Managerial Economics
Prof. Trupti Mishra
S.J.M. School of Management
Indian Institute of Technology, Bombay

Lecture - 35
Oligopoly and Game Theory

In the last class, we were talking specifically about the group behavior of the oligopoly's firms; and in that context, one methodology or the one tool emerged as to understand that how the firms they behave or how when they collude or when they are not, when they are competing, how it can be how it can be routed into a typical group behavior, and what is the tool to understand this group behavior is generally known as game theory; and in last class as I was telling oligopoly is a market structure, which talks about economics of cooperation, either positively when they collude with each other and also negatively when they are competing with each other.

So, today we will understand game theory, a specific tool to understand the group behavior and how the firms behave; and when it comes to specific application of game theory, generally we understand the firm's behavior, and we understand the different company behavior in a typical oligopoly market. So, game theory has a tool. It has application for variety of the topics or the variety of subject, but specifically in case of economic analysis, we understand that to or we use that to understand the relationship between the firms, when they compete, typically when they compete and how they generally respond to rivals action or rival reaction to their price and output plan. So, to start with, we will talk about the equilibrium situation of the oligopoly, and how we will see the need and how there is a need for the game theory? We will see from there.

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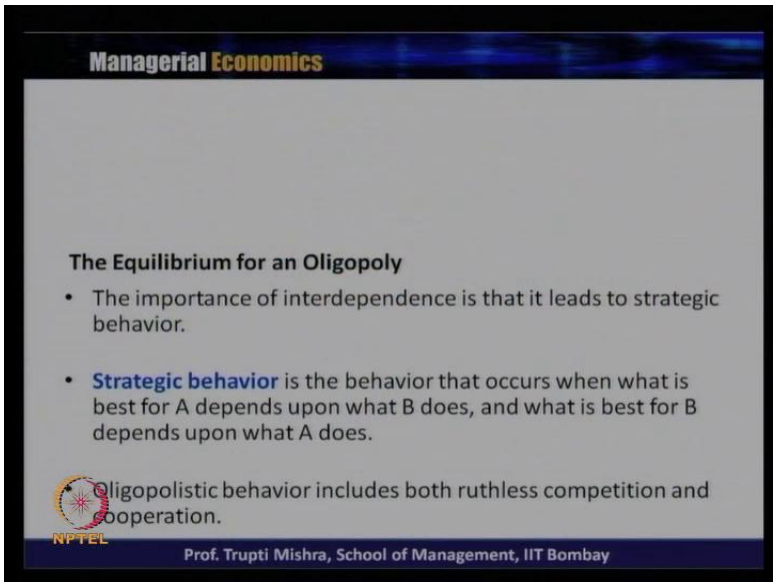

So, when you talk about the equilibrium, in many cases equilibrium is absent in case of oligopoly, because the interdependence, there is interdependence between this firm when it comes to the action and reaction of the firms related to price and output decision. So, there is importance of interdependence in case of the oligopoly's firm. And since, there is interdependence; generally it leads to strategic behavior.

What is strategic behavior? Strategic behavior is the behavior that occurs when what is best for A depends upon what B does, and what is best for B depends upon what A does. So, strategic behavior is where the end output or whether profit price output decision or whether the strategy of one firm is not dependent on their own price and output decision or the strategy decision. Rather it is dependent on what is the strategy, what is the output price decision taken by the other firm.

So, in laymen understanding, strategic behavior is one, when what is best for A depends upon what B does and what is best for B depends on what A does. Oligopoly's behavior if you look at it, if you remember, also in the last class what we discussed. Oligopoly's behavior includes both ruthless completion and cooperation. So, when it comes to collusive oligopoly, it is about the cooperation and when it comes to non-collusive oligopoly, it is generally the competition.

Since, its cooperation, since its competition, the behavior is strategic behavior because it is strategic behavior in the sense that the firms well being depends upon what the other

firms does. So, if there are two firms, it is a case of what the duopoly market. If there are two firms, what is best for one firm that depends upon how the other firm is doing in the market. Whether other is increasing the price, decreasing the price, increasing the output, decreasing the output, what kind of advertising company are using, what is the after sale service they are giving. Based on that, it depends that how is the, what should be the profit or what should be the output, what should be the price for the previous firm.

So, if there are case of duopoly market, there are two firms, A and B. To simply put it strategic behavior is one where what is best for A depends upon what B does and what is best for B depends upon what A does. Now, that can be considered as the strategic behavior.

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Now, there is one evidence that there is limit pricing. What is limit pricing? If you remember in case of the oligopoly's market, we are discussing about the price leadership model where the dominant firm or the low cost firm, they set the price in such a low level that it is difficult to survive for the small firms or the inefficient firm and in that case, they goes out of this market.

So, in order to do this here, this is a kind of strategic behavior comes from the low cost firm or the dominant firm because in term of that, they are restricting the entry. They are creating a barrier to entry to the small firm and that is best for the dominant firm because it gives more market share if the small firm leaves the market. So, this is one of the

activity that comes under strategic behavior is that when the price leaders of the market, whether it is A dominant firm or the low cost firm, when they charge such a low price, that makes really difficult for the small firms to survive in the market.

Similarly, we have the price retaliation like whatever the price decided by the market forces, that will not be accepted by the firm and they will charge a price where at least it is not going to make an equilibrium output or equilibrium price and they are going to charge a price and with that price, may be it leads to them to get a larger market share or larger profit. So, this again strategic behavior means the price is such that or the typical firm will charge a price that is having a largest market share. They will charge a price which is not conducive to the market.

Then the capacity expansion. So, capacity expansion is where the large scale firm, they generally operate to a scale operation and when they do a scale operation, they always do at a lower price. So, that when the other firms they try to come into the market, they cannot compete with a high cost firm, low cost firm and they with a low price, rather they have to operate in a high cost.

So, capacity expansion is one where the large firm is not leaving the scope for the other firms to expand in the market and also, they always charge a price which gives them less profit, so that it is not incentive for the other firms to operate in the market and that is why they do an entry restriction through the capacity expansion and similarly for the market saturation also, so that if you look at it, the large firm is continuously going on producing a product and they when the new firm enter into the market, they also change their product style.

So, the new firm has to compete with the existing product of the large firm and also, the new product of the large firm. So, in that way that creates a barrier to enter that it is not about the existing product, also the new product which is given by the by the same brand name. So, if the large scale firm is operating in the market for a longer period of time and also whatever the new product comes from their market; obviously, people they knows the brand, they knows the company and they will have more affinity for that typical product rather than new product in the market.

So, whether to compete with a new firm, the existing firm, go for a new product or about the capacity expansion or about the price leaders retaliation or about the limit price, there

are these are all comes under this strategic behavior. Why this is called as strategic behavior? Because all these activities, not only get more market share, more profit for this typical firm rather all this activities are done, so that the other firm should not get into the market or the other firm should not get more market share or more profit.

So, here the activity is not for only the firm itself, rather for how to restrict the market share, how to restrict the profit of the other firm and that is why this is known as the strategic behavior. So, in this case, all this firm what is best for them is not dependent on whatever the activities taken by them, rather what is the best for that firm depends also on how the other firms, they are behaving in the market . So, since it is the case of economics of typically in the oligopoly, it is the economics of competition and economic of cooperation. The strategic behavior is important because the valuing of the one firm is dependent on how the other firms, they are doing in the market.

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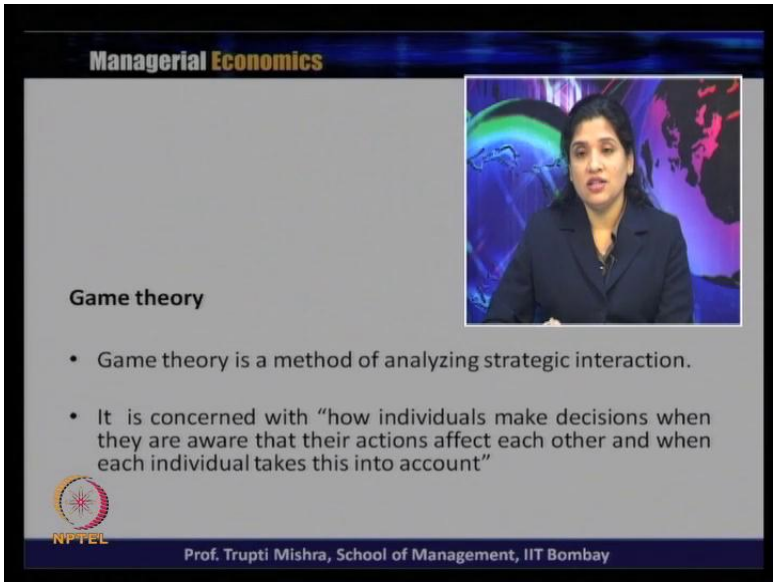

So, here it comes, game theory to analyze this strategic behavior. So, game theory is a method which is generally being used to analyze this strategic interaction or the strategic behavior. It is concerned with how individual make decision when they are aware that their action affects each other and when each individual takes this into account. So, when one individual firm takes a decision, they know that whatever the decision they are going to take, it is not only affecting their own firm but also affecting the other firms. So, in this case, game theory generally analyze the situation when the individual firm is

concern or the game theory is concerned with the analysis that how individual firm takes their action or how individual firms react to the situation when they know that this particular action is not only affecting their own firm, also it is affecting the other firms there in the market. So, it is mathematical tool that generally help to study the strategic situation or the strategic behavior.

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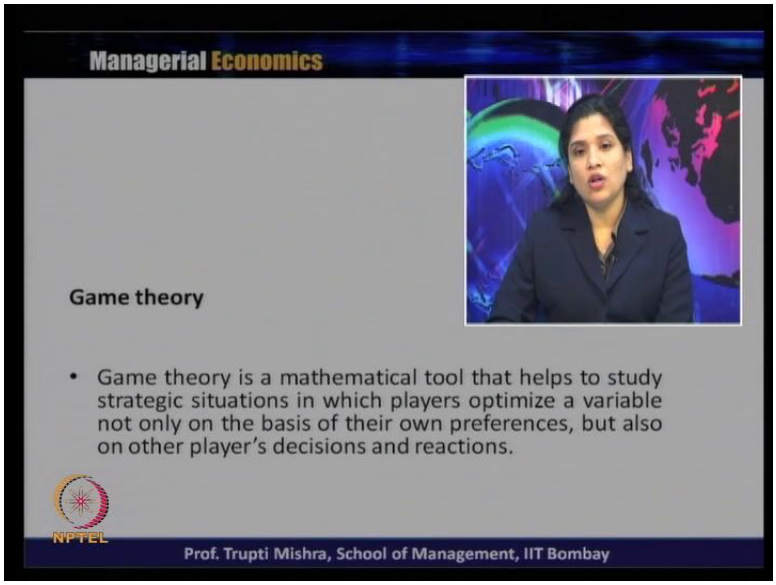

So, game theory is a mathematical tool in a, to put it simply game theory is a mathematical tool which use to understand the firms behavior in oligopoly market structure. So, it helps to study the strategic situation in which players optimize a variable, not only on the basis of their own preferences, but also on the other decision and the reaction.

So, it is here the optimization situation, it is not on the basis of their own opportunity, in own constant also what is the opportunity of the other firm or what is the constant of the other firm. So, here we can call it that here this tool is getting used by the individual players or tool is getting used by the economics to analyze that how firms, they optimize their outcome, end outcome not on the basis of their own opportunity and constant, also the other firms present in the market, their opportunity and their constant.

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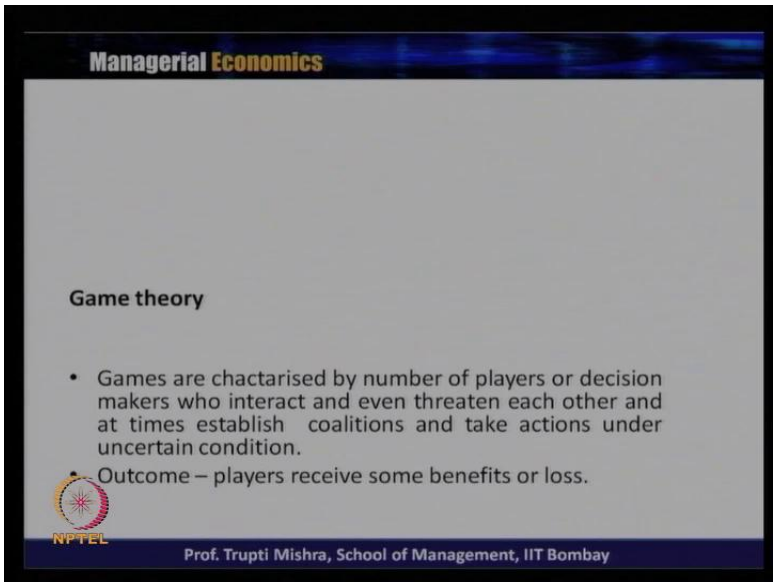

So, games typically in case of the game theory, here the games are characterized by the number of players or the decision maker to interact and even threaten each other and at times establish the coalitions and take actions under uncertain condition. So, generally here in the game theory, games are characterized by the number of players or the players may be the decision makers. Players may be the firm and who interact with the other firms who even threaten each other at time to establish the coalitions. Typically, if you talk about price leadership model, it is about the bargaining strength. So, in this case, bargaining strength also one firm generally push the pressure that if you are getting agreed to the price, I am going to charge a price independently which is no way going to give you the benefit.

So, in some times the players or the decision makers, they threaten each other to establish the coalition and take also the action under the uncertain condition. So, the price leader has also taken the action when there is uncertainty in the market, what is the price to be followed and what is the output to be produced.

Now, what is the outcome? The players or the so-called decision makers. They interact in a different way, in a positive also in the negative. When the positive, they come into a coalition. When it is negative, they get into the competition. Now, what is the end outcome? The end outcome is they get some benefit or they get some loss. So, if it is output, they get revenue profit share. So, if there is a decrease in the profit that is loss, if

there is an increase in the profit that is gain or the benefit. If there is a decrease in the market share, it is loss and if there is an increase in the market share, it is benefit or it is gain. Maybe we can call it revenue or profit, again when it is good for the increasing direction, its benefit. When it goes in the decrease direction, it is a loss.

So, players, they get into a situation where they compete with each other, cooperate with each other in a specific situation with a set of constraint and the outcome is positive. Positive leads to benefit, the outcome is negative. Negative leads to loss. So, there are different types of moves taken by the different players in various games that is systematical. Also, that is systematic and also structurally designed and they take different moves. They take, there moves can be in the simple way, we can call it the activity.

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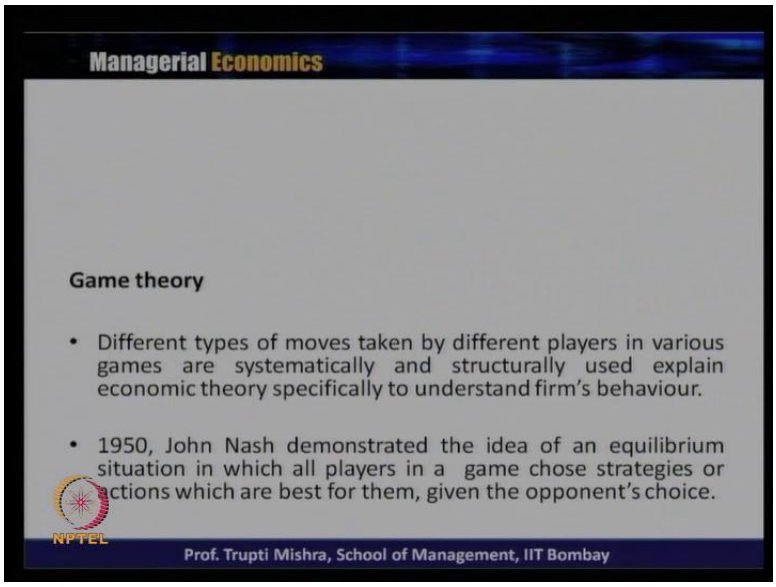

They take different actions, different moves which are systematically and structurally used to explain the economic theory specifically to understand the firm's behavior. So, different types of moves taken by different players in various games are systematically and structurally used to explain economic theory specifically to understand the firm's behavior. 1950, John Nash demonstrated the idea of an equilibrium situation in which all players in a game chose a strategies or actions which are best for them, given the opponent's choice. So, this game theory specifically when it applied to economic analysis, the first development here using the game theory to economic analysis, the first

development or the first concept development came from Nash in 1950 and later on, he got a noble prize for his contribution to this economic theory in the form of the Nash equilibrium.

What is Nash equilibrium? This is the kind of equilibrium in the market using the game theory, typically analyzing the firm's behavior. Here John Nash, generally he developed this concept of Nash equilibrium and here all players in the game chose the strategy or the action which are best for them against the opponent's choice. So, what is best for one firm depends on whatever the action taken by the opponents or whatever the reaction are happened by the opponents due to this specific action.

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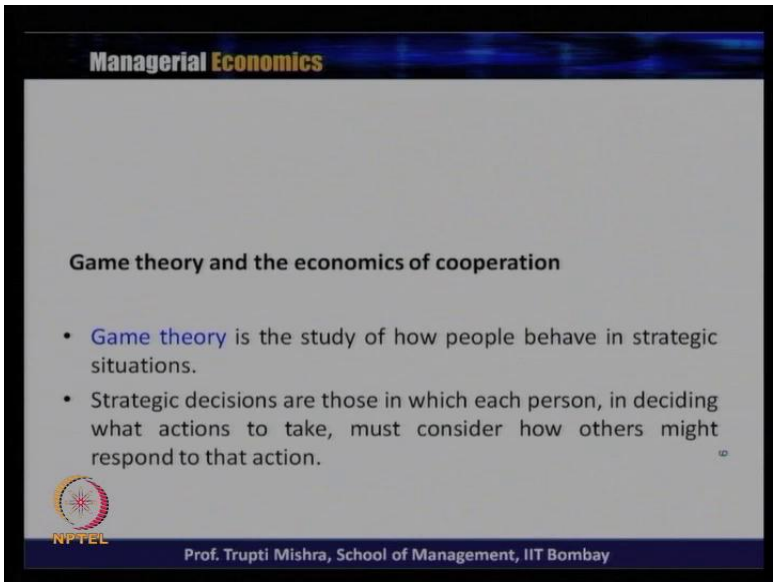

So, game theory is typically a study of how people behave in the strategic situations. So, to make it understand very simpler from the layman understanding, game theory is a study of how people behave in the strategic situations. What is strategic decision? Strategic decisions are those in which each person, in deciding what actions to take must consider how others might respond into that action. So, strategic decision are those in which each person, in deciding what action they have to take, they must consider how the others might respond to that typical action. So, as the number of firms is in an oligopoly's market is small, each firm has to act strategically one is small number and also.

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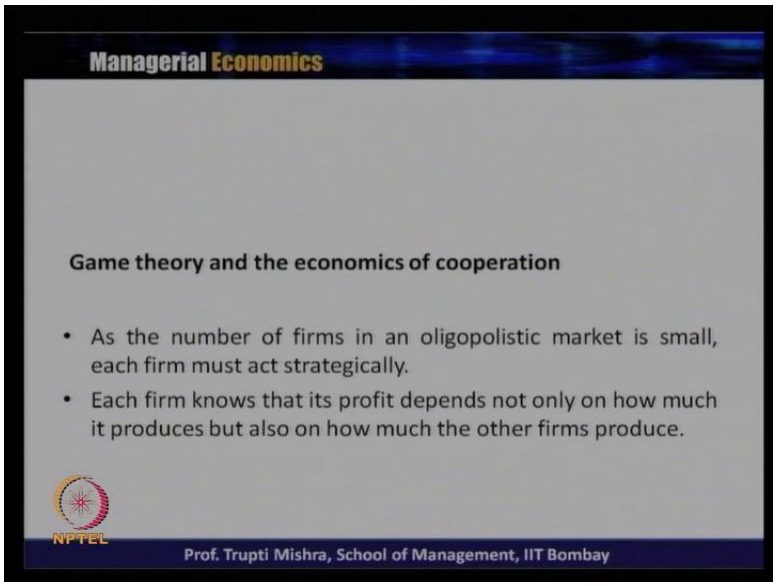

Secondly, they are interrelated. One firm is related to the other firm, either they are competing with each other or they are colluding with each other to maximize the joint profit. So, since the number of firm is small and also, they are interdependent to each other, they have to act strategically and each firm knows that its profit depends not only how much it produces, but also how much the other firm produces. So, if you narrow down the strategic action in case of the interdependence between two firms, what is the profit of the firm, it is not dependent only what it produces or how much it is selling. Rather it is also dependent on the fact that how much others, they are producing, how much the other firms they are producing in the market and how much they are selling.

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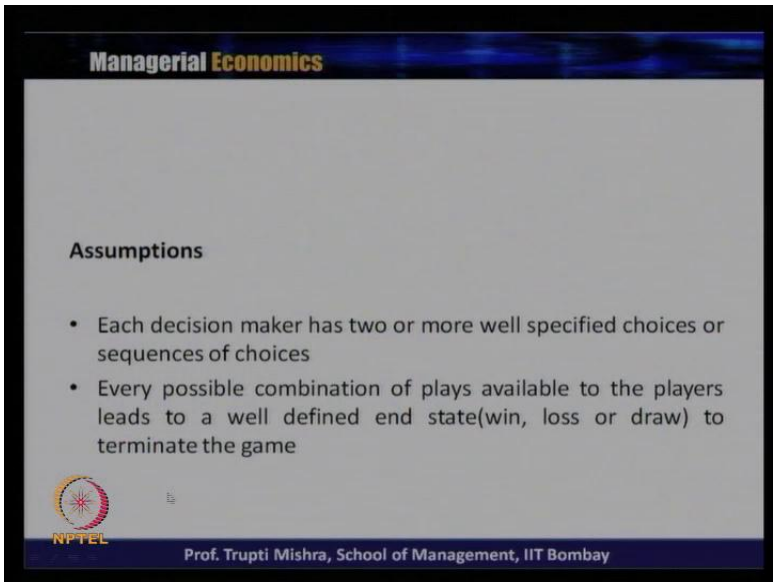

So, each decision maker or the each firm has two or more well specified choice or the sequence of the choices. Every possible combination of plays available to the player leads to a well defined end state, either it is win or it is loss or it is draw to terminate the game. So, when it comes to specific game, what are the assumptions we need to take? Each decision maker has two or more well defined choice or the sequence of choices. Either they have to go for choice one, choice two or in a sequence that first I will go for choice one, first I will go for choice two. So, that is well defined and whatever define that and that has to be only taken by the player, not the other choices.

Then, whatever the possible combination of plays are available, it will lead to some kind of outcome. When it is positive, it is win. If it is negative, it is loss and when it is a mix of rather when there is no definite outcome of this, then it leads to the draw kind of situation.

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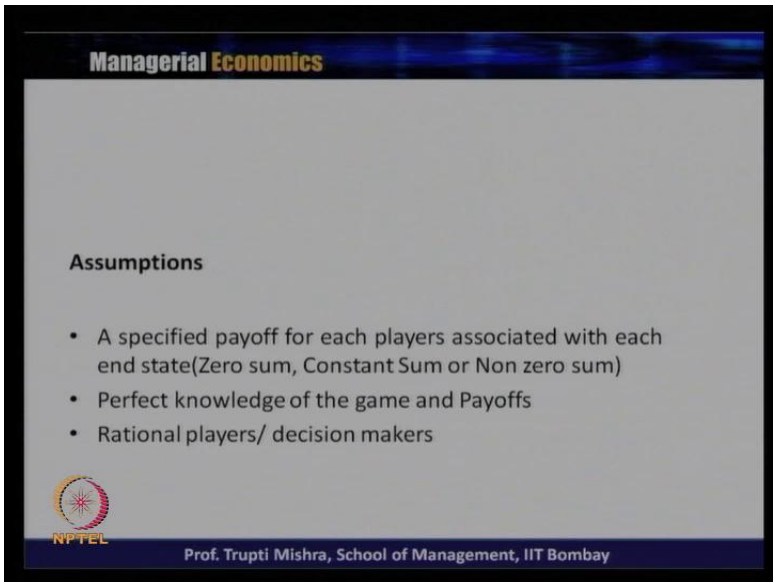

So, specified payoff or the specified outcome from the game for each players associated with each end state, either it leads to zero sum or it leads to constant sum or it leads to non zero sum. We will talk about this zero sum, constant sum and non zero sum game when you talk about the types of game in details, but for the understanding here, let us understand that whatever the specified payoff for each player associated with some kind of end state. So, there is some end out come when the payoff is associated with each of this player.

It is assumed that the players, they have the perfect knowledge about the game and the outcome. Generally, the end outcome what we are calling as the payoff, they have to be the rational because if you remember all economic agents, they have to be rational. If they want to optimize their end outcome or they want to maximize their profit and the player has to be in this case, the player has to be rational or the decision makers has to be rational. They have to always make the rational choice. They cannot go for a buyer's choice.

Now, we will come to the structure of the game. So, previously we were discussing about the assumption. What are the assumption to be followed about the game? Now, we will discuss what should be the structure of the game. The first structure of the game is that about the player's individual firms. They can be the players.

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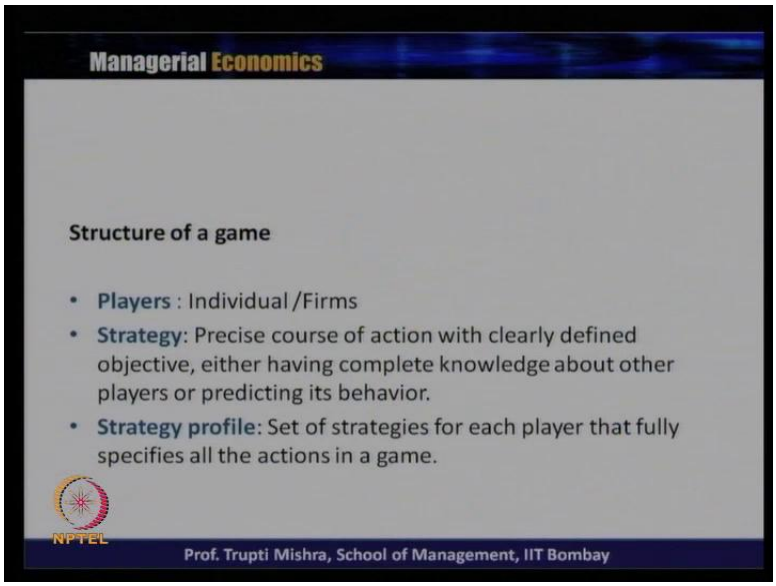

So, neither the decision maker, individual may be the decision maker. So, individual can be the players. Also, the firms can be the players over here. Strategy, now, what is strategy? It is the precise course of action with a clearly defined objective, either having a complete knowledge about the other players or predicting its behavior. So, strategy is the course of action taken by the firm with a clearly defined objective that if they are taking this action, what is the end outcome or what is the end output. Either to take this action, either they have complete knowledge about the other players or at least they can predict what will be the behavior of the firms when they are taking this action.

Strategy profile- It is a set of strategy for each player that fully specify all the action in a game. So, it is not about only one strategy taken by the player in the entire game, rather may be if the player is taking 4 strategy or the other player is taking the 6 strategy or the third player is taking 5 strategy, they are having a strategy profile which specify whatever the strategy taken by the players in the game and that generally known as a strategy profile. The action taken by the player in the game looking at what is the objective and at least assuming that how the players, they are going to behave with, when this action is being taken. There is a strategy profile that is least of action taken by the firm.

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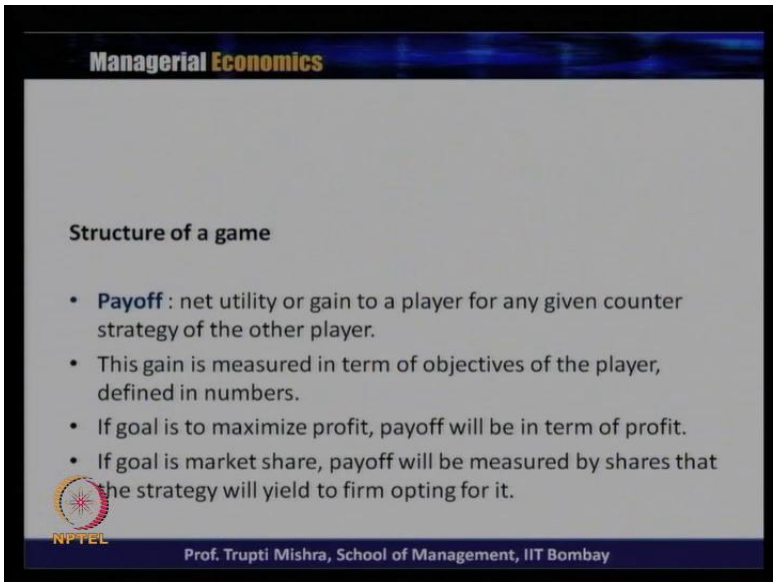

Then payoff. Now, what is payoff? This is the net utility or the gain to a player for any given counter strategy of the other player. So, net utility generally this is the outcome or the utility or the gain to a player for any given counter strategy of other players and this gain is measured in term of the objective of the player defined in number. So, generally in the payoff, we get it in terms of the number and this is the utility or the gain due to any action or due to any strategy by the player.

This gain is in term of the objective of the player. So, suppose if the action is taken, either there will be increase in the market share, increase in the profit, and increase in the output or the revenue and again, what is the rival's action. On that basis, again whether there is a increase in the share or the decrease in the share, increase in the profit or there decrease in the profit or what has to be the basis of the revenue.

If goal is to maximize profit, payoff will be in term of profit. So, if the goal is maximized to maximize the profit, the payoff will be also in the same terminology. We have to do it in term of profit. If the goal is to increase the market share, the payoff will be also measured by the share that the strategy will yield to firm opting for it. So, if it is to maximize the profit, the payoff will be in term of profit. If it is maximized market share, the payoff will be in term of market share. If it is maximized revenue, the payoff will be in term of the revenue. So, depends upon that what is the goal of the firm. For taking this

action that will decide what will be the payoff, what will be the measurement of payment or what will be the measurement unit of the payoff matrix.

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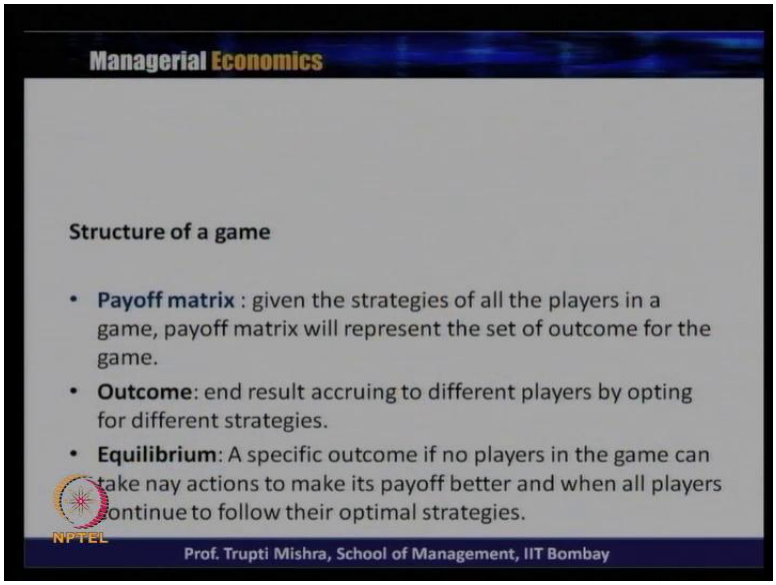

So, payoff matrix generally given strategy of all the players. In the game, payoff matrix will represent the set of outcome for the game. What is outcome? Outcome is the end result accruing to the different players by opting for a different strategy. So, whatever the strategy they take, what is the outcome that is generally known as the end outcome. That is the end result. Whatever is coming to the player by opting a specific strategy or specific action, some of that will give us the payoff matrix equilibrium, a specific outcome if no players in the game can take any actions to make its payoff better and when all player continue to follow their optimized strategy.

So, how we will get the equilibrium? This is the specific outcome if no player in the game can take any action to make it better. So, finally, when both the players, they reach to a specific outcome and after that whatever the mean is taken by any of this player, if it is not going to give any benefit to them, that is the equilibrium. So, it is a kind of state of balance beyond which whatever the action taken by the firm, it is not going to increase the share market. Share increase the revenue or increase the profit. Then, we will talk about the kind of strategy.

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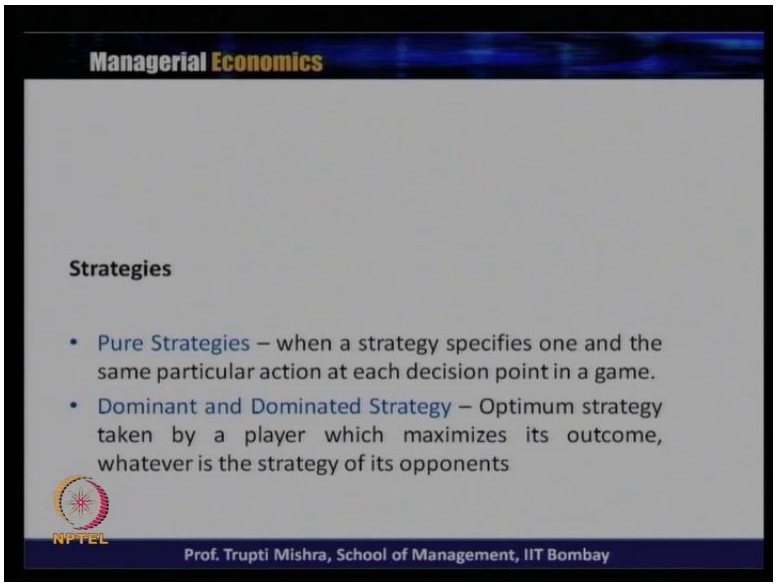

So, the first strategy comes here is pure strategy. What is pure strategy? When a strategy specifies one and the same particular action at each decision point in a game that is generally known as the pure strategy. So, if the strategy specify if whether it is about taking a decision on output, taking a decision on sales, taking a decision maximizing profit, taking a decision on advertising, whatever the strategy whatever the decision point. If the same particular action is going to follow or the strategy specify the same particular action for each decision point, this is generally known as the pure strategy.

Then, we have dominant and dominated strategy optimum strategy taken by player which maximize its outcome whatever the strategy of its opponent. So, what is dominant strategy? The optimum strategy that is taken by the player which maximize its outcome irrespective of whatever may be the strategy of the opponent. So, whatever the optimum strategy taken by one firm keeping in the view, whatever may be the strategy by the other firm, if that is giving the best outcome that is generally known as the dominant strategy.

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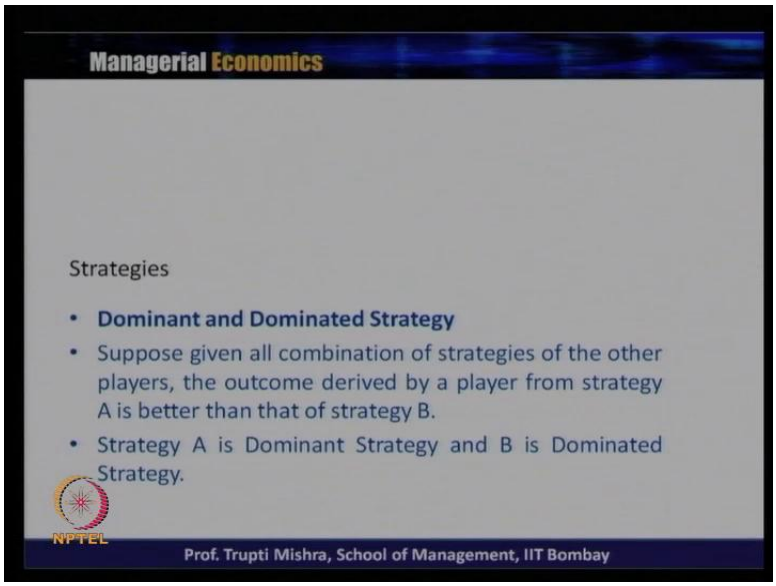

So, we will just take an example to understand this dominant strategy. Suppose, given all combination strategy of the other player, the outcome derived by a player from strategy A is better than strategy B. Generally, strategy A is the dominant strategy. So, given all possible combinations of strategy of the other player, if the outcome by a player from strategy A is better than strategy B. In this case, strategy A will be known as the dominant strategy and strategy B is the dominated strategy. Why strategy B is the dominated strategy? Because it is not the best looking at whatever the strategy taken by the rivals or whatever the strategy taken by all the possible strategy taken by the opponents.

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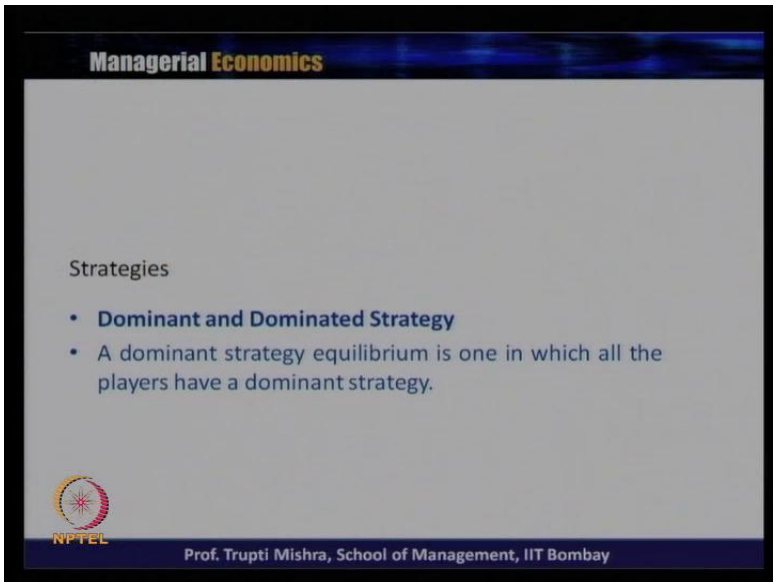

So, a dominant strategy equilibrium is one in which all the players have a dominant strategy. So, it is not about the Nash equilibrium. It is about the dominant strategy equilibrium and dominant strategy equilibrium is one where all the players, they have at least one dominant strategy and through that, we reach to the dominant strategy equilibrium. So, suppose one player is having a dominant strategy, other player is not having. We cannot get dominant strategy equilibrium in that particular game.

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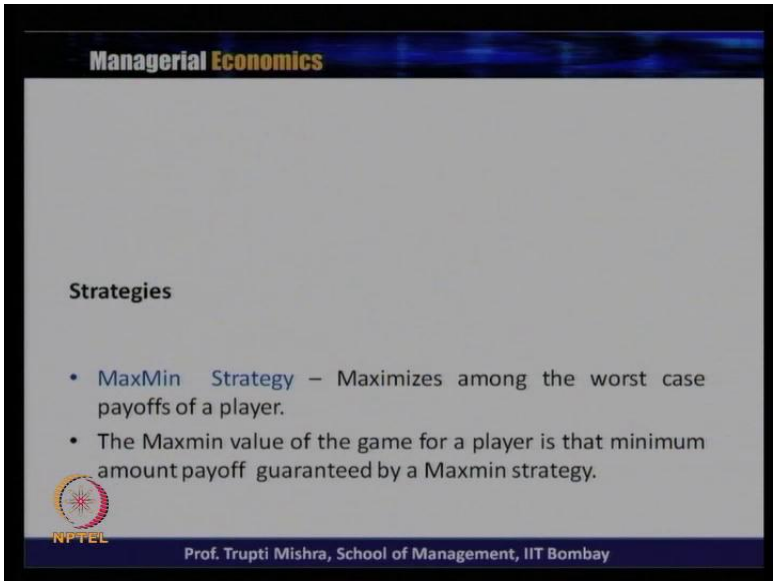

Then, we have maximum strategy. Maximum strategy is the one which maximize among the worst case payoffs of the player and Maxmin value of the game for player is that minimum amount payoff guaranteed by a Maxmin strategy. So, Maxmin value of the game for a player that is at least minimum the player is getting if they are playing this particular strategy.

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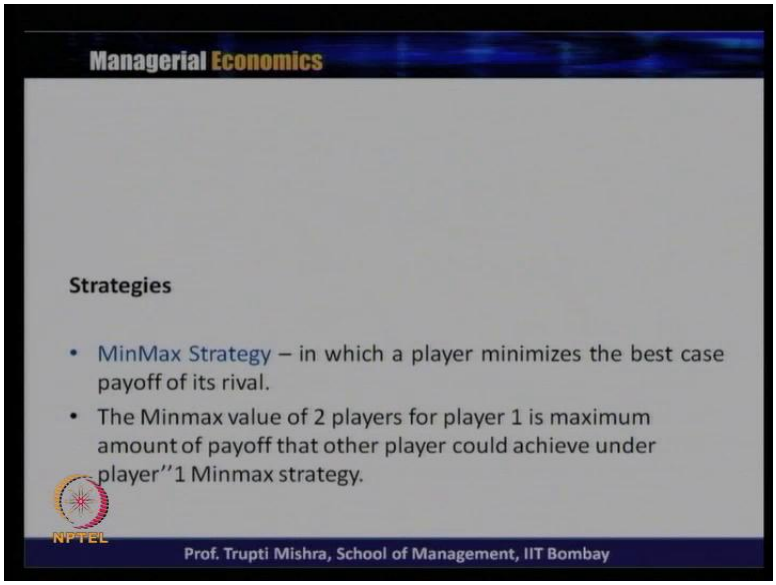

Then Minmax strategy in which generally player minimize the best case payoff its rival. So, whatever the best case payoff the rivals, this particular player try to minimize this and the Minmax value of 2 players for player 1 is maximum on the payoff that other player could achieve under player 1 of the Minmax strategy. So, Minmax value of 2 players for player 1 is maximum amount of payoff what that can be achieved under the player Minmax strategy.

We will understand all this strategy by just taking the example. We will start with the dominant-dominated strategy, Maxmin-Minmax strategy and also, we will see whether we have a Nash equilibrium just taking this example.

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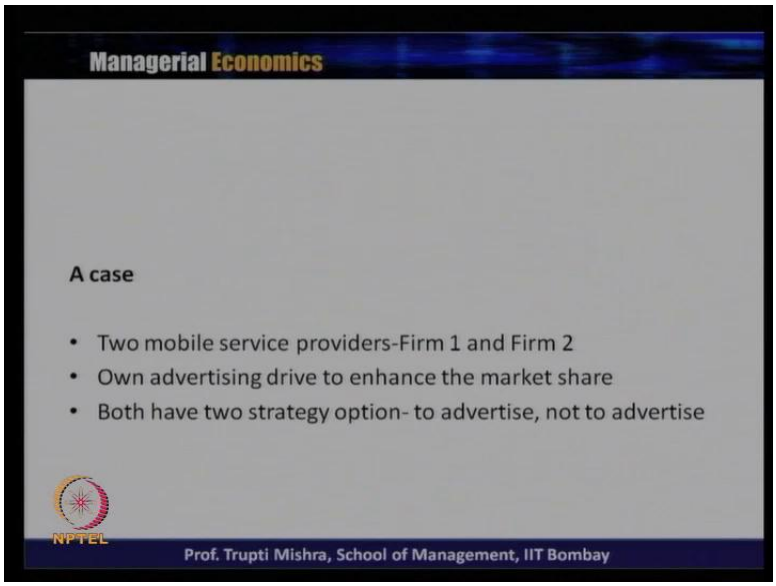

So, there are two mobile service providers in the market. One is firm 1 and second one is firm 2. They have their own advertising drive to enhance the market share . So, both have two strategy option- either to advertise or not to advertise. So, two mobile service providers, one is firm 1 and other is firm 2, they have their own advertising drive to enhance the market share. Both have two strategy options- either to advertise or not to advertise.

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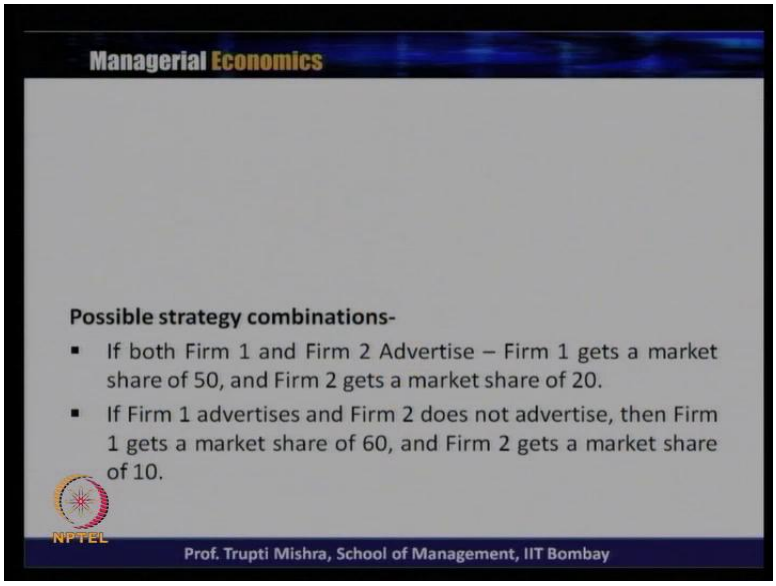

Now, what would be the possible strategy combinations? If both firm 1 and firm 2 advertise, firm 1 get a market share of 50 and firm 2 get a market share of 20. So, if firm 1 and firm 2 both of them are advertising, the outcome is he has to maximize the market share by advertising. So, in this case, if both of them are advertising, firm 1 get a market share of 50 and firm 2 get a market share of 20.

If firm 1 advertises and firm 2 does not advertise, the firm 1 get a market share of 60 and firm 2 get a market share of 10. So, when both of them are advertising, firm 1 get 50 and firm 2 gets 20. When firm 1 only advertises and firm 2 does not advertise, then firm 1 get a market share of 60 and firm 2 get a market share of 10.

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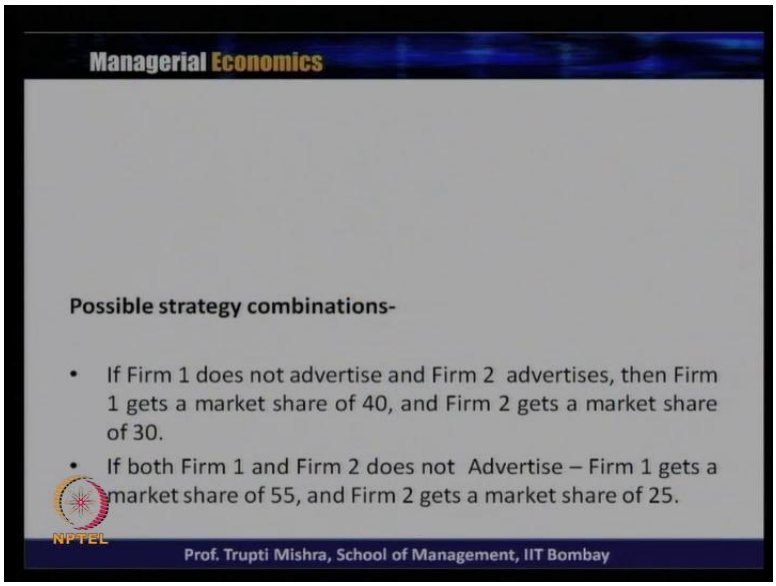

If firm 1 is not advertising and firm 2 advertises, then firm 1 get a market share of 40 and firm 2 get a market share of 30. If both firm 1 and firm 2 does not advertise, then firm 1 get a market share of 55 and firm 2 get a market share of 25.

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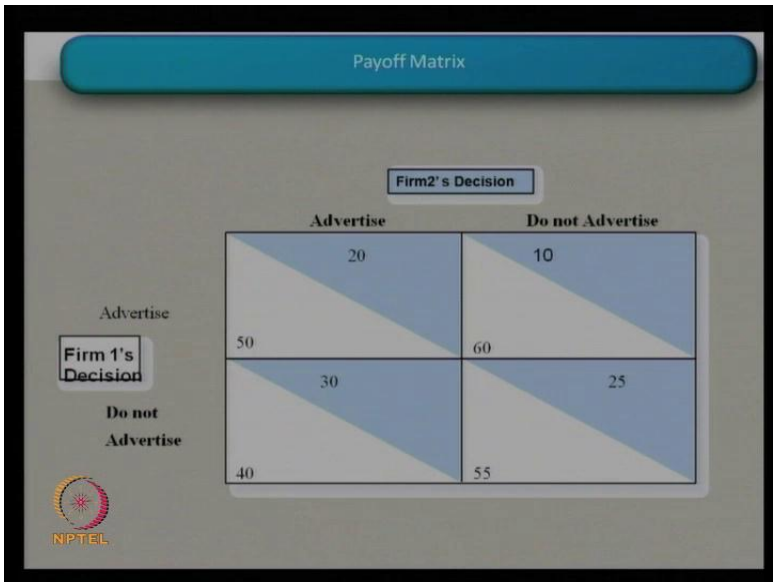

Now, this is the payoff matrix. On the basis of their strategy, now we will take this payoff matrix to understand what is their dominated strategy, what is their dominant strategy, what is the Maxmin strategy, what is their Minmax strategy and whether they are reaching the equilibrium or not, whether they are reaching the Nash equilibrium or not.

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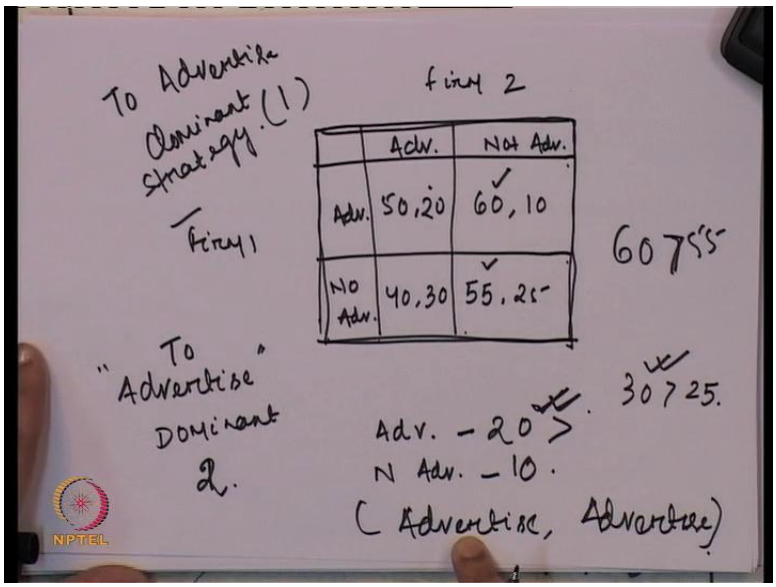

So, we will just take this payoff to understand these different strategies. So, let us call this is firm 2, this is firm 1, this is advertise, this is not going for advertise. This is again

advertise, this is not going for advertisement. So, when both the firms are advertising, then firm 1 get market share of 50 and firm get 2 get a market share of 20. When firm 1 is advertising and firm 2 is not advertising, then firm 1 get 60 and firm 2 get 10. When firm 2 is advertising and firm 1 is not advertising, then firm 1 get 40 and firm 2 get 30. When both of them are not advertising, then firm 1 get 55 and firm 2 get 25.

Now, we will understand what is Maxmin, what is the Minmax, what is the dominant strategy or whether they are reaching equilibrium or not. We are assuming that firm 1 and firm 2 both have to be rational. Now, we will understand this from the firm 2 point of view. Now, if firm 1 is advertising and firm 2 will choose strategy advertising and here they are getting 20 rather than 10. So, if firm 1 is advertising and firm 2 has two options, either they have to advertise or they have to not advertise. If they are advertising, they are getting 20. If they are not advertising, they are getting 10. So, since 20 is greater than 10, if firm 2 is going for advertising, they are getting a better payoff by advertising.

Now, we will analyze the case for firm 2 when firm 2 is not advertising. So, here if firm 1 is not advertising, then it gets 30. If he is advertising, then he gets 30, but if he is not advertising, he is getting 25. So, in this case, again 30 is greater than 25. So, what is the dominant strategy for here because whatever firm 1 does, whether advertise or not advertise, always advertising is the best option for firm 2 and since, advertise is the best option for firm 2, to advertise is the dominant strategy for firm 2.

Now, how it is a dominant strategy? Because when firm 1 is advertising and firm 2 is also advertising, they are getting a payoff of 20 rather than not advertising. When firm 2 is not advertising, it is getting a payoff of 30 by advertising which is more than the payoff which is not advertising. So, whether firm 1 advertise or not advertise, always the payoff is maximum for firm 2 when they are advertising like 20 and 30 and that is why to advertise is the dominant strategy for firm 2.

Now, we will analyze this from firm 1 perspective. Now, suppose firm 2 advertise. What firm 1 will do if he is advertising, he is getting 50. If he is not advertising, he is getting 40. So, if firm 2 is advertising, if firm 1 is advertising, he is getting a better payoff rather than not advertising and when firm 2 is not advertising and firm 1 is advertising, he is getting a payoff of 60. Firm 2 is not advertising and firm 1 is not advertising, then he get

a better payoff of 55. Since, 60 is greater than 55 and in both these cases, whether firm 2 advertise or not advertise, firm 1 is getting a better payoff in advertising.

So, when firm 2 is advertising, this is the payoff. When firm 2 is not advertising, this is the payoff. When firm 1 is advertising that is where for firm 1 is also to advertise is the dominant strategy. Dominant strategy for firm 1 also. How do you interpret this? Dominant strategy irrespective of whatever the action are taken by the other firm to advertise is the best possible action or the best strategy by the firm. So, in this case, dominant strategy for both the firm, what is the dominant strategy for firm 1 to advertise what is the dominant strategy for firm 2 to advertise.

Since, both the firms have the dominant strategy, we get a equilibrium and the equilibrium gives us a strategy that is advertise. This is the payoff or this is the strategy advertise both the firms and this gives us the equilibrium. Since, both of them have the dominant strategy, this is generally the dominant strategy equilibrium. Then, we will understand the Maxmin and Minmax strategy taking the specific example.

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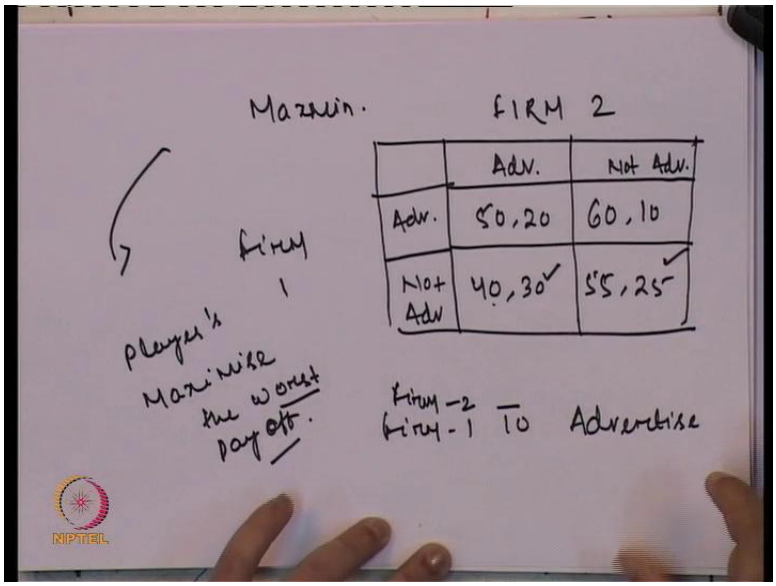

So, to start with, we will do the Maxmin. We will just do the payoff matrix once again to understand this. So, advertise not advertise, advertise not advertise. So, this is firm 2 and this is firm 1. So, this is 50, 20, 40, 30, 60, 10, 55, 25. Now, to understand Maxmin, what is Maxmin? Players will try to maximize the payoff. The worst payoff, maximize the worst payoff.

Now, how this worst payoff will come? That will come from the strategic behavior. What worst can happen for firm 1 if they advertise? They get 50. If they are not advertising, they get 40. They try to maximize that they should advertise because they are getting a highest payoff . So, for them what is the Maxmin strategy? The Maxmin strategy is to advertise.

Similarly, when the other firm is not advertising, what is the payoff for them? If they are advertising, they get 60. If they are not advertising, they are getting 55. So, for them what is best? Again, if they are advertising when the firm 2 is not advertising also. So, this is the pay off, that is 50, 40, 60, 55 related to the two kind of strategy when they are advertising and when they are not advertising. They will try to maximize the value, they are trying to maximize the payoff. So, the worst payoff can be 40. If they are not advertising and firm 2 is advertising and if they are not advertising when firm 2 is not advertising, but since they have to maximize the profit. They will take always the highest payoff and that is why the Maxmin strategy for firm 1 is to advertise. Similarly, we will understand for firm 2.

Now, for firm 2, if the firm 2 is advertising, they get 20. They are not advertising, they are getting 30. Similarly, if they are not advertising, they get 30 10 and if they are not advertising, again they are getting 25. So, what is the Maxmin? They have to maximize the payoff here. What is the Maximize here between this advertising and not advertising? It is 20 and 10. So, if they are advertising, they are getting 20. If they are not advertising, they are getting 10 and since, they have to maximize the outcome, since they have to maximize the payoff, they will always take this because this 20 is the highest payoff.

Similarly, when it comes to firm 2, when firm 1 is not advertising, if they are advertising, they are getting 30. If they are not advertising, they are getting 25 and since, 30 is more than 25, they have to maximize the value and they will take 30. So, it is always the Maxmin strategy. For firm 2, it is also to advertise. Then, we will understand the Minmax strategy. What is the logic for Minmax strategy? The player will try to minimize the payoff for the opponents by their own strategy or by their own action. So, to put it simply, when firm 1 will decide whether to advertise or not advertise, they look at which one will give the minimum payoff to the opponents because that will be chosen by them and that is why they look for that how to minimize the payoff of the opponents rather than how to maximize the payoff of their own firm.

What generally they look it in the Maxmin strategy? So, Minmax strategy, their focus is to minimize the payoff of the rivals or to minimize the payoff of the opponent.

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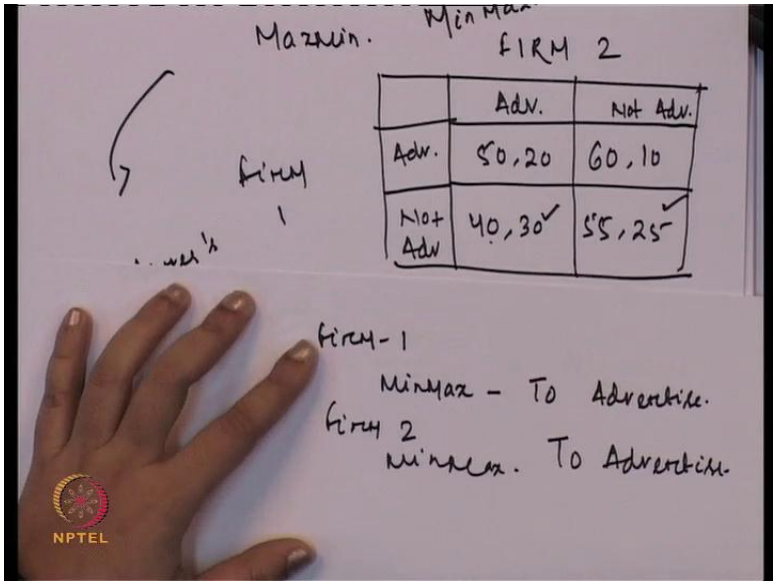

So, if you will if you will take now about the Minmax, we will take for firm 1. Now, what can be the Minmax? When it comes to firm 2, when they are advertising, what is best to firm 2? They have to also that is 20. When they are not advertising, what is best for firm 2? That is 30, but if they are not advertising, the other one is getting 25.

So, now what he will do? Firm 1 will try to advertise, so that firm 2 is also advertising and they are getting a less payoff rather than not advertising, because if firm 1 is not advertising, it is getting a highest payoff in both the cases, whether firm 2 advertise or not advertise, but if firm 1 is advertising, whether firm 2 advertise or firm 2 is not advertising, still they get a payoff which is lower than their counter part and that is why the Minmax strategy for firm 1 has to be advertised.

Similarly, we will now understand from firm 2 perspective. Now, for firm 2, if they are advertising, what is the payoff for firm 1? That is 50 and if they are not advertising, that is 40. When firm 2 is not advertising and the firm 1 is advertising, they are getting 60 and not advertising, they are getting 55. So, since 50 is less than 60 and 40 is less than 55, firm 2 will feel that it is better to advertise because they are getting a lower payoff whether they are advertising or not advertising. So, in that case the Minmax strategy for firm 2 will be also to advertise because if they are advertising, that gives the less payoff

to the firm 2 rather than not advertising. So, this is how we understand this dominated strategy and Maxmin and Minmax strategy.

Now, in this case, in the particular case, if you look at all the strategy whether it is dominant whether it is Maxmin or whether it is Minmax, all the strategy they are to advertise for both the firm. This may not happen in all these cases. There may be also whatever the dominant strategy of that may not be the dominant strategy of B or it may happen that there is a dominant strategy for one player, but there is no dominant strategy for the other player. So, in this case, the possibility is that we will not get a dominant strategy equilibrium where there is a dominant strategy for both the players.

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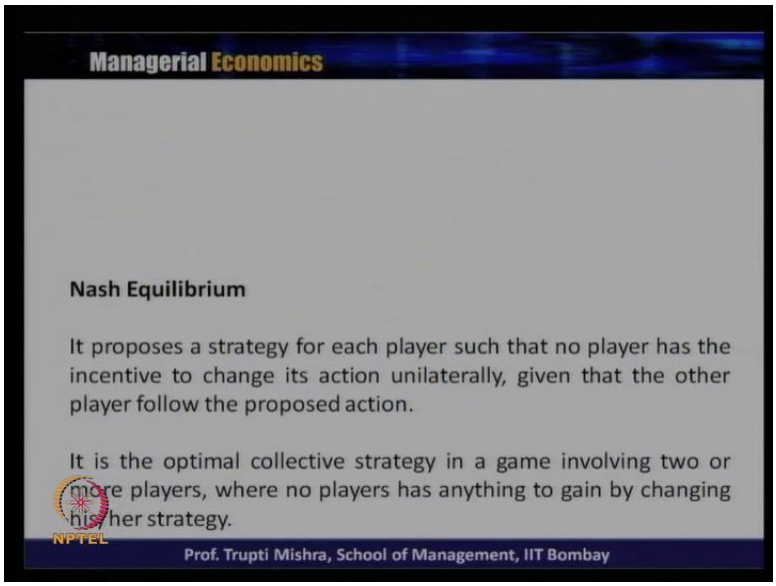

Then, we will talk about Nash equilibrium. Nash equilibrium generally propose a strategy for each player such that no player has the incentive to change its action unilaterally, given that the other player follow the propose action because again equilibrium is a state of balance, equilibrium is a state of rest. Beyond this, there is no incentive for the other firm to go for this equilibrium because that is the place where they get the maximum profit or maximum positive outcome.

So, generally Nash equilibrium propose a strategy for each player such that no player has change incentive to change its action unilaterally, giving the other players to follow the proposed action and it is an optimal collective strategy in a game involving two or more player where no player has anything to gain by changing his or her strategy.

So, we will understand this Nash equilibrium taking our previous example. We will take out the payoff matrix where it is a case of two firms that is firm 1 and firm 2 and they have two options to advertise or not advertise and the final output is in term of the payoff that is whatever the outcome they are getting.

So, here we will add one more new assumption and the new assumption is here that firm 1, you just typically expensive advertising agency and since, the advertising agency is doing advertisement for them that increase their cost of production and here, the firm would try to shift the burden to the consumer in term of increase in the price of the product, so that the company gets lesser market share when it advertise as compared to when it does not advertise.

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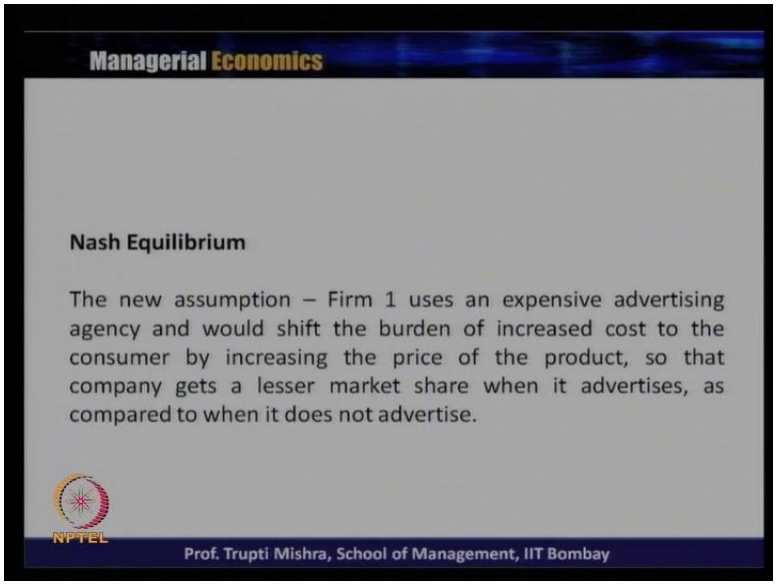

So, since they are shifting the burden of the increasing cost to the consumer, it is obvious that the market share will decrease because when price increases, even if it is a good product, still some amount of the quantity demanded decreases. So, that will increase the price of the product and that will decrease the market share and company gets a less market share when its advertise compared to what when it does not advertise.

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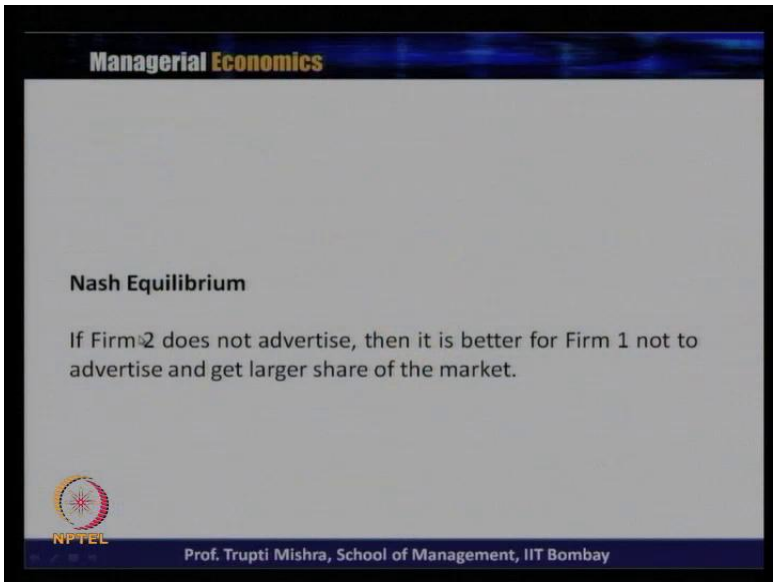

So accordingly, our payoff matrix will change; and if firm 2 in this case does not advertise, then it is better for firm 1 not to advertise and get a larger share of market. Now, here in one case, firm 1 is doing an expensive advertising and they are passing the cost to the consumer and second case, in continuation to that they are getting a less market share, but if firm 2 does not advertise here, then it is better for firm 1 not to advertise and get a larger share of market.

So, here what is the best action for firm 2? They are doing the advertising because firm 2 is also doing the advertising; if firm 2 is not doing the advertising, now what is the best choice for firm 1? Best choice for firm 1 is not to advertise, because if they are not advertising, they do not have to spend for a advertising agency, there is no increase in the cost of production, there is no increase in the market price, there is no decrease in the market share; and if there is no decrease in the market share, this is the best possible action at the best possible strategy for firm 1.

So, we will continue our discussion on Nash equilibrium. Taking this specific example, we will talk about the different types of gain, we will talk about the pralines dilemma and we will talk about that how this game theory is applied specifically to few of the oligopoly's model in our next session.