Game theory as a management decision tool: A review of literature analysis

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Abstract: ***The business environment is getting more turbulent and complex today. The growth of business depends on effective tools that able to consider the effect of strategic alternative choice of regulators of the business arena and to provide strategic information system for better decision making process. Game theory analyses the behaviour of rational players as Harsanyi(1982) points out : if a psychologist attempts to explain a players move in a game, he has to describe his behaviour according to rational - normative approach or as an understandable deviation from it. Weitz and Wang (2004) studies the problem of competition along distribution channel and it demonstrate that the double marginalization is reduced by the increase of competition at retailers level. Esmaeili et.al.(2009) approaches the problem of buyer-seller relationship to the whole supply chain of business.***

Therefore application of game theory seems to be an effective tool for the business. Since game theory is a mathematical approach, its statistical validity in various business problems has many challenges. But its applicability in today's world has to be established. This paper extensively analyze the review of literature regarding the application of game theory in business decision making and attempt to find its scope as an effective business tool.

Key Words: Competitor, Dominance, rationale, business players

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Introduction

Game theory was first formalized by Von Neuman and Morhastern (1944), researchers have been debating about the possibility to apply it to solve business problems and in particular to use it as a tool to predict competitive bahaviour(Herbig, 1991). Game theory has been used traditionally in military strategy (Silman and cruz 1975). Kotler and Singh (1981) pointed out that competition in markets is somehow similar to competition in the battlefield.

Research Methodology and Objective of study

This paper is based on extensive literature survey, sheds the light on the criticalities and highlights the application of Game theory in Business. The Study attempts to answer to the question; Why the use of Game theory in business is rare? And can game theory be an effective tool for the business decision in today's scenario?

Basic Assumption of Game theory

The aim of game theory is to : "enrich a formal language to describe conscious and goal – oriented processes that involve one or more players "(Shubik, 1972) In its original formulation game theory includes some of the assumption of neoclassic economic theory (Herbig, 1991) as :

I. Robust Information - every player knows all the rules of the game and the preferences of the other players for each result

II. Exact information: every player is exhaustively informed about all the choices foregoing the time of his decision.

III. Logical decision process: every player takes decisions based on the maximization of his utility function; in case of uncertainty the player makes subjective predictions based on probability in order to calculate his utility function.

IV. Intelligence: every player is rational and able to predict the choices of other players, thinking about what would be the rational choice he would take if he was in the same situation of an other player.

V. Competitive and non cooperative behaviour: as a consequence of the previous assumptions, individual choices are based on the maximization of each individual utility function and not on that of all the players as a whole. There is a non cooperative bias which, from a systemic point of view, brings to non optimal choices, like in the prisoner's dilemma.

VI. Dynamism: player's situations, as well as environmental factors, are changeable; therefore most games are non-static and do not supply a single move solution.

VII. Interdependence: the results of each player are mutually related with decisions of other players; thus unilateral decisions are not possible.

VIII. Time: the result is affected by the length of the game.

IX. Interactivity: game theory attempts to establish equilibrium between different players.

Criticism of basic assumptions of game theory

The hypothesis on which game theory is founded are considered far from reality(Wagner 1985, Herbig 1991). The axiomatic approach to define the player of game clashes with the business research approach , which is based on empirical observation , measurement and analysis of consumers responses. Hence game theory may be considered useless in the complex world of business specially in marketing Apart from this

there are many criticism like in the real world , the environment is not known and certain and not completely knowable. In many games the results are not fixed but are articulated in terms of probability

Arguments in favour of Game theory

According to Di Benendetto(1986), it is possible to demonstrate , with few logical revisions, the relation between the economic definition of game and business decisions process. According to Bacharach (1977), game theory has the following attributes:

a) a well defined set of possible ways of action for each player; b) Each player has well defined preferences within the possible results of the game; c) Relations and results are determined by the choices of the ways of action made by the players; d) Every player has complete knowledge of the attributes above.

According to Di Benedetto (1986), the choices about business marketing mix taken by middle management coincide with the ways of action (a); player's preferences correspond to the product's objective decided by top management (b); relations and results depend on competitors' choices in the market (c); the bestinformation optimizes the decision process (d)The assumption of rationality is the main limit for the application of game theory to marketing. However, irrationality can be comprised in game theory model using the "bluff and threats" (Chatterjee & Lilien, 1986; Herbig, 1991; Kreps Wilson, 1982b).

An irrational action can be included in the game if the player is able to assert the bluff. Hence, a behavior that would be considered irrational by game theory with complete information becomes possible in situations of incomplete information (as for bluff and threats). Kreps and Wilson (1982) included the reputation factor in their game model, stating the effect of a player's reputation on the behavior of other players. Regarding the assumption of complete information, it is very difficult to think backwards to determine the intents of each single manager and translate them in payoffs of a game matrix. To solve this problem some authors (Chatterjee & Lilien, 1986; Di Benedetto, 1986; Cho e Kreps, 1987), proposed that game theory model could be extended to comprise incomplete information about payoff functions.

Di Benedetto (1986) points out that it is possible to integrate information about competitors' intentions with qualitative interviews and surveys submitted to managers and experts in the industrial sector. The results of these surveys can then be used to test the empirical soundness of the model. Cho and Kreps (1987) highlighted that it is possible to establish equilibrium also in case of games with incomplete information, gathering information from marketing signals (as defined by Eliashberg & Robertson), which indicate the preference of a player for a specific move and his possible reactions. From the point of view of competition, game theory gives a rewarding model to analyze interdependences and the effects of competitors' interactions. Interesting development in this field are those coming from the coopetition approach (Branderburger & Nalebuff, (1996), which brought to the creation of win-win games, widening the horizons of game theory beyond the mere description of competitive scenarios These "mixed strategies" can be considered as interesting attempts to overcome the limits of complete information of the classical game theory, thus making it more suitable to be used in marketing decisions concerning competitive strategy.

Game theory for pricing decisions

While we can find a wide literature about the application of game theory to auctions, there is very little about its possible use to price decisions of firms operating in the business to consumer market. This is probably due to the difficult application of game theory in scenarios including a great number of players. An attempt to use game theory for pricing is that of Rao and Shakun (1972), which developed a quasi-game theoretic model for price fixing model for the introduction of a new product.

They used the concept of "acceptable interval of prices" (Gabor & Granger, 1966) and several postulates. They hypothesized the existence of two groups of consumers: one believing that price is an indicator of quality, thus they are prone to pay for the most expensive product; and a second group of consumers which believe that all products in the market have an acceptable level of quality, as a consequence they buy the cheapest product. They derived the probabilities of purchase for each product as a function of price for two products and for three products. Then they developed their "quasi game theoretic model" (In this model the authors regard information as not complete and they apply game theory thinking without considering complete information) considering the possible behaviour of the two groups of consumers for each of the two or three products. From this they calculated the optimal price for the introduction of a new product for each of the consumer's behaviour options.

There are several other studies about the application of game theory considering price as a quality indicator. When it is not possible for the consumer to judge quality before the purchase the only factors on which consumer can establish his choice are price(Kreps & Wilson, 1982), reputation of the seller (Milgrom & Roberts,1986) or both of them.

Milgrom and Roberts (1986) created a model with several parameters. They set cost of production of high quality products beside to the cost of production of low quality products and they considering also the level of advertising expenditure. According to this model, for some of the levels of cost, price is a good signal of quality, while for other levels of cost (as for example when costs are the same for both high quality and low quality products) it is necessary to budget a certain level of adverting expenditure to obtain higher prices.

Bandyopadhyay et al. (2001) highlighted that price can be an imperfect indicator of the quality of an experiential good, if supported by producer's reputation. Argoneto (2007) analysed the case of the music band Radiohead who in 2007 gave access to download their new album from Internet at a price chose by the customers; the consumer could choose how much to pay to download the album, could also decide to pay nothing. A rational player would not pay to download the album, but results showed that consumers are not rational. About 50% of consumers decided to pay and the average price paid for the download was of € 6.00. Consumers do not follow the axiom of homo economicus.

Game theory and advertising

There are quite a few outdated models that attempt to determine the optimal advertising budget using game theory. Montgomery and Urban (1969) described five models of advertising budget allocation based on the assumption the best way to allocate advertising budget was to apply game theory to

what other competitors do. Shakun (1965) used a mathematical approach creating an exponential function to sales response to advertising, which is similar to that of Vidale and Wolfe (1957).

Game theory and product decisions

According to Weiner (2002), theoretically, game theory can be applied to decisions about the introduction of new products. It can be useful to understand if there is a first mover advantage, the possible moves of competitors about new products and to take decisions about defensive strategies.In spite of this theoretic possibility there is very little literature about new product decisions using game theory. Among the best studies in this field there are those of Mitchell & Hustad (1981) and Kaiser (2001). Kaiser (2001) states that product innovation increases consumer's utility but is effective only if the investments of the innovating firm in marketing are conspicuous so that the communication about the new product can reach the target of consumers. He applies a game based on Cournot's oligopoly for the innovation expenditure and demonstrates that both the tendency to marketing activity for new products and that to introduction of new products decrease when the number of competitors and the level of interchangeability of products increase.The most prolific research field on game theory and product is that of "patents" (Muto, 1987; Gallini & Winter, 1985; Fudenberg & Triola, 1987; Park, 1987), which is of minor interest for marketing management.

Game theory and distribution

We can find several studies utilizing non-cooperative game theory to analyze the relations among producers and dealers along distribution channels. The approach used is usually the "leader-follower" (Weitz & Wang, 2004). Other studies approach the problem of competition along distribution channel and demonstrate that the double marginalization is reduced by the increase of competition at retailer level (McGuire & Staelin, 1983; Chouglan, 1985). Chouglan (1985) approaches the problem of channel choice in a duopolistic market and shows how the integration of distribution function along the distribution channel creates higher price competition and lower prices compared to the utilization of dealers. Starting from these results Choi (1991) analyzes a distribution channel structure with two producers and one retailer selling both products. Choi approaches the problem using three kinds of non-cooperative games (two with Stackelberg duopoly and one with Nash's equilibrium) and shows how the results depend by the shape of demand function: In case of linear demand function: It is convenient for the producer to have more exclusive retailers; The retailer is stimulated to deal with several producers; It is convenient for all the operators in the distribution channel

and for consumers that none dominates the market; In case of symmetrical reduction of production costs, the retailer gains more than the producer; If products are less differentiated, prices grow. In case of non linear demand function: It is convenient for all the operators in the distribution channel that producers have exclusive retailers; When product's differentiation raises, if producer uses an exclusive retailer his profit increases, if retailers are not exclusive profit declines.

Other studies which analyze the behavior of operators in distribution channels are those of Lee and Stalin (1997) that focus on strategic interaction more than on linearity of demand function and Jeuland and Shugan (1983) approaching the problem with non-cooperative games. A recent study of Esmaeili et al. (2009) approaches the problem of buyer – seller relations extending the field of study to the whole supply chain using both cooperative and non-cooperative approaches. The research on this field followed the evolution of marketing. The focus shifted from "leader-follower" models, where retailer where prone to producers choices towards new model describing equal relations and coordination between producers and retailers.

Limitations of the

Conclusions

There are several possible applications of game theory for business management decisions, with some limitations. Game theory can be a great utility in business decisions when the number of players is little. The rationality postulated in game theory can be useful in the market..

Emotional and symbolic issues of the purchase process can hardly be harmonized with neoclassical rationality of the homo economicus on which game theory is founded. In a famous experiment, Jensen et al. (2007) applied game theory (ultimatum game) to chimpanzees and pointed out how these primates act in a perfectly rational way according to the postulates of homo economicus.

Chimpanzees are rational, human beings are not, chimpanzees would not pay for something they can have for free, men do (as for the album of Radio head). This is because evolving the homo sapiens acquired the aptitude to empathy and to abstraction, which differentiates his behaviour from that of monkeys; consumers are homo sapiens and not chimpanzees. This explains also why, although game theory exists since more than 60 years, it didn't raise much interest for business researchers and professionals. Nevertheless, if we keep in mind its limits, it is possible to use game theory in specific areas for business decisions.

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