Game Theory and Mobile Operator Business

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Abstract

Strategy plays a crucial role in managing any successful business. To formulate successful strategies, one needs to understand the competitors' state of mind. Game theory is a tool primarily used to solve multi-personal decision problems. Oligopolies like mobile communications industry, with typically 3 to 6 operators, provide ample opportunities to use game theory in solving such problems. The paper gives an overview of game theory and looks at areas of application within the mobile industry. It also mentions the relevance of game theory in the Mobile Operator Business (MOB) game.

Keywords: Game theory, oligopoly, mobile industry, MOB.

1 Introduction

Since ancient times, philosophers and political commentators have been pondering on profound issues such as relationships among human beings. Game theoretic insights can be found in such thoughts [1]. However, a mathematical theory of games was invented only in 1944 by John von Neumann and Oskar Morgenstern. Since then, game theory has evolved as a powerful tool for interpersonal decision-making and management. The definitions of certain fundamental terms involved in understanding this theory is provided in the ensuing section, followed by motivations for using game theory and areas of its application.

1.1 Definitions

According to Stanford Encyclopedia of Philosophy [2], the definition of games and game theory are as follows:

Game: All Situations in which at least an agent can only act to maximize his utility through anticipating the responses to his actions by one or more other agents. Agents here mean players.

Game Theory: Study of ways in which strategic interactions among rational players produce outcomes with respect to the utilities of those players, none of which might have been intended by any of them.

1.2 Motivations

Game theory is used as a tool for analysis in business and economics. Some of the motivations include:

- Improving strategic decision making
- Helping in running a business and evaluating policies.
- Becoming better managers and economists.

1.3 Areas of application

In business, game theory is applied in markets with one or more number of players such as monopoly, duopoly or oligopoly. A comprehensive list of news related to other areas where game theory is applicable is mentioned in [3].

The organization of remaining sections is as follows: Section 2 explains the classifications of games based on various factors. Section 3 describes game equilibrium. The applications of game theory in mobile industry are dealt with in section 4. Section 5 explains the usefulness of game theory in MOB game followed by inference in section 6.

2 Game Classifications

Game theory models situations based on various factors such as the nature of moves, the extent of information available to players, the probability of using strategies by each player etc. Some of those are mentioned here. A detailed explanation of these is provided in [4].

2.1 Move-based

Games are primarily based on the sequence of moves (not temporal) made by the players. They are:

- Sequential games: Also known as dynamic games.
- Simultaneous games: Also known as static games.

2.2 Information-based

Based on the information available to the players of a game, they are classified as games of:

- Perfect/Imperfect information

Information is perfect if all the players know the moves taken by each other at every point of the game. e.g.: Dynamic games like Chess. Absence of such an information leads to a game of imperfect information. e.g.: Static games.

- Complete/Incomplete information:

Information is complete when every player's payoff are well known. An absence of such knowledge makes it a game of incomplete information.

2.3 Representations

Games are represented in two ways usually based on the type of moves and information of games involved.

- Extensive form: This tree-like diagram is normally used to represent the dynamic games. For instance, chess or maze.

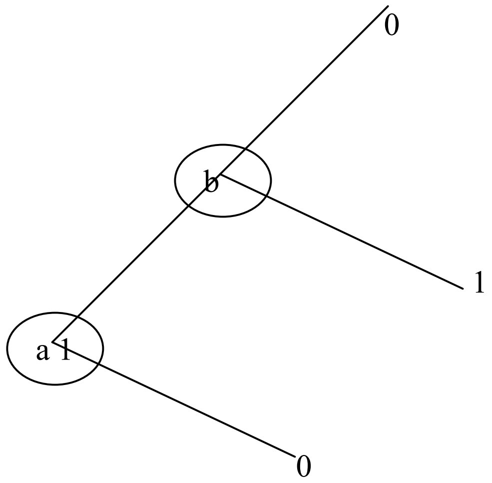

Figure 1 Example of Extensive form

Fig 1 illustrates one such extensive form for a one-player game of maze [5].

- Normal form: This form, also know as strategic form is normally used to represent static games. In this form, the strategy and payoffs are represented as a bi-matrix. The famous example of prisoner's dilemma is one such game that can be represented in normal form [4].

P1 \ P2	Deny	Confess
Deny	-1,-1	-9,0
Confess	0,-9	**-6,-6**

Figure 2 Example of Normal form

Figure 2 illustrates the normal form representation of the game. Here, (Deny, Confess) are the strategies while the numbers represent the payoffs.

2.4 Strategy-based

Games based on the probability of using a certain strategy are classified as games of:

- Pure strategy: When strategies are applied with probability one or zero.
- Mixed strategy: When the probabilities of using a certain strategy are expressed as a distribution.

2.5 Utility-based

Games based on the sum of the utilities or payoffs of the players involved [5].

- Zero-sum
- Constant-sum
- Variable-sum

Game with one or more of these classifications may exist. However, some exceptions do apply. A static game can never have perfect information.

3 Game equilibrium

Equilibrium is a steady-state condition when all the players involved in the game has an incentive to stay at that point, unless and until any external force acts on them to change their strategies. Games, just as in a market, consist of one or more equilibrium points. Concept of Nash Equilibrium [8] is widely used in game theory to identify the equilibrium states. For instance, in the game of Prisoner's dilemma as shown in Figure 2, the Nash equilibrium is the scenario when both prisoners decide to confess.

4 Game Theory in Mobile Industry

Mobile industry is largely an oligopolistic industry with 3 to 6 players. The dynamics of this industry provides enough possibilities for the application of game theory. Some of those aspects are mentioned here.

4.1 Bidding or Auctions

Mobile industry is no stranger to auctions. The now infamous licensing of 3G spectrums in various countries that led to its initial failure falls in the category of auctions [6][7]. The aim of these auctions were primarily to achieve maximum payoff for the governments. With a lure for greater benefits of launching 3G services, many operators entered this bidding process, thus taking the final prices of spectrum higher. In game-theoretic terms, these are static games with incomplete and imperfect information. The amount of supply and demand plays an important role in deciding the prices here.

4.2 Bargaining

Roaming is the most important and valuable feature of mobile communications industry. In order to make this a reality, operators enter into bilateral national and international agreements with other operators. Since the operators are of different sizes with varying market powers, such agreements involve bargaining or negotiations. Bargaining also drives corporate take-overs at times. In mobile industry, this would mean a bigger player buying a smaller player, when it sees greater value in it and the same is true for a seller vice versa. The value of an asset increases as the number of buyers increase. Bargaining theory helps to understand these scenarios. In game-theoretic terms, these are dynamic games with complete and perfect information. Various game-theoretic models have been proposed to explain bargaining theory. One such model is an infinite-period bargaining model proposed by Rubinstein [4] for wage-employment outcome.

4.3 Competitive advantage

4.3.1 Pricing

Pricing is a crucial element in mobile communications market, that could make or break an operator's business. While under-pricing could lead to losses for the operators, over-priced services may well see their shares fall. With an increasing number of services being rolled-out in today's mobile market, pricing them has become a great challenge. In game-theoretic terms, the price war in mobile market can be modelled as a multi-stage game with complete and imperfect information. Bertrand's duopoly model provides an answer to this in a duopoly environment [4].

4.3.2 New services Roll-out

While prices are key in maintaining the competitive advantage, rolling out new services before the competitors provide enormous edge to an operator. Hence, with the right understanding of time-to-market a service achieves significance in the mobile market.

P1 \ P2	New Service	Wait-and-Watch
New Service	**0,0**	a,-a
Wait-and Watch	-a,a	0,0

Figure 3 New service rollout

This can be modelled as an n-person zero-sum game according to game theory. Fig 3 illustrates the Nash Equilibrium for such a game with 2 players. Equilibrium is achieved when both the players have launched the same new service thus reducing the competitive advantage to zero. Pricing plays a key role after this equilibrium has been achieved.

4.3.3 Coordination

New services need new capabilities at the underlying technology level. For instance, faster access to the Internet through a mobile phone would require an advanced access technology like WCDMA. With differences in the underlying technology, interoperability becomes a major issue. This in turn prevents positive network externalities [9], a very essential factor for success of any service or technology in fixed and mobile networks. Hence, the choice of technology and services has to be coordinated and synchronised among the operators to achieve maximum payoff. This has been studied in game theory as the coordination problem. In game-theoretic terms, this is an n-person game with variable sum.

P1 \ P2	Tech. 1	Tech. 2
Tech. 1	**1,1**	0,0
Tech 2	0,0	**1,1**

Figure 4 Coordination Problem

An instance of the same with two equilibrium points as illustrated in Figure 4. This means that coordination is essential, irrespective of the technology or service. Operators need to take special care of this problem, in order to gain maximum advantage. SMS or short messaging service is one such example of success due to increasing network externalities.

5 Game Theory in MOB

Business games help decision makers to get them trained in a simulated environment without taking real risks. MOB game [10] provides a similar experience for the mobile communications industry. Such games typically have a finite number of seasons or stages for a finite number of teams. In game-theoretic terms, this would mean a multi-stage game with complete and imperfect information. Each season would hence be a sub-game dealing with different problems as mentioned in section 4. Hence, game theory plays a significant role in the manner in which the industry and market interact.

6 Inference

Mobile communications industry has become one of the fastest growing global industries. This demands enormous understanding from the decision makers of this industry. Operators, regulators and customers play a key role in making this industry dynamic the way it is now and would be in the future. Game theory has proved itself to be a valuable tool for analysis in various areas including business and economics. The paper provides an overview of this theory and its applications in the mobile communications industry.

Game theory could help an operator to set the right kind of strategies in pricing, bargaining, auctions or in any matters of establishing competitive advantage over its rivals. The theory also helps regulators in situations like auctions. MOB game is used to simulate the mobile market and teams playing this and other such games could keep the related issues and their game-theoretic solutions in mind while making decisions. This would enable them greater success and understanding of the real world. Having said that, life is also a game, can you model it?

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