Game Theory in Strategic Management

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Abstract. Game theory provides a formal language for describing conscious, goal-oriented, decision-making processes involving one or more players, where there is an interdependence of outcomes. This paper seeks to explore the potential of using game theory in strategic management. From the presented review of the current literature, the paper illustrates that the strength of game theory in strategic management lies in its ability to provide insights into competitive environments and strategies.

1 Introduction

Over the years, numerous definitions for *strategy* have been advocated in the literature. Chandler (1962) defined strategy as 'the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out the goals'. Alternatively, strategy may be defined as the common thread among a firm's activities and product markets. It is comprised of four components: product-market scope, growth vector (or changes that a firm makes in its product-market scope), competitive advantage, and synergy (Ansoff 1965). Leonard et al. (1969) posited that strategy is the pattern of objectives, purposes, or goals and major policies and plans for achieving these goals, stated in such a way as to define what business the company is in, or is to be in and the kind of company it is or is to be.

Strategy may also be defined as the study of the sources (and creation) of efficiencies that make firms successful, for example innovation, new product development, diversification, entry, corporate governance, acquisitions, joint venture and strategic alliances, executive compensation, influence of top management teams, etc. (Camerer, 1991). In addition, Porter (1996) argued that strategy is creating fit among a company's activities. The success of a strategy depends on doing many things well, not just a few, and integrating among them. If there is no fit among activities, there is no distinctive strategy and little sustainability.

Numerous researchers have advocated the way in which strategy is (or should be) formulated. Literature in this area can be divided into several schools of thought. Three are prescriptive, treating strategy formation as: (i) a process of conceptual design, (ii) of formal planning, and (iii) of analytical positioning. Four schools deal with specific aspects of the process descriptively: (i) the entrepreneurial school – views strategy formation as a visionary process, (ii) the cognitive school, (iii) the learning school – strategy formation as an emergent process, (iv) the environmental school – view formation as a passive process (Mintzburg, 1989). The design school and the learning school are most entrenched and will be discussed briefly.

The *Design School* approach dominates the strategic management literature. It advocates a strategy formation process that uses a few essential concepts to design and overall strategy, most common of which is that of matching. The design school places emphasis on the appraisals of the external situations (to uncover threats and opportunities in the environment) and internal situations (to uncover strengths and weaknesses of the organization). The design school also takes into account organizational values and organizational social responsibilities. Organizational values are the beliefs and preferences of those who formally lead the organization, while social responsibility refers to the ethics of the society in which the organization is embedded, at least as perceived by the managers (Mintzburg 1990). The core tenets of the design school are elaborated upon further when we look at the dominant generic strategy typologies of Porter (1980, 1985), and Miles and Snow (1978).

The *Design School* depicts a deliberate process. First think, then act. Formulate, then implement. The *Learning School* takes the position that strategies can form as well as be formulated. A realized strategy can emerge in response to an evolving situation, or it can be brought about deliberately, through a process of formulation followed by implementation. But when planned intentions do not produce the desired actions, organizations are left with unrealized strategies. Although many intended strategies are ill conceived, the problem often lies one step beyond, in the distinction made between formulation and implementation, the common assumption that thought must be independent of (and precede) action (Mintzburg 1987).

The learning school of thought believes that conventional approach to strategic management where strategy formation happens at the top, far removed from the details of running an organization on a daily basis, may not be the best approach. The learning school advocates emergent strategies that are those that may appear without or in spite of clear intentions. Actions simply converge to patterns. They may become deliberate, and if the patterns are recognized and then legitimized by senior management, they become strategies. The learning school, therefore, believes that pure deliberate strategy precludes learning once the strategy is formulated; emerging strategy fosters it. People take actions one by one and respond to them, so that patterns eventually form (Mintzburg 1987).

Strategic management, therefore, involves major decisions on environments to compete in, for example which industry, or which geographic area – corporate level strategies; and the best way to compete in those environments – business level strategies (Herbert and Deresky 1987).

2 Game Theory

Game theory can be defined as part of a large body of theory providing a formal language to describe conscious, goal-oriented, decision making processes involving one or more players. The solution concepts derived from game-theory may be thought of as as normative or descriptive views of multi-person decision-making (Shubik 1972). Game theory may also be described as the analysis of rational behaviour in situations involving interdependence of outcomes (Camerer 1991).

The essence of game theoretic models are two or more players (*read* firms) who have a range of actions or similar freedom to a set of choices, and also have certain information. Each player has a set of preferences for the diverse possible outcomes, and the results of the interaction depend on all the players decisions. Put another way, game-theoretic mod-

els have six common features: conflicting parties, choices, information, desired outcomes, results of choices and outcomes dependent on choices of all participants (Martin 1978).

Game theory provides a set of tools and components that may be used to develop logically consistent models of rational human behaviour. These models allow researchers to discount explanations of behaviour where people act against their own objectives, neglect opportunities, or ignore strategic behaviour of other parties (Postrel 1991).

What category of theories does game theory lie? Most of game theory is not meant to be purely *normative* (describing the ideal choices people should make) as an equilibrium strategy is only ideal if other players believe that players will act in certain ways that would require the theory to be *descriptive* (describing the actual choice of others). Game theory is also not purely descriptive (Camerer 1991). Aumann (1991) suggests that game theory is *analytic*: analysis of the formal implications of various levels of mutual rationality in strategic situations, i.e., what to do when certain assumptions are met. The latter however may not be the case.

Raifa (1982) argues for a practical approach to game theory which she refers to as *asymmetrically normative*. Here game theory tells players what they should do (normatively) if other players behave in typical ways (descriptive). Although sound descriptive theory on which to base normative-descriptive advice is lacking, three behaviour principles can provide guidance on players behaviour towards convergence. First, players initially try cooperative strategies that make convergence better off (if all use them) than under equilibrium strategies. Second, players do not assume with confidence the rationality of others. And finally, players do not look very far forward or backward (Camerer 1991).

For example, in the mid-1980s, a major US airline (Camerer 1991),

> "announced triple mileage awards to frequent flyers to grab market share. But their move was quickly matched by other airlines.....the first mover advantage got little permanent advantage. Overall air travel rose only a little and the airlines [were] stuck with billions of miles payable."

If the airline that triggered the miles war had looked further ahead in the game and anticipated the reaction of competitors, the mileage war may not have occurred.

3 Game Theory in Strategic Management

Many business strategy decisions involve interdependent outcomes and therefore seem to lend themselves to game theory. Game theoretic modeling is appropriate, for example, when studying strategic actions between agents with differing goals, a situation typical of many strategic management issues.

A real world example often cited in the literature is the sharp price discounting that charaterized the very price sensitive large turbine generator market in the United States in the early 1960s. General Electric (GE), the dominant firm, and its competitors had difficulty in achieving a mutual understanding as to what prices should prevail and know whether one's rival had 'cheated' by undercutting those prices. Firms were often tempted to give large discounts to win sales, which led to a steady decline in prices. In response GE produced a pricing book containing simplified pricing formulas allowing a consumer (and competitors) to match specifications to prices. GE also committed to providing a certain level of discount off list prices for frequent customers, as well committed to reimbursing the difference to any customer who later learned that GE had sold the same product to

another client at a lower price. Within a year of the pricing policy, the deep discounts among competitors had stopped (Ghemawat and McGahan 1998).

In coming up with the pricing policy, GE had to anticipate how the only other dominant market player, Westinghouse, would respond. The policy worked because Westinghouse understood (as GE had correctly predicted) that the standardized pricing book and commitment to fixed discounts allowed the two companies to coordinate pricing. Note that deep discount pricing hurts all companies. The issues GE dealt with in trying to anticipate how a competitor will react to one's actions form the core of game-theory (Ghemawat and McGahan 1998).

Game theoretic reasoning is a decision rule or algorithm that selects an equilibrium strategy. Doubt has however been expressed over game-theoretic reasoning as an appropriate description of how people or firms decide which strategies to use. Criticisms include the use of rules that require (in the context of strategy implementation in firms) (1) firms to believe that others are using the same rules (which participating firms would doubt) and (2) firms to maintain the assumption that all other firms are rational, even after they make irrational choices (Burmone 1987, Saloner 1991).

Note that equilibrium analysis is the determination of equilibrium points. Game theory reasoning posits that players (firms) discover equilibria by *introspection*, a process that may be unnatural and difficult in practical situations. Introspection includes mentally (or computationally) simulating outcomes of various choices, eliminating choices that do not yield the best outcomes, or adjusting them until a set of mutually best outcomes are achieved. If players have common knowledge of a game's pay-off and that all players are rational, then the introspection will result in convergence to an equilibrium.

Common knowledge is information that everyone knows, and that everyones knows, everyones knows. Although common knowledge is sufficient for justifying an equilibrium, it is not a necessary condition (Camerer 1991). Rumelt, Schandel and Teece (1990, in Saloner 1991) went further to state that,

> 'Rational models of competitive interaction posit players who engage in very subtle and complex reasoning. Yet our common experience is that decision makers are far less comprehensive analysts than these models posit. If one is a player, is it really rational to posit such complex behaviour of others.'

There are several alternatives to the strict rational requirements of introspection. One such alternative are *Justifiable* strategies which are optimal choices for 'some' belief on what the other players will do, where the belief may not necessarily come from introspection of the other players thinking. Another alternative are the *rationalizable* strategies that are where players believe others will use justifiable strategies (Camerer 1991). These simpler rules of justifiability and rationalizability are applicable to many business strategy situations where firms make choices in unique situations where pay-offs and competitor behaviour are uncertain, with firms having little experience to learn from (Milgrom and Roberts 1990).

Three other approaches, communication, evolution and adaption, may produce equilibria in games as a substitute to game-theoretic reasoning (introspection). *Communication* is when firms announce their intentions. These pre-play announcements are typically non-binding and have no penalty if not followed (Farrel 1987). Often referred to as cheap talk, examples include pre-announcements of new product releases or changes in pricing. Cheap talk may encourage equilibration by strengthening players' beliefs on what others will do. Pre-play communication may remove each firms doubts about the reasoning process that the rival is going through (Saloner 1991).

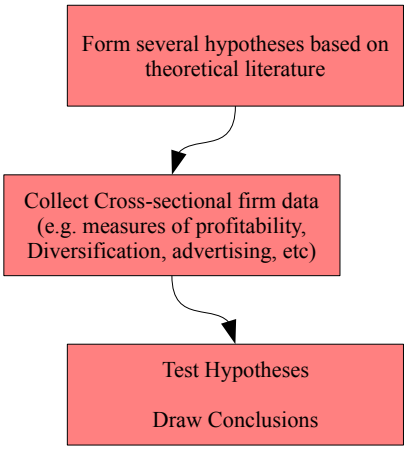

Figure 3.1 – *Steps in Empirical Strategy Research*

Equilibration via the *evolutionary* approach posits that players (firms) that use equilibrium strategies are more likely to survive and produce off-spring (next series of games) than others. While useful in biological settings, evolutionary equilibriation may be inappropriate for analysis of business strategies as the evolutionary process is probably far too slow to produce convergence before a game's equilibrium changes.

Finally, *adaptation* may be defined as learning which strategy to play in a particular game. Adaption is perhaps the most effective and common equilibrating force. It requires only a little memory of past experience and minimal computational ability, and it is less demanding than introspection or communication (Camerer 1991). Studies have also shown that convergence under adaption occurs under general conditions (Milgrom and Roberts 1991). The adaptation, however, must be fast enough to outrun environmental change.

3.1 Game Theory and Empirical Strategy Research

Game theory approaches and empirical studies in strategy research can yield complementarities between them from the reciprocal guidance that they give each other. Most strategy research is empirical following the process depicted in Figure 3.1. Researchers form several hypotheses based on theoretical literature. They then collect cross-sectional firm data (for example, measures of profitability, diversification, advertising, etc. Hypotheses testing follows, results from which conclusions are drawn.

Empirical strategy studies, therefore, could provide a rich source of stylized facts on firm practice, a starting point for game theory models. Similarly, well done game-theory-based models provide predictions that empiricists can test (Camerer 1991). Examples of the latter include the study of corn wet milling (Porter and Spence 1982), reputation of oil and gas tax shelter partners (Wolfson 1985), and tournament effects in managerial compensation (Lambert, Lareker and Weigelts 1990) were all inspired by game-theory predictions. It is worth noting, however, that there are significant challenges in directly empirically testing many game-theoretic models. This maybe due to difficulty in finding large samples of firms meeting the exact criteria set in the game theory models. Despite the challenges, game-theoretic models hold great prospects for a tremendous impact on strategic management.

Game theoretic modeling may play two important roles vis-a-vis empirical testing in strategic management. First, is in the development and refining of hypotheses for reduced form empirical models. In this case, the empirical investigation would focus on whether the data are consistent with the broad qualitative features, instead of the specific structural characteristics of the models (Saloner 1991). For example, Saloner (1987) developed models that showed a firm may have an incentive to predatory pricing against a rival in anticipation of a merger with the rival, allowing it to purchase the rival on better terms. Qualitative aspects of the same were empirically investigated by Burn's (1986) study of the American Tobacco Company. He concluded that alleged predation significantly lowered the acquisition costs, supporting the conclusions from the models developed in Saloner (1987).

The second major role game theory plays in empirical testing is that the developed models can be used to generate and test structural models. Underlying the testing would be empirical data collected from a particular industry over a period of time. While detailed game-theoretic models underlie the structural models, the estimation relies on the broad qualitative features, especially the relationships between various parameters (for example, cost, demand, price, etc) that hold at equilibrium and the comparative static properties of those relationships (Saloner 1991). Examples include Porter (1983) and Breshmahan (1987).

3.2 Applications of Game Theory in Strategic Management

Several applications of game-theory to strategic management can be found in the literature. A few examples are presented here. Karani (1984a) used a dynamic game-theoretic model of marketing conditions in an oligopoly to investigate how firms optimal marketing expenditure is related to the product life cycle. His results supported and refined the conventional view that the earlier it is in the cycle, the greater the value of the market share.

Karani (1984b) employed a game-theoretic model of oligopolistic competition to provide analytical support for the generic strategies of low cost and differentiated positions advocated by Hall (1980) and Porter (1980), further refining their conclusions. Recall that an oligopoly may be defined as a small number of firms in the same market, setting price or quantity. The game-theoretic model explicitly considers product differentiations, economies of scale and the impact of marketing activities on demand. He used the model to illustrate that firm profitability is an increasing function of market share, i.e., a superior cost or differentiation position leads to a larger market share that then leads to higher profitability.

Using the game-theoretic model Karani (1984b) shows that the differentiation and average cost position are related by two opposing factors: (1) high differentiation likely yields a higher cost position independent of scale, leading to a higher average cost position; (2) high differentiation probably yields high competitive strength, that leads to higher market share, that precipitates a low average cost position. The dominant factor will depend on the situation. From the model, contrary to Porter (1980) and Hall (1980), high differentiation and low average cost are not necessarily incompatible.

An analysis of the dynamics accompanying buyer-supplier negotiations using differential game theory was modeled by Bard (1987). The study investigated both cooperative and non-cooperative bargaining scenarios. For the former, the buyer and supplier attempt to reach optimal solutions for both their mutual benefit, while in the latter, both parties attempt to maximize their benefit, with no regard to the other. Although the non-cooperative

atmosphere was found to not necessarily be efficient, it provided a measure of stability, and may therefore be considered a conservative strategy.

Price-wars were modeled as an equilibrium strategy of a repeated game by Slade (1989). The models captured several aspects of price wars including price as a choice variable, observable by all; price-wars as occasional events, normally separated by periods of stable prices; the effecting of considerable price matching during the price-wars; and finally the fact that the wars come to a natural end and collusion resumes.

Golan, Karp and Perloff (2000), developed game-theoretic models to determine the strategies of oligopolistic firms based on prices, advertising and quantities data, as well as demand and cost driven variables such as input prices and seasonal dummies. Using price-advertising pairs in the United States cola market, they developed two methods for estimating the strategies of firms, i.e., the probabilities that they will take certain actions. The first model, the general maximum-entropy (GME) estimator provides an advantage from its computational simplicity and employs only sample information. The second model, the GME-Nash approach estimates the firms strategies consistent with the underlying data-generation process and the restrictions implied by game-theory. Both models were shown to be practical for estimating games and generally applicable to many problems encountered in strategic management.

Advances in game theory have also led to several studies on the optimal adjustment of prices over a business cycle (Green and Porter 1984; Dudey 1992; Staiger and Wolak 1992); and the demonstration through the use of cooperative game theory that competition and cooperation can co-exist (Bradenburger and Stuart, 1998). Other examples of the use of game-theory in strategic management research include, looking at questions relating to the vertical scope of the firms activities (Grossman and Hart 1986); and the effect of incentives on the optimal horizontal scope (Jensen 1986).

4 Conclusion

Game-theory provides an exciting avenue for analyzing and developing decision making models applicable to strategic management. The models can be derived from a theoretical perspective, developed from empirical data, or a combination of both.

In general, game-theoretic models are not meant to supplant the decision maker or strategist in the organization with a model that can mechanically determine the optimal strategies (Karani, 1984). As Moorthy (1985 pp. 279) states:

> "Game theory cannot be used as a technique that provides precise solutions to [strategic management] problems. One rather obvious reason is that game theory does not have a single solution to provide, and there are other reasons as well. For many real-world problems, a game theoretic analysis may prove intractable. Capturing the reality of the situation may entail a model with hundreds of strategies for each player, but computing the equilibrium of such games is not easy."

Game-theoretic analyses, however, can provide useful and possibly counter-intuitive insights on competitors interactions. Although the analyses entail significant complexity, the benefit can be substantial, especially in situations where concentrated competition, mutual familiarity, and repeated interaction are present, as is the situation in strategic management (Ghemawat and McGhan 1998). As illustrated from the review of the literature on the use

of game theory in strategic management, *its strength lies in the ability to provide insights into competitive environments and strategies* (Karani, 1984; Moorthy 1985).

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