Game Theory

GAME THEORY AND OLIGOPOLY BEHAVIOUR:

Game theory analyses the way that two or more players or parties choose actions or strategies that jointly affect each participant. In other words, game theory determines rational behaviour of players whose interests are mutually dependent on one another's decision. Its objective is to find mathematically complete principles which define rational behaviour for the participants in a social economy, or to derive from them the general characteristics of that behaviour. The theory was developed by John von Neumann (1903-1957), who was a Hungarian born mathematician.

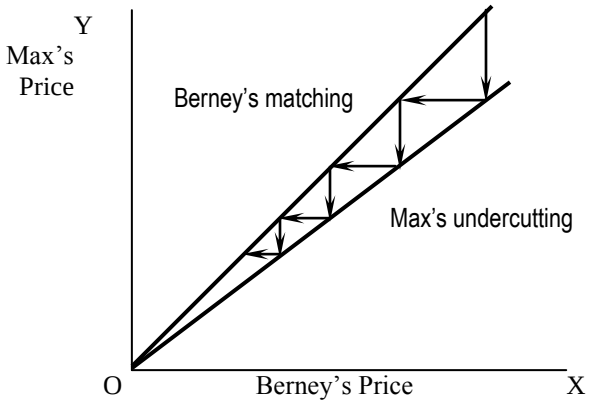
By game we mean any situation in which the interests of the participants conflict. While taking decision each party must consider what probably will be the decision of the other so that he may make a choice most profitable to himself. This what usually happens in a game of chess or cards. This is applicable to situations arising in an oligopoly.

There are two common games, i.e., constant-sum game and zero-sum game:

- ***Constant-Sum Game:*** is the game in which the participants take share of the total gain.
- ***Zero-Sum Game:*** is the game in which the winnings of one are matched exactly by the losses of the other.

In the following example, the dynamics of price-cutting will be analysed, so lets the game begin! Suppose there are two rival firms in an industry, viz., Berney & Max:

At present the Berney's Motto: "We will not be undersold"
Currently, the Max's Motto: "We sell for 10% less"



In the above diagram, the vertical arrows show Max's price cuts; the horizontal arrows show Berney's responding strategy of matching each price cut. By tracing through the pattern of reaction and counter-reaction, you can see that this kind of rivalry will end in mutual ruin at a zero price. Because the only price compatible with both strategies is a price of zero; 90 percent of zero is zero. If one party cut the price, the other party will match the price cuts, and it will continue until the price of zero is attained. Now the

Berney will start 'what-if' analysis. What Max will do if Berney charge price A, price B, and so forth. The novel element in the duopoly game is that the firm's profits will depend on the rival's strategy as well as on its own.

The useful tool for representing the interaction between two players is a two-way 'payoff table'. A payoff table is a means of showing the strategies and the payoffs of a game between two players. In the payoff table, a firm can choose between the strategies listed in its rows or columns. For example, Max can choose between its two columns and Berney can choose between its two rows. In this example, each firm decides whether to charge its normal price or to start a price war by choosing a low price:

		Max's Price	
		Normal Price *	Price War
Berney's Price	Normal Price *	**A** Rs. 10 Rs. 10	**B** – Rs. 100 – Rs. 100
	Price War	**C** – Rs. 10 – Rs. 100	**D** – Rs. 50 – Rs. 50

A Payoff Table for a Price War

* Normal price strategy is the dominant price strategy.

The above payoff table shows the price war game between Berney and Max. The amounts in rupees inside the cells show the payoffs of the two firms; that is, these are the profits earned by each firm for each of the four outcomes. The lower left amount shows the payoff to the player on the left, i.e., Berney; the upper right shows the payoff to the player at the top, i.e., Max. Just like Max, Berney has two choices, i.e., either to opt for normal price or go for a price war. In cell C, the Berney plays normal price and Max plays price war. The result is that Berney has a profit of – Rs. 100 while Max has a profit of – Rs. 10. Thinking through the best strategies for each player leads to the dominant equilibrium in cell A, where both the players avoid price war.

Dominant Strategy: The simplest strategy in game theory is 'dominant strategy'. This situation arises when one player has a best strategy no matter what strategy the other player follows. The firm's best price strategy is to follow normal price. In the above case, charging the normal price is a dominant strategy for both firms in the 'price-war game'. When both or all players have a dominant strategy, the outcome is said to be 'dominant equilibrium' because each player is having its own dominant strategy.

Nash Equilibrium: This theory presented by a mathematician John Nash. Nash equilibrium applies to the situation when all the participants in a game are each pursuing their best possible strategy in the knowledge of the strategies of all other participants. For example, imagine a two-person country where both the people have to decide the side of the road on which to drive. The payoffs are as follows:

(i) No crash: happens when both drive on the left or right. It is Nash equilibrium. There are two possible Nash equilibria, i.e., either both driving on the left, or both driving on the right.
(ii) Crash: happens when one drives on the left and the other drives on the right. If one drives on the left and the other drives on right, it is not Nash equilibrium because, given the choice of the other, each would change their own policy.

Now take our previous example of Bernie and Max. Suppose each firm considers whether to have its normal price or to raise its price toward the monopoly price and try to earn monopoly profits. It is a rivalry game, which is shown in the following diagram:

Berney's Price	Max's Price: High Price	Max's Price: Normal Price *
High Price	**A** Rs. 200 Rs. 100	**B** Rs. 150 – Rs. 20
Normal Price *	**C** – Rs. 30 Rs. 150	**D** Rs. 10 Rs. 10

A Payoff Table showing Rivalry Game

In the above game, it is shown that the firms can stay at their normal price equilibrium that we found in the price-war game, or they can try to raise their price to earn some monopoly profits.

Cell A: Each firm follows high price strategy and both firms have the highest joint profit of Rs. 300. It is the situation where both the firms behave like a monopolist for having high prices.

Cell D: Each firm follows normal price strategy and both firms have the lowest joint profit of Rs. 20. It is the situation of normal price equilibrium that we found in the price-war game.

Cell C: Max follows a high price strategy but Burney undercuts. So Burney takes most of the market and has the highest profit of any situation, while Max actually loses money.

Cell B: Berney gambles on high price, but Max's normal price means a loss for Berney.

Conclusion: In the above example of the rivalry game, Berney has a dominant strategy; it will profit more by choosing a normal price no matter what Max does. On the other hand, Max does not have a dominant strategy because Max would want to play normal if Berney plays normal and would want to play high if Berney plays high. In the above game, the best policy for Max is to play normal price. This situation illustrates the basic rule of basing your strategy on the assumptions that your opponent will act in his or her best interest. This is Nash equilibrium. Nash equilibrium is one in which no player can

improve his or her payoff given the other player's strategy. The Nash equilibrium is also sometimes called 'non-cooperative equilibrium', because each party chooses its strategy without collusion or cooperation, choosing that strategy which is best for itself, without regard for the welfare of society or any other party.

EXAMPLES OF GAME THEORY:
To Collude or Not to Collude:

(a) The duopolists may decide to collude, which means that they will behave in a cooperative manner. A ***cooperative equilibrium*** comes when the parties act in unison to find strategies that will benefit their joint payoffs. They may decide to form a cartel, setting a high price and dividing all profit equally between the firms. Clearly this will benefit the duopolists at the expense of consumers.

(b) If the cooperative equilibrium is not possible, the firms would quickly gravitate to the ***non-cooperative or Nash equilibrium.*** This is also known as a ***'perfectly competitive equilibrium'*** because each firm and consumer makes decisions by taking the prices of everyone else as given. In this equilibrium, each firm maximises profits and each consumer maximises utility leading to zero-profit outcome in which price equals marginal cost. According to Adam Smith, there is an invisible hand that makes perfectly competitive equilibrium socially efficient, even though each person is behaving in a non-cooperative manner. By contrast, if some parties were to cooperate and decide to move to the monopoly price, the efficiency of the economy would suffer. That is why governments intervene to enforce antitrust laws that contain harsh penalties for those who collude to fix prices or divide up the markets.

The Pollution Game: In many circumstances, non-cooperative behaviour leads to economic inefficiency or social misery. One notable example is the arms race, where non-cooperative behaviour between the United States and the (former) Soviet Union, and Pakistan and India led to massive military spending and development of weapons of mass destruction, makes the continents unsafe. Another example of pollution game is shown in payoff table as follows:

		US Steel: Low Pollution	US Steel: High Pollution *
Oxy Steel	Low Pollution	**A** Rs. 100 Rs. 100	**B** Rs. 120 – Rs. 30
Oxy Steel	High Pollution *	**C** – Rs. 30 Rs. 120	**D** Rs. 100 Rs. 100

A Payoff Table showing Non-cooperative behaviour leads to more Pollution

* Nash equilibrium

In the above diagram, an example of two steel manufacturing concerns, namely, US Steel and Oxy Steel, operating in the United States is taken. In this world of unregulated firms, each individual profit-maximising firm would prefer to pollute the earth's environment

rather than install expensive pollution-control equipment. In such a world, if a firm behaves altruistically and cleans up its wastes, that firm will have higher production costs, higher prices, and fewer customers. If the costs are high enough, the firm may even go bankrupt. This is a situation in which the Nash equilibrium is inefficient. When markets or decentralised equilibria become dangerously inefficient, governments may step in. By setting efficient regulations or emissions charges, government can induce firms to move to outcome A, the Low pollute/Low pollute world. In that equilibrium, the firms make the same profit as in the high-pollution world, and the earth is a healthier place to live in.

Monetary-Fiscal Game: The game theory is also important to understanding a nation's economic policies. Economists and politicians have argued that monetary policy and fiscal policy are skewed in an undesirable direction; fiscal deficits are too high and reduce national saving, while monetary policy produces interest rates that retard investments. It is customary in a modern economy to separate monetary and fiscal functions. A country's central bank determines the monetary policy – interest rates, and the fiscal policy – taxes and spending – is determined by the executive and legislative branches. But the monetary and fiscal authorities have different objectives. The central bank takes a stance that emphasises austerity and low inflation. The fiscal authorities worry about full employment, popularity, keeping taxes low, preserving spending programs, and getting re-elected. Thus they pick high deficits. The central bank wants minimise the inflation and chooses high interest rates. Thus the outcome is the non-cooperative equilibrium between fiscal authorities and monetary policy makers at cell C:

Monetary Policy \ Fiscal Policy	High Deficits *	Low Deficits †
High Deficits *	**A** • Very low unemployment • Very high inflation • Moderate investment	**B** • Moderate unemployment • Moderate inflation • High investment
Low Deficits †	**C** • Moderate unemployment • Moderate inflation • Low investment	**D** • High unemployment • Low inflation • Moderate investment

A Payoff Table showing the Monetary-Fiscal Game

* Nash equilibrium
† Cooperative equilibrium

Perhaps the best strategy of monetary fiscal game is to lower the deficits, lower interest rates and raise investment, which was adopted by President Bill Clinton for the survival of US economy.