

Managerial Economics
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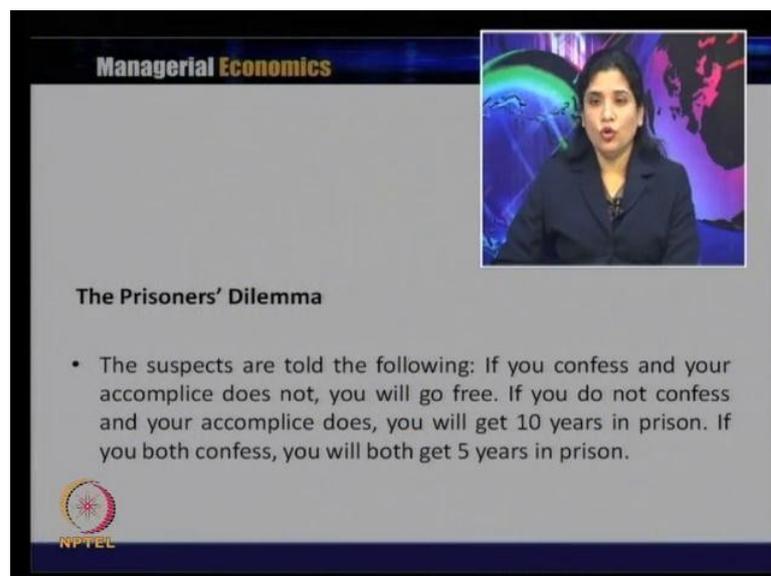
Lecture - 72
Oligopoly and Game Theory (Contd...)

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.

(Refer Slide Time: 25:57)



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The Prisoners' Dilemma

- The suspects are told the following: If you confess and your accomplice does not, you will go free. If you do not confess and your accomplice does, you will get 10 years in prison. If you both confess, you will both get 5 years in prison.

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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.

(Refer Slide Time: 26:43)

The Prisoners' Dilemma

		Prisoner 1's Decision	
		Confess	Remain Silent
Prisoner 2's Decision	Confess	Prisoner 1 gets 5 years Prisoner 2 gets 5 years	Prisoner 1 gets 10 years Prisoner 2 goes free
	Remain Silent	Prisoner 1 goes free Prisoner 2 gets 10 years	Prisoner 1 gets 1 year Prisoner 2 gets 1 year



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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Prisoner

		Confess	Not Confess.
		5, 5 10, 10	10, 0 goes free
Prisoner 2.	Confess		
	NOT Confess	0, 10	1, 1

Remain silent - 1, 1



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 them 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 it 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.

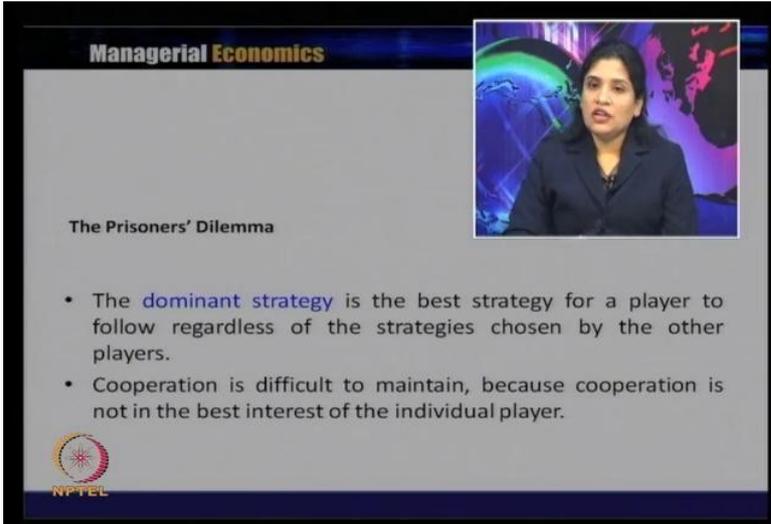
So, if you confess and your accomplice does not you will go free and your accomplice will get 10 years. So, in this case there is a small change over here. So, this is 5 and 5. So, when both of them they are confessing they are just getting 5 years. When 1 is confessing the other 1 is not confessing;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

(Refer Slide Time: 31:42)



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The Prisoners' Dilemma

- The **dominant strategy** is the best strategy for a player to follow regardless of the strategies chosen by the other players.
- Cooperation is difficult to maintain, because cooperation is not in the best interest of the individual player.

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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. (Refer Slide Time: 33:58)

Jack and Jill Oligopoly Game

		Jack's Decision	
		Sell 40 Gallons	Sell 30 Gallons
Jill's Decision	Sell 40 Gallons	Jack gets \$1,600 Revenue Jill gets \$1,600 Revenue	Jack gets \$1,500 Revenue Jill gets \$2,000 Revenue
	Sell 30 Gallons	Jack gets \$2,000 Revenue Jill gets \$1,500 Revenue	Jack gets \$1,800 Revenue Jill gets \$1,800 Revenue

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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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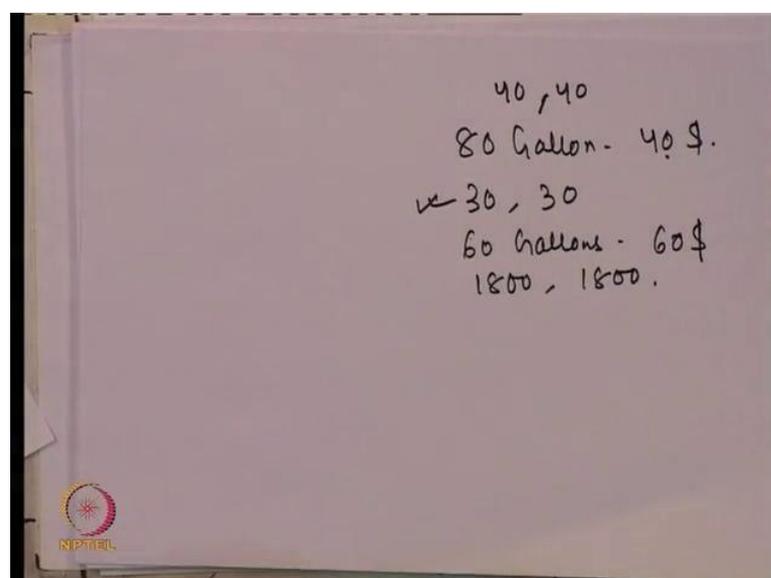
① \$ 40 - 1 gallon.
 40 Gallon
 1600, 1600.
 ↓
 30 Gallon. \$ 50.
 1800, 1800.
 50\$. { Jack - 40, Jill - 30.
 2000, 1500.
 Jill - 40, Jack - 30
 2500, 1500

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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 2000 and 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 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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		Jack's Decision	
		Sell 40 Gallons	Sell 30 Gallons
Jill's Decision	Sell 40 Gallons	Jack gets \$1,600 Revenue Jill gets \$1,600 Revenue	Jack gets \$1,500 Revenue Jill gets \$2,000 Revenue
	Sell 30 Gallons	Jack gets \$2,000 Revenue Jill gets \$1,500 Revenue	Jack gets \$1,800 Revenue Jill gets \$1,800 Revenue

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.

(Refer Slide Time: 39:14)

An Arms-Race Game

		Decision of the Country 1	
		Arm	Disarm
Decision of the Country 2	Arm	Country 1 at risk USSR at risk	Country 1 at Risk Country 2 safe and powerful
	Disarm	Country 1 safe and powerful Country 2 at risk and weak	Country 1 safe Country 2 safe



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

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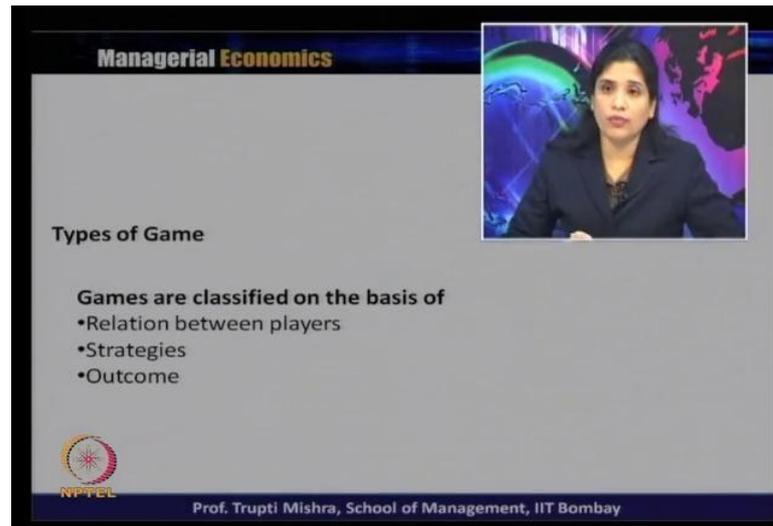
		Country - 1	
		ARM	DISARM
Country: 2	ARM	Country 1 2 RISK	Country - 1 RISK COUNTR2 - SAFE
	DISARM	Country - 1 SAFE Country - 2 RISK	Country - 1 SAFE Country - 12



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.

(Refer Slide Time: 41:31)



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Types of Game

Games are classified on the basis of

- Relation between players
- Strategies
- Outcome

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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.

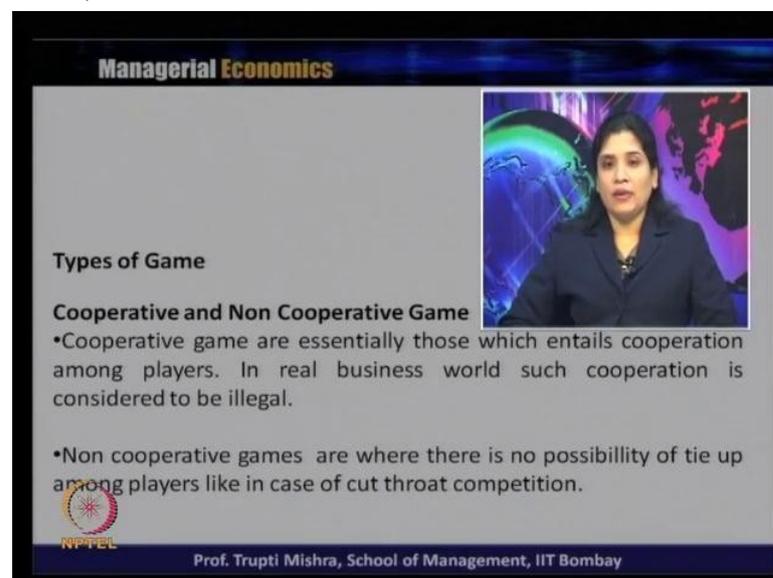
Similarly, about that 2 oligopolist. Jack and Jill in both this cases if they are selling both of them they are selling just 30 gallons they are getting a profit of 1800 but still they are not doing that; both of them they are selling 40 gallon. And, finally they lead into a suboptimal

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, prisoner's 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.

(Refer Slide Time: 44:16)



Managerial Economics

Types of Game

Cooperative and Non Cooperative Game

- Cooperative game are essentially those which entails cooperation among players. In real business world such cooperation is considered to be illegal.
- Non cooperative games are where there is no possibility of tie up among players like in case of cut throat competition.

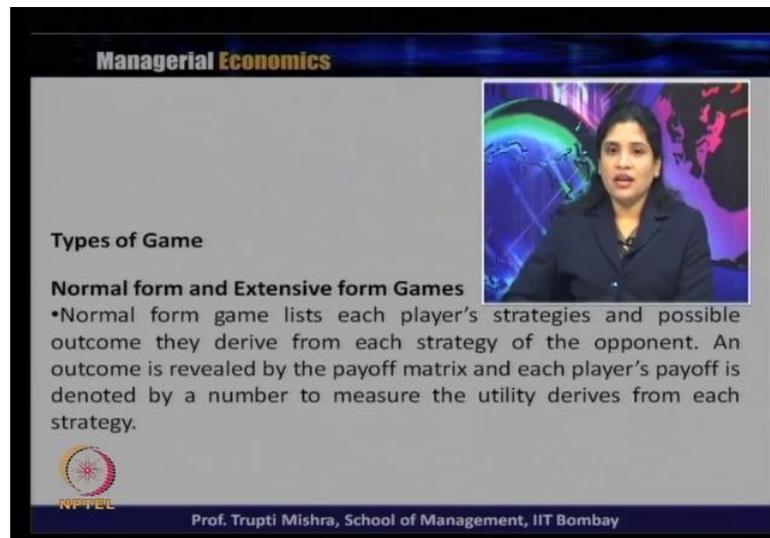
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So, the 1st kind of game is cooperative and non-cooperative game. So, cooperative games are essentially those which entails cooperation among the players. In real business world such cooperation is considered to be illegal generally that is called 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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Managerial Economics

Types of Game

Normal form and Extensive form Games

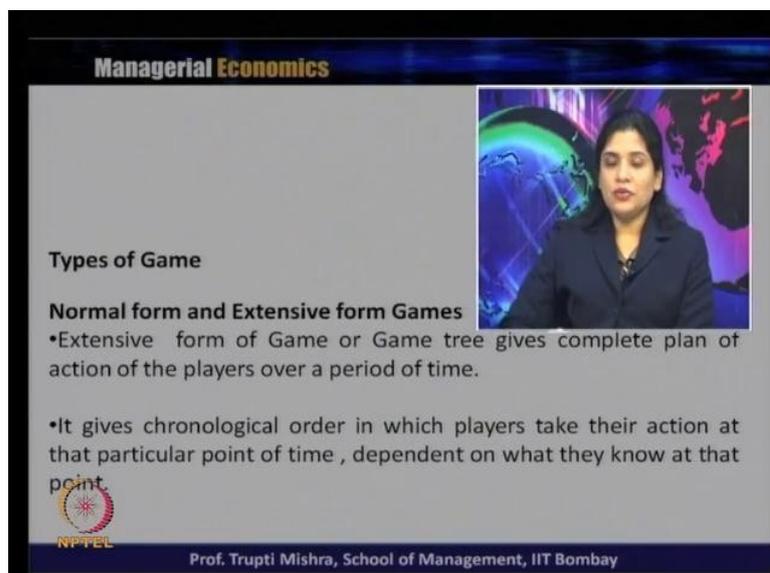
- Normal form game lists each player's strategies and possible outcome they derive from each strategy of the opponent. An outcome is revealed by the payoff matrix and each player's payoff is denoted by a number to measure the utility derives from each strategy.

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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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Types of Game

Normal form and Extensive form Games

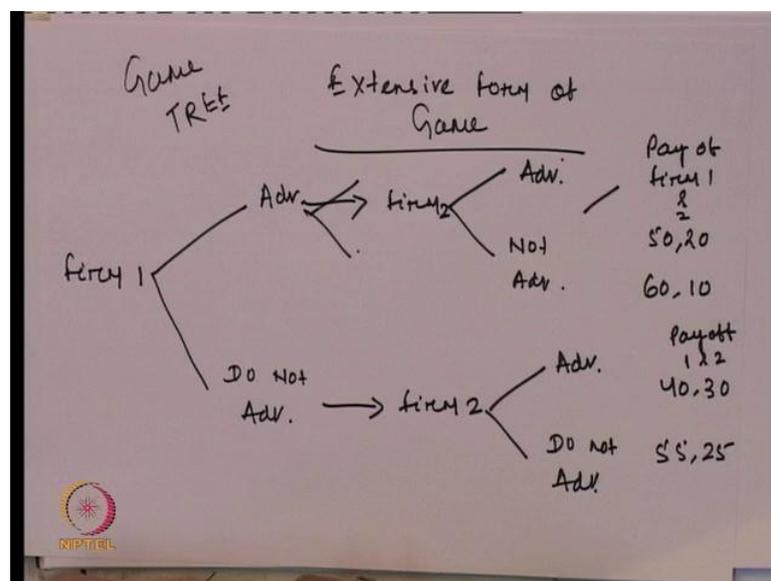
- Extensive form of Game or Game tree gives complete plan of action of the players over a period of time.
- It gives chronological order in which players take their action at that particular point of time, dependent on what they know at that point.

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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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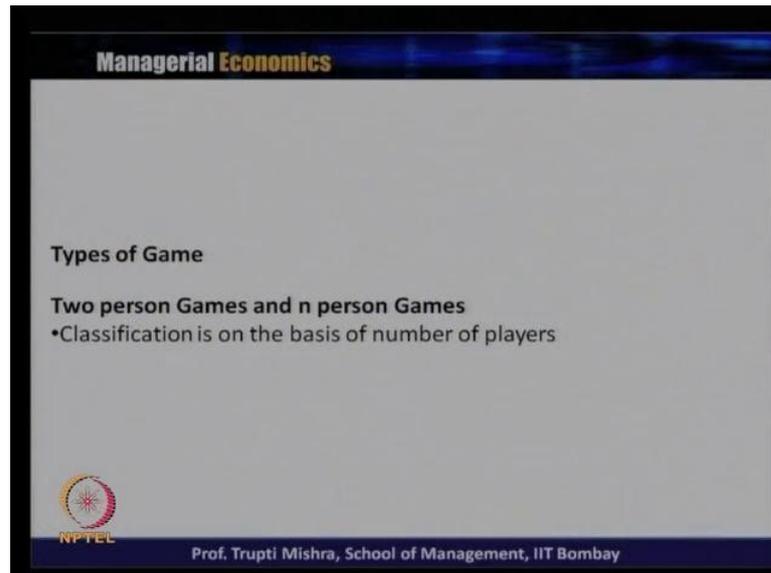


So, we will just take an example to understand the extensive form of game. So, for if you look at in the previous case, again we will take, where we take the case of the advertisement; so firm 1 if have 2 option either to advertise or do not advertise. This leads to again 2 outcome that is for firm 2.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

Two person Games and n person Games

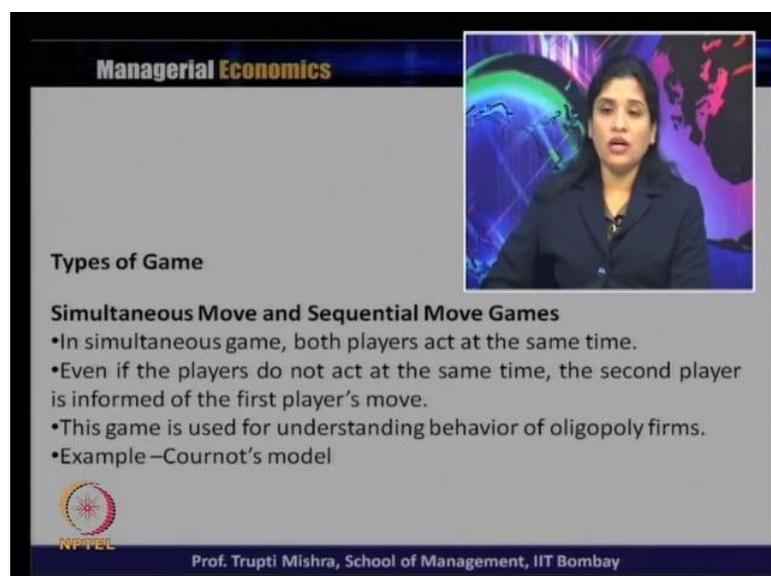
- Classification is on the basis of number of players

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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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Types of Game

Simultaneous Move and Sequential Move Games

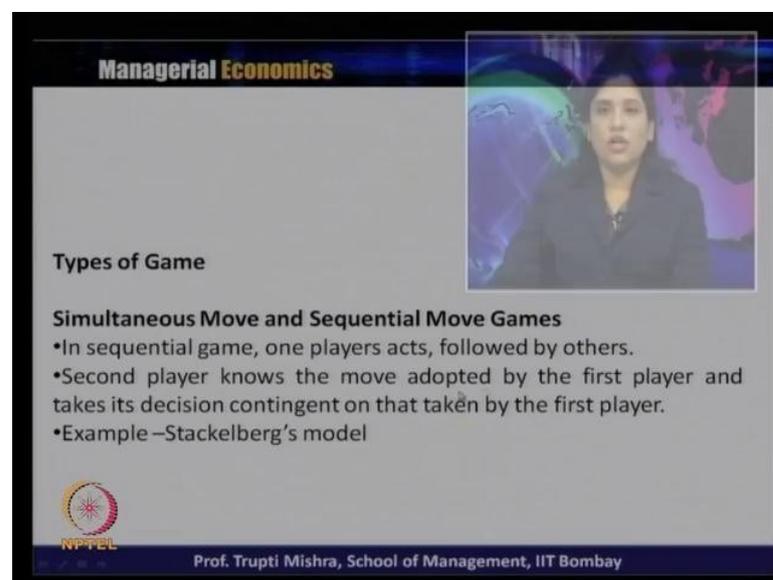
- In simultaneous game, both players act at the same time.
- Even if the players do not act at the same time, the second player is informed of the first player's move.
- This game is used for understanding behavior of oligopoly firms.
- Example –Cournot's model

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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.

(Refer Slide Time 50:22)



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Types of Game

Simultaneous Move and Sequential Move Games

- In sequential game, one player acts, followed by others.
- Second player knows the move adopted by the first player and takes its decision contingent on that taken by the first player.
- Example - Stackelberg's model

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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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Types of Game

Constant Sum, Zero Sum and Non Zero Sum Games

- The extent to which the goals of players coincide is the basis for classification.
- Extent of rivalry and outcomes

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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.

(Refer Slide Time: 51:03)

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Types of Game

Constant Sum, Zero Sum and Non Zero Sum Games

- In constant sum game, total benefit of players , given each strategy is constant and the players have to share the profit.
- Games of total conflict
- Games of pure competition
- Poker – combined wealth of players remain constant.
- Player of share A increases, player B must decrease.

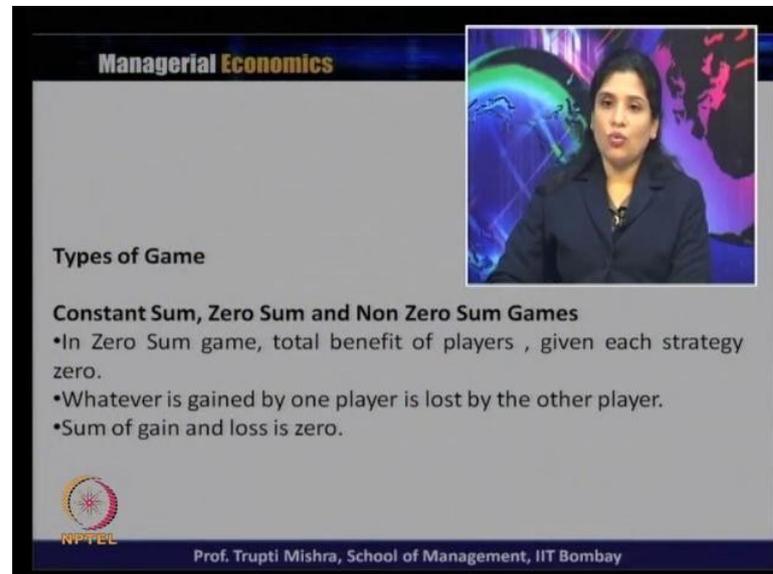
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So, in a constant sum game, total benefit of players, given each strategy is constant the players have to share the profit. It is a game of if you look at constant sum game is the game of the total conflict, and also this is a game of the pure competition.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

Constant Sum, Zero Sum and Non Zero Sum Games

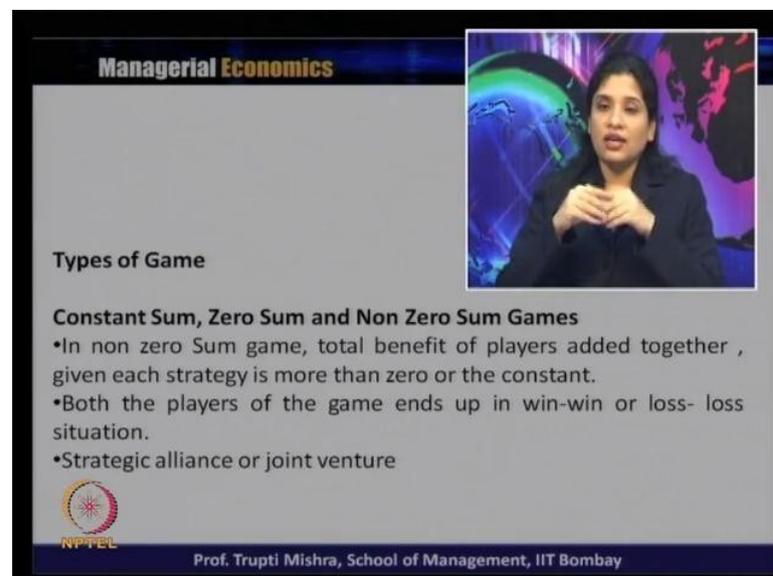
- In Zero Sum game, total benefit of players , given each strategy zero.
- Whatever is gained by one player is lost by the other player.
- Sum of gain and loss is zero.

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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.

(Refer Slide Time: 51:44)



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Types of Game

Constant Sum, Zero Sum and Non Zero Sum Games

- In non zero Sum game, total benefit of players added together , given each strategy is more than zero or the constant.
- Both the players of the game ends up in win-win or loss- loss situation.
- Strategic alliance or joint venture

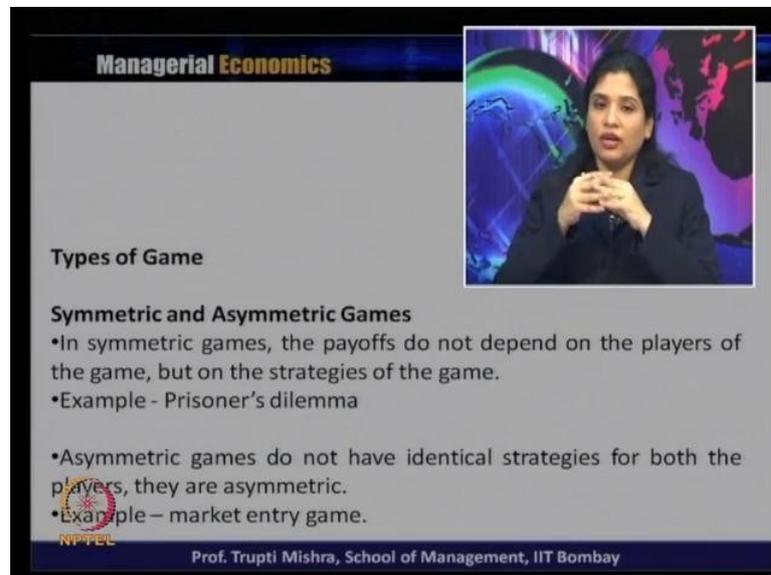
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Then, we have non-zero sum game. And, in case of non zero sum game the total benefit of players added together given each strategy is more than zero and constant. So, both the players of the game ends up in win or lose situation; and the typical example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

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Types of Game

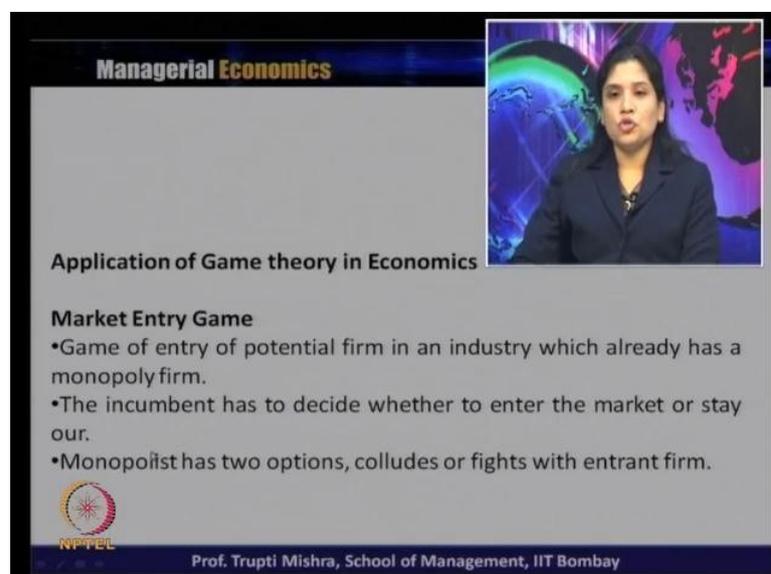
Symmetric and Asymmetric Games

- In symmetric games, the payoffs do not depend on the players of the game, but on the strategies of the game.
- Example - Prisoner's dilemma
- Asymmetric games do not have identical strategies for both the players, they are asymmetric.
- Example - market entry game.

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Then we have symmetric and asymmetric game. So, in the symmetric game the payoffs do not depend 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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Application of Game theory in Economics

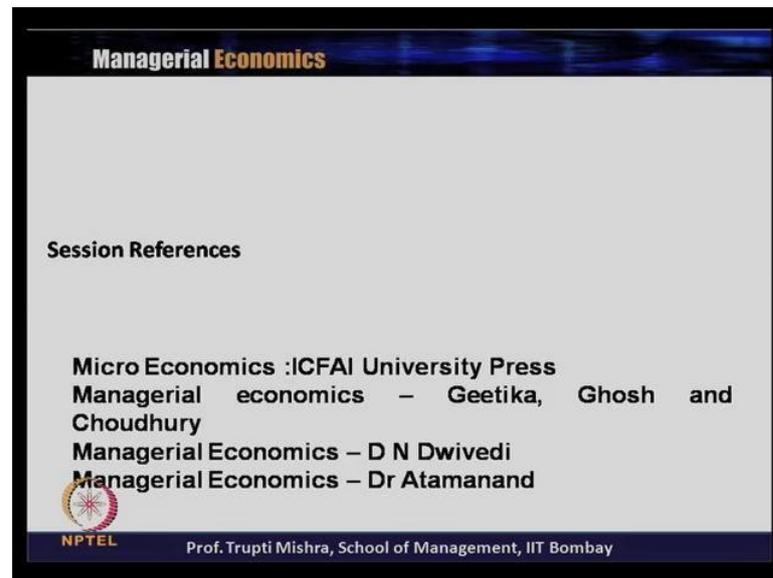
Market Entry Game

- Game of entry of potential firm in an industry which already has a monopoly firm.
- The incumbent has to decide whether to enter the market or stay out.
- Monopolist has two options, colludes or fights with entrant firm.

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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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Managerial Economics

Session References

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