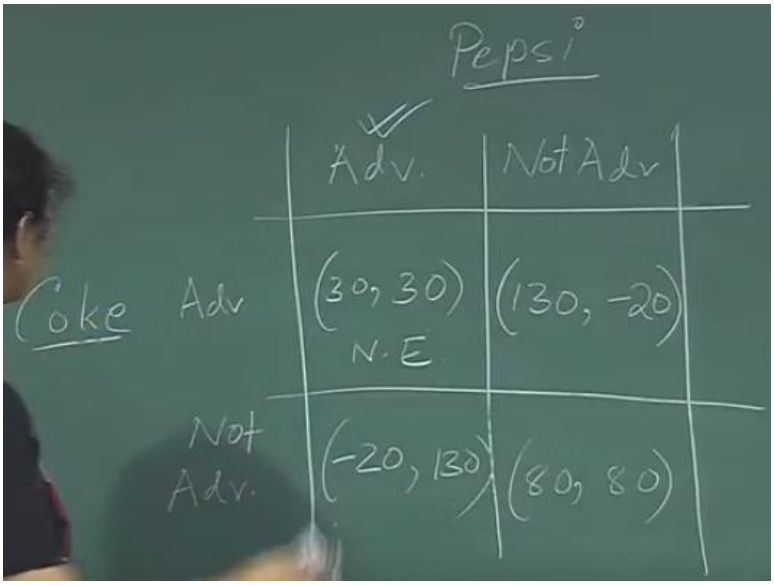

So we have Pepsi here and say these are the 2 players and their options are to advertise and no advertise. Again here Coke also has similar options of advertise, not advertise. So these are the options that they have and as per our payoff matrix so if they if both advertises then each gets 30, 30. They do not advertise then each gets 80 and 80.

If Pepsi does not advertise and Coke advertises then Coke gets a very high profit of 130 and Pepsi has a loss of Pepsi incurs a loss of 20 crores, so we denote it as -20 and in case where Pepsi advertises and Coke does not advertise it is just the opposite. So it is -20 for Coke and 130 for Pepsi.

So again so it is now you probably know you have probably understood the exercise how we are going to decide what is the dominant strategy for both and we see that the dominant strategy for Pepsi is to advertise because when Coke advertises Pepsi's payoff is more here in case of advertising; when Coke does not advertise, then also Pepsi's payoff, Pepsi's payoff is more in case of advertising.

So advertising is the dominant strategy for Pepsi and the same for Coke also when Pepsi advertises Coke's payoff is 30 and in case of not advertising it is sorry and Pepsi not advertising it is -20. So in case of Pepsi also it is for Coke also it is advertising and in case of Pepsi also it is advertising.

So what they end up is this is the dominant strategy and this becomes their Nash Equilibrium. So this becomes their Nash Equilibrium. So although had they stuck to the agreement of not advertising each would be better off by getting a profit of 80 and 80, but since each of them acts

on their self-interest and each of them is not being able to trust the other completely they end up in this box where they end up with a profit which is much lower than the collusion situation where they successfully collude.

So this is the example of Coke and Pepsi's decision. Now the question is does that mean that cooperation is never possible? Does that mean that cooperation is never possible because had that been the case then probably we would not be having, we would not be needing a law to stop Cartelization.

So Cartel's successfully sometimes run and that is the reason that the competition law is always watchful of firms if they are having any collusion and charging a monopoly price or quantity in the market. So there is a possibility of collusion and let us look at a few situations where cooperation may be possible.

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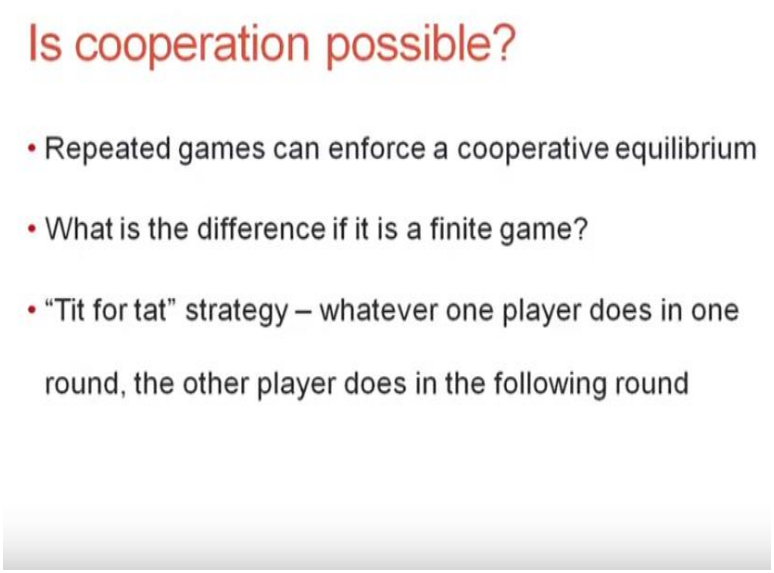

Now repeated games can enforce a cooperative equilibrium. How so? So let us take the same example and look at what happens. So let us go back to the same example. Now what happens this is a one-time situation. So this is a one-time situation of Pepsi and Coke deciding or not deciding to advertise and then in this situation this is the payoff that we are this is the equilibrium that we are reaching.

Now what happens if it is a repeated game which means that this is a decision or this is a choice that Pepsi and Coke has to make every year. Say for example every year they have to make this

decision whether to launch a new advertisement, new campaign or not. So this is a repeated game and in that case if it is a repeated game, then what is possible?

So in a repeated game now the Pepsi and Coke both know that if I break the agreement in the following period, if I break the agreement my rival is also going to break the agreement. So in that case I am worse off later. So although so let me give an example.

Say for example Pepsi and Coke they, say for example Pepsi tells Coke that let us collude, let us decide not to advertise but if you advertise, if you break the agreement then in the following all the periods I am going to advertise. So if this is a threat that one firm gives to the other in that case cooperation is possible, how so?

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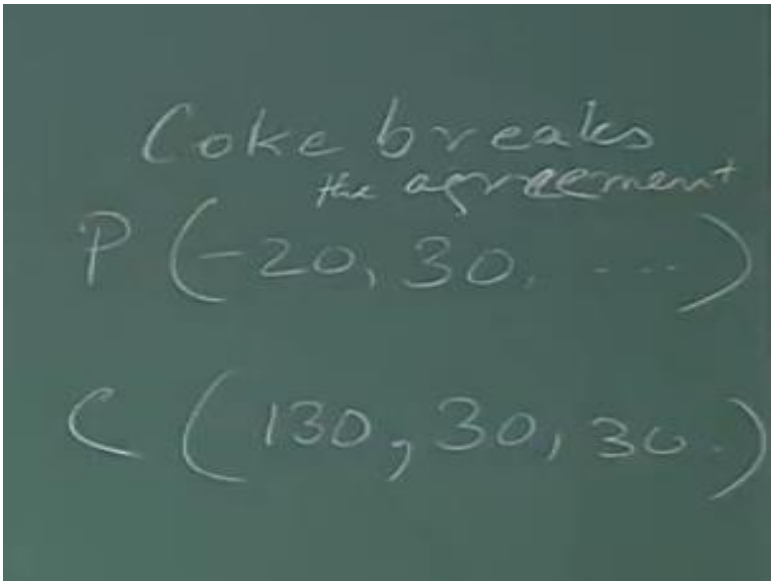

So let us look at their payoffs. Now say for example Pepsi gives the threat and both decide that we are not going to advertise, so for Pepsi and Coke. Now Pepsi has given Coke this threat. Now Coke if it decides that if I break the agreement then in the first period I am going to earn in the first period I am going to earn 130 crores and Pepsi is going to make a loss of 20 crores. In the following periods so once Pepsi suffers this loss Pepsi is never ever going to not advertise.

So Pepsi is going to advertise in all the following periods because that is what Pepsi has threatened to do. So in that case in all the following periods Pepsi will be earning a profit of 30 crores and Coke will also have to earn a profit of 30 crores because then it does not have any

other because it knows that Pepsi is going to advertise in the following period so Coke is also going to advertise in the following period and all the consequent periods they are going to get a payoff of 30 each.

So this is the situation when Coke decides to break the agreement. Now what is the payoff if Coke does not break the agreement? So this is where Coke breaks the agreement. So what happens if Coke does not break the agreement? So let me write it here itself.

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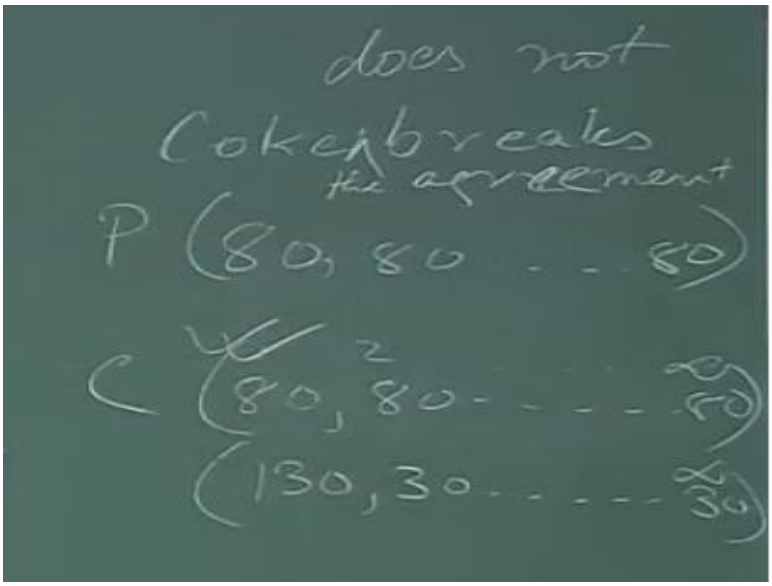

So when Coke does not break the agreement, in that case each earns 80 crores in all the periods. So in that case, so in all the periods, in all the periods both are going to earn 80 each. So obviously to Coke this is a better situation than 130. So this is a better situation than this. This is a better situation than this because earning 130 in the first period and 30 in all the consecutive periods compared to earning 80 in all the periods is always so this is always a better choice for Coke, so Coke is going to stick to the agreement.

So this is where cooperation is possible and why is cooperation possible here? For Pepsi this is a worse situation. For Pepsi this is a worse situation because for Pepsi it earns a loss in the first period. So one thing that needs to be kept in mind is the objective of the firm is to maximize its own profit.

The objective of the firm is not to harm its harm its rivals or not to create a situation where the rival gets a earns a loss. So that is not the objective of the firm and since the objective of the firm

is to maximize its own profit so none of the firms is going to break the agreement. So in case of repeated games, repeated games can enforce a cooperative equilibrium.

So even going back to the so this is although this is a situation of threat where actually I said Pepsi imposes a threat on Coke that I am going to always advertise later but that is not always necessary because sometimes the players learn through the game. Say for example in the case of prisoner's dilemma it is possible if they are repeatedly getting caught and repeatedly the same thing is happening probably they will learn over the overtime during the repetition of the games that it is better not to talk. So repeated games can enforce a cooperative equilibrium.

Now what is the difference if it is a finite game? So here I said it goes on till so they know that forever from now we are going to earn this profit of where no one advertises. But what happens if say for example in the same situation where Pepsi has given a threat that I am going to advertise in the later periods and all of a sudden both of the firms come to know that in 10 years' time the government is going to pass a law that no one can advertise aerated soft drinks.

The advertisement of or promotion of aerated soft drinks is banned. So they know advertising will be banned from on the 10th year. Say note know that advertising will be banned on the after the 10th year. So till the 10th year from this is the 10th year and beyond that advertising will be banned. So in that case what are they going to do?

So in that case Pepsi just go to the situation of the 10th year now Coke knows that in the 11th year Pepsi cannot exercise the threat because advertising will be banned in any case. So to the in the 10th year Coke is going to break the agreement. So Coke is going to break the agreement in the 10th year and Pepsi also knows the same.

Pepsi knows that Coke is going to break the agreement in the 10th year. So Pepsi is also going to advertise in the 10th year. Now come back a year earlier in the 9th year Pepsi knows that Coke is going to break the agreement in the following year so and Coke also knows that he is it is going to break the agreement in the following year so they both advertise in the 9th year.

So this thinking or making or strategizing in this way or planning in this way, each of the firms come back a year earlier and they know that in the following period the agreement will be broken and the knowledge that the agreement will be broken at a later year basically breaks down the agreement in the very first year.

So in the from the very first year itself both are going to advertise and or this threat does not hold if there is a finite time for which the threat is applicable. So in that case both are going to

advertise from the very first period for the 10 years and after that in any case there is no advertising. Okay another strategy is tit for tat strategy. Whatever one player does in one round, the other player does in the following round.

So this is also a situation where cooperation is possible because the firm learns from the reaction of its rival. So the year that it has advertised following year the rival is going to advertise. If it does not the other also does the same. So it knows that it can trust the other firm to do exactly the same thing that it does in the first year so in that case cooperation is possible because in that case cooperation in case of cooperation both of them are better off.

So this was about game theory. In the following module we are going to look at different ways of pricing in case of a oligopoly firm. Thank you.