Management Dynamics in the Knowledge Economy
Vol.6 (2018) no.4, pp.645-654; DOI 10.25019/MDKE/6.4.09
ISSN 2392-8042 (online)

Game Theory in Strategic Management - Dynamic Games. Theoretical and Practical Examples

Mihail BUSU
Bucharest University of Economic Studies
2-2A Calea Grivitei, Sector 1, 010731 Bucharest, Romania
mihail.busu@man.ase.ro

Abstract. *Game Theory provides an analysis tool for describing the decision-making process of one or more players, their behavior when there are plenty of possible outcomes. Strategic behavior is a generic term that designates all concerted and consistent actions promoted by an enterprise in order to influence the competitive environment or at least to adapt to its evolution. This paper aims at exploring the real potential of strategic management based on dynamic game theory decisions and illustrates that the usefulness and power of game theory applied in strategic management lie in its ability to provide insights on competitive climate and strategies. In this paper, we will investigate some potential contributions of game theory to strategic management, especially with regard to applications in individual industries. The examples presented in the second part of the paper are based on strategic management decisions that involve dominant strategies.*

Keywords: *game theory; sequential games; strategic management; Nash equilibrium.*

Introduction

Prisoner dilemma - one game, one decision

In the classic game of the prisoner's dilemma, each party makes a single decision. The game is played once. The two players would be better if they could cooperate and could understand not to choose the dominant strategy. When the game takes place in reality, each player is stimulated to break any previous agreement and do what is in their own interest. If the players or parties meet more than once, then the strategies of each of them can become more complicated. There might be other ways to try to forge cooperation that would be satisfactory to both parties.

Repeated games - the same players, more rounds, more decisions

To see how the nature of the game changes when it is repeated, we will refer to the actions of two companies in competitive positions. Assume that each party announced it would abstain from lower prices as long as his rival will. But if the rival breaches understanding, then the former may respond by increasing production and falling prices. ACE stands threat can ensure that the two companies will cooperate?

If two companies expect to compete on the same market in the next 10 years, a period after which a new product is expected to change the entire configuration of the industry, everyone will want to cheat in the tenth year when there will be no chance of revenge.

Now let's think about what would happen in the 9th year. Both companies will think that none of them will want to cooperate in the tenth year. But if they do not cooperate in the 10th year, then the threat of not cooperating in the future is inefficient. For this reason, in the 9th year, each firm will consider it worthwhile violating the deal by producing more than was foreseen in the agreement. Understanding ends in the 9th year. This will lead to understanding fire almost immediately.

This example illustrates an important principle of strategic thinking: think of yourself first fulltime and following the reverse way, discover what it is the best choice. Decision making in this way is called or reversing the reverse induction. For each decision the player takes, the optimal response of the opponent must be discovered and which will be the gain in each case.

Reversing also applies to the numerous games studied in the economic literature. To determine the behavior of each player, we assume that producers will start to finish in their attempt to determine what would be the best option for every choice opponent might do (Camerer, 1991). For example, in the prisoner's dilemma, one of the prisoners is thinking: "Assuming my partner confesses, which is the best strategy that I have?". Each opponent is thinking of the consequences of decisions and ration from the end to the beginning to see what they have to do (Aumann, 2017).

In strategic games that do not have a known end - for which there is always the possibility of another round - There are a variety of strategies that allow players to cooperate to get better results (Leonard, 1969).

Reputations of the players

To improve reputation can be useful when players are involved in repeated interactions (Colman, 2013). A company that relies on local customers for repeat business, to improve reputation by providing a quality service is a more powerful incentive compared to a business that is based on short-term contracts (Porter, 1980). A mechanic can be encouraged to upload an invoice or not - to cheat a client unless the client expects to be served again. The driver can act correct and earn a better reputation for quality service provided.

Winning a good reputation is expensive in the short term (Mintzburg, 1990) - the car driver must provide good services, but initially, he will not be able to use only his own garages. Reductions in short-term profit are an investment that will repay it in the future when the mechanic won a reputation Bun as a result of the quality services offered.

Tooth for tooth

Participants of a game often avoid a simple strategy, although they may seem irrational in the short term, it can be effective in inducing cooperation, as long as the game is repeated a number of times (McCain, 2014). A common strategy is "tooth for tooth." In the case of two oligopolistic enterprises, one of them threatens to increase production if the other will do the same, although this will not maximize its short-term profits (Martin, 1978). If its opponent continues with this threat, especially if it has been implemented several times, an enterprise may decide that it is more profitable to cooperate and maintain low production than cheating (Shubik, 1972). In reality, such simple strategies

can play an important role in ensuring that there is fierce competition in the markets where there are three or four companies (Porter, 1980).

Involvement of the institutions in game theory

Often, the involvement of state institutions changes players' strategies. For example, in the banking system of deposits, intentions to eliminate the assurance of the depositors determines them to withdraw funds when rumors about some financial issues related to their bank appear. Otherwise, depositors know that their money is secure even if the bank goes bankrupt.

Example 1. Banking crises
For a deposit at a commercial bank today, the insurance will be within the limit of 100,000 euros. This means that if the bank makes bad investments and goes bankrupt, the state will guarantee this deposit within the maximum limit of EUR 100,000. The Nash equilibrium concept can help us understand bank bankruptcy and financial panic. Consider the example of a bank with only two depositors, to be called A and B. Each depositor must decide whether to withdraw his bank deposits or keep them there. Suppose everyone deposited 1,000 Euros to the bank. The bank used this money to make loans and make investments, but it also retained EUR 200. If the bank's loans are repaid, the bank may grant an interest rate of 5% its depositors.

If none of the depositors attempt to withdraw the funds from the bank, suppose they will both receive the full amount of the deposits plus interest of 5% (for a total of 1050 Euro). If depositors withdraw their amount, while depositor B keeps the bank, it can draw 200 euros, the total amount that a bank has available as cash. The bank must then close its doors and depositor B receives nothing. The same thing happens if depositor B withdraws his money, and depositor A does not. If snooze bend withdraws their deposits, the highest amount you can receive EUR 100 each. The situation is shown in figure no. 1.

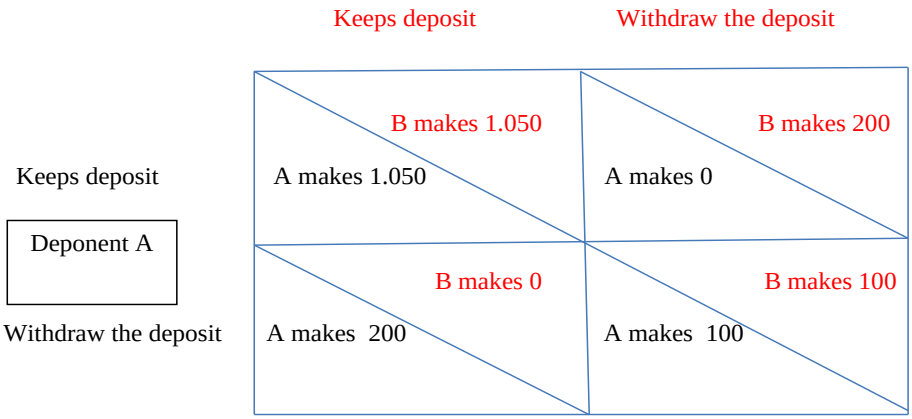

Figure 1. Banking panic game

Obviously, the best situation for both savers is that NIC and none of them not to withdraw funds from the bank. In this case, they can both get an amount of 1,050 Euros. This situation represents a Nash equilibrium. If depositor A keeps his money at the bank, B's best strategy is to do the same. Each motivation as follows: "If the others keep their

money in the bank, the best strategy is to do the same". Hence, there is an equilibrium point when neither depositors will withdraw their funds and the bank does not close

This example illustrates a situation where there may be a good balance - if the bank remains open and Depositors receive the entire amount of money deposited + interest - and a bad balance - when the bank is forced to go bankrupt. This situation is inconsistent with the prisoner's dilemma, where the only balance was inferior to a set of strategic alternatives (no prisoner admitted).

Financial crises can be thought of as a change from an efficient balance to an inefficient one. This can happen if depositors start worrying about bank rumors, even if these fears are unfounded. The simple argument illustrated by this game provides some reason the existence of insured deposits. With deposit insurance, each depositor trusts that his/her money is safe, no matter what the other depositor does.

Mixed strategy games

To understand how such a game takes place, we will present a game between McDonald's and Burger King.

Table 1. Payoff matrices for McDonald's and Burger King

		Burger King		
		Discounted price	**status quo**	**Aggressive commercial**
McDonald's	**Discounted price**	60, 35	65, 20	55, 45
	status quo	40, 40	60, 40	45, 55
	Aggressive commercial	55, 50	60, 30	60, 40

The two companies are involved in a game where, regardless of the current action, each of them will want to change tactics in the next round of this infinite game. Suppose the current position of these two companies is: McDonald's - low price and Burger King - aggressive. According to table no. 1, McDonald's will want to move to aggressive advertising at the next step. Then, from the aggressive advertisement cell, aggressive advertising Burger King is stimulated to play: low price. At this time, Mc Donald's will also play low price, followed by Burger King who will play: aggressive advertising. At this point, I returned to the point I left.

Table 2. Movement sequential action of the two players

		Burger King		
		Discounted price	**status quo**	**Aggressive commercial**
McDonald's	**Discounted price**	60, 35	65, 20	55, 45
	status quo	40, 40	60, 40	45, 55
	Aggressive commercial	55, 50	60, 30	60, 40

Table 2 shows that the status quo is a dominated strategy. A dominated strategy is a strategy that is always worse for each player than any other strategy. Status quo always has a better strategy. Thus, dominated strategies can be eliminated as possible solutions in any game. If we do this in the previous table, we will get a simplified form in Table no. 3.

Table 3. Matrix profits variant status quo deleted

		Burger King	
		Discounted price	**Aggressive commercial**
McDonald's	**Discounted price**	60, 35	55, 45
	Aggressive commercial	55, 50	60, 40

Even with the status quo option removed, there is a simple solution to this game (do not have a Nash equilibrium). What should the two companies do in this case? The answer is: play a mixed strategy. In an optimal mixed strategy, each player selects their actions randomly, so that the expected profit is maximum, considering that the strategy applied by his opponent is random. It can be shown that an optimal set of probabilities always exists to solve such problems. From the above matrix, we could notice that Burger King's optimal strategy is to play discounted 50% of the time aggressive advertise 50% of the time. For McDonald's optimal strategy is to play the same strategy 50% of the time.

Sequential games

In the game called the prize laureate, each player has to make a decision without knowing what the other person will do. Players must act simultaneously. However, in many situations, a player is the one who must move first, and the second one will then directly respond to the choice made by the former. This type of game is called a sequential play, as players change their place and each can see what choices have been made in previous moves. In a sequential game, the player who moves first must consider moving the second player's response to every possible move he makes.

Sports offer a number of examples of strategic behavior. The situation faced by a coach of a football team, when deciding whether to introduce a defender is the first example

of a sequential game. Theoretically, it is said that a right-handed quarterback is better against left-handed striker et vice versa. Does that mean that if a right-wing striker appears in the field, then the opponent's coach has to introduce a left-handed defender? Not necessarily. A coach who is considering changing players needs to think about how the opposing coach will respond to every choice he makes.

This example illustrates an important aspect of sequential play. The player who makes the first move must think about how the second player will answer. Let's take the case of a company that has to face the potential entry of a new competitor on the market.

Suppose a company producing software called Redhat, plans to introduce a new system operating which will compete with Microsoft Windows. Redhat has to decide whether or not to take this step. If it is, Microsoft must opt for active competition in its second condition them or triggering the price war. Suppose Redhat enters the market and Microsoft compete peacefully. We assume that Microsoft will have profits of 50 billion and Redhat 10 billion. If, on the other hand, Microsoft engages in a price war, we assume that both companies will lose money, Microsoft loses one billion, and Redhat 500 million. If Redhat decides not to compete, it will not earn any dollars, while Microsoft will still have an $ 80 billion in profits. Now we ask ourselves:

- Is Redhat entering the competition?
- Will Microsoft engage in a price war?

We can use a game in the form of a decision tree to simplify this complex scenario.

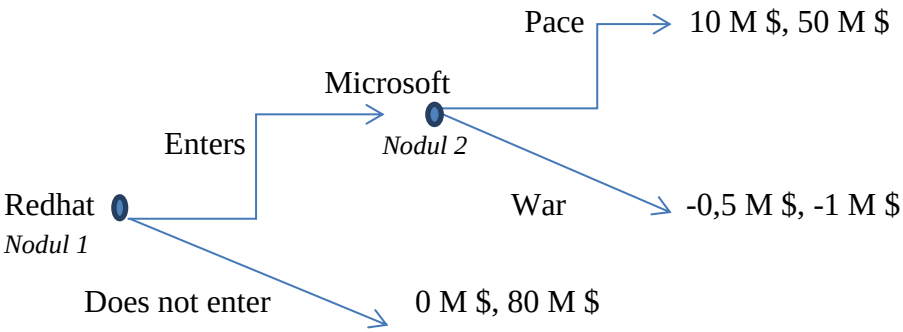

Figure 2. Sequential game

Redhat makes the first move. If Redhat decides to enter the market, Microsoft can then decide between coexistence peaceful and a price war. Through reasoning the inverse induction used in these options, we can see that Redhat will enter the market and Microsoft will choose the peaceful way.

The games in the form of the decision tree are the classic models of sequential games. The different branches of a decision tree type game indicate the various effects that might occur, given the alternative strategies that players might follow. Each node is the moment of the decision for one of the players. In this game, Redhat moves first, and Microsoft moves second, after it finds out whether Redhat entered on the market, or not.

If Redhat decides to enter, we follow the top branch of the decision tree from the first node to the second.

In the process of deciding whether to compete or not, managers of Redhat will motivate as follows: "If we compete, Microsoft may want to either be a price war or compete fairly. In the first case it would lose $ 1 billion, and in the latter, it would earn $ 50 billion. It is clear that once we compete, it will be in Microsoft's interest to compete properly, so we should get in. "

This example method returns to "going back method". "Strategic thinking" requires first to think about the end game and follow the path from beginning to end to determine the best current option. Redhat wondered what Microsoft would do if they competed. The reverse was followed from the end to the beginning to determine whether or not to compete.

Using backward is easy using the decision tree. At each node leading to the end of the game, the best strategy is determined by the player making the decision at that point. Analyzing Microsoft options at node 2, Redhat knows that if it enters the market, Microsoft will compete peacefully, allowing Redhat have a profit of 10 billion. Redhat 's other option at the first knot is not to enter, which would not yield any profit. Certainly, the best strategy of Redhat is to enter the market.

Threats

In this simple game, we can add another element, allowing Microsoft to threaten Redhat a price war, before Redhat to decide whether or not to enter the market. Microsoft can threaten a price war in the hope that this will discourage Redhat to enter the market. This threat will really have any effect on Redhat's decision? No, because Redhat could argue that, if it decides to enter the market, then the best response of Microsoft would be to compete peacefully. The threat is not credible. By this, we mean that it will not be in the interest of Microsoft to carry out his threats when it is time to do so. Nash equilibrium for this game involves Redhat's entry into the competition and two companies that compete peacefully.

Things may be different if we look at this game as a repeated game. Let's assume that Microsoft is constantly facing new competitors on its market. It may be in Microsoft's long-term interest to engage in a war of aggressive pricing against a new competitor, even if in the short run it would be lost. By doing so, Microsoft has won the reputation of a tough competitor and makes future threats more credible. A company that acts in this way sacrifices its profits in the short term, but, taking its potential remote rivals, it has more to gain in the long run. Compromise between short-term profits and long-term profits can make sense for a firm, but doing so can restrict fair competitive behavior.

Inconsistency of time

Threats and promises are common components of strategic behavior. In the previous case, the company that thinks to enter the market understands that the threat of the existing firm is not credible. Once the company enters the market, the best strategy of the existing firm is to compete peacefully. Because the potential intruder (the

competitor entering the market) can use the backward path for it, the threat initial is ineffective in preventing entry - is not credible.

Now, instead of looking at this problem from the point of view of the company that intends to enter the market, let's look at the situation of a monopoly trying to protect its market. Does it make sense to try to scare your potential rivals by threatening a price war? Such a strategy is inconsistent - When it comes to the effective re-imposition of the threat, it is not in the interest of the monopolist to do so. Because the rival potential knows exactly the consequences, he can ignore the threat. For the monopoly, the announcement of a price war is not a consistent strategy, since the company will not consider it profitable to deal with this threat.

The inconsistency of time is born in several contexts, usually in situations where the promise or threat of one of the players is designed to influence the actions of the other player.

Let's take the case of Sarah, who now graduated from high school. His parents believe that doing work in the summer would teach her that involves responsibility, so have offered to help her and will pay college fees provided to work in summer. But Sarah can tell that such a threat is inconsistent, knowing that her parents want her to get a good education, college, and knowing how lazy is, it is certain that parents will help with duties even if she does not engage in the summer. Since she prefers to work rather than work, she will not get engaged. threat her parents was not effective, because the inconsistency occurred in time. Sarah, he knew that they would not actually respond to this threat since if he did, it would not be the best strategy to follow.

Commitment

Being able to commit yourself to do a future action may be necessary for a threat or promise to be credible.

Military strategies are usually confronted with the problem of making the threats credible. During the Cold War, the US policy was to threaten that it would not dare to be the first to use nuclear weapons. This policy increased the possibility that, if the Soviet Union invades Western Europe, the US would take revenge on the Soviet Union using nuclear weapons if necessary. Such revenge would cause the Soviet Union to use nuclear weapons against the US. A Soviet military plan to use reverse may mean that if the Soviet Union invades Europe, the US could achieve a nuclear attack against the Soviet Union and cause the deaths of millions of Americans. Thus, the US threat of revenge would not be credible. An argument for keeping thousands of soldiers in Europe would be that their loss in a Soviet invasion would force the US military to confront the Soviet Union. By engaging troops in Europe, the American threat was more credible.

In the markets imperfect competition, there are a number of ways through which a firm can take concrete actions to prevent a rival from entering the market if the simple threats are not credible. This can be illustrated in the previous example with Microsoft and Redhat.

Consider a coffee company, let's call it Northwest Coffee, to open stores all over town with the aim of capturing the market. To prevent a potential rival (to call it Pete Coffee)

to open stores in the free spaces, Northwest could threaten a price war if a rival opens competing stores. The decision tree and the playing board are shown in Figure 3.

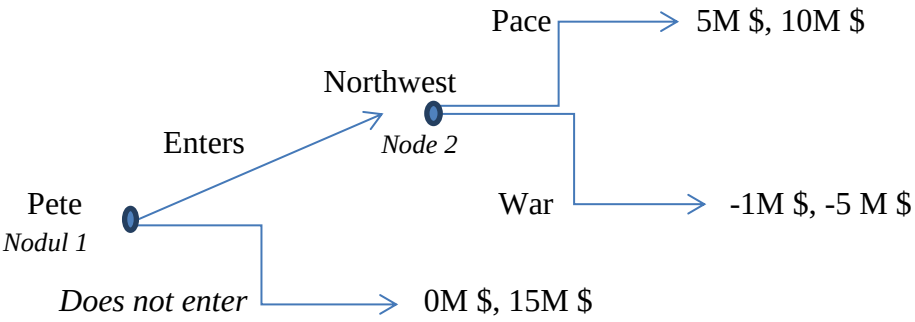

Figure 3. The game entry without commitment. Northwest behavior can threaten a price war if Pete Coffee entering the market, but such a threat will affect credibility

As in the previous example, Pete Coffee reversal technique may be used to satisfy himself that if he enters the market, Northwest will find it more profitable to compete peacefully. Any threat to the Northwest Coffee would not be credible.

Conclusions

Reverse technique is crucial for strategic behavior. Strategic thinking involves looking in the future to predict how others will behave, and then using this information to make decisions. Strategic choices are often intended to influence the choices of others. Once these choices have been made, the implementation of the initial strategy may not be the best in time. If this situation occurs, the initial strategy is inconsistent over time.

Repeated games are games that take place in several stages and the players move simultaneously. In sequential games, players move one by one instead move simultaneously. In the mixed strategy game, there is no Nash equilibrium.

References

Aumann, R.J. (2017). Game theory. In Macmillan Publishers (Ed.), *The New Palgrave Dictionary of Economics* (pp.1-40). London: Palgrave Macmillan.

Camerer, C. (1991). Does Strategy Research Need Game Theory? *Strategic Management Journal*, 12, 137-152.

Camerer, C.F. (2011). *Behavioral game theory: Experiments in strategic interaction*. Princeton, NJ: Princeton University Press.

Colman, A.M. (2013). *Game theory and its applications: In the social and biological sciences*. London: Psychology Press.

Leonard, C.M. (1969). The prefrontal cortex of the rat. I. Cortical projection of the mediodorsal nucleus. II. Efferent connections. *Brain research*, 12(2), 321-343.

Martin, B. (1978). The selective usefulness of game theory. *Social Studies of Science*, 8(1), 85-110.

McCain, R.A. (2014). *Game Theory: A Nontechnical Introduction to the Analysis of Strategy* (Third Edition). New Jersey: World Scientific Publishing Company.
Mintzburg, H. (1990). The Design School: Reconsidering the basic premises of strategic management. *Strategic Management Journal*, 11(3), 171-195.
Porter, M.E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors*. New York, NY: The Free Press.
Shubik, M. (1972). On gaming and game theory. *Management Science*, 18(5), 37-53.

Received: October 28, 2018
Accepted: December 22, 2018