Strategy: An Introduction to Game Theory
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Lecture - 51

Hello, welcome to mooc lectures on Strategy, An Introduction to Game Theory. In this module, I am going to talk about a Paradox called Chain Store Paradox.

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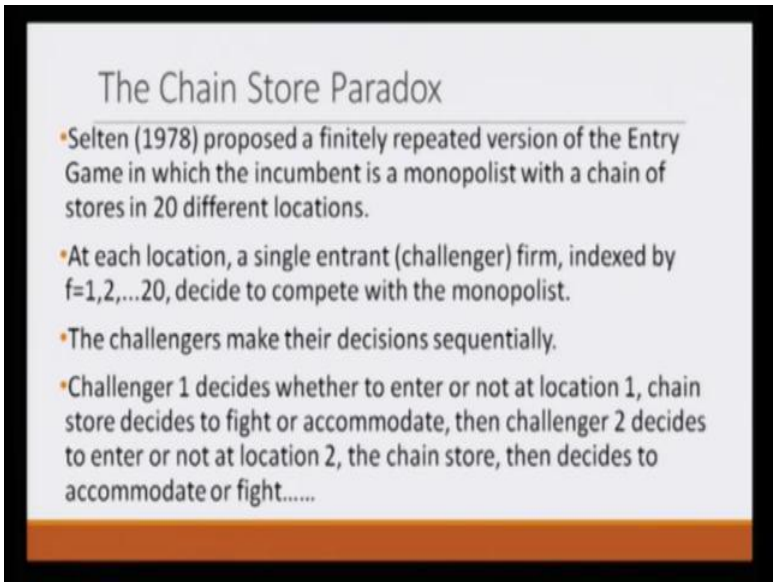

So, we have been talking about repeated game, we have learned extensive form game, this paradox arises, because of the result that we obtained in the case of extensive form game and repeated game. So, this is the setting Selten, who also won Noble Price for his contribution in game theory, he proposed a finitely repeated version of an entry game.

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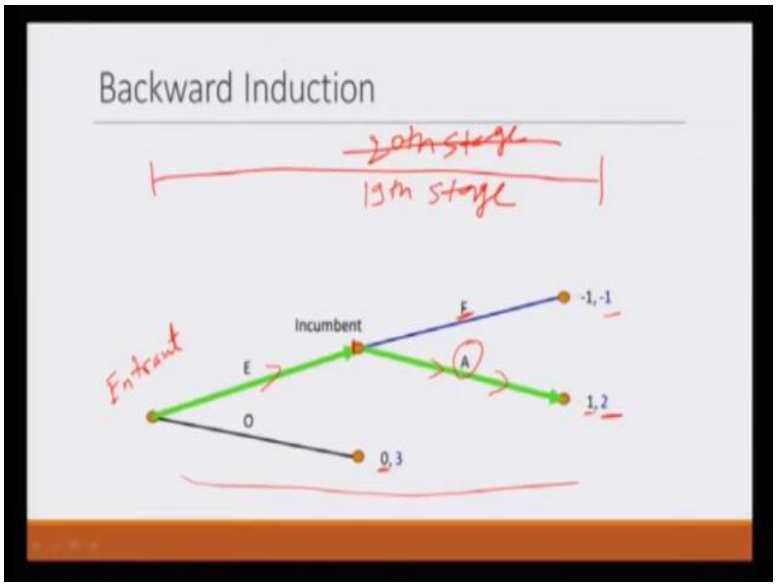

Remember, the entry game that we discussed in the during extensive form game, this is the entry game, what we have that we have here an entrant, we can call this entrant a challenger and we have incumbent. Entrant can either decide to enter in the market or remain to opt out of the market and if entrant decides to enter in the market, then incumbent either decides to fight or accommodate and accordingly, they get the payoff.

The details you should refer back to ((Refer Time: 01:21)) extensive form game. So, Selten proposed a version of this entry game in which the incumbent means player 2, who gets to move second is a monopolist and who has a store at 20 different locations. At each location a single entrant or challenger indexed by 1 to 20, so that we can give them different name, they either decide to enter in the market or remain out of the market; they decide to compete with the monopolist. These challengers they make their decisions sequentially, it is not that all together, they try to enter into 20 different markets, these 20 different challengers, they decide whether they want to enter in the market or not sequentially starting from 1, 2, 3 and towards 20.

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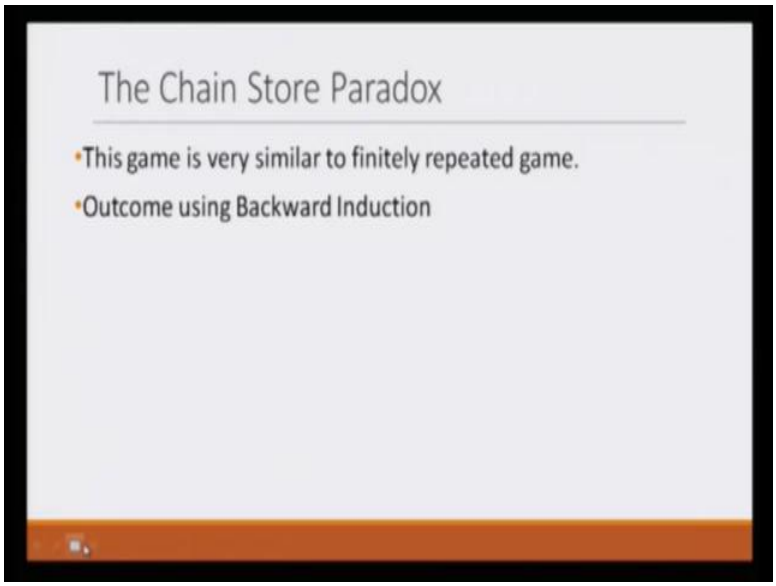

So, how should we solve this game? As we have already talked about, it is very similar to finitely repeated game and we should be able to use the backward induction. What does this backward induction say ((Refer Time: 02:36))? Let us say of course, this is at the, we are talking about this game at the 20th stage, this is being played. And of course, there will be many more subgames like this, because there will be branches after each player depending let us say, if we call this at the first stage, let us say, what happens in the second stage. The same game we have to draw here, here, as well here at three places.

So, just in two stages we get four subgames, one whole game and at the second stage, three subgames. Similarly, if we want to do in the next stage, everywhere we will have to use this game again. So, at 20th stage that game tree will become really, really large and combustion, but it would be easy to deal with it, because in the 20th stage all the games would look like this entry game. So, it is very, very easy to solve, then no one has to worry about, what happens afterward, so they would play rationally.

So, in the 20th challenger what would 20th challenger do, let us think of it using backward direction, the 20th challenger would decide based on what incumbent is going to do. And incumbent, if given an opportunity at this point would accommodate as we have learned, because accommodate gives 2 and this fight gives minus 1, 2 is greater than minus 1.

So, incumbent if given an opportunity to play decides to accommodate, the entrant or the challenger at the 20th stage would know that this is what going to happen. So, if entrant enters, then afterward incumbent would accommodate, an entrant would earn 1 and if entrant decides to remain out of the game, entrant would earn 0. This logic we had discussed during extensive form game. So, 1 is of course greater than 0, so entrant will decide to enter and incumbent will accommodate.

Now, let us think about the 19th stage, in 19th stage what happens, the 19th challenger would know, because he is a rational player. The structure of the game is known to everyone, so he would know what is going to happen in the 20th stage. The 20th stage incumbent is going to accommodate, once entrant enters in the market. So, 19th challenger or entrant would know this.

So, again what do we need to do at 19th stage, this game will be played, but again we will have to modify the payoff accordingly, but when we modify in all the branches, in all the histories, we have to add the same number. So, nothing would change and 19th entrant would decide to enter and challenger would accommodate. If we follow this logic and let us come to the first challenger, the first challenger would also enter in the market and incumbent would accommodate.

The logic is very similar to what we have seen, when we talked about the finite repetition of prisoner's dilemma game. So, using backward induction what do we learn that in all the markets challenger or entrant would enter in the market and the monopolist would accommodate them.

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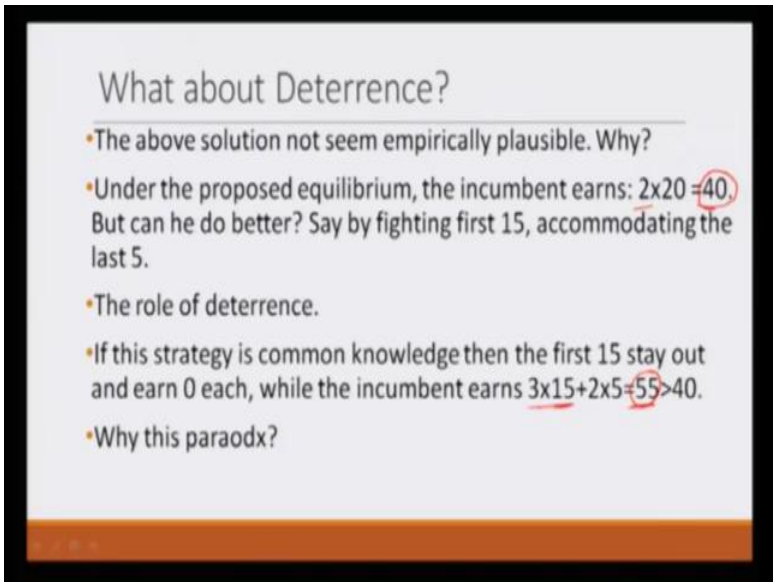

But, is it the best strategy for the monopolist? Let us see, let us think about another strategy in which the incumbent decides to fight, first 15 of the challenger, first 15 of the entrant and for remaining 5, it decides to accommodate them. So, what happens let us see, because this would be known to it is common knowledge and we are talking about perfect information game, so everyone knows everything.

So, what happens, first 15 challengers would decide to remain out of the market. So, in that case what happens ((Refer Time: 07:15)), let us see what happens the incumbent earns 3. So, his total earning would be 3 and this happens in the 15 market. So, 15 multiplied by 3, 45 and in remaining 5 market, ((Refer Time: 07:31)) the incumbent would accommodate, so he would earn 2, so 5 multiplied by 2, so total of 55.

But, let us say what subgame perfect equilibrium suggests that in all the market, the incumbent would accommodate and knowing this the entrant would enter in the market. So, in that case in all 20 market earning for the monopolist would be choose, so the total earning would be 40. Now, if we compare this 55 with 40, of course, 55 is greater than 40.

So, is it not this a better strategy, a strategy which is starts sub imperfect gives better payoffs to the monopolist, 55 in comparison to 40. This is also called deterrence that in the beginning, because of aggressive behavior, the monopolist is about to deter the entry of these challengers in the market. So, this is the paradox, how can we resolve it.

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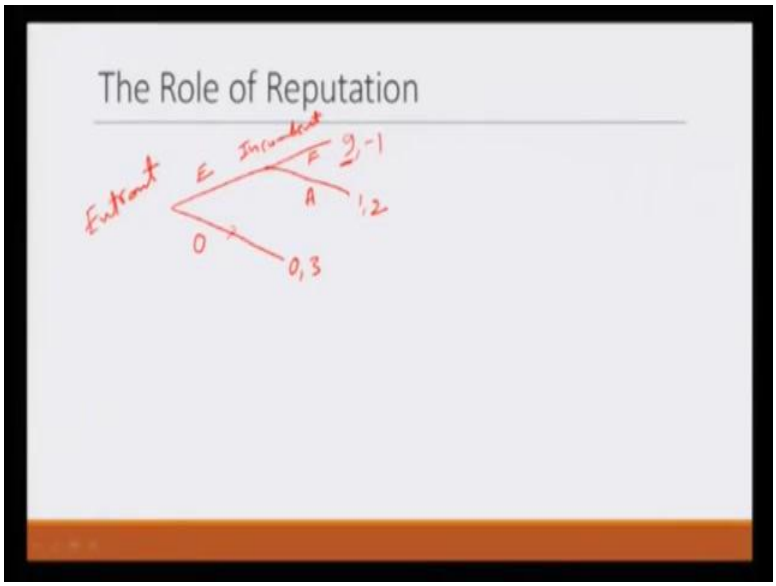

Now, let us think that incumbent and entrant, they are following; they are playing slightly different game. In this game, what happens, if I draw let say for example, here is entrant, here is incumbent Entrant either enters or remain out, if they remain out, payoff remain same 0, 3 and here it is fight or accommodate. In case of accommodate, let me check how much I have written earlier ((Refer Time: 09:15)), it is 1 comma 2, it is 1 comma 2 and earlier, I had retain minus 1 minus 1, both of them they get minus 1 minus 1 in the file.

But, let us assume that there is a one present chance; that is a very slight chance that incumbent is one who likes fighting. So, and he gets plus 10 payoff just for fighting. So, we let me rewrite it. So, payoff here is 9 comma minus 1, having own this, what would if this is the case, what would be the outcome in this game, the outcome would be very simple, because entrant knows that once it enters in the market, incumbent would fight. So, that is why entrant would decide to remain out.

So, now let us say there are two possibilities, slightly possibility 1 percent or 5 percent that player incumbent is of fighter type, were he gets a positive payoff from fighting. ((Refer Time: 10:22)) But, there is a major chance 99 percent or 99 percent incumbent is of this type. So, what happens let us think about the first challenger, first challenger enters in the market, because he puts very little bit of weight on this fighter type of

incumbent. So, he says most likely incumbent is going to accommodate, once I enter in the market.

But, what happens he observes enters in the market and then, what happens the incumbent fights. So, of course, now he loses his money, but he cannot do anything about it. But, the challenger to, the entrant to, potential entrant to put observe this and what would we do, he would update his believe. Now, he would put more weight not just to 1 percent or 5 percent, but much higher weight that it incumbent is of fighter type.

So, he may decide to enter or he may decide to remain out, but if he decides to enter and let us say incumbent fights again, then what happens, the next challenger would have this believe, know he enjoys this fighting and then, he would decide to remain out. So, he would deter, the monopolist would deter the entry of this challengers. Let us modify our argument little bit more, let us say that, this incumbent, there is no possibility that at least incumbent knows that he is not a crazy type. But, now he learns that, if he acts crazy, then it is beneficial for him, he would earn 55 in place of 40.

So, he pretense that he is a fighter type and he fights. Now, not only entrant, incumbent knows this, entrant also knows this, that incumbent can even pretend that he is a fighter type. Now, after in incumbent fights with challenger 1, then challenger 2 does not learn anything new, why because he does not know this thing will be become clear, when we talk about signaling little later. That he does not know whether the information, he is getting the fight that he is saying is actual fight or incumbent is acting like he is a fighter.

So, he does not know, he has no new information, he would not be able to update his believe that incumbent is fighter type and so on. None of the players would be able to update they are believe. So, again if we start with from the backward side 20th challenger, he would know, he has this information that most likely the incumbent is normal type, very slight percentage is that, he is the fighter type.

And the fight that he has observed, he is not able he would own able to figure out, whether it is, because incumbent is fighter or it is because incumbent is normal type, but he is pretending to be a fighter. So, he would not update and he would go with the actual game and again, he would enter in the market and in the 20th stage, incumbent has nothing to show, nothing to proof, nothing to do for his reputation, because there is no more game left.

So, what he would do, he would definitely accommodate and if we start with the logic and move in the backward side, again all the challengers would enter in the market and incumbent would accommodate all of them. So, what is happening we are getting into circular logic, we do not understand, what is happening here? One thing is very, very clear that this paradox is difficult to resolve at this level, where we have limited information, limited knowledge of game theory.

But, if we allow for mix strategy, what is happening that maybe the incumbent is playing a mix strategy, write in the beginning to show that to build the reputation; that is the possibility that we are not exploring. So, that is one way to answer for this paradox, ((Refer Time: 14:48)) but nevertheless, this is a paradox that we observe.

Thank you.