Managerial Economics
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Lecture - 36
Oligopoly and Game Theory (Contd…)

So, we will continue our discussion on game theory. Last class if you remember we discussed about the different assumption of the game theory. What is the need of game theory generally in which case what is the usefulness of the game theory is there in the economic analysis? Then, we discussed about the structure of a game, and then we took a small example to understand. What is the dominant strategy? What is the maxmin strategy? And what is the minmax strategy? And how generally equilibrium is achieved when there are two dominant strategy. Then, we introduced the concept of Nash equilibrium. And, Nash equilibrium if you remember this is the best action given by the player whatever the irrespective of whatever the opponent does that is the best strategy; that is the generally the Nash equilibrium.

So, taking the, taking the example of both the firms to advertise or not to advertise. What we discussed in the previous session, the same example we are going to take to understand this Nash equilibrium.

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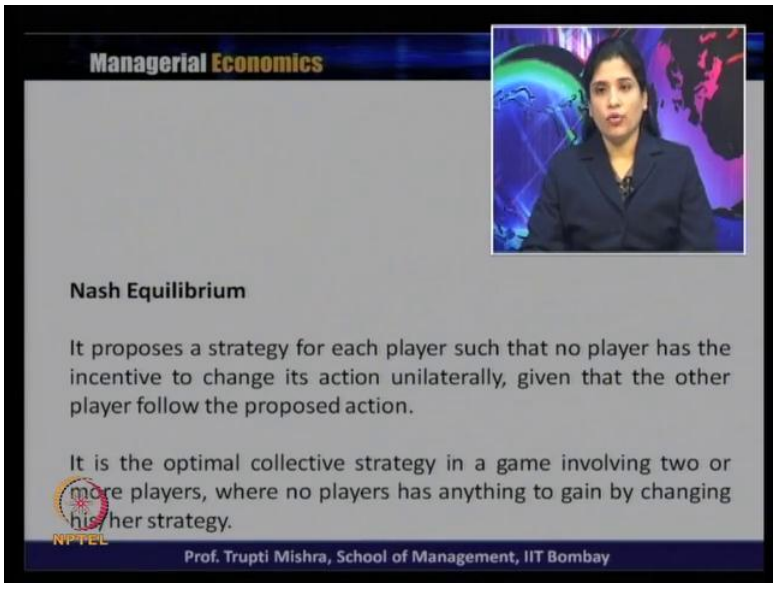

So, just to a quick recap Nash equilibrium is a strategy for each player as such that no player has the incentive to change its action unilaterally, given that the other player follows the proposed action. So, generally this is a state of equilibrium, this is a state of balance. Beyond which whatever the effort the player they are going to put it is not going to change their payoff and that is why this typical combination is called as the Nash equilibrium. It is generally the other way to put is that it is the optimal collective strategy in the game involving two or more players, where no player has anything to gain by changing his or her strategy. So, this is the point this is the optimal collective strategy. This is the optimal strategy for both the firms; beyond which whatever may be the change no player has to gain anything by changing the strategy.

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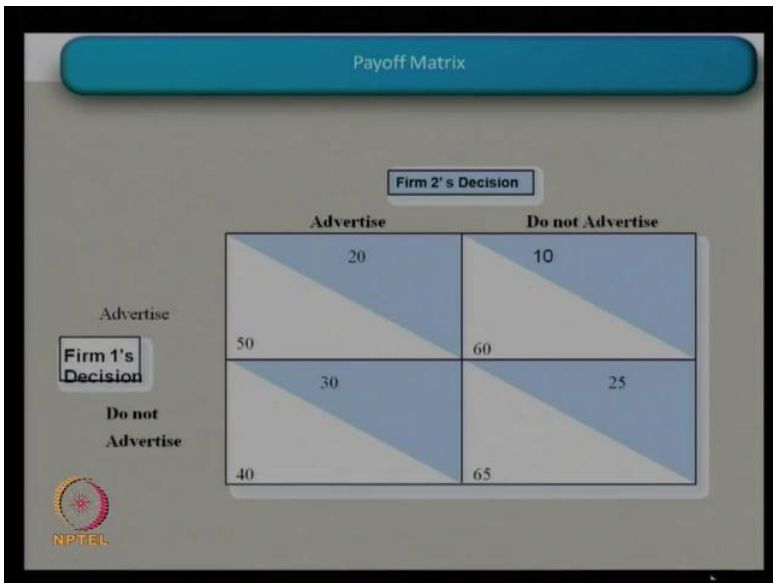

So, we will take the same example to understand this Nash equilibrium.

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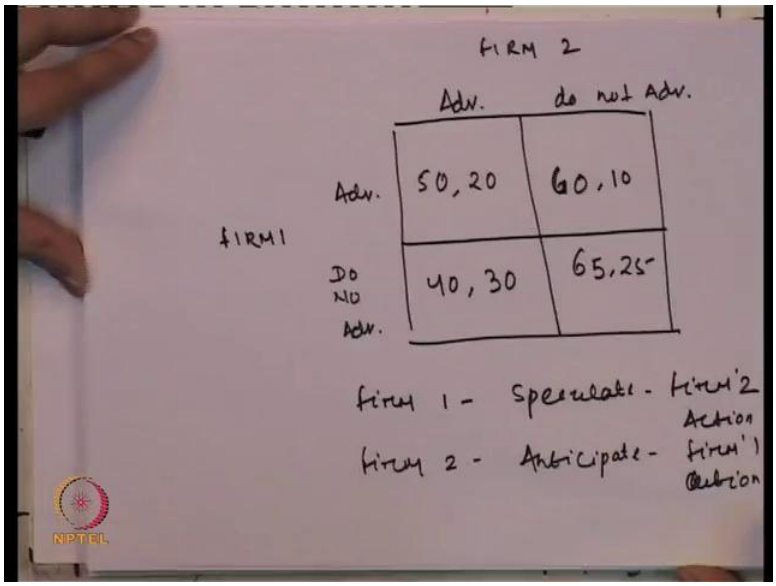

And, here there are two firms. Firm 1 and firm 2 and it is a choice between them that whether they should advertise or whether they should not advertise. So, we will take the case of firm 2 here. We will take the case of firm 1 here. It is whether they should go for the advertisement, whether they should not advertise. Here again we have taken the advertise and do not advertise.

So, when both the firms they are advertising. Firm 1 get a share of 50, firm 2 get a share of 20. When firm 1 advertise and firm 2 is not advertising. Firm 1 is getting 60 and firm 2 is getting 10. When firm 1 is firm 2 is advertising firm 1 is not advertising he gets 40; firm 1 get 40 and firm 2 get 30. And when both of them they are not advertising. They get a payoff of 65 by 25. Now, how we can decide their Nash equilibrium. Now, what firm 1 will try to do? Firm 1 will try to speculate firms 2 action action. And, in return what firm 2 will do? Firm 2 will also try to anticipate. What is firm 1 action?

Now, to start with let us see what, what the firm 1 will 1st do? So, to start with firm 1 will presume that that firm 2 is going to firm 2 is going to advertise. If firm 2 is going to advertise it is better for the firm 1 to advertise because in that case they are getting a payoff 50. If he is not going for advertising even if firm 2 is going for advertising he is getting a payoff of 40. What is best for him? Best for him to go for the advertisement because he will presume that anyway since it is the case of the market share the optimal output at the end of the day is that there should be increase in the market share.

And, market share how it will increase if firm they are going for the advertisement. So, in this case if firm 1 always presumes that the firm 2 is going to advertise. And, if firm 2 is going to advertise then in that case if firm 1 also advertises he gets a market share of 50. Whereas if he is not advertising; even if firm 2 is advertising he get a market share of 40. So, since 50 is greater than 40. It is always best outcome or the best payoff to go for advertisement.

Now, we will understand from the prospective of the firm 2. Now, how firm 2 will react to this or how firm 2 will behave in this case? So, firm 2 knows that same, same thought process again or the same speculation again, that since it is about the market share. Market share increases whenever there is a increase in the advertisement the more it reaches to the consumer more is the market share. So, in this case firm 2 will also think that anyway firm 1 is going to advertise because he has to increase the market share. And, if firm 1 is advertising, if firm 2 is advertising it gets a share of payoff because their payoff is 20. If firm 1 is advertising and firm 2 is not advertising that gets the share of 10. So, since 20 is greater than 10 this should be prefer or this should be the best outcome best strategy. So, for firm 2 also the best strategy or may be the decision of the firm 2 has to advertise.

Now, what is the Nash equilibrium? Nash equilibrium is since whatever the strategy taken by firm 1 irrespective of whatever the other firm is doing. If it is matching with the strategy whatever is taken by firm 2 irrespective of what firm 1 is doing. So, this is what? This is a similarity that both the firm they are going to advertise whatever the other firms they are doing. So, in this case it Nash equilibrium is Nash equilibrium for both the firm is to advertise and advertise. So, this combination of firm 2 and firm 1 is generally leads to Nash equilibrium because the whatever the best for b irrespective of whatever the best for b irrespective of what a does or whatever best for a irrespective of whatever b does if that equal then we get the Nash equilibrium.

So, Nash equilibrium is in this case specific case; whatever is firm 2 is doing irrespective of firm 1 that strategy is advertised and whatever is firm 1 is doing irrespective of firm 2 the strategy again to advertise. That is why to advertise and to advertise this combination leads to the Nash equilibrium. So, taking the same example we can understand that how generally when the both the company they are into a competition or they are into taking a decision making that whether they have to go for it not for it. In that case generally they

look at what may be the opponent choice, but here they have to when they have to reach a decision; they have to see that irrespective of whatever the other company is doing or whatever the other firm is doing. What they are getting out of it? Now, in this case both the firms they have the dominant strategy.

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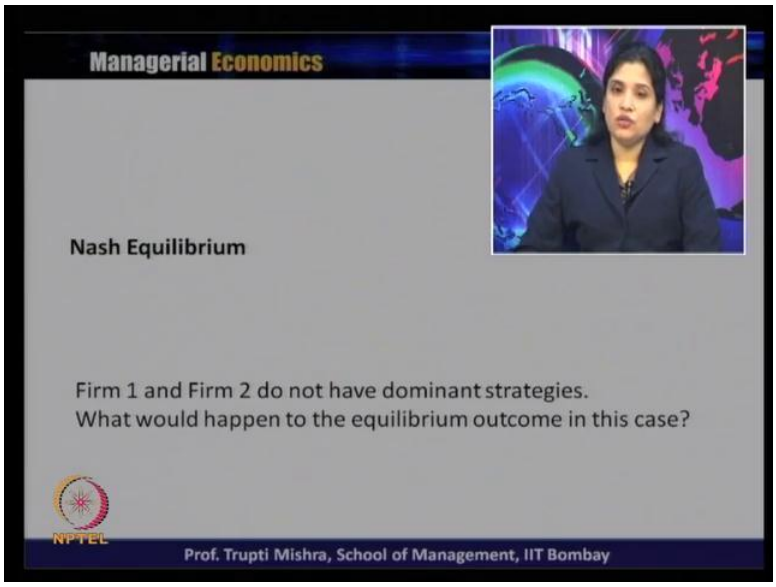

The dominant strategy for firm 1 is to advertise. The dominant strategy for firm 2 is also advertises. But maybe, we will get a case where firm 1 and firm 2 they do not have the dominant strategy. Now, what would happen to the equilibrium output in this case? Because it may it may happen that the payoff changes or the payoff is in such a way that there is no dominant strategy for one of them. Suppose one is having a dominant strategy; the other is not having a dominant strategy. In that case, what is the Nash equilibrium? Because Nash equilibrium is ideally the dominant strategy of 1 when it is matches the dominant strategy of the others, we get the Nash equilibrium.

But if any case if the there is absence of dominant strategy of one of the firm or may be the other firm in this case. What should be the equilibrium output? So, we will just change the payoff slightly, and we will see in this case when there is no dominant strategy. How the equilibrium output is achieved? So, we will just change the payoff matrix for firm 1 and firm 2. So, this is advertise, this is not advertising. This is advertising, this is not advertising. So, this is the payoff in the 1st case. This is the payoff in the 2nd case. This is the pay off in the 3rd case. This is the payoff in the 4th case.

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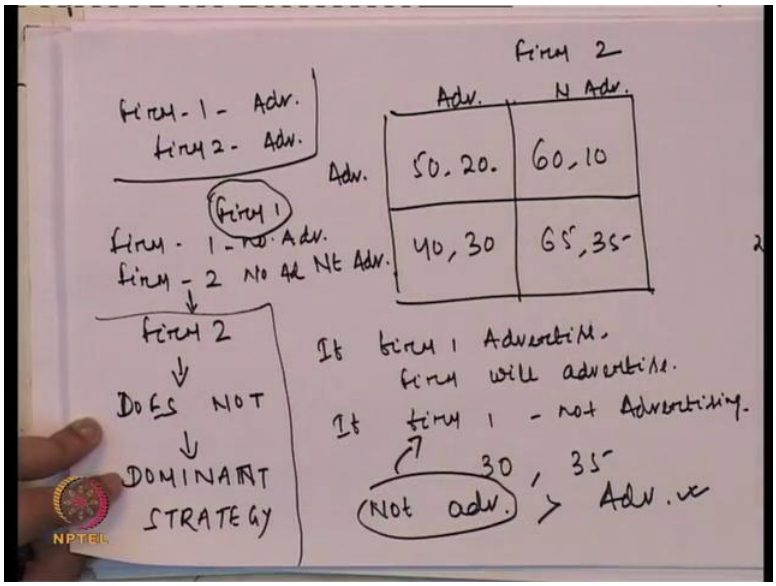

Now, we will start it again, how to whether we can reach the equilibrium looking at the strategy taken by firm a and firm 2. Now, suppose if firm 1 advertises. Now, what firm 2 will do? Firm 2 will also advertise, because it gets, it gets a better payoff in case of advertising like 50 and 40. Now, sorry it is 20 and 10, because 20 he gets by advertising by not advertising it is gets 10. Suppose, if firm 1 is not advertising. Now, here you need to look at the options that whether it is still profitable for the 2nd firm to go for the advertising. So, if firm 1 is not advertising

Now, what the firm 2 will do? Firm 2 will also not advertise because the payoff what they are getting from not advertising is higher than the whatever the payment they are getting from the advertising. So, in the previous case since this was 25 the pay off. It is profitable for the firm 2 to advertise even if firm 2 is not firm 1 is not advertising. But in this case if firm 1 is not advertising and firm 2 is advertising they are getting a payoff of 30. If they are not advertising when firm 1 is not advertising then they are getting a 35. So, not advertising payoff is greater than advertising and that is why they will prefer not to advertise, when the firm 1 is not advertising.

So, if you look at here. If now if you look at if firm 2 is advertising and this is for when firm 1 is advertising not advertising. What firm 2 should do? So, in this case when firm 1 is not advertising; firm 2 is also going to a strategy where it is where the 2nd firm is also not advertising. Similarly, if you look at now if the firm 2 is advertising and if firm 1 is

also advertising. And, if firm 2 is not firm 2 is not advertising, when firm 1 is not advertising. So, in this case specifically if you look at firm 2 it depends upon what firm does. So, if firm 1 advertise. Firm 2 also advertise. And, if firm 1 is not advertising, firm 2 is also not advertising. This leads to the conclusion that firm 2 it does not have a dominant strategy because the strategy are different whenever the opponent changes the whenever the opponent changes the strategy; even the other firm also they have to change the strategy. So, we reach to 1 conclusion here that firm 2 do not have a dominant strategy. Now, we will analyze the case for firm 1.

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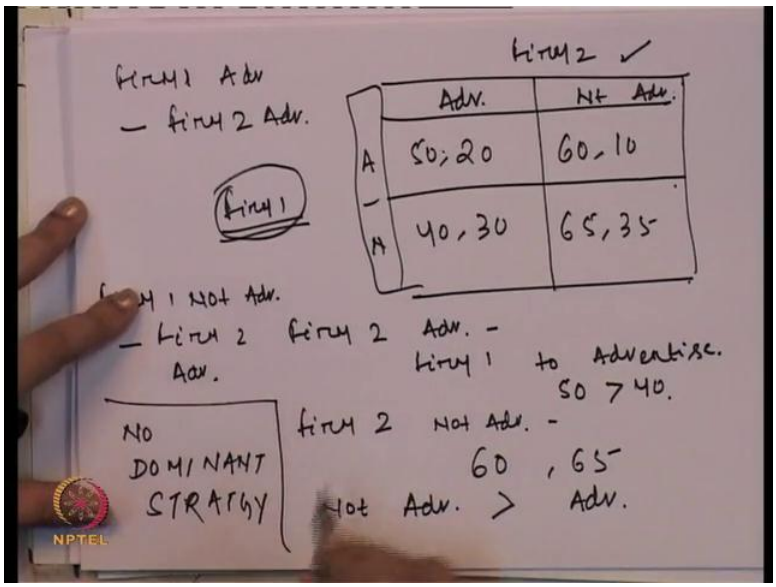

So, we will just take the payoff matrix for the reference. So, this is firm 2 advertising, not advertising. This is firm 1; again this is advertising, this is not advertising. And the payoff are 50, 20 40, 30 60, 10 and 65, 35. So, we have already reached to a conclusion that firm 2 does not have a dominant strategy because it is dependent on firm 1. If firm 1 advertise it advertise firm 1 is not advertising, it is not advertising. Now, we will analyze for firm 1 1. If firm 2 advertise then it is better for firm 1 to also advertise. Why it is better for firm 1 to also advertise? Because 50 the payoff of advertising is greater than 40 which is the payoff for not advertising.

This is one situation. 2nd when firm 2 is not advertising. In this case if firm 2 is not advertising, if firm 1 is advertising they get a payoff of 60. When firm 2 is not advertising and firm 1 is also not advertising they get a payoff of 65. So, not advertise is

the payoff of not advertise is greater than the payoff for advertise. Now, what is the best for a firm 1 here the or may be if you can conclude here that if firm 1 should advertise, if firm 2 is advertising. And firm 1 is not advertising, when firm 2 is not advertising.

So, we can say again here that firm 2; firm 1 is also having no dominant strategy because it is dependent on whatever the strategy taken by whatever the strategy taken by firm 2. So, if firm 2 is advertising, firm 1 is also advertising. And, if firm 1 firm 2 is not advertising firm 1 is also not advertising. So, in this case also if you look at there is no dominant strategy for firm 1 because it is not the best whatever the best that depends on dependent on the rivals action. And, in this case there is no specific action. It is all the dependent on the whatever the best that is dependent on the rivals action. So, in this case if you look at neither firm 1 nor firm 2 they have a dominant strategy. Now, how we should reach or how we should find out the equilibrium output over here or whether it is possible to get the Nash equilibrium.

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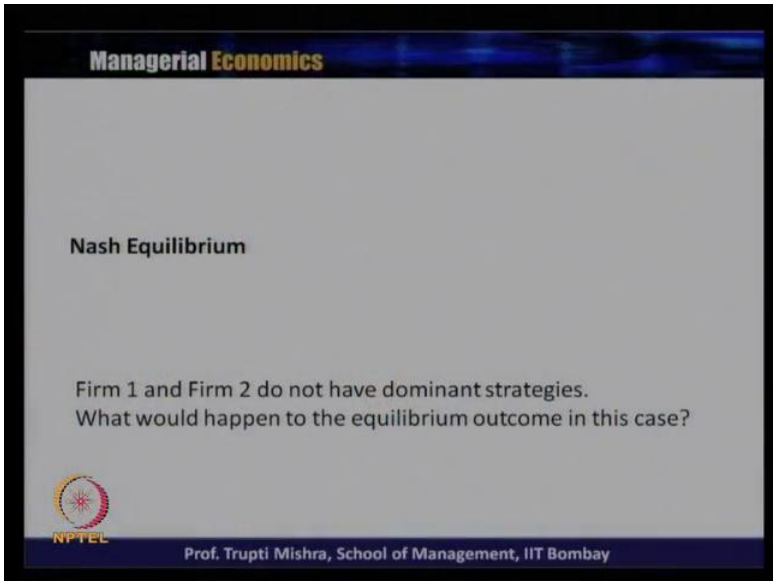

So, we have, we have checked a situation we have analyzed a situation where firm 1 and firm 2, they do not have the dominant strategy. What would happen to the equilibrium output in this case.

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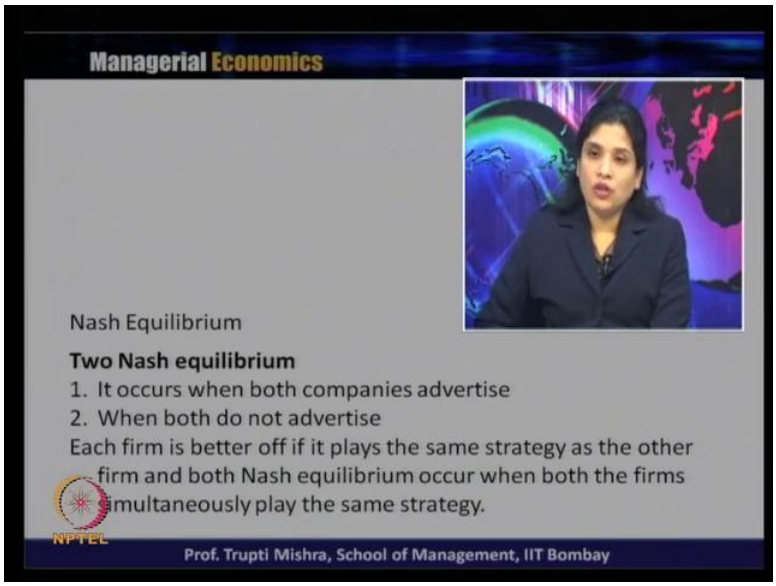

Here we will get to Nash equilibrium; we will not get a individual Nash equilibrium for the entire situation. Here we will get 2 Nash equilibrium. 1 Nash equilibrium it occurs when both companies they advertise. When firm 1 and firm 2 they are advertising both of them they are advertising we get 1 Nash equilibrium. And, when both of them they do not advertise we get another Nash equilibrium. So, when the dominant strategy of 1 is not matching with the dominant strategy of others or maybe there is a absence of the dominant strategy for both the firms over here. We will not get a individual Nash equilibrium for the entire game rather we will get 2 Nash equilibrium.1 Nash equilibrium occurs when both company advertise. And, 2nd Nash equilibrium occurs when both the firms they are not advertising.

And, here each firm is better off if it play the same strategy as the other firm. So, if 1 firm is advertising the other firm should also advertise. And, if the other firm is not advertising this firm also should not advertise. And, simultaneously both the Nash equilibrium occurs when both the firms simultaneously play the same strategy. So, it is not that when 1 firm is advertising and the other firm is not advertising the Nash equilibrium will come rather Nash equilibrium will come when both the firms simultaneously play the same strategy. If one is advertising the other one is also advertising, And, if 1 firm is not advertising the other firm is also not advertising. And, Nash equilibrium come Nash equilibrium comes when both the firms they play the same strategy at a particular point of time.

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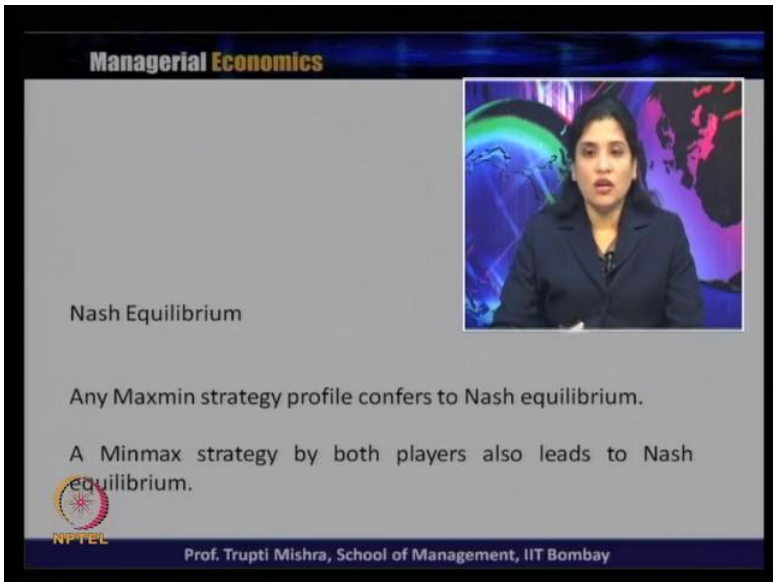

So, any maxmin strategy profile confers to Nash equilibrium because maxmin strategy generally this is the maximization of the worst payoff that confess to Nash equilibrium. And, also the minmax strategy where both the player also lead to Nash equilibrium. So, in the 1st case maximizing the worst payoff by both the players that will need to Nash equilibrium because it is basically in that case the player chooses a strategy which maximizes the payoff among the worst payoff; so that, in that case also, we can get a Nash equilibrium. And also, in case of minmax strategy, where the strategy is not to maximize something of the own pay off rather to minimize the payoff for the others. And, that is why the minmax strategy for both the players if you look at because one firm generally try to minimize the payoff for the others. And, at the same time the other firm is also trying to minimize the pay off for the other firm. And, in this case generally that also leads to a kind of a Nash equilibrium.

Then, we will discuss interesting generally, which is more common it is a kind of game generally followed to understand the human behavior rather than typical profit maximizing firm. And, how this specific game is also a part of if you look at also a part of the economic theory; because it is basically individual but when we generalize this to the individual firms or the economic agents generally they behave in that situation.

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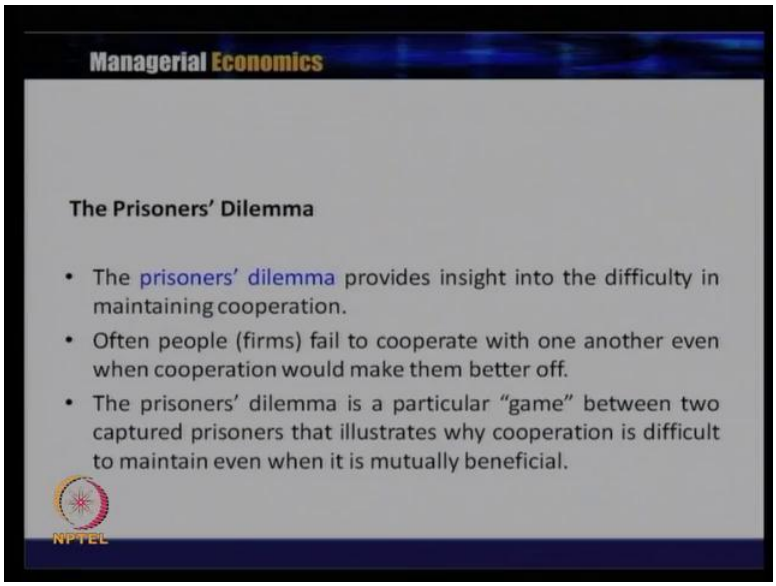

So, we will start like interesting case study or interesting kind of game where the basically the moral of this case study is that even if cooperation is profitable still they will not cooperate with each other because they feel that this is not going to the best for them. So, prisoners dilemma generally provides and insight into the difficulty in maintaining the cooperation. And, even if the cooperation is profitable still they find it difficult in maintaining the cooperation. And, which is the reason they never reach to the optimal solution they always get into a sub optimal solution. So, often people or when it comes to oligopolist firm. They fail to cooperate with one another even when they when cooperation would make them better off. So, they fail to cooperate whether it is a case of individual economic agent or whether it is a case of a firm they fail to cooperate with each other, when the cooperation would make them better off.

So, this prisoners dilemma it is a particular game between 2 capture prisoners that illustrate why cooperation is difficult to maintain even if when it is mutual beneficial. So, this is the, if you look at this is the case study of 2 captured prisoners. And, when they, they were captured by the authority they knew that the cooperation is going to help them out the cooperation is profitable but it always is difficult to maintain the cooperation. Finally, they land into a situation, which is sub optimal but that is not the optimal solution or that is not best solution for them.

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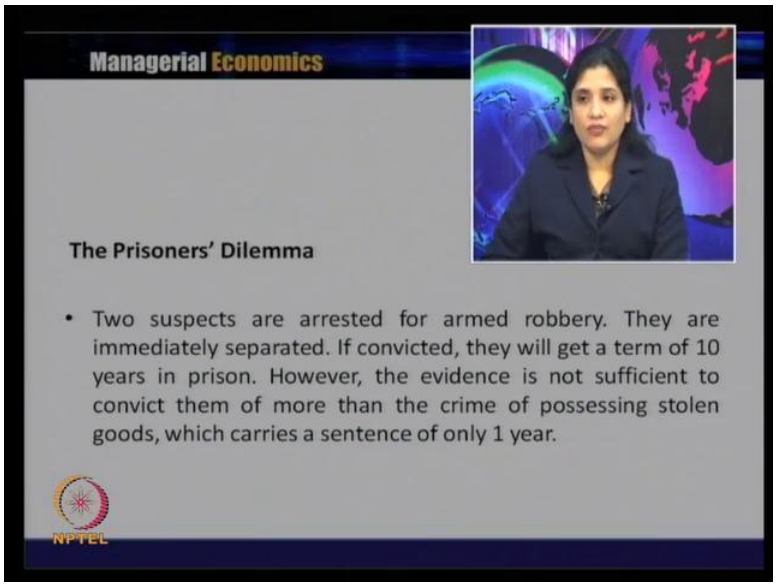

So, here two suspects, the story goes like this or the case study goes like this. Two suspects are arrested for a armed robbery. They are immediately separated they are taken into prison. So, the suspect they are arrested at for some robbery and immediately they were separated. There is no information between both of them there is no communication between both of them. And it is then choices were given whether they should confess or whether they should not confess. So, they are arrested, they are immediately separated. And, how the payoff will come?

If convicted they will get a term of 10 years in prison. If the, if the crime is it is proved they are getting conviction. And conviction they are getting 10 years in prison. The evidence is not sufficient to convict them more than the crime of possessing stolen goods, which carries a sentence of only 1 year; if the evidence is not sufficient to convict them, because it is a case of robbery. So, in this case, if the, it is not getting proved they cannot get the 10 years of prison. And they will just carry a sentence of only 1 one year, because they have 1 crime left that they have a possession of the stolen goods there in the with them.

So, if it is at if you look at its two different activity there are caught for being 1, but still they have some stolen goods. And, for them they will get the punishment for 1 year. But if they are getting convicted for bank robbery, they will get a punishment of 10 years.

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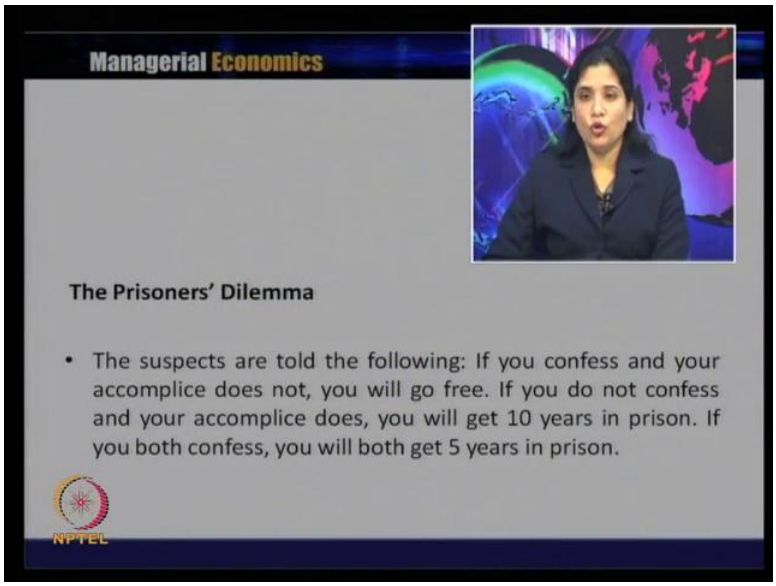

The suspects are given for information from the authority. They are told the following if you confess if you confess you your accomplice does not, you will go free. If you do not confess then you accomplice does you will get 10 years in prison. If you both confess, you will get both get 5 years in prison. So, these are the options given to the suspect. If you confess then you will go free because you have confessed that you have done the crime. If you do not confess, but your other 1 other 1 confess other the partner that confess then you will get 10 years and he will go free. If both you are confessing then you will get both get 5 years in prison.

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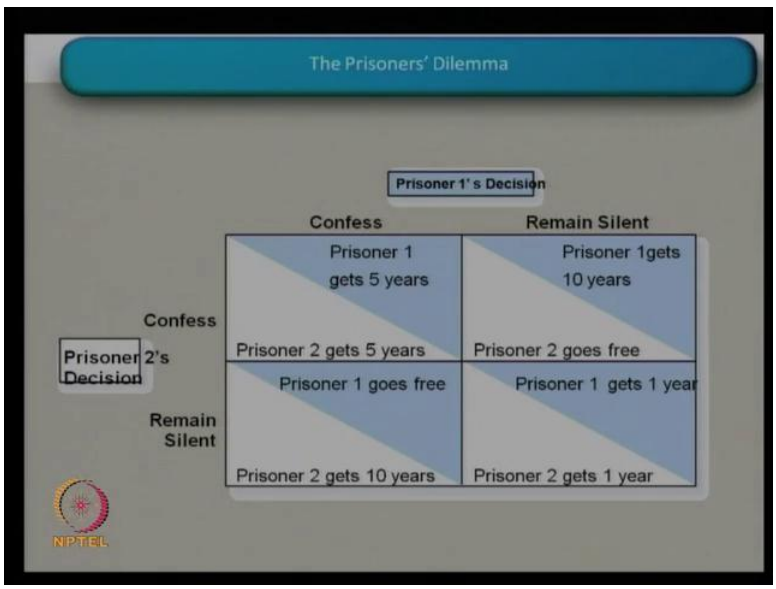

Now, from there we get they get this is the payoff matrix and, how these payoff matrix how the pay off matrix we can construct now.

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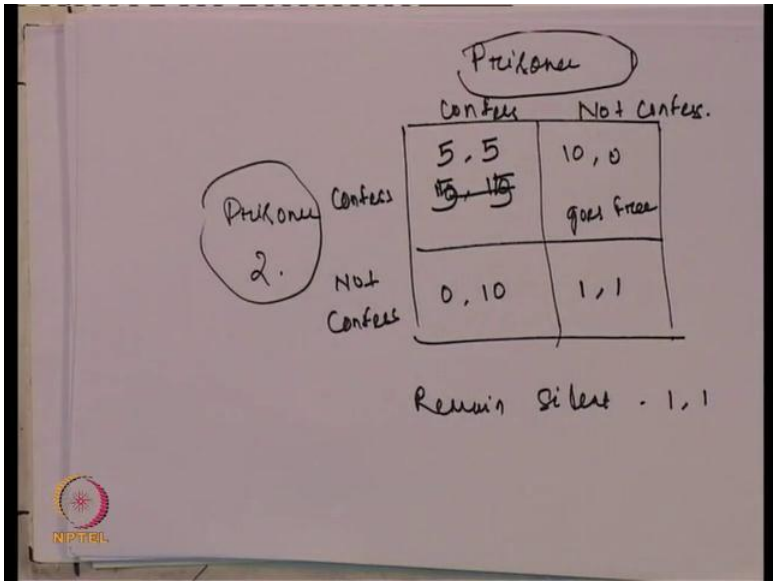

This is for prisoner 1, this is for prisoner 2. So, in this case he is getting 10 years both of them they are getting they are ok. So, both of them they get 10 years when both of they confess. Then, prisoner 2, if so let us call it, this is confess, this is not confess. This is confess, this is not confess. If both the prisoner 1 and prisoner 2 both of them they are confessing they are getting the sentence of 10 years. If prisoner 1, prisoner 1 not confessing, prisoner 2 confess then prisoner 1 here get 10 years. And, prisoner 2 gets prisoner 2, prisoner 2 generally goes free because he has confessed. Both of them they are not confessing prisoner 1 confess prisoner 2 not confessing prisoner 1. So, we call its 1 not then we can call it prisoner 1 goes free. So, we get 0 prisoner 2 is getting 10 years. Both of them they are not confessing they get 1, 1. Now, what is the best option or maybe we can just change this on the basis of our payoff.

So, if you confess and your accomplice does not you will go free and your accomplice will get 10 years. So, in this case there is a small change over here. So, this is 5 and 5. So, when both of them they are confessing they are just getting 5 years. When 1 is confessing the other 1 is not confessing; who is confessing he is going free the other 1 is getting 10. And, similarly if both of them they are not confessing they are getting 1, 1.

Now, what is the best option for them? If you look at best option for them is too silent. If they are not confessing remain silent they just get 1, 1.

But practically how this will happen? Practically this is not going to take place. Since, they are the rivals and since there is no communication between prisoner 1 and prisoner and prisoner 2; they will feel that if I am not going to confess the other 1 is going to confess. So, in this case I am going to get 10 years the other 1 goes free. And, in the same thought prisoner 2 also will think that if I am not going to confess the other is anyway going to confess. And, in that case I am getting a prison of 10 years and the other 1 is going free.

Here, if we look at cooperation is beneficial if both of them they are remain silent. If both of them they have the trust at the other 1 is not going to confess they will not they will remain silent. And they would have got just 1 year 1 year. But ideally how this will happen both of them? They will confess with the thought if I am not going to confess the other 1 is going to get the confess. And, in that case, he is going free and I am just getting I am getting more I am getting 10 years.

So, in that case with the same line of thought both of them they will confess. And, finally they will land in a they will land in a payoff which is not optimal rather this is suboptimal. Because the optimal 1 is here when both the prisoners they are remain both the prisoners they are remain silent. But they are not silent they both of them they are going to confess. And, that is the reason they will end into a suboptimal solution and which is may be not the Nash equilibrium for here you cannot get a Nash equilibrium. And, finally they will end in a situation which is not optimal rather it is a suboptimal situation.

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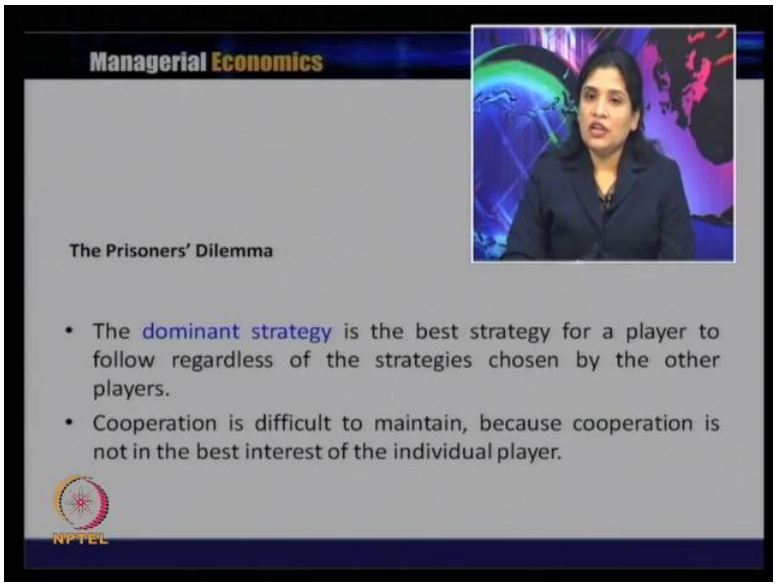

Now, the same thing so if you look at here again. What is the dominant strategy? The dominant strategy is the best strategy for a player to follow regardless of the strategy chosen by the other player. So, in this case can we say that when we confess that is the best strategy. Because a best strategy for both the prisoner because what is the dominant strategy? Dominant strategy is 1 where irrespective of whatever is the other 1 is doing that is the best strategy. If prisoner would not decides to remain confessed that should be the best strategy irrespective of what other is doing.

So, in this case if you look at still confess is the best strategy for best strategy for the prisoner 1. Because if the other 1 is not confessing other 1 is confessing he is just getting 5 years the other 1 is not confessing then he is going free. And, if the other 1 is may be remaining silent that is again another strategy. So, in this case the dominant strategy is the best strategy for the player follows the regardless, but if you look at it may be the dominant strategy but this is not best payoff. Because for prisoner 1 what are the option?

If he remain silent, if the other 1 can remain silent it is that is 1, but the other 1 confess then you get 10 years. So, he has to maximize the maximize or the minimize the whatever the worst payoff can happen in case of the rivals action. So he will prefer to confess because at least even if it is not a optimal solution but still it is better than if he is not confessing. And, the same thing will happen with prisoner 2 and both of them they will confess they will reach to a solution; which is may be the best strategy at that point,

but that is not the optimal solution. And, what is the problem over here? Problem over here is there is lack of cooperation. And, they find that cooperation is difficult and that is the reason they are getting into a suboptimal solution. So, cooperation is difficult to maintain because cooperation is not the best interest of the individual player. Then, we will take this example in a revenue function or in a revenue payoff. And we will understand how the price increase and how generally it the oligopolist changes.

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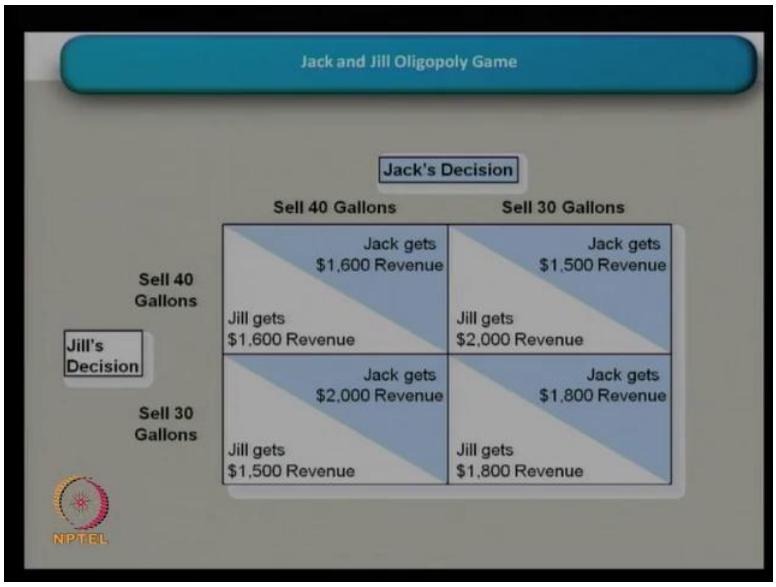

Accordingly, so there are two oligopolist Jack and Jill. And, they are into the business of they generally sell the oil in the market. So, in the 1st case they have different options when the price is 40 rupees for 40 dollar per gallon.

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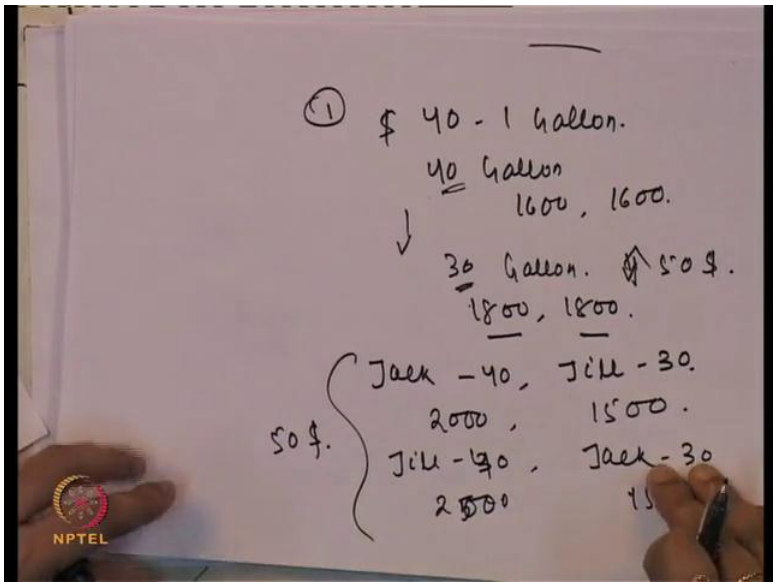

So, if you look at if the price is 40 dollar per per 1 gallon; both of them they are selling 40 gallon each and they are getting 1600 as revenue. Now, if they both of them they are reducing the from 40 gallon to 30 gallon; the price is going to 50 dollar. And, both of them they are getting 1800 as revenue. This is one case, where 40 rupees for 1 gallon and both of them they are just selling 40 gallons. Similarly, when they are just selling 30 gallon the price will increase to 50 gallon; and both of them they are getting a revenue of 1800. If Jack sell 40 and Jill sell 30 in this case what is the revenue? If Jack sell 40 and Jill sell 30. In this case Jill will get Jack will get Jack sell 40 gallons Jill sell ok. So, in this case Jack will get 2000 and Jill will get 1500. Similarly, if Jill is selling 30 and Jill is selling 40 and Jack is selling 30; then in this case it is getting 2000and here it is 1500. The price is 50 dollar.

Now, we will see what both of them they will do. So. now if you look at the slide when Jack is selling 40, Jill is selling 40 both of them they are getting 1600 as the revenue. And, they know that if both of them they are selling 30 gallon the price will go up. And, they can get a 1600 as the revenue because price will go for 60 rupees per gallon and they are getting 60 dollar per gallon and they are getting 1800 as the revenue. But ideally what they will do? They will not reduce both of them they will try to sell 40. Here, what is the optimal strategy optimal strategy is to sell less. So, that the price will go up and they will get they will get a higher revenue. But what they will do both of them? They will not sell 30 they will sell 40. So, in this case if you look at if Jack is selling 40 and

Jill is selling 30. He is going to get a revenue Jill is going to get a revenue of 1500 and Jill Jack is going to get a revenue of 1500 and Jill Jack is going to get a revenue of 2000. Price come price goes up to because it is 70 in place of 80; it is 70 now. So, that in that case the price goes up to 50 dollar per gallon.

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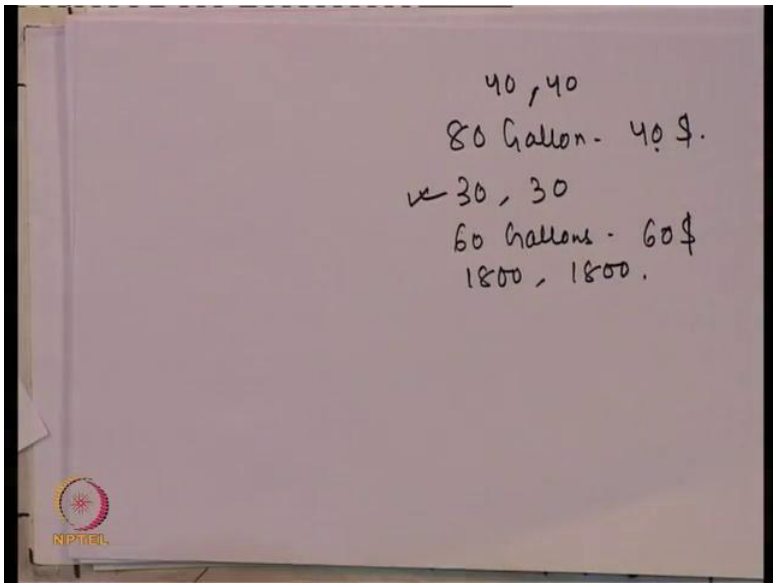

Now, in the other case also if Jill is selling more and Jack is selling less in the same case the total in the 1st case. If both of them they are selling both of them when they are selling 40 40 total is 80 gallon; and the price is 40 dollar per gallon.

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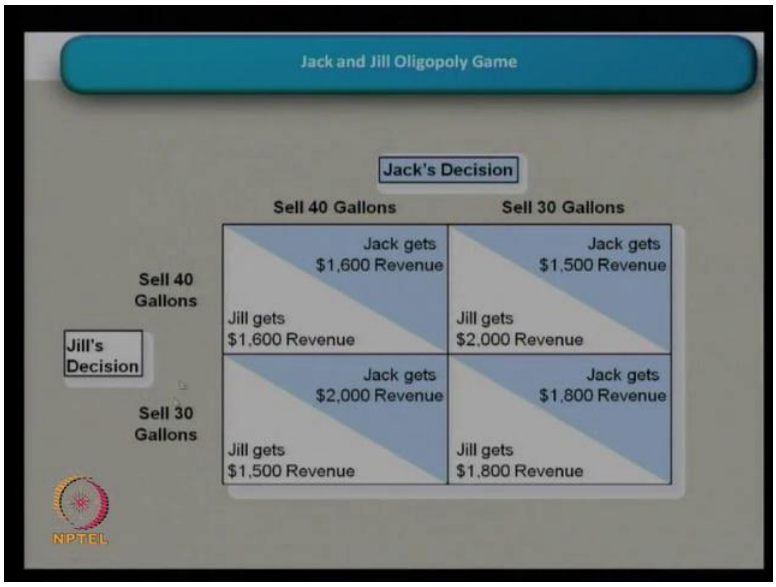

Now, the ideal solution is both of them they should just sell 30, 30 gallons that comes to 60 gallon; the price goes up to 60 dollar. And, in this case both of them they will get a revenue of 1800. What they will try to do? Ideal is this, both of them if they are reducing they are getting it. But they will not try to reduce it both of them they are trying to just produce just sell 40 gallon. And, they will land in a revenue which is again not a optimal solution like if you look at here Jack gets 1600, Jill get 1600. And why they get into this 40 gallon because if at any point of time Jill is selling 30 gallon; he gets less revenue as compared to Jack because Jack is not going to reduce beyond 40 gallons. And, in some situation if Jack is reducing it to 30 gallons, Jill is not going to reduce. And, in this case Jack get a revenue of 1500 and Jill get a revenue of 2000.

So, if you look at the payoff in the 4th box. This looks more profitable for them this should be the optimal strategy, but they will not follow here. They will land in a situation where it is suboptimal or where they are getting less profit.

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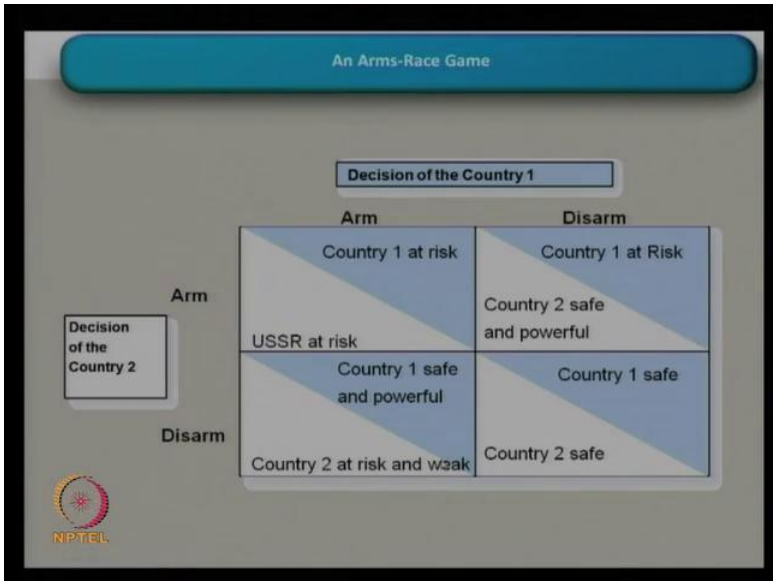

This same example can be can be taken into again in a different context like you have 2 country; country 1 and country 2.

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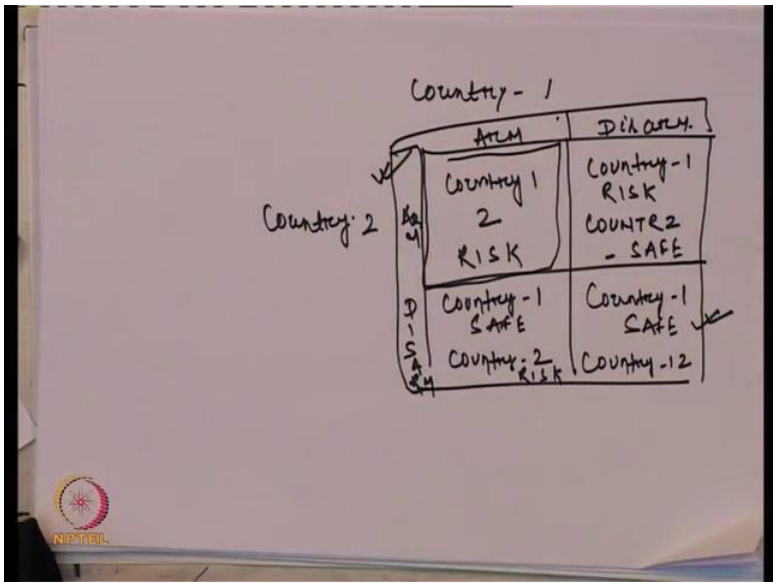

And, the options are whether to keep arm and ammunition or whether to not to keep the arm and ammunition. So, the choices are if you look at whether to arm or to disarm here again whether to arm or whether to disarm. If country 1 is keeping arm, country 2 is keeping arm, then both country 1 and country 2 they are at the risk. If country 1 is disarm and country 2 is still keeping arm. In this case country 1 is may be at the risk. And, country 2 is country 2 is safe and powerful.

Similarly, here if country 1 is disarm and country 2 is keeping arm. In this case again country 1 is safe, and country 2 is risk. And, when both of them they are not keeping the arm and ammunition both of them they are safe. Here in this case; what is the optimal strategy? Optimal strategy is here where both country 1 and country 2 they are safe but they will not going to this options, they are going to exercise this option. And, they both the country 1 and country 2 they are going on the risk.

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So, if you look at what is what you can conclude from here on the basis of all situation that even if the cooperation is difficult. Even if the cooperation is profitable still they go situation where may be they always land into a suboptimal strategy like whether you take a case of the prisoners, whether you take the case of the oligopolist, whether you take the case of the typical country, whether it is keeping arm and ammunition.

All these cases cooperation is always lead them to a strategy or lead them to a outcome which is best for both of them. But since there is no trust or there is lack of cooperation. They always feel that the rivals is going in a different direction and rival will try to give us the worst payoff; and that is the reason that they will land into a situation which is suboptimal. So, if you, if you remember from the case of prisoner the best outcome is to remain silent. But they will not remain silent both of them they will confess and they will land into a situation which is suboptimal.

Similarly, about that 2 oligopolist. Jack and Jill in both this cases if they are selling both of them they are selling just 30 gallons they are getting a profit of 1800 but still they are not doing that; both of them they are selling 40 gallon. And, finally they lead into a suboptimal situation. And similarly in the country level also keeping arm and ammunition both the country they are at the risk, but still they are keeping it because there is a lack of trust and there is lack of cooperation that the other firm is also.

Other countries also going to disarm, but the best option is that both of them they disarm themselves and they become they become safe. But that is not going to happen in this case and that is why both of both the country they keep it in the they keep their strategy as arm; and they get into a situation while both the countries are at the risk. So, prisoners dilemma is particularly talks about a game where cooperation is profitable but it is difficult to maintain. That is why we do not get into the optimal strategy rather we get into the suboptimal strategy.

Then, we will talk about some types of game like what are the different types of game. On the basis of the outcome, on the basis of the players and then we will see how this is linked into the different oligopolist model. What we discussed in our oligopoly market structure? So, games are classified either on the basis of the relation between players or in the basis of the strategy or on the basis of the outcome.

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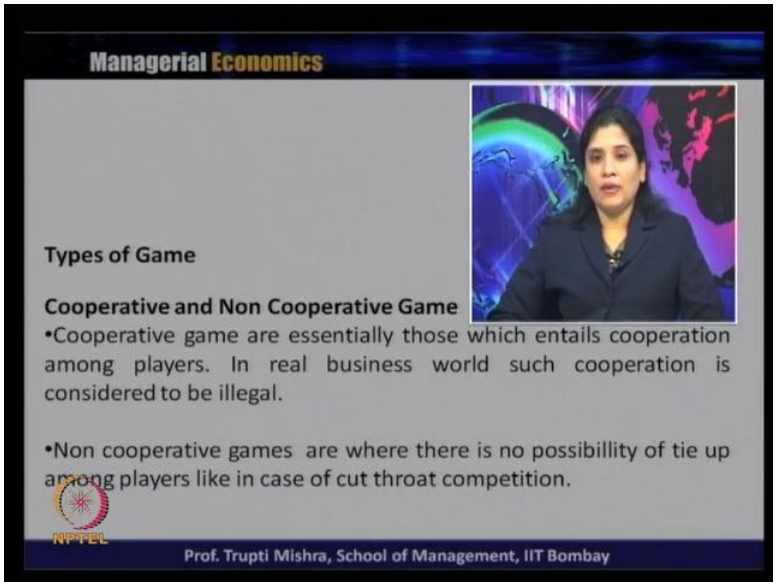

So, the 1st kind of game is cooperative and non cooperative game. So, cooperative games are essentially those which entails cooperation among the players. In real business world such cooperation is considered to be illegal generally that is called as collusion. It is not legal in the real world, but cooperative games are essentially those which entails the cooperation among the player. And non cooperative games are where there is no possible to tie up among players like in case of cut throat competition. So, non

cooperative games there is no tie up between the players or there is no collusion between the players it generally happens in case of the cut throat competition.

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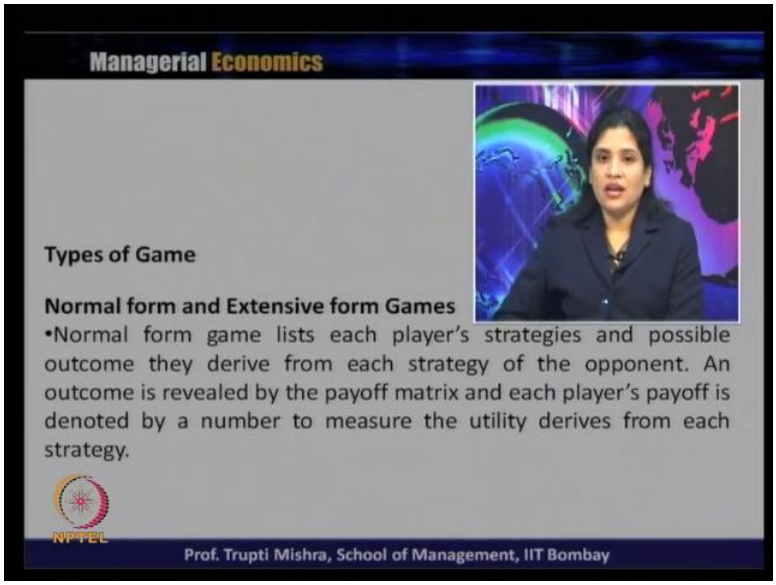

Then we have normal form and extensive form games. So, normal form games list each player strategy and possible outcome that they derive from each strategy of the opponents. An outcome is revealed by the payoff matrix and each player's payoff is denoted by the number to measure the utility derived from each strategy. So, in the previous case whatever the payoff we are finding out on the basis of the different strategy that is generally a normal form of the game. So, normal form of the game generally identify the list of the action taken by the players that is the strategy what is the end outcome in term of the strategy. And, listing all this end outcome in term of a payoff matrix that is generally the normal form of a game.

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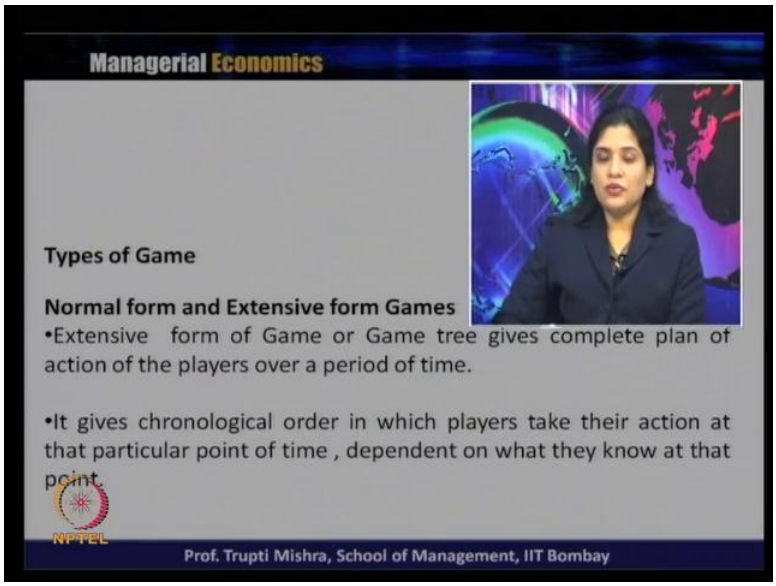

Whereas, in case of extensive form of game or the typical game tree we call it gives a complete plan of action of the player over a period of time. And, it is it gives a chronological order in which player take their action at that particular point of time, depended on what they know at what point. So, generally game tree is generally gives a complete plan of the player over a period of time it is in a chronological order. And, here player takes whatever the particular point of time. Whatever the decision takes that generally if you look at the when you are deciding the one decision point that leads to the what is the previous decision point. And, player it is dependent on the previous decision of the player.

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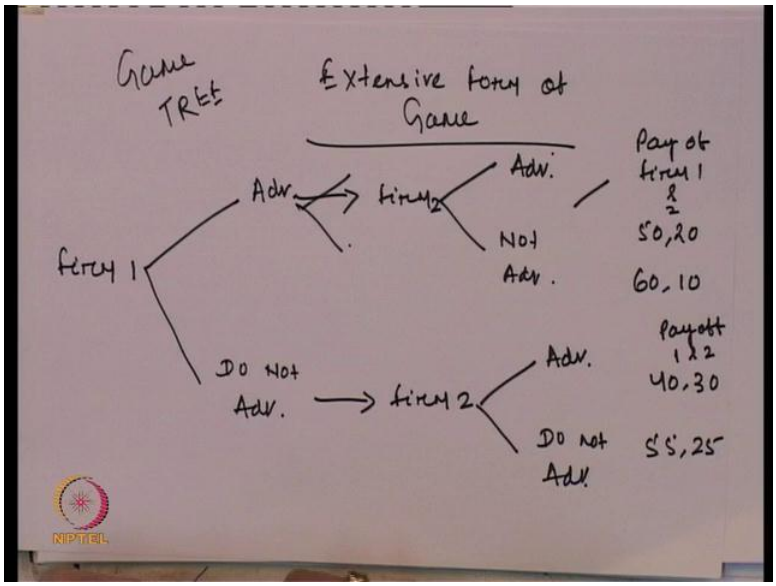

So, we will just take an example to understand the extensive form of game. So, for if you look at in the previous case, again we will take, where we take the case of the advertisement; so firm 1 if have 2 option either to advertise or do not advertise. This leads to again 2 outcome that is for firm 2. So, this leads to outcome for firm 2; and here again 2 two options advertisement or not advertisement.

And, this leads to the payoff for both firm 1 and 2; and this comes as if you remember 50,20 and if it is not advertising then it is 60 and 10. Similarly, if it is the firm 1 is do not advertise, do not advertise then this leads to for firm 2 to take 2 action again advertise, do not advertise. And, from here we get the payoff for firm 1 and 2. If do not advertise, firm 1 do not advertise firm 2 advertise we get a payoff of 40, 30. And, in the case of firm 1 do not advertise firm 2 also do not advertise we get a payoff of 55 and 25. So, this is the extensive form of game which records the particular action at the different point of time and then dependent.

So, if you look at why firm 2 is advertising its depends upon because firm 1 is advertising. Firm 2 why it is not advertising? Again, it is depend on what firm 1 is doing? Similarly, if you start from the payoff. Why the payoff is this? Because firm 2 is advertising because firm 1 is advertising. So, extensive form of the game or this is also known as the Game Tree. In this case it gives a chronological order in which players take

their action at that particular point of time dependent on what they know at that particular point.

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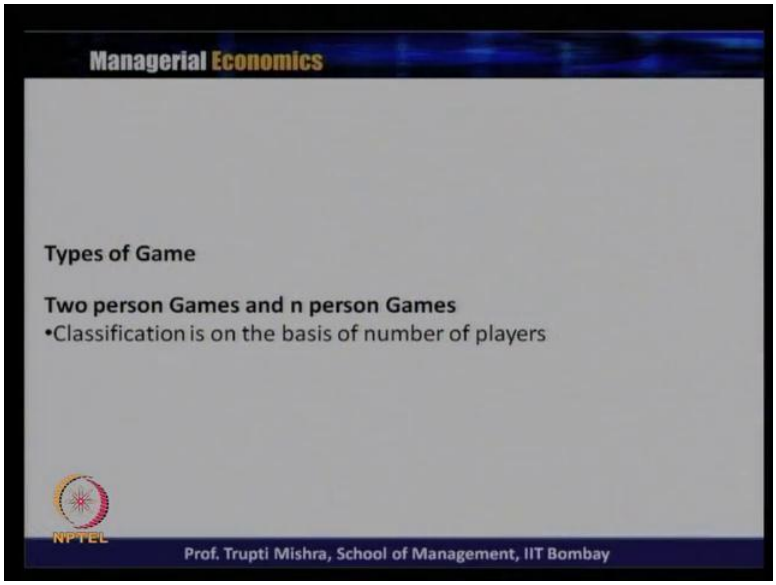

Then, we will take a different kind of game types of game that is 2 person games and n person games. This is classification is on the basis of the number of players. So, if it is 2 number is 2 it is a 2 person game. If it is more than 2 then it is a n person games. Then we have simultaneous move and sequential move game.

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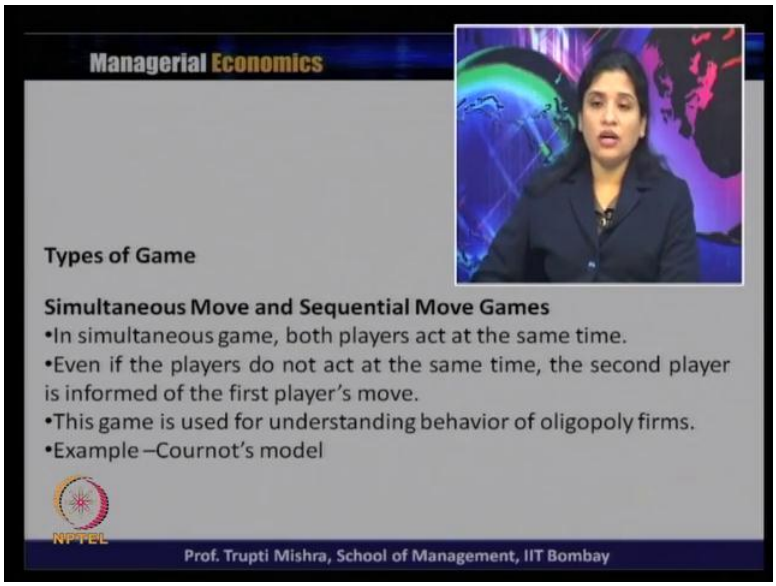

So, in simultaneously game both the players act at the same time. Even if players do not act at the same time, the 2nd player is informed about the 1st player move. So, in case of simultaneously move game both the players act at the same time. Even if the players do not act at the same time the 2nd player is informed about the 1st player move. This game is used for generally understanding the behavior of the oligopoly firm and the typical example is Cournot model. So, if you remember in case of Cournot model it is the, it is the reaction function and that decides that what will be the outcome of the other firm; dependent on the output of the whatever the output decision of the previous firm.

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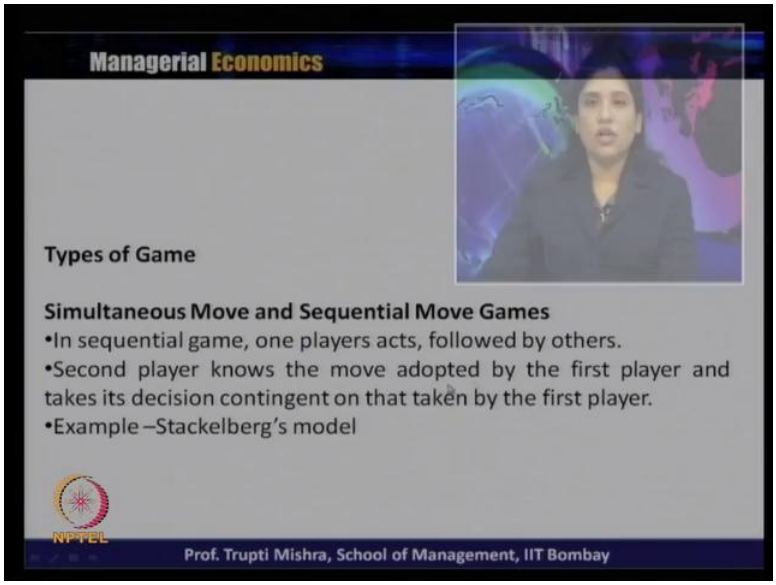

Then in case of sequential game 1 player acts followed by the other 2nd player knows that the move adopted by the 1st player and take its decision contingent that is taken by the 1st player. And, the typical example is the Stackelberg model what we discussed in our discussion during the previous oligopolistic market. So, simultaneously move game is the example of the Cournot model and sequential move game is the example of the stackelberg model.

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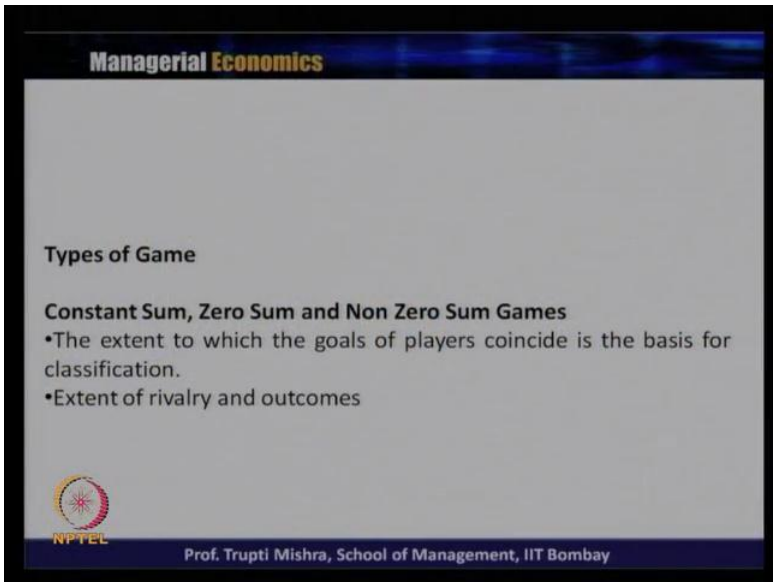

Then we have constant sum zero sum and non zero sum game. So, in this case the classification is on the basis of the rivalry on the basis of the outcome. So, the extent to which goals of the player is coincide is the basis of the classification.

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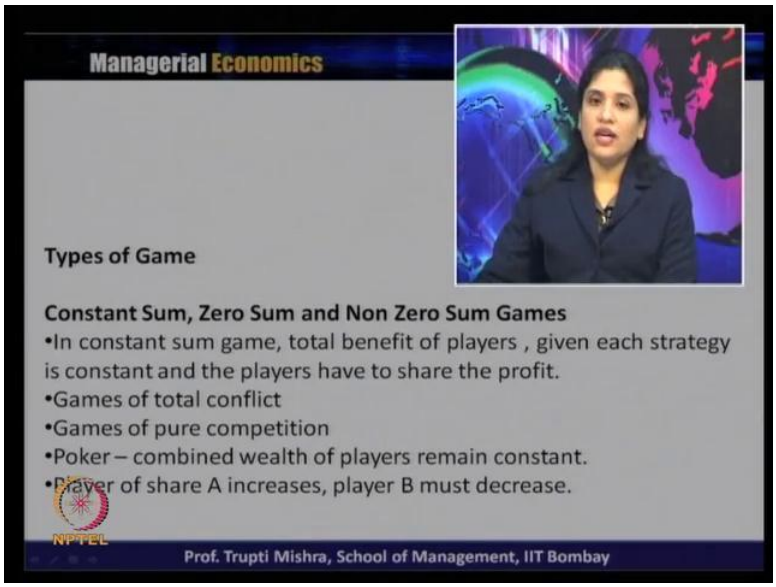

So, in a constant sum game, total benefit of players, given each strategy is constant the players have to share the profit. It is a game of if you look at constant sum game is the game of the total conflict, and also this is a game of the pure competition. The typical

example is the game of poker, where it is the combined wealth of player players remain constant. Player of share A increases though share of player B must decrease.

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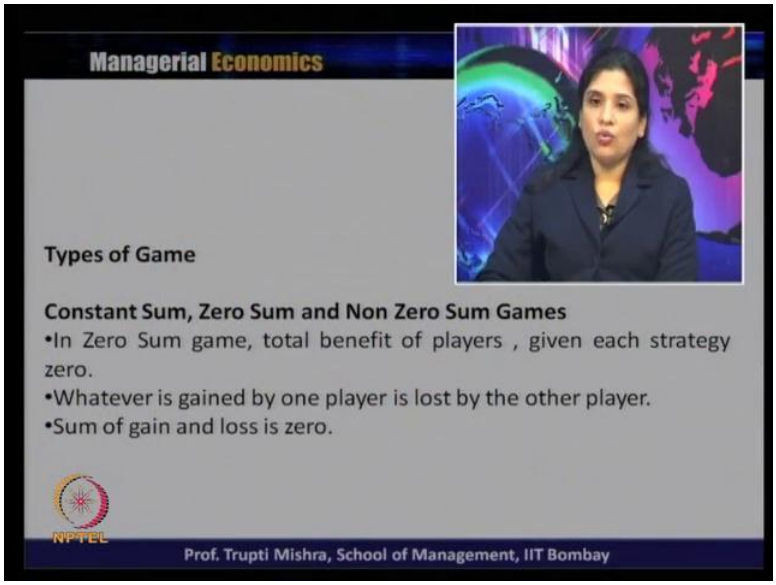

Then we have zero sum game, here the total benefit has to be equal to zero. So, the sum of gain and loss is zero. And, whatever is gained by 1 player is lost by the other player.

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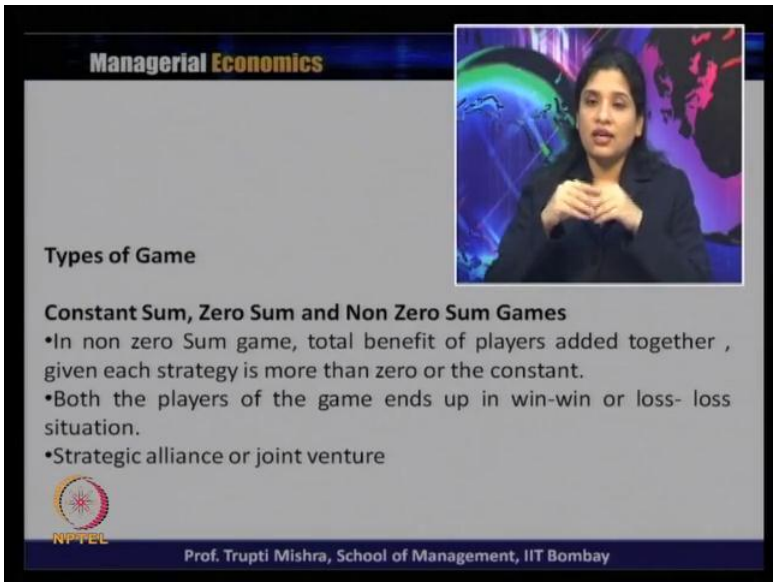

Then, we have non-zero sum game. And, in case of non zero sum game the total benefit of players added together given each strategy is more than zero and constant. So, both the players of the game ends up in win or lose situation; and the typical example is the

strategy and the joint venture. So, in case of non-zero sum game total benefits are added together is more than zero or more than a constant. And typical example of strategy (( )) and the joint venture we take as the non-zero sum game.

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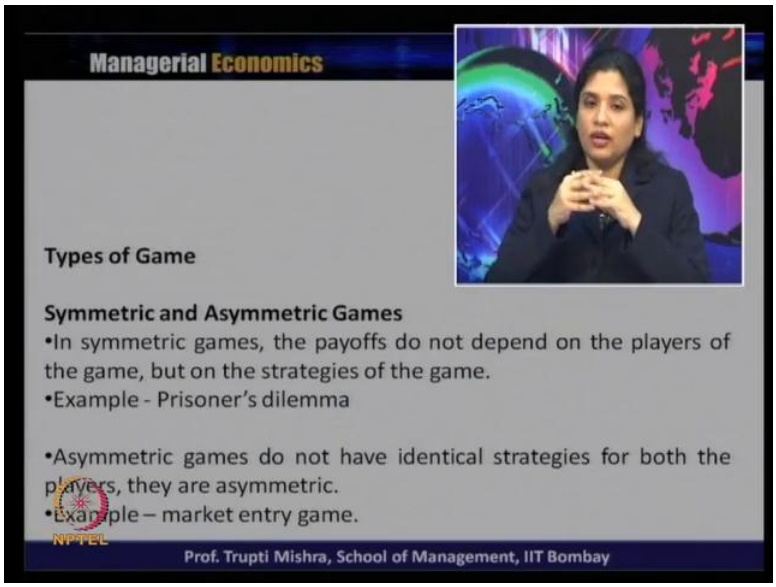

Then we have symmetric and asymmetric game. So, in the symmetric game the payoffs do not depends on the player of the game, but on the strategy of the game. And, typical example is the prisoner dilemma. So, this is the here the payoff is not on the who player of the game rather its what is the strategy taken by the game. And, typical example prisoner dilemma what we discussed before few minutes. And, asymmetric game do not have identical strategy for both the player, because they are asymmetric. And, typical example is the market entry game. Then we will take 2, 3 situation to understand this application of game theory in economics.

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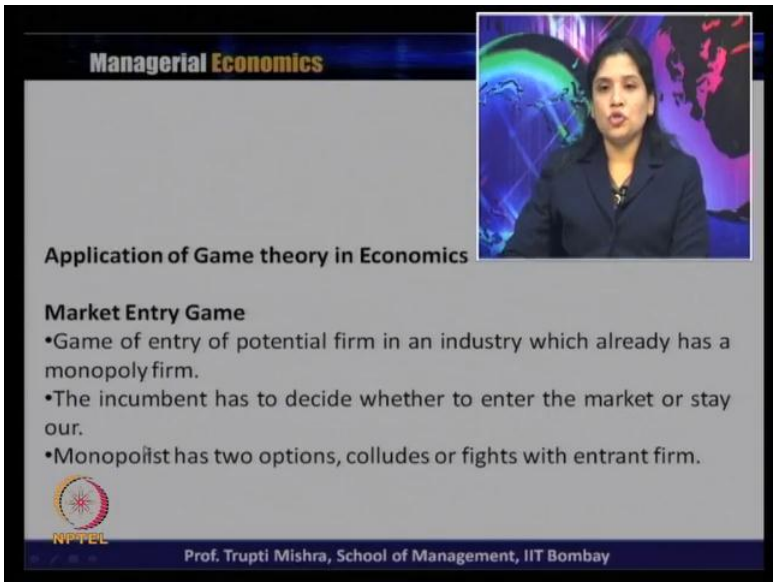

So, game of entry of potential firm in an industry, which is already monopoly firm. And, here the incumbent has to decide whether to enter the market or stay, stay out. And, monopolist has 2 option collude or fight with the entered firm. So, we will just prepare a payoff matrix on this basis; and we will see that how this game theory is also applicable on the basis of the on the basis of the decision of the firms, when they enter into the market. And also we will see the application of this in the Cournot model and application of this in the Stackelberg model in our next session.

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