MANAGERIAL ECONOMICS

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Lecture No - 35 : Game Theory

Session Outline

Application of Game Theory in Economics

The Equilibrium for an Oligopoly

- The importance of interdependence is that it leads to 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.

- Oligopolistic behavior includes both ruthless competition and cooperation.

Strategic behavior

- Limit Pricing
- Price Retaliation
- Capacity Expansion
- Market Saturation

Game theory

- Game theory is a method of analyzing strategic interaction.

- It is concerned with "how individuals make decisions when they are aware that their actions affect each other and when each individual takes this into account"

Game theory

- Game theory is a mathematical tool that helps to study strategic situations in which players optimize a variable not only on the basis of their own preferences, but also on other player's decisions and reactions.

Game theory

- Games are chactarised by number of players or decision makers who interact and even threaten each other and at times establish coalitions and take actions under uncertain condition.

- Outcome – players receive some benefits or loss.

Game theory

- Different types of moves taken by different players in various games are systematically and structurally used explain economic theory specifically to understand firm's behaviour.

- 1950, John Nash demonstrated the idea of an equilibrium situation in which all players in a game chose strategies or actions which are best for them, given the opponent's choice.

Game theory and the economics of cooperation

- Game theory is the study of how people behave in strategic situations.

- Strategic decisions are those in which each person, in deciding what actions to take, must consider how others might respond to that action.

Game theory and the economics of cooperation

- As the number of firms in an oligopolistic market is small, each firm must act strategically.

- Each firm knows that its profit depends not only on how much it produces but also on how much the other firms produce.

Assumptions

- Each decision maker has two or more well specified choices or sequences of choices

- Every possible combination of plays available to the players leads to a well defined end state(win, loss or draw) to terminate the game

Assumptions

- A specified payoff for each players associated with each end state(Zero sum, Constant Sum or Non zero sum)

- Perfect knowledge of the game and Payoffs

- Rational players/ decision makers

Structure of a game

- **Players** : Individual /Firms
- **Strategy**: Precise course of action with clearly defined objective, either having complete knowledge about other players or predicting its behavior.
- **Strategy profile**: Set of strategies for each player that fully specifies all the actions in a game.

Structure of a game

- **Payoff** : net utility or gain to a player for any given counter strategy of the other player.

- This gain is measured in term of objectives of the player, defined in numbers.

- If goal is to maximize profit, payoff will be in term of profit.

- If goal is market share, payoff will be measured by shares that the strategy will yield to firm opting for it.

Structure of a game

- **Payoff matrix** : given the strategies of all the players in a game, payoff matrix will represent the set of outcome for the game.

- **Outcome**: end result accruing to different players by opting for different strategies.

- **Equilibrium**: A specific outcome if no players in the game can take nay actions to make its payoff better and when all players continue to follow their optimal strategies.

Strategies

- Pure Strategies – when a strategy specifies one and the same particular action at each decision point in a game.

- Dominant and Dominated Strategy – Optimum strategy taken by a player which maximizes its outcome, whatever is the strategy of its opponents

Strategies

- **Dominant and Dominated Strategy**

- Suppose given all combination of strategies of the other players, the outcome derived by a player from strategy A is better than that of strategy B.

- Strategy A is Dominant Strategy and B is Dominated Strategy.

Strategies

- **Dominant and Dominated Strategy**
- A dominant strategy equilibrium is one in which all the players have a dominant strategy.

Strategies

- MaxMin Strategy – Maximizes among the worst case payoffs of a player.

- The Maxmin value of the game for a player is that minimum amount payoff guaranteed by a Maxmin strategy.

Strategies

- MinMax Strategy – in which a player minimizes the best case payoff of its rival.

- The Minmax value of 2 players for player 1 is maximum amount of payoff that other player could achieve under player''1 Minmax strategy.

A case

- Two mobile service providers-Firm 1 and Firm 2
- Own advertising drive to enhance the market share
- Both have two strategy option- to advertise, not to advertise

Possible strategy combinations-

- If both Firm 1 and Firm 2 Advertise – Firm 1 gets a market share of 50, and Firm 2 gets a market share of 20.

- If Firm 1 advertises and Firm 2 does not advertise, then Firm 1 gets a market share of 60, and Firm 2 gets a market share of 10.

Possible strategy combinations-

- If Firm 1 does not advertise and Firm 2 advertises, then Firm 1 gets a market share of 40, and Firm 2 gets a market share of 30.

- If both Firm 1 and Firm 2 does not Advertise – Firm 1 gets a market share of 55, and Firm 2 gets a market share of 25.

Payoff Matrix

Firm2' s Decision

	Advertise	**Do not Advertise**
Advertise	20 50	10 60
Do not Advertise	30 40	25 55

Firm 1's Decision

To Advertise is dominant strategy for Both Firm 1 and Firm 2

To Advertise is MaxMin Strategy for both the players

To Advertise is MinMax Strategy for both the players

Nash Equilibrium

It proposes a strategy for each player such that no player has the incentive to change its action unilaterally, given that the other player follow the proposed action.

It is the optimal collective strategy in a game involving two or more players, where no players has anything to gain by changing his/her strategy.

Payoff Matrix

Firm 2's Decision

	Advertise	Do not Advertise
Advertise	20 / 50	10 / 60
Do not Advertise	30 / 40	25 / 65

Firm 1's Decision

Nash Equilibrium

The new assumption – Firm 1 uses an expensive advertising agency and would shift the burden of increased cost to the consumer by increasing the price of the product, so that company gets a lesser market share when it advertises, as compared to when it does not advertise.

Nash Equilibrium

If Firm 2 does not advertise, then it is better for Firm 1 not to advertise and get larger share of the market.

Nash Equilibrium

Firm 1 and Firm 2 do not have dominant strategies.
What would happen to the equilibrium outcome in this case?

Nash Equilibrium

Two Nash equilibrium
1. It occurs when both companies advertise
2. When both do not advertise
Each firm is better off if it plays the same strategy as the other firm and both Nash equilibrium occur when both the firms simultaneously play the same strategy.

Nash Equilibrium

Any Maxmin strategy profile confers to Nash equilibrium.

A Minmax strategy by both players also leads to Nash equilibrium.

The Prisoners' Dilemma

- The prisoners' dilemma provides insight into the difficulty in maintaining cooperation.

- Often people (firms) fail to cooperate with one another even when cooperation would make them better off.

- The prisoners' dilemma is a particular "game" between two captured prisoners that illustrates why cooperation is difficult to maintain even when it is mutually beneficial.

The Prisoners' Dilemma

- Two suspects are arrested for armed robbery. They are immediately separated. If convicted, they will get a term of 10 years in prison. However, the evidence is not sufficient to convict them of more than the crime of possessing stolen goods, which carries a sentence of only 1 year.

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.

The Prisoners' Dilemma

Prisoner 1's Decision

	Confess	Remain Silent
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

Prisoner 2's Decision

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.

Jack and Jill Oligopoly Game

Jack's Decision

	Sell 40 Gallons	Sell 30 Gallons
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

Jill's Decision

An Arms-Race Game

Decision of the Country 1

	Arm	**Disarm**
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

Decision of the Country 2

Types of Game

Games are classified on the basis of
- Relation between players
- Strategies
- Outcome

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 possibillity of tie up among players like in case of cut throat competition.

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.

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.

Types of Game

Two person Games and n person Games
•Classification is on the basis of number of players

Session References

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